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INVESTMENT DECISIONS BY EUROPEAN FIRMS AND FINANCING CONSTRAINTS

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Abstract

We reinvestigate the question of whether corporate investment during the financial crisis depended to a significant extent, and differently than in the pre-crisis period, on firms' short-term liquidity and indebtedness. Using data on listed firms in the euro area and the United Kingdom, we employ a correlated random coefficient panel data model estimated with instrumental variables in order to address potential endogeneity concerns. First, we find that to attain plausible identification, we must allow for the possibility that the unobserved firm-specific component of investment changed with the onset of the financial crisis. Second, our results suggest that neither cash reserves nor short-term debt, considered separately, were significant determinants of investment. However, we do find evidence of a negative conditional dependence between corporate investment and short-term debt net of cash reserves.

JEL Classification: G01, G31, G32.
Keywords: capital expenditure, financing constraints, financial crisis, correlated random coefficient, panel data models, instrumental variables.

Contents

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1 INTRODUCTION

During the financial and sovereign debt crises investment in Europe declined markedly and has recovered only marginally since then. In the euro area, gross fixed capital formation decreased by 16 per cent in real terms between 2007 and 2012, a sizeable drop both in a historical perspective and compared to other advanced economies.

Existing studies examining the decrease in investment during the financial crisis employing firm-level US data largely focus on the degree to which the fall can be attributed to financial factors, and reach rather different conclusions. On the one hand, Duchin, Ozbas and Sensoy (2010) and Almeida et al. (2011), among others, present evidence showing that firms' short-term liquidity and indebtedness significantly influenced their capital expenditures during the crisis. On the other hand, Kahle and Stulz (2013) find no stark differences between the capital expenditures of similar firms with different degrees of leverage or different cash holdings.

These recent studies build on the extensive empirical literature analysing the relationship between corporate investment, firms' financial resources and financing constraints (see Hubbard, 1998, for an extensive survey). The theoretical framework underlying this empirical literature is based on models of investment with financing frictions (see, among others, Jaffee and Russell, 1976; Stiglitz and Weiss, 1981; Holmström and Tirole, 1997), which feature the relevance of financial factors upon corporate investment owing to the existence of capital market imperfections. According to these models of investment behaviour, negative shocks to the supply of external finance might hinder investment in cases where firms lack sufficient financial slack to fund any profitable investment opportunities internally. Moreover, this theory suggests that such effects could be particularly severe for firms which are particularly financially constrained, or dependent upon external finance.

Our work is related to the above-mentioned empirical studies, which deal with the relationship between financial factors and investment decisions. In particular, we reinvestigate the role of financial resources in corporate investment decisions before and during the financial crisis, working with data on listed firms in the euro area as well as in the United Kingdom. In addition, we examine whether the relationship between investment and firms' financial positions changed when the financial crisis turned into a sovereign debt crisis. More specifically, we evaluate whether firms with different financial positions displayed different investment intensities prior to and during the financial crisis.

We employ a panel data approach in which we study the investment of firms both before and after the onset of the crisis, as a function of their financial resources: cash reserves and short-term debt, defined as debt maturing within one year. We control for unobserved individual heterogeneity and

for observed investment opportunities, proxied by Tobin's Q. Our econometric specification belongs to the family of correlated random coefficient panel data models (Wooldridge, 2005; Murtazashvili and Wooldridge, 2008) and allows unobserved heterogeneity at the firm level to interact with a crisis indicator. Due to this latter feature, the effect of unobserved firm-specific characteristics on investment is allowed to change as we move from the pre-crisis to the crisis period.

Given that firms' financial positions may be correlated with unobserved changes in their investment opportunities, not measured by Tobins Q and thus captured by the error term, our regressors of interest are possibly endogenous. In order to take the consequent identification issues into account, we adopt the methodology of instrumental variables in the context of correlated random coefficient models (Murtazashvili and Wooldridge, 2008) to estimate the sensitivity of investment to cash reserves and short-term debt prior to and after the outbreak of the crisis. More specifically, we instrument the endogenous variables with lagged values of the financial variables of our interest. The number of lags is carefully selected in order to ensure that instruments are strongly correlated with the endogenous regressors and at the same time uncorrelated with unobserved investment opportunities captured by the error term. To attain this goal, we employ numbers of lags such that all values of the selected instruments pre-date the sample period under analysis. In this way, we expect to remove the confounding effect produced by the non-zero correlation between changes in a firms financial position and unobserved variation in its investment opportunities.

To preview the results, we find that neither cash reserves nor short-term debt, considered separately, were significant determinants of investment over our sample period. Moreover, no evidence emerges to suggest that the effects of these two variables changed with the onset of the financial crisis. However, our results indicate that investment depended negatively on short-term debt net of cash – a measure of net short-term indebtedness – during the financial crisis, while there was no such conditional dependence either in the pre-crisis period or during the sovereign debt crisis.

The rest of the paper proceeds as follows: Section 2 reviews the literature. Section 3 describes how the dataset has been constructed and provides some descriptive statistics. Section 4 states our main research question and presents some preliminary evidence based on sample averages. Section 5 details the empirical strategy as well as presenting the econometric results. Section 6 concludes and discusses future research directions.

2 RELATED LITERATURE

The impact of financial factors on the investment decisions of firms is a largely debated topic in the economic and corporate finance literature. In this section, we briefly review the most important

developments in this research area and its main testable implications.

The traditional neoclassical theory (Jorgenson, 1963) is based on the assumption that, in a context of perfectly competitive markets, the firm is able to adjust its actual capital stock to the desired (optimal) stock, instantaneously and without additional costs. The optimal stock corresponds to the level of capital for which the marginal product of capital equals its user cost. Under standard technology assumptions, the optimal capital stock depends on output and on the real user cost of capital. Capital stock adjusts to its optimal level through investment. In the special case of constant factor prices, the desired capital stock is proportional to output. As a result, output fluctuations have a key role in explaining investment dynamics ("accelerator theory"); see the critical review offered by Chirinko (1993).

Neoclassical investment models also assume perfect information in capital markets, in line with the influential work of Modigliani and Miller (1958). In a framework of competitive and frictionless capital markets, with agents having access to the same information set, the Modigliani-Miller theorem states that debt versus equity financing has no impact on the total market value of the firm. An implication of this result is that corporate financial policy is irrelevant for investment decisions.

However, in a framework in which capital markets are imperfect and financial frictions are present, the financial structure of a firm becomes relevant for corporate investment. In particular, under asymmetric information between borrowers and lenders, the cost of external finance is higher than that of internal finance due to the existence of an "external finance premium" (Bernanke and Gertler, 1989): this premium arises in a set-up in which lenders incur a cost in order to monitor entrepreneur's performance. When informational asymmetries exist and state verification is costly (Townsend, 1979), a "financial accelerator" model points to credit conditions propagating and amplifying exogenous shocks to the real economy (Bernanke, Gertler and Gilchrist, 1999).[1]

An adverse selection problem related to informational asymmetries between managers and investors is also the underpinning of the pecking-order theory developed by Myers and Majluf (1984). In the Myers and Majluf model internal funds have a cost advantage over external financing, leading

[1]The key mechanism involves a link between the external finance premium and the net worth of potential borrowers, whose intensity varies with the state of the economy. As explained by Bernanke, Gertler and Gilchrist (1999), in the presence of credit-market frictions and with credit demand held constant, standard models of lending with asymmetric information imply that the external finance premium depends inversely on borrowers' net worth. When borrowers have little wealth for investment, the potential divergence of interests between the borrower and the suppliers of external funds is greater, implying increased agency costs. Hence, in equilibrium, lenders must be compensated for higher agency costs by a larger premium. To the extent that borrowers' net worth is procyclical (because of the procyclicality of profits and asset prices, for example), the external finance premium is countercyclical, amplifying the swings in borrowing and thus in investment and economic activity more in general.

to a financing hierarchy in which firms prefer internally generated funds to debt, lastly raising equity, to finance their investments. As a consequence, capital structure is determined by a financing hierarchy – or a "pecking order" – for the issuance of debt and new capital. The main empirical prediction is that firms with higher cash holdings tend to invest more, while firms with higher debt burdens invest less.

A competing explanation of why liquidity affects investment is provided by a different strand of literature which highlights the existing agency problems between corporate managers and outside shareholders (see, e.g., the "free-cash-flow theory" developed by Jensen, 1986). Managers have the incentive to increase the size of their company ("empire building" tendency) by over-investing free cash flows in unproductive projects, given that their compensation is usually linked with the growth in sales. In such a framework, agency problems affect corporate investment, which decreases with the debt level and increases beyond the optimal level when free cash flow gets larger (Stein, 2003, discusses many of these issues).

In the empirical literature, departing from the neoclassical tradition, a large literature has examined the validity of these theoretical predictions and, more in general, the existence of financing constraints arising from informational asymmetries and agency problems (see Hubbard, 1998, for a survey). Most of this literature has relied on firm-level data and reduced-form investment models featuring costly external finance. In a seminal paper, Fazzari, Hubbard and Petersen (1988) provide evidence that financing constraints exert a significant impact on investment through the effect they have on the cost of raising external finance. Specifically, these authors document that investment decisions of financially constrained firms are more sensitive to fluctuations in internal funds (i.e., cash flow and liquidity) than those of less constrained companies, even after controlling for investment opportunities. In particular, the investment-cash flow sensitivity is measured by the coefficient which obtains regressing investment on cash flow, conditioning on Tobin's Q.[2] Differences in the estimates of the investment-cash flow sensitivity across subsamples of firms are consistent with the existence of a wedge between the costs of external and internal funds. Hadlock (1998) extends the analysis of Fazzari, Hubbard and Petersen (1988) to take into account agency problems and ownership structure. He uses managers' ownership stake in order to gauge the alignment of interests between managers and shareholders. Hadlock (1998) finds that the investment-cash flow sensitivity is related in a non-linear fashion to insider shareholdings: as insider holdings increase, the sensitivity rises; then, after holdings reach a certain level, it stops increasing in ownership and eventually starts decreasing. According to Hadlock, this evidence corroborates an asymmetric-information in-

[2]This conditioning is motivated by the fact that in a standard model of a perfectly competitive firm investment is a function of Tobin's Q, adjusted for relative prices of investment goods and tax rates, only (see e.g. Blundell et al., 1992).

terpretation of the wedge between internal and external funds, while it seems to be inconsistent with the "free-cash-flow" explanation of the relationship between liquidity and investment.

In contrast, Kaplan and Zingales (1997) come to different conclusions than Fazzari, Hubbard and Petersen (1988). Specifically, these authors find that less financially constrained firms may possess a higher sensitivity of investment to the availability of internal funds than more financially constrained companies. This is argued to arise from investment-cash flow sensitivity not being monotonic in the degree of financing constraints (see also Kaplan and Zingales, 2000). Consequently, they conclude that the sensitivity of investment to cash flow is not a reliable empirical measure of the severity of financing constraints. Interestingly, Bond and Söderbom (2013) show that the investment-cash flow sensitivity – conditional on marginal Tobin's Q, which is meant to control for fundamentals – increases monotonically with the cost premium for external finance, downplaying the findings of Kaplan and Zingales (1997).

Besides Kaplan and Zingales (1997), other studies have questioned the results achieved by Fazzari, Hubbard and Petersen (1988). Poterba (1988) is the first to challenge their findings, stressing that cash flow may appear to be associated with investment because of measurement errors in average Tobin's Q, which is an imperfect proxy for marginal Q.[3] The same argument is further developed by Erickson and Whited (2000): using generalized method of moments estimators in a Q-investment model, these authors find that estimates of the investment-cash flow sensitivity are statistically insignificant both for liquidity-constrained and liquidity-unconstrained firms. They also maintain that most of the findings based on investment-cash flow regressions are affected by the presence of errors in measuring Tobin's marginal Q, which potentially leads to inconsistent estimates of the cash flow coefficient. The described estimation problem is further examined by Erickson and Whited (2002, 2012). The bottom line is that measurement errors, rather than financing constraints, seem to induce the observed relationship between investment and cash flow. As suggested by Chang et al. (2014), an alternative way to deal with the measurement error problem is to extract – via the Beveridge-Nelson (1981) decomposition – the transitory component of cash flow, which does not contain information about future growth opportunities, and therefore is not likely to correlate with the error term when growth opportunities are inadequately controlled for. In this way, according to Chang et al. (2014), the coefficient on the transitory component of cash-flow can be consistently estimated and meaningfully interpreted.

Another interesting interpretation of Fazzari, Hubbard and Petersen's findings is provided by Moyen (2004), who points out that results on the investment-cash flow sensitivity depend crucially

[3]The exact relationship between marginal and average Tobin's Q is derived by Hayashi (1982).

on the criterion employed to identify whether a firms is financially constrained or not. In her paper, Moyen (2004) presents an unconstrained model, in which firms can raise external finance, and a constrained model, in which firms cannot do so. Then, a sample is simulated from both models. Firms are classified as financially constrained or unconstrained on the basis of five different a priori criteria. On the one hand, if dividends or cash flow are used as a proxy of financing constraints, results consistent with those of Fazzari, Hubbard and Petersen are produced; on the other hand, if the constrained model is used to identify firms with financing constraints Kaplan and Zingales's result obtains.

The pattern of investment-cash flow sensitivity has been also analysed from a time series perspective by Chen and Chen (2012): these authors study the evolution of investment-cash flow sensitivity over time for U.S. firms and find that this relationship has become weaker over the past 40 years, disappearing almost completely even during the global financial crisis.[4] However, there exists considerable empirical evidence suggesting that U.S. firms have experienced a severe credit crunch during the crisis; as a result, according to Chen and Chen (2012), the investment-cash flow sensitivity does not seem to provide a consistent and accurate measure of financing constraints.

More recently, motivated in part by the global financial crisis, new interest in the impact of financial frictions on investment has arisen, given that in recessions financial market imperfections may strengthen constraints firms face. Among the most prominent contributions, Almeida and Campello (2007) examine the relationship between cash flow and asset tangibility of a firm. These authors find that the investment-cash flow sensitivity increases with tangibility of firms' assets, but only if firms are financially constrained. On the contrary, no significant impact is detected for unconstrained firms. Duchin, Ozbas and Sensoy (2010) analyse how frictions affect investment fluctuations gauging the sensitivity of firms' capital expenditures to their pre-crisis cash holdings and short-term debt. They document that the decline in investment following the outset of the financial crisis was more pronounced for firms which had low cash reserves or high short-term debt, and argue that due to financing constraints these firms were more severely affected by the credit supply shock which realised. Similarly, Campello, Graham, and Harvey (2010) present evidence showing that the impact of the credit shock in the U.S. was particularly severe on financially constrained firms, which cut their capital spending more than unconstrained ones. Likewise, working with a panel of 1,200 Italian firms, Gaiotti (2013) finds that reduced credit availability played a non-negligible role in contributing to the Great Recession in 2008–2009.

In a paper related to Duchin, Ozbas and Sensoy (2010), Almeida et al. (2011) conclude that U.S.

[4] A similar finding is documented at the global level by Moshirian et al. (2017), who examine firm-level data across 41 countries during the 1993–2013 period.

firms whose long-term debt was largely maturing during the global financial crisis were not able to roll it over during the global financial crisis, suffered from a liquidity shortage and cut their investment more than otherwise similar firms whose debt was scheduled to mature after the crisis. Firms with access to pre-agreed credit lines with their banks could draw on these lines and avoid liquidity problems (Campello et al., 2012). Firms without such access faced a trade-off between savings and investment (Campello et al., 2011). Different conclusions are reached by Kahle and Stulz (2013), who compare the investment of cash-rich and highly levered firms to that of firms which are similar along characteristics other than cash reserves and indebtedness, respectively. Contrary to previous studies, these authors find no evidence of highly levered firms having cut their investment more during the crisis and only weak evidence of cash-rich firms having invested more than their respective control group.

The effect produced by financing frictions on firm investment dynamics has clearly sparked much debate in the theoretical and empirical literature. From the above survey it is clear that some issues are still unresolved and controversial, such as, for instance, the influence exerted by leverage and by internal funds upon capital expenditure, and how the association among these variables has changed with the outbreak of the crisis. This motivates our interest in deepening the analysis on the links between financial frictions and investment decisions during the recent global financial crisis which, as stressed by Duchin, Ozbas and Sensoy (2010, p. 418), represents a "negative shock to the supply of external finance for non-financial firms".

In the next section we present the dataset used to conduct our research, which contains data on corporate investment and investment financing at the EU level. Then, we propose our hypotheses (Section 4), introduce the model specification and discuss the econometric results (Section 5).

3 DATA OVERVIEW

3.1 Data description

We employ quarterly, firm-level data from the Standard and Poor's Capital IQ database. Our main sample, for which we obtain data on all of our variables of interest, covers the period 2006:Q3–2012:Q2. In addition, we extract data on cash reserves, short-term debt and total assets from 1999:Q1 to 2006:Q2, allowing us to instrument these variables with their lagged values. We include in the sample all listed corporations in the euro area as well as in the United Kingdom other than utilities and financial firms, with Standard Industrial Classification (SIC) codes in the intervals 4900–4949 and 6000–6999, respectively. We exclude the latter as in many cases they are subject to

heavy regulation.

For each firm and for each quarter over the period 2006:Q3–2012:Q2, we obtain, whenever reported, their capital expenditures, total assets, short-term debt, common equity, deferred tax liabilities, cash reserves and market capitalization. From these raw data, we construct the following variables, which will be used in the econometric analysis (Standard and Poor's Capital IQ item names in parentheses):

- investment = capital expenditures (CAPEX) / total assets (TOTAL_ASSETS);
- cash reserves = cash and short-term investments (CASH_ST_INVEST) / total assets (TOTAL_ASSETS);
- short-term debt = debt in current liabilities (TOTAL_DEBT_CURRENT) / total assets (TOTAL_ASSETS);
- net short-term debt = (debt in current liabilities (TOTAL_DEBT_CURRENT) - cash and short-term investments (CASH_ST_INVEST)) / total assets (TOTAL_ASSETS);
- Tobin's Q = market value of assets / (0.9 total assets (TOTAL_ASSETS) + 0.1 market value of assets),

where market value of assets = total assets (TOTAL_ASSETS) + market value of common equity (MARKETCAP) - common equity (TOTAL_COMMON_EQUITY) - deferred tax liabilities (DEF_TAX_LIAB_LT).

All variables are defined as in Duchin, Ozbas and Sensoy (2010) to make our results comparable to theirs. As is usual in the literature, we measure corporate investment by employing the capital expenditures item of the income statement (over total assets), which records expenditures incurred by the company for the acquisition of or upgrade of physical assets such as property, industrial buildings or equipment. Short-term debt is made up of debt liabilities maturing within a year, while those maturing beyond one year are referred to as long-term debt (both are scaled by total assets). Turning to liquidity, cash reserves to total assets is a ratio that measures the portion of a company assets held in cash or marketable securities to cover payable accounts, short-term debt, and other liabilities. Net short-term debt over total assets is defined as the ratio of short-term debt minus cash to total assets and represents a measure of net short-term indebtedness.

Another important variable, which will be employed in the subsequent econometric analysis, is the average Tobin's Q, defined as the market value of assets divided by the book value of assets (replacement cost of physical assets). Indeed, according to the Q-theory of investment based upon

the work of Tobin (1969), investment is stimulated when the market's valuation of capital exceeds the cost of its production or, in other words, when market returns on equity are low relative to the real returns on investment in physical assets. In order to calculate Tobin's Q, we use the market capitalization, which is given by the product of stock price and number of shares outstanding. As in Kaplan and Zingales (1997), we employ market capitalization at the beginning of the quarter in which book values are reported.

3.2 Descriptive statistics

Table 1 reports summary statistics for the variables under consideration. These statistics refer to the firm-quarter observations, i.e., they are computed across firms and over quarters. Before calculating them, the data have been adjusted as follows. Firms (882) with a market capitalization of less than 40 million euros as of June 30, 2006 have been excluded. In addition, firms (64) with a quarterly sales or asset growth greater than 100% at any point during our sample period have been dropped. These adjustments ensure that the smallest firms with volatile accounting data as well as firms which merged or underwent restructuring during our sample period have been eliminated. Finally, all variables other than Tobin's Q have been winsorized at the 1st and the 99th percentile, in order to mitigate the influence of outliers. Tobin's Q is calculated as in Baker, Stein and Wurgler (2003) and is by construction bounded above at 10. As a result of these adjustments, 946 companies have been excluded. Therefore, the final sample consists of 3252 listed firms. Table 2 shows the distribution of listed firms by country.

The average quarterly capital expenditures in our sample is 1.1% of total assets. Cash reserves and other liquid assets account for an average of 14% of total assets, and show considerable variation among firms. Short-term debt, on the other hand, is equal to 8% of total assets. Average net short-term debt over total assets is negative and equal to -3%. Firms are rather heterogeneous in size, as evidenced by the high standard deviation of their market capitalization.

We also examine the dynamics of the variables through time. We focus on capital expenditures over total assets, cash reserves over total assets, short-term debt over total assets, net short-term debt over total assets and Tobin's Q. In order to provide a synthetic representation of the main trends along the time series dimension, we calculate cross-sectional averages of firm-level data over the period 2006:Q3–2012:Q2. Figure 1 illustrates the cross-sectional averages of capital expenditures and Tobin's Q. Figure 2 refers to cash holdings (reserves) and short-term debt, while Figure 3 pertains to net short-term debt.

Investment declines pronouncedly between the end of 2008 and the first quarter of 2010, with a

moderate increase thereafter. A similar pattern may be observed for Tobin's Q, even though its fall, which started in 2007:Q4, precedes the decrease in capital expenditures. Similarly, cash reserves decline markedly from 2007:Q4 to 2008:Q3, probably as a result of the financial turbulence in that period. In 2010:Q4 cash reserves increase to the pre-crisis level, before falling again considerably with the onset of the sovereign debt crisis. This pattern lends support to the view that, after the outbreak of the financial crisis, companies hoarded cash as a response to increased uncertainty and downside risks related to future economic prospects. Short-term debt follows a different pattern. In particular, it increases constantly from 7.5% of total assets in 2007:Q3 to 9.5% in 2008:Q4. Then, it declines to less than 8% in 2010:Q4, evidencing a deleveraging process, before rising again after the outbreak of the sovereign debt crisis. Net short-term debt, which is given by the difference between short-term debt and cash holdings, also increases from -4% of total assets in 2007:Q4 to -1.8% in 2009:Q2, driven by a decline in cash reserves and a contemporaneous rise in short-term debt. Then, in 2010:Q4, net short-term debt reverts to its level in 2007:Q1, due to the aforementioned deleveraging of the private sector and to a rise in cash holdings. In 2011 and 2012 it increases again steadily, mainly owing to an upward trend in short-term debt, reaching a level of -0.020 in 2012:Q2, the last data point in the sample.

4 RESEARCH HYPOTHESIS AND PRELIMINARY EVIDENCE

As discussed in Section 2, a strand of investment literature argues that financial constraints exert a significant impact on investment (Fazzari, Hubbard, and Petersen, 1988, among others). In a more recent work, Duchin, Ozbas and Sensoy (2010) examine how the financial crisis affected corporate investment. Working with a panel of US firms, they find that the decrease in capital expenditures during the first year of the financial crisis was greatest for firms with low cash reserves or with high short-term debt. This is the hypothesis we are going to test in the sequel.

Following Duchin, Ozbas and Sensoy (2010), we begin by examining average corporate investment before and after the financial crisis. In order to investigate whether firms with different initial financial positions altered their investment to different degrees, we group firms in terciles based on their average cash reserves, short-term debt and net short-term debt in 2006:Q2, before the sample period under consideration. Table 3 shows average investment in the period 2006:Q3–2008:Q2 ("Before crisis") and in 2008:Q3–2010:Q2 ("Financial crisis"). In order to examine separately the impact of the sovereign debt crisis, average investment is also calculated for the period 2010:Q3–2012:Q2 ("Sovereign debt crisis").

In panel A, firms are sorted based on their cash reserves, in panel B based on short-term debt

and in panel C based on net short-term debt. All the values reported in Table 3 correspond to sample averages across firms and over time. Mean comparison test results are also reported.

Focusing on the first two columns in panel A, we note that investment fell considerably for firms in the first cash reserves tercile (-0.43 percentage points of total assets), while firms in the second (medium cash reserves) and third (high cash reserves) terciles recorded more modest declines (-0.33 and -0.29 percentage points, respectively). All these variations are significantly different from zero at conventional levels. On the other hand, average investment during the sovereign debt crisis remained essentially unchanged from that during the financial crisis, with no discernible differences between firms with low, medium and high cash reserves.

A comparable picture emerges from an inspection of panels B and C: in each tercile, investment was lower during the financial crisis than in the pre-crisis period. What is more, the pre-crisis and crisis means are statistically different from each other in each tercile. Furthermore, firms in the third tercile (high short-term debt and high net short-term debt) recorded the steepest investment decline, while the negative variations in capital expenditures among all the other firms were less pronounced. Again, also in panels B and C, average investment was broadly constant across the financial crisis and the sovereign debt crisis. This is confirmed by the t-statistics in the last column, indicating no statistically significant differences in the means.

This evidence, based on simple sample averages, appears consistent with the conclusion in Duchin, Ozbas and Sensoy (2010), namely that the negative credit supply shock due to the financial crisis affected more severely firms that had low cash reserves or high short-term debt. In what follows, we investigate whether this preliminary finding obtains also when applying more formal econometric methods.

5 EMPIRICAL ANALYSIS: MODEL SPECIFICATION AND ECONOMETRIC RESULTS

In this section, we test the dependence between the financial positions of firms and their investment both before and during the financial crisis, focusing on a panel of firms in the euro area and in the United Kingdom. The analysis is conducted controlling for unobserved firms heterogeneity and observable measures of investment opportunities, namely Tobin's Q. We take also into account potential endogeneity concerns.

Our empirical specification is inspired by theoretical frameworks that feature both fundamentals and financial variables as determinants of investment (see Stein, 2003, for a comprehensive review).

Almeida and Campello (2007) develop a simple model that well captures the key relationships that our empirical specification can shed light on. Namely, in their model with limited pledgeability, fundamentals determine the first-best level of investment, which however may be beyond the reach of the firm due to a binding credit constraint. Whether this constraint binds or not depends on the availability of internal funds available for investment. Given that existing debt reduces the expected value of the firm in liquidation to accruing to new creditors, it can be more difficult for a firm with a high level of debt to raise external funds. For this reason, we investigate not only cash reserves but also debt as potential determinants of investment.

The rest of this section is structured as follows: in Section 5.1 we set up the panel approach and we describe the econometric specification, which is a correlated random coefficient model (Wooldridge, 2005; Murtazashvili and Wooldridge, 2008). In Section 5.2 we describe the pre-crisis and two crises subsamples. In Section 5.3 we present results on the dependence between investment and financial resources of firms before and during the financial crisis. In Section 5.4, the same analysis is carried out working with a longer crisis sample, which includes the sovereign debt crisis. In Section 5.5, we study the sensitivity of our results to different definitions of the financial crisis subsample. In Section 5.6, we examine the robustness of our findings to the exclusion from the sample of the most financially vulnerable countries, which we expect to have been most affected by the financial crisis. In addition, we perform estimation by considering only firms in the construction, manufacturing, transportation, communications sectors and assess how results change when the sample composition is altered in this way. Finally, we focus on a subsample of companies that are not state owned. In Section 5.7 we estimate a model specification which includes both cash and short-term debt as explanatory variables. Lastly, in Section 5.8, we compare our results with those obtained in the most closely related empirical literature.

5.1 Model specification

We wish to examine the sensitivity of firms' corporate investment to their financial positions before and after the outbreak of the crisis. To this aim, we exploit the longitudinal structure of the data: firms are observed over time so that a panel model can be coherently adopted to account, other than for the observed regressors, also for the plausible unobserved heterogeneity of firms' time-averaged investment levels. In particular, the aim to investigate whether firms' investment behaviour changed after the outbreak of the crisis has led us to adopt a particular specification belonging to the family of correlated random coefficient (CRC) models (Wooldridge, 2005; Murtazashvili and Wooldridge, 2008). This model allows us to study the functional relationship between investment and observed

as well as unobserved components, and at the same time to account for firm-specific coefficients that can change in different periods. This way, we let each coefficient of the model to vary across firms and also between two periods, before and after the outbreak of the crisis. The resulting CRC panel model is specified as follows:

$$\begin{aligned} &investment_{it} = c_i + \delta_i d_t + \beta_{1i}^f f_{it} + \beta_{2i}^f f_{it} d_t + \beta_{1i}^q q_{it} + \beta_{2i}^q q_{it} d_t + u_{it}, \\ &i = 1, 2, \ldots, N; \;\; t = 1, 2, \ldots, T \end{aligned} \tag{1}$$

where f_{it} is the financial variable of our interest (cash reserves, short-term debt or net short-term debt) for firm i at time t, d_t is an indicator variable equal to 1 during the crisis period and 0 otherwise, q_{it} is our control variable (Tobin's Q), while the terms c_i and δ_i capture unobserved heterogeneity at the firm level. Note that due to the presence of the interaction terms containing d_t the relationship between investment and both the observed regressors and the unobserved heterogeneity is allowed to change when entering the crisis period. Moreover, the conditional dependence between investment and the observed explanatory variables can differ across firms as the coefficients β_{hi}^k ($h = 1, 2$, $i = 1, 2, \ldots, N$ and $k = f, q$) are firm-specific.

The reason why we allow for a change in firm-specific investment levels, represented by the $\delta_i d_t$ term, is threefold. First, this feature in combination with the other interaction terms containing d_t ensures that all the parameters, including the intercept, of the affine function representing the conditional mean of investment can change when entering the crisis period. Second, omitting the interaction term $\delta_i d_t$ could bias the point estimates of the coefficients on the other interaction terms β_{2i}^k. In particular, if the financial variable of interest f_{it} were correlated with the change in the firm-specific component of investment δ_i, one would obtain a biased estimate of β_{2i}^f. Third, in comparison to an alternative analysis based on two separate equations, one for the non-crisis and the other for the crisis period, our proposed model with the interaction terms has the advantage that we can directly test for coefficient stability between the two sample periods.

The coefficients we are mainly interested in are β_{1i}^f and β_{2i}^f, the former capturing the influence of the financial variable f_{it} on investment during the non-crisis period and the latter the differential impact of f_{it} on investment during the crisis period. Another object of our interest is the sum of coefficients $\beta_{1i}^f + \beta_{2i}^f$, which represents the impact of the financial variable f_{it} on investment during the crisis period.

A consistent estimation of the coefficients is complicated by the potential correlation between the financial variable f_{it} and within-firm changes in unobserved investment opportunities, i.e., the idiosyncratic error term u_{it}. For instance, in the case of f_{it} being cash reserves, such correlation may arise due to firms accumulating cash in anticipation of future investment opportunities (Almeida,

Campello and Weisbach, 2004; Baum, Caglayan and Talavera, 2013). Or, alternatively, firms lacking investment opportunities may accumulate cash. That is, future (or contemporaneous) values of u_{it} may be correlated with f_{it}, implying that the strict exogeneity assumption guaranteeing the consistency of the fixed effects estimator is violated.

To address these endogeneity concerns, we employ an instrumental variables (IV) type estimator. More specifically, we make use of the results in Murtazashvili and Wooldridge (2008), in which assumptions sufficient for the consistency of the FE-IV (two-stage least squares, 2SLS) estimator for the population averaged coefficients, i.e., $\mathbb{E}[\boldsymbol{\beta}_i]$, are formulated. These authors show that, after the data have been transformed in such a way that the unobserved heterogeneity is eliminated (by applying the within-transformation), the FE-IV estimator is consistent for $\mathbb{E}[\boldsymbol{\beta}_i]$ provided that a full set of time period dummies is included on the right hand side of the equation after the transformation has been applied, and the following conditions are satisfied:

$$\mathbb{E}[u_{it}|\boldsymbol{z}_{i,1}, \boldsymbol{z}_{i,2}, \ldots, \boldsymbol{z}_{iT}] = 0, \;\; t = 1, 2, \ldots, T \tag{2}$$

$$\mathbb{E}[\boldsymbol{\beta}_i|\ddot{\boldsymbol{z}}_{it}] = \mathbb{E}[\boldsymbol{\beta}_i], \;\; t = 1, 2, \ldots, T \tag{3}$$

$$Cov(\ddot{x}_{itj}, \beta_{ij}|\ddot{\boldsymbol{z}}_{it}) = Cov(\ddot{x}_{itj}, \beta_{ij}), \;\; j = 1, 2, \ldots, K; \;\; t = 1, 2, \ldots, T \tag{4}$$

$$rank(\sum_{t=1}^{T} \mathbb{E}(\ddot{\boldsymbol{z}}'_{it}\ddot{\boldsymbol{x}}_{it})) = K, \tag{5}$$

$$rank(\sum_{t=1}^{T} \mathbb{E}(\ddot{\boldsymbol{z}}'_{it}\ddot{\boldsymbol{z}}_{it})) = K, \tag{6}$$

where $\ddot{\boldsymbol{z}}_{it}$ denotes the K-element vector of instrumental variables, $\ddot{\boldsymbol{x}}_{it}$ the K-element vector of covariates, both transformed to eliminate the unobserved heterogeneity. In the specification in (1), $\boldsymbol{x}_{it} = (f_{it}, f_{it}d_t, q_{it}, q_{it}d_t)'$ and $\boldsymbol{\beta}_i = (\beta_{1i}^f, \beta_{2i}^f, \beta_{1i}^q, \beta_{2i}^q)'$.

In our case, in order to eliminate the *compound unobserved heterogeneity* (represented by the term $c_i + \delta_i d_t$), the standard within-transformation is applied separately in the non-crisis and the crisis sample period to the dependent variable, the control, the endogenous explanatory variables and their instruments (i.e., $investment_{i,t}$, $q_{i,t}$, $f_{i,t}$ and $z_{i,t}$). For this reason, our procedure is akin to applying the standard fixed effects estimator to equation (1) without the interaction terms, separately for the non-crisis and the crisis periods.

As to the instrumental variables employed, we consider lagged values of the endogenous financial variables. The choice of the instruments is governed by two requirements. First, the instruments should be strongly correlated with the endogenous regressors. To satisfy this requirement the financial variables employed as instruments and the number of lags are chosen to obtain significant first-stage estimates. For this reason, we sometimes use the lagged values of another financial variable

(e.g. cash) as an instrument for the financial variable under study (e.g. short-term debt).[5] Second, the instruments should be expected to satisfy the strict exogeneity condition, i.e., equation (2) above. To achieve this requirement, we select the number of lags such that all values of the instruments pre-date the sample period under analysis by a considerable margin. Consequently, even though the financial variables we consider are potentially forward-looking in nature, we do not expect the instruments to be correlated with the idiosyncratic error terms. Furthermore, to formally evaluate whether our instruments satisfy the strict exogeneity assumption, we employ the test proposed in Wooldridge (2010).

Throughout the analysis, we employ just-identified 2SLS models for two reasons. First, just-identified 2SLS estimates are median-unbiased whereas those obtained using overidentified 2SLS are biased towards the OLS estimates (Angrist and Pischke, 2009a, p. 209; Angrist and Pischke, 2009b). Second, as the instruments we utilise are strongly correlated with the endogenous regressors, there is no strong case to be made for using overidentified models.

Regarding the second condition required for the consistency of the FE-IV estimator stated in equation (3), we presume that it is satisfied as $\boldsymbol{\beta}_i$ is allowed to be arbitrarily correlated with the systematic components of $\boldsymbol{z}_{it}$. Moreover, given that our instruments predate the sample period, we do not expect there to be any correlation between the within-firm variations in our instruments and the random coefficients $\boldsymbol{\beta}_i$. Condition (4) is relatively weak as it merely involves the covariance between the within-firm variations in $(f_{it}, q_{it})'$ and the random coefficients $(\beta_{hi}^f, \beta_{hi}^q)'$, respectively, not to depend on the within-firm variations in the instrumental variables. The full rank condition (5) requires that after netting out the unobserved heterogeneity there is still sufficient correlation between the instruments and the covariates. Finally, condition (6) is very weak in that it requires only sufficient variation in the transformed instruments.

In addition to the specification in (1), we consider the following alternative CRC model:

$$\begin{aligned} &investment_{it} = c_i + \beta_{1i}^f f_{it} + \beta_{2i}^f f_{it} d_t + \beta_{1i}^q q_{it} + \beta_{2i}^q q_{it} d_t + u_{it} \\ &i = 1, 2, \ldots, N; \;\; t = 1, 2, \ldots, T. \end{aligned} \tag{7}$$

This is a simpler version of specification (1), featuring c_i without the $\delta_i d_t$ term. That is, the unobserved firm-specific component of investment is restricted to be the same in the non-crisis and the crisis period. We estimate this specification employing the fixed effects estimator, both without and with instrumental variables. In the former case, we obtain our estimates by applying results

[5] To ensure that our results are not artefacts of such choices, we also investigate the influence of each financial variable using the lagged values of the same variable as its instrument. These results are presented at the end of the paper in Tables 35–36.

in Wooldridge (2005), whereas in the latter case we can again apply the findings in Murtazashvili and Wooldridge (2008). Differently from when employing instrumental variables, estimating the coefficients in equation (7) under the assumption that all the covariates are strictly exogenous does not require including time dummies after the within transformation, and it only requires the mild condition $\mathbb{E}[\boldsymbol{\beta}_i|\ddot{\boldsymbol{x}}_{it}] = \mathbb{E}[\boldsymbol{\beta}_i], \;\; t = 1, 2, \ldots, T$.

To differentiate between (1) and (7), we call specification (7) a correlated random coefficient (CRC) model and specification (1) a CRC model with compound unobserved heterogeneity (CRC-CUH). The three estimators (CRC, CRC-IV, CRC-IV-CUH) enable us to evaluate the importance of both instrumenting our explanatory variables of interest and allowing unobserved heterogeneity at the firm level to change when entering the crisis period.

5.2 The pre-crisis and crisis samples

In order to study the sensitivity of investment to financial resources before and during the financial crisis, we split the whole sample (2006:Q3–2012:Q2) into a pre-crisis and a crisis subsample. What is more, we partition the crisis period into a financial crisis and a sovereign debt crisis subsample.

A natural candidate indicator to date the beginning of the financial crisis is the three-month Euribor-OIS spread (Figure 4), which is the difference between the three-month Euribor and the corresponding overnight index swap (OIS) rate. Both the Euribor and the OIS rate measure the cost of unsecured borrowing in the interbank market, but unlike the Euribor, the OIS entails only a nominal counterparty risk. Therefore, the Euribor-OIS spread can be viewed as an indicator of banks' perception of counterparties' creditworthiness and availability of funds for interbank lending purposes.[6]

As Figure 4 illustrates, the Euribor-OIS spread was stable and relatively low at the beginning of the sample period (less than 10 basis points). Then, in August 2007, because of the rising number of defaults on subprime mortgages in the US, it increased to a level of 60 basis points. In October 2008, after the collapse of Lehman Brothers, the spread soared to a record of 195 basis points, marking the eruption of the credit crunch. For this reason, we date the beginning of the financial crisis in Europe in 2008:Q3, just before the bankruptcy of Lehman Brothers, which occurred on September 15, 2008.

Furthermore, in order to isolate the impact of the sovereign debt crisis, the crisis period is divided into a financial crisis and a sovereign debt crisis subsample. Conventionally, we date the start of the sovereign debt crisis in 2010:Q3. The last part of the sample in Figure 4 shows that the Euribor-OIS

[6] See Caballero, Farhi and Gourinchas (2008).

spread jumped again in August 2011, owing to fears of contagion of the sovereign debt crisis to Spain and Italy, and remained at historically high levels in the following months.

In total, as illustrated in Figure 5, we consider four different sample periods to perform the econometric analysis. The full sample covers the period 2006:Q3–2012:Q2. The first sample period starts in 2006:Q3 and goes on until 2010:Q2. The pre-crisis and crisis periods both span 8 quarters, in order to average out any seasonal patterns in the data (Duchin, Ozbas and Sensoy, 2010). In the second sample period, the pre-crisis lasts only four quarters and the crisis starts one year earlier (2007:Q3). This alternative dating of the financial crisis is motivated by the evolution of the Euribor-OIS spread, which started to increase already in the summer of 2007.

The third sample covers the period 2006:Q3–2008:Q2. In this case, the crisis period lasts only four quarters (2007:Q3–2008:Q2), and it is used in order to obtain results for the same time span as in Duchin, Ozbas and Sensoy (2010). The fourth sample is simply the first one appended with the sovereign debt crisis period (2010:Q3–2012:Q2).

5.3 Investment and financial positions of firms during the financial crisis

In this section, we examine the relationship between capital expenditures and financial positions of firms prior and during the financial crisis, employing the three estimators discussed in Section 5.1.

The first (CRC) is a standard fixed effects estimator applied to the specification in (7) which does not rely on instrumental variables.[7] The second, addressing the potential endogeneity of the financial variables of our interest, is a fixed effects instrumental variables estimator of the specification in (7), termed CRC-IV. Similarly, the third estimator (CRC-IV-CUH) relies on instrumental variables but it is instead applied to the specification in (1). Throughout the analysis, we employ standard errors clustered at the firm level. In order to provide evidence in support of the validity of the instruments employed, we report the outcome of the Kleibergen-Paap Lagrange Multiplier (LM) underidentification test (Kleibergen and Paap, 2006). The null hypothesis of the Kleibergen-Paap LM test is that the structural equation is underidentified (i.e., the rank condition fails).

Table 4 focuses on the sensitivity of investment to cash holdings and displays estimates for the baseline sample period, 2006:Q3–2010:Q2, with the financial crisis starting in 2008:Q3.

In column (1), the CRC coefficient estimates imply that a higher Tobin's Q was accompanied by a higher investment intensity over the whole sample period, given that the coefficient on q is positive and significant (0.410) whereas the one on $q \times d$ (which measures the change in the correlation when

[7] For all the fixed-effects models (cash, short-term debt and net short-term debt), we carried out the Hausman test and we always rejected the random effects specification in favour of the fixed effects. Results are available from the authors upon request.

moving from the pre-crisis to the crisis) is negative and significant, but lower in magnitude (-0.178). Given that Tobin's Q was on average 0.33 lower in the crisis than in the pre-crisis period and the marginal effect of Tobin's Q on investment in the crisis period is 0.232, the predicted change in investment due to the average variation in Tobin's Q is -0.0766 percentage points. This is less than a quarter of the average fall in investment of 0.33 percentage points, but the estimates imply marginal effects similar to those in Duchin, Ozbas and Sensoy (2010). On the other hand, higher cash reserves were associated with lower capital expenditures in the pre-crisis period, even though the relationship became less strong during the crisis. However, this negative correlation could merely reflect that firms lacking investment opportunities accumulated cash, which would imply that cash reserves are endogenous to investment.

To address this potential endogeneity of cash reserves,[8] we proceed by estimating the same specification as in column (1) with instrumental variables (two-stage least squares), instrumenting cash with its lagged values. We use as an instrument cash reserves lagged 18 quarters. The Kleibergen-Paap LM test statistics is 7.49, and at this value the null hypothesis is strongly rejected, suggesting that the instruments are adequate to identify the equation. Furthermore, by using cash holdings lagged 18 quarters, all values of the instrumental variable pre-date the sample period under analysis – which consists of sixteen quarters – and therefore our identification assumption can be expected to be satisfied.[9]

The CRC-IV estimates, contained in column (2), differ considerably from those in column (1) and lend support to cash being correlated with unobserved within-firm changes in investment opportunities. Notably, the coefficient on $cash$ is no longer statistically significant, whereas that on the interaction between the crisis indicator and cash ($cash \times d$) is larger in magnitude than the estimate obtained without instrumental variables. However, given that the sum of the coefficients on $cash$ and $cash \times d$ is not significantly different from zero, we cannot conclude that during the financial crisis higher cash holdings were associated with higher investment intensity.

In column (3), we present CRC-IV-CUH estimates for the specification in equation (1), in which both the observed measures and unobserved firm-specific characteristics are allowed to affect invest-

[8] Formal tests indicate that cash reserves (as well as short-term debt) are not exogenous (Wooldridge, 2010, p. 132). More specifically, when plugging the residuals obtained in the first-stage instrumental variables regression into the CRC specification, the corresponding coefficients are jointly significantly different from zero. Results are available from the authors upon request.

[9] Formal tests also indicate that this instrument and the instruments used in the sequel when considering specifications with short-term debt and net short-term debt are strictly exogenous (Wooldridge, 2010). Namely, when adding the instrument forwarded one period into the specification in (1) and estimating it with instrumental variables, the corresponding coefficient estimate is not significantly different from zero. Results are available from the authors upon request.

ment differently before and during the financial crisis. For comparability purposes, we use the same instruments as in column (2), i.e., cash reserves lagged 18 quarters. According to the Kleibergen-Paap LM test statistics, we reject the null hypothesis of underidentification, hence the instruments can be considered to be adequate. Looking at the coefficient estimates, it is worth noting that a statistically significant differential impact of cash on investment ($cash \times d$) no longer obtains. Furthermore, given that the sum of the coefficients on $cash$ and $cash \times d$ is not significantly different from zero, we cannot conclude that during the financial crisis firms with high cash reserves invested more than firms with low cash holdings, when controlling for the effect of unobserved firm characteristics on investment separately during the pre-crisis and the crisis period. Note that if cash reserves were correlated with unobserved firm-specific characteristics and the effect of the latter on investment changed with the onset of the crisis, omitting the term $\delta_i d_t^f$ in equation (1) would imply that the coefficient on $cash \times d$ is inconsistently estimated. This rationalizes the fact that the coefficient on the interaction term between cash and the crisis indicator is statistically significant when imposing the restriction that unobserved firm characteristics have a constant effect on investment throughout the sample period (columns (1)–(2)). Note that allowing for a change in the unobserved firm-specific component of investment also affects the coefficients on Tobin's Q. The corresponding estimates in column (3) imply that on average 30 per cent of the drop in investment is captured by the the fall in Tobin's Q.

In Table 5, we extend our analysis by studying the role of leverage in investment decisions. Also in this case we focus on the baseline sample period, 2006:Q3–2010:Q2, with the financial crisis starting in 2008:Q3. One should bear in mind that our measure of short-term debt refers to debt maturing within one year. The hypothesis we seek to test is whether firms with different degrees of short-term indebtedness displayed different investment intensities during the financial crisis.

Column (1) reports the CRC estimates. The positive fixed effects estimate of the short-term debt coefficient in the pre-crisis period is statistically significant at the 1% level, but relatively low in magnitude. The interaction term between the financial crisis dummy and short-term debt ($st\_debt \times d$) is instead negative, larger in absolute value than that on st_debt, and significant at the 0.1% level. Moreover, as evidenced by the F-test on the hypothesis $\mathbb{E}[\beta_{1i}^f + \beta_{2i}^f] = 0$, during the financial crisis highly leveraged firms appear to have reduced their capital expenditures by more than unleveraged ones. Also according to this specification, a higher Tobin's Q is accompanied by a higher investment intensity.

The results based on the CRC-IV estimates are shown in column (2). We use as instruments cash reserves lagged 20 quarters and the interaction of cash reserves lagged 22 quarters with the crisis indicator. The Kleibergen-Paap LM underidentification test rejects the null hypothesis at 8% level.

According to the CRC-IV estimates, the relationship between investment and short-term debt during the financial crisis is no longer statistically significant. The positive association between short-term debt and investment in the pre-crisis period, on the other hand, continues to hold (the corresponding coefficient is still significant at the 10% level).

Column (3) presents the CRC-IV-CUH estimates. The same instruments as in column (2) are used. According to the Kleibergen-Paap LM test, the model is correctly identified. In this case, the coefficients on neither st_debt nor $st\_debt \times d$ are statistically significant (the corresponding t-statistics are equal to 0.60 and to -0.43, respectively). This and the p-value of the F-test on the sum suggest that, when controlling for the effect of unobserved firm characteristics on investment separately during the pre-crisis and the crisis period, no significant relationship between investment intensity and the level of short-term debt obtains. The coefficient on Tobin's Q, instead, is positive and highly significant, as in column (2). Moreover, the estimates imply similar, economically significant marginal effects of Tobin's Q on investment as those obtained from the specification with cash holdings in Table 4.

Lastly, in Table 6, we focus on the sensitivity of investment to net short-term debt, which represents net short-term indebtedness. The baseline sample period is again used (2006:Q3–2010:Q2), with the financial crisis starting in 2008:Q3.

According to the CRC estimates, the coefficient on q is positive and highly significant, while that on $q \times d$ is negative and also significant at the 0.1% level, even though lower in magnitude. The coefficient on net_st_debt is equal to 0.78 and highly significant, meaning that investment was higher for firms with high net short-term debt in the pre-crisis sample. At the same time, the coefficient on $net\_st\_debt \times d$ is highly significant and negative, equal to -0.94. However, the sum of the coefficients on net_st_debt and $net\_st\_debt \times d$ is not significantly different from zero, suggesting that during the financial crisis there were no significant differences in the investment intensities of firms with different levels of net short-term debt.

Column (2) presents the CRC-IV estimates. We use as instruments cash reserves lagged 24 quarters. According to the Kleibergen-Paap LM test, the null hypothesis of underidentification is strongly rejected. The coefficient on Tobin's Q continues to be positive and highly significant. Moreover, the negative estimate on $net\_st\_debt \times d$ is significant at the 10% level. However, all the other coefficients are not significant at conventional levels.

Lastly, column (3) focuses on the CRC-IV-CUH estimates. The same instruments as in column (2) are used. Also in this case the Kleibergen-Paap LM test statistics indicates that underidentification is not an issue. The coefficient on q is positive and significantly different from zero, whereas the one on $q \times d$ is insignificant. Yet, two differences emerge with respect to column (2). First, the

coefficient on $net\_st\_debt \times d$ becomes larger in absolute value. Second, the sum of the coefficients on net_st_debt and $net\_st\_debt \times d$, equal to -6.81, becomes statistically significant at the 10% level. That is, a 10 percentage point increase in net short-term debt relative to total assets would have reduced quarterly investment intensity during the financial crisis by 0.68%. Relative to the average investment intensity of 1.1% over the whole sample period, this is a considerable marginal effect. In sum, the estimates in column (3) suggest that investment during the crisis declined more strongly for firms with high net short-term debt than for companies with low net short-term debt.

Let us proceed by providing an interpretation of the strength of the instruments employed in Table 6. To do so, we present, in Table 7, the first-stage estimates corresponding to columns (2) and (3) of Table 6. The results show that net short-term debt varies negatively with lagged values of cash holdings. This suggests that firms with above-average cash holdings in the past had lower levels of net short-term debt over our sample period. The fact that this negative relationship holds for cash reserves lagged 24 quarters suggests that deviations of this financial variable from its time average are highly autocorrelated for the firms in our sample.

To further gauge the economic significance of these results, let us relate the coefficient estimates to the average changes in the two observed explanatory variables, Tobin's Q and net short-term debt. The average Tobin's Q in the crisis period was 0.33 lower that in the pre-crisis period. Multiplying this difference with the marginal effect of Tobin's Q on investment during the crisis period (0.41 + 0.047) yields a predicted change of -0.15 percentage points. Net short-term debt, on the other hand, increased on average by 0.0111 between the pre-crisis and the crisis period. Thus, given that the marginal effect of net short-term debt on investment during the crisis is equal to -6.81, the ceteris paribus response of investment to the change in net short-term debt amounts to -0.076. That is, the predicted change in investment due to the average variations in Tobin's Q and net short-term debt is -0.23 percentage points, which is nearly 70 per cent of the average fall in investment of 0.33 percentage points. The remaining 30 per cent of the decrease is captured by the variation in unobserved heterogeneity at the firm level, time dummies and the residuals. Therefore, our results suggest that net-short term debt accounted for approximately one third of the variation in investment explained by the two regressors.

In order to investigate whether these findings are sensitive to the instruments chosen, in Table 8 we present additional results on the sensitivity of investment to net short-term debt. We focus on the model in equation (1). To ease comparison, column (1) reports results relative to a specification in which we use as instruments cash reserves lagged 24 quarters, as in Table 6. The remaining columns, on which we focus on, refer to specifications with different sets of instruments. In all cases, the null hypothesis of underidentification is strongly rejected based on the Kleibergen-Paap

LM test, providing evidence in support of the validity of the chosen instruments.

In columns (2), (3) and (4), the coefficient on net_st_debt is never significant at conventional levels. The coefficient on $net\_st\_debt \times d$ is instead significant at the 10% level in column (4), even though the sum of the coefficients on net_st_debt and $net\_st\_debt \times d$ turns out to be insignificant. Conversely, in columns (2) and (3), the sum of the coefficients on net_st_debt and $net\_st\_debt \times d$ is statistically different from zero almost at the 10% level, pointing to a negative effect of short-term debt net of cash reserves on investment during the financial crisis. It is worth pointing out that the coefficient estimates across specifications imply similar, economically significant marginal effects during the crisis period.

To summarise, focusing on the baseline sample period 2006:Q3–2010:Q2, we find that neither cash holdings nor short-term debt individually had a statistically significant effect on corporate investment. However, short-term debt net of cash reserves negatively affected capital expenditures during the financial crisis. Furthermore, our control variable of observable investment opportunities, Tobin's Q, correlates strongly with investment, no matter the specification and estimation method used.

5.4 The sovereign debt crisis

In this section we extend the crisis sample to 2012:Q2, in order to include the sovereign debt crisis period. That is, the crisis dummy takes the value one during the financial and sovereign debt crises (2008:Q3–2012:Q2) and is zero otherwise (2006:Q3–2008:Q2). This longer crisis period allows us to examine whether the results presented above apply not only to the financial crisis but also to the sovereign debt crisis.

Table 9 focuses on cash holdings. Overall, results are similar to those in Table 4. More in particular, the coefficient on q is always positive and significant, while the one on $q \times d$ is significantly different from zero only in column (1). In addition, the coefficient on $cash$ is significant only according to the CRC estimates. Differently from Table 4, the coefficient on $cash \times d$ is never significant, no matter the estimator and the model used. Moreover, although the point estimate on $cash \times d$ in column (3) is positive and large in magnitude, it cannot be judged to be significantly different from zero at conventional levels. The instruments can be considered valid, given that the Kleibergen-Paap LM test statistics rejects the null hypothesis of underidentification at the 10% level both in column (2) and in column (3). In sum, when the analysis is extended to the entire 2006:Q3–2012:Q2 sample, the finding that cash reserves were not, even in the crisis period, a significant determinant of investment continues to hold. The possibility that cash holdings exerted an influence

on investment only during the sovereign debt crisis, which we cannot yet rule out, is considered later in this section.

Similar conclusions can be drawn when looking at Table 10, which focuses on short-term debt over the entire 2006:Q3–2012:Q2 sample. The estimates in column (1) are little changed with respect to the corresponding ones in Table 5. In column (2), instead, the point estimates are slightly different from those in Table 5. Moreover, the coefficient on st_debt is significant at the 5% level, while in Table 5 the corresponding coefficient is significant at the 10% level. Also the coefficient estimates in column (3) are somewhat different from those in Table 5. However, as in Table 5, neither the coefficients on st_debt and $st\_debt \times d$ nor their sum are statistically significant. To sum up, we conclude that short-term debt did not exert an influence on investment either in the pre-crisis or in the crisis period, even when the latter is extended to 2012.

Table 11 reports the estimates for net short-term debt, which in Table 6 was found to have affected investment negatively during the financial crisis. In column (1), the coefficients are close to those displayed in Table 6. In particular, the coefficient on net_st_debt is positive, while the one on $net\_st\_debt \times d$ is negative and larger in absolute value than the former. Moreover, both are significantly different from zero. Column (2) displays estimates for q and $q \times d$ that are similar to those in Table 6. The coefficient on $net\_st\_debt \times d$ instead is no longer significantly different from zero at the 10% level. Other differences emerge when examining column (3). Namely, neither the coefficients on net_st_debt and $net\_st\_debt \times d$ nor their sum are statistically different from zero. This is in contrast with Table 6, where the coefficient on $net\_st\_debt \times d$ was negative, large in absolute value and statistically significant. These results suggest that short-term debt net of liquidity negatively affected corporate investment only during the financial crisis. Still, in what follows, we examine carefully whether net short-term debt had any effect on investment during the sovereign debt crisis by treating it as a separate crisis period. Compared to the estimates pertaining to the shorter crisis period, the results in Tables 9–11 suggest that Tobin's Q remained an economically significant determinant of investment also during the sovereign debt crisis, as evidenced by the similar marginal effects during the longer crisis period.

To further investigate the influence of firms' financial positions on their capital expenditures during the sovereign debt crisis, we add in equations (1) and (7) interaction terms with a sovereign debt crisis indicator that takes the value one during the sovereign debt crisis period and is zero otherwise. Thus, differently from the specifications considered in Tables 9, 10 and 11 above, we consider two sets of interaction terms, one accounting for the effect of the financial crisis and the other designed to capture the impact of the sovereign debt crisis. We wish to test whether financial factors influenced investment differently during the sovereign debt crisis than during the financial

crisis.

Therefore, the model in (1) with the additional set of interaction terms becomes:

$$\begin{aligned} investment_{it} &= c_i + \delta_{1i} d_t^f + \delta_{2i} d_t^s + \beta_{1i}^f f_{it} + \beta_{2i}^f f_{it} d_t^f + \beta_{3i}^f f_{it} d_t^s \\ &+ \beta_{1i}^q q_{it} + \beta_{2i}^q q_{it} d_t^f + \beta_{3i}^q q_{it} d_t^s + u_{it}, \end{aligned} \tag{8}$$

where the dummy variable d_t^f is equal to one during the financial crisis (2008:Q3–2010:Q2), while d_t^s is equal to one during the sovereign debt crisis (2010:Q3–2012:Q2), and zero otherwise. Similarly, additional interaction terms for the sovereign debt crisis are added to the alternative model in (7).

Note that in this specification, firm fixed effects, the financial variable of interest and Tobin's Q are interacted with the sovereign debt indicator as well as with financial crisis one. That is, the coefficients on both the observed and the unobserved explanatory variables may change as we move from the pre-crisis period to the financial crisis and from the financial crisis to the sovereign debt crisis. It is worth pointing out that estimating the model in equation (8) should deliver the same point estimates for the pre-crisis and the financial crisis period as the specification in (1). Any differences between the coefficient estimates reported below and the corresponding ones in Tables 4–6 stem from the composition of the sample, due to data availability, and the instruments employed being different.

Results are given in Table 12 for cash reserves, while Table 13 refers to short-term debt and Table 14 to net short-term debt. In Table 12, although the coefficients (on q, $q \times d^f$, $cash$ and $cash \times d^f$) capturing conditional dependencies during the pre-crisis and the financial crisis differ slightly from those in Table 4, one can draw the same conclusions as above. In particular, the CRC-IV-CUH estimates suggests that in neither the pre-crisis nor the financial crisis period was there a dependence between investment and cash holdings. If instead one's inferences were based on the CRC-IV estimates, one could claim that cash reserves exerted a positive differential effect on capital expenditures during the financial crisis (as the point estimate on $cash \times d^f$ is almost significant at the 10% level). As to the sovereign debt crisis, none of the specifications suggest that there was a positive relationship between investment and cash holdings during this crisis period. In other words, our conclusion about cash reserves not being a significant determinant of investment during the financial crisis also applies to the sovereign debt crisis. Moreover, the results in Table 12 show that the statistically insignificant coefficient on the interaction term between the crisis indicator and cash reserves in Table 9, where the two crisis periods are pooled together, is not driven by the financial crisis period.

Analogously, the estimates in Table 13 pertaining to the pre-crisis and the financial crisis pe-

riod are similar to the corresponding ones in Table 5. Namely, in columns (2) and (3), no evidence emerges suggesting that short-term debt was a significant determinant of investment between 2006:Q3 and 2010:Q2. What is more, the statistically significant differential effect of short-term debt during the sovereign debt crisis (the coefficient on $st\_debt \times d^s$) in column (1) no longer obtains when employing instrumental variables. This and the F-tests on the sums of the coefficients suggest that short-term debt exerted no significant influence on capital expenditure not only during the financial crisis but also during the sovereign debt crisis. In other words, the effect of short-term debt on investment does not appear to have changed when the financial crisis turned into a sovereign debt crisis.

Also in Table 14, the coefficient estimates for the pre-crisis and the financial crisis do not differ markedly from the corresponding ones in the specification examining the period until 2010:Q2, in Table 6. This shows that the results obtained using the baseline sample period are robust to the variation in the sample of firms resulting from employing additional instruments and prolonging the sample period. As to the differential impact of net short-term debt on investment during the sovereign debt crisis, one notices that in column (3) a statistically significant effect (at the 10% level) obtains also during this latter crisis period. Even though the coefficient on $net\_st\_debt \times d^s$ is smaller in absolute value than that on $net\_st\_debt \times d^f$, they are not significantly different from each other (an F-test of equality yields a p-value of 0.31). Thus, we can conclude that the negative differential effect of short-term debt net of cash reserves on investment was of a similar magnitude during the sovereign debt crisis as during the financial crisis. However, the overall effect of net_st_debt on investment is only significant for the financial crisis, as can be seen from the p-values of the F-tests on the sums. The fact that we found no differential effect of net short-term debt when pooling the two crisis periods together (Table 11) could be due not allowing the impact of unobserved firm-specific characteristics to change when entering the sovereign debt crisis period.

Taken together, the estimates with an additional set of interaction terms for the sovereign debt crisis suggest that Tobin's Q remained an economically significant determinant of investment also during the sovereign debt crisis, albeit having a somewhat smaller marginal effect than during the financial crisis. As to net short-term debt, the estimates suggest that it was also economically significant determinant of investment during the sovereign debt crisis. In particular, a 10 percentage point increase in net short-term debt, would have been associated with 0.19% lower investment intensity during the sovereign debt crisis.

5.5 Alternative definitions of the financial crisis

In this section we conduct a series of robustness tests. The aim is to assess the sensitivity of the results to a different dating of the financial crisis. In particular, we use two alternative definitions of the financial crisis period: i) 2007:Q3–2010:Q2; ii) 2007:Q3–2008:Q2. In the first case, the financial crisis is simply defined to have started a year earlier than in the previously considered baseline sample split. In the second case, it is additionally supposed that the financial crisis ended in 2008:Q2. Dating the onset of the financial crisis to 2007:Q3 is motivated by the evolution of the three-month Euribor-OIS spread in Figure 4, which climbed to over 60 basis points already in summer 2007, due to the subprime crisis in the US.

In what follows, we present results from employing the alternative definitions of the financial crisis period for each of our three variables of interest. First, we consider the sample in which the financial crisis spans the period 2007:Q3–2010:Q2. Table 15 reports results for cash holdings, Table 16 for short-term debt and Table 17 for net short-term debt.

In Table 15, the estimates are little changed from those in Table 4. The coefficient on q in column (3) is an exception, not being statistically significant, unlike the corresponding estimate in Table 4. This may be due to the fact that the sample size in the pre-crisis period is too small (and the number of regressors too large), reducing the power of the t-test. However, the sum of the coefficients q and $q \times d$ is highly significantly different from zero (an F-test yields a p-value smaller than 10^{-5}). Another difference with respect to Table 4 is the coefficient on $cash \times d$ in column (2), which in Table 15 is not statistically significant. Similarly, the sum of $cash$ and $cash \times d$ is not significantly different from zero (p-value = 0.20). That is, the results in Table 15, based on the first alternative definition of the financial crisis, provide even less evidence about any conditional dependence between cash reserves and investment than the estimates in Table 4.

Also the results for short-term debt in Table 16 are similar to those obtained using the baseline sample period, in Table 5. However, as in the specification with cash reserves, the coefficient on q is not significant in column (3), unlike when employing the baseline sample split. Nevertheless, the sum of the coefficients q and $q \times d$ is highly significant (p-value $< 10^{-6}$). No evidence emerges though suggesting that short-term debt exerted an influence on investment either during the pre-crisis or the crisis period (the sum of the coefficients on st_debt and $st\_debt \times d$ is not significantly different from zero in columns (2) and (3)).

Table 17 focuses on net short-term debt. Also for this variable, no stark differences emerge with respect to the baseline sample split, in Table 6. As in Tables 15 and 16, the coefficient on q, capturing any effect on investment during the four-quarter pre-crisis period, is not significantly different from

zero according to the CRC-IV-CUH estimates. However, there is evidence of a positive conditional dependence between Tobin's Q and investment during the crisis period. As to net short-term debt, the coefficient capturing its differential impact on investment during the financial crisis is statistically significant (at 6% level), as in Table 6. However, differently from when using the baseline sample period, the sum of the coefficients on net_st_debt and $net\_st\_debt \times d$ is not significantly different from zero (p-value = 0.24). This suggests the negative effect of net short-term debt on investment emerged rather during the more acute phase of the financial crisis, starting in 2008:Q3, than in the preceding year.

As a further check, we consider the third sample in Figure 5, which covers the shorter period 2006:Q3–2008:Q2, with the financial crisis starting in 2007:Q3. Note that with respect to the baseline 2006:Q3–2010:Q2 sample, the number of observations essentially halves. This sample split is also used by Duchin, Ozbas and Sensoy (2010), who argue it allows one to identify the effect of a negative shock to the supply of external finance given that in 2007:Q3–2008:Q2 the crisis was mainly a financial phenomenon. The results reported in Tables 18, 19 and 20 refer to cash holdings, short-term debt and net short-term debt, respectively.

Most of the coefficient estimates in the three tables are statistically insignificant at conventional levels. As in Tables 15–17, also the coefficient on Tobin's Q is not significantly different from zero when the CRC-IV-CUH specification is considered. However, in Tables 18 and 20 the sum of the coefficients on q and $q \times d$ is significant (at 1% and 2% level, respectively). As to our variables of interest – cash reserves, short-term debt and net short-term debt – and their interactions with the crisis indicator, neither the CRC-IV nor the CRC-IV-CUH delivers any statistically significant estimates with two exceptions. The coefficient estimate of $st\_debt \times d$ obtained using the CRC-IV-CUH (Table 19) and that of net_st_debt delivered by the CRC-IV (Table 20) are both significant at the 10% level. The significance of the former finding, however, is undermined by the fact that the sum of the coefficient on st_debt and $st\_debt \times d$ is not significantly different from zero (p-value = 0.17). The latter result, on the other hand, no longer obtains when employing the CRC-IV-CUH, suggesting that it stems from not allowing the effect of unobserved firm-specific characteristics on investment to change. In sum, the results suggest that firms' financial positions did not exert a significant influence on investment during the first phase of the financial crisis, 2007:Q3–2008:Q2. However, these findings have to be treated cautiously, as the analysis is based on only two years of quarterly data. In other words, the fact that we do not find statistically significant coefficients may reflect the small sample size of both the pre-crisis and crisis periods.

5.6 Different sample composition

In this section we examine the robustness of our findings to considering only the core euro-area countries and the UK, which we expect to have been affected by the financial crisis differently than the peripheral countries. Then, we focus on companies belonging to the construction, manufacturing, transportation and communications sectors, disregarding those in the other sectors, and assess how our estimates change as the sample composition is altered in this way. Finally, we investigate how our results are affected when excluding companies that are at least partially state owned. Throughout we consider the baseline timing, 2006:Q3–2010:Q2, with the financial crisis starting in 2008:Q3. We do not examine the sovereign debt crisis period for the reason that above we found significant effects only during the financial crisis.

We first restrict our attention to the core euro-area countries – Austria, Belgium, France, Germany, the Netherlands – and the United Kingdom, accounting for approximately 70 per cent of the firms in the whole sample. Table 21 refers to cash holdings, Table 22 to short-term debt and Table 23 to net short-term debt.

Compared to the results for the whole sample in Table 4, the estimates in Table 21 are similar in magnitude and statistical significance. There is a difference, though, between the two in the coefficient on $cash \times d$ in column (2). In particular, the estimate obtained by excluding the peripheral countries is not statistically significant. That is, cash reserves cannot be judged to have exerted a positive differential impact on investment even when employing the CRC-IV specification. Moreover, as in Table 4, the sum of the coefficients on $cash$ and $cash \times d$ when considering the CRC-IV estimates is not significantly different from zero.

Similarly, when comparing the estimates in Table 22 with those in Table 5, no marked differences emerge. However, unlike when employing the full sample, a statistically insignificant coefficient on st_debt obtains when the CRC-IV is employed. Also according to the CRC-IV-CUH estimates, there is no evidence of any conditional dependence between short-term indebtedness and investment. This and the other similarities between the results in Tables 5 and 22 suggest that our results on short-term debt are not driven by firms in the peripheral countries.

Table 23 reports the results for net short-term debt. Again, the estimates are little changed relative to the full sample. In particular, all the coefficients have the same sign and are close in magnitude to those in Table 6. Examining the statistical significance of the estimates, one observes that the coefficient on net_st_debt is no longer significant at the 10% level when employing the CRC-IV-CUH. However, the sum of the coefficients on net_st_debt and $net\_st\_debt \times d$ remains significantly different from zero at the 10% level. This suggests that the conditional dependence

between short-term debt net of cash reserves and investment is not attributable only to firms in the peripheral countries. The fact the estimated marginal effect of net short-term debt on investment during the financial crisis (-4.12) is smaller than in the full sample could simply reflect the smaller average increase in net short-term debt in the core countries, being less than half of that in the full sample.

Next, we present the results obtained when focusing on the construction, manufacturing, transportation and communications sectors. Firms belonging to agriculture, forestry and fishing, mining, wholesale trade, retail trade, and services have been dropped from the sample. The choice of the smaller set of sectors is motivated by the on average lower cash holding and the higher short-term debt of the firms therein. Results are given in Tables 24 (cash reserves), 25 (short-term debt) and 26 (net short-term debt). Consistently with the previous findings, no evidence emerges to suggest that cash or short-term debt, considered separately, were significant determinants of investment over the sample period. Similarly, the results for net short-term debt are in broadly line with those in Table 6. Nonetheless, according to the CRC-IV-CUH estimates, net short-term debt exerted a larger differential effect on investment during the crisis than in the full sample (the coefficient on $net\_st\_debt \times d$ becomes 50% larger in absolute value). The fact that the sum of the coefficients on net_st_debt and $net\_st\_debt \times d$ is no longer statistically significant can be attributed to the statistically insignificant coefficient on net_st_debt. However, note that the sum of the coefficients in absolute value exceeds the corresponding one in Table 6. As to the Kleibergen-Paap LM test statistics, measuring the strength of the instruments employed, the higher p-values are presumably linked with the smaller number of observations in this restricted sample.

Finally, we restrict attention to companies that are not state owned. Specifically, we exclude all firms for which the percentage of outstanding shares held by the state exceeds 1%. This exercise is motivated by the literature on the effects of public ownership on corporate decisions, including investment (see, e.g., Megginson, Nash and Van Randenborgh, 1994; Kotter and Lel, 2011; Boubakri, Cosset and Saffar, 2013).[10] Tables 27, 28 and 29 present the results of this analysis, and refer respectively to cash reserves, short-term debt and net short-term debt. One notes that the coefficient estimates are almost identical to those in Tables 4–6. Thus, no evidence emerges to suggest that our results are driven by partially state-owned companies, which tend to be among the most capital-intensive firms in most EU countries.

[10]These papers are part of a wider literature looking at the effects of large shareholders and public ownership on the quality of corporate governance; see, e.g., Borisova et al. (2012) and Borisova et al. (2015). As highlighted by La Porta et al. (1998), large ownership concentration may be a reflection of poor investor protection, especially in French-civil-law countries.

Let us conclude this section with a brief summary of our findings. On the one hand, our main result – net short-term debt having influenced investment during the financial crisis – also obtains when we restrict our attention to firms located in the core euro-area countries (Austria, Belgium, France, Germany, and the Netherlands) and the United Kingdom. Moreover, there is some evidence that the sensitivity of investment to net short-term debt, although somewhat imprecisely estimated, was larger in the construction, manufacturing, transportation and communications sectors.

5.7 Specification with both cash and short-term debt

We continue by investigating further the result of net short-term debt being a significant determinant of investment in our sample. More specifically, we estimate a specification which includes both cash and short-term debt as explanatory variables. In this way, we relax the assumption underlying the specification with net short-term debt that the coefficients on cash and short-term debt are equal in magnitude but have the opposite signs. In other words, we can shed light on whether short-term debt exerted a stronger influence on investment than cash, or vice versa. The results from this exercise are reported in Table 30, where $f1$ refers to short-term debt and $f2$ to cash.

Focusing on the CRC-IV-CUH estimates, the sum of the coefficients on st_debt and $st\_debt \times d$ is statistically significant at the 10% level, while neither the coefficients on $cash$ and $cash \times d$ nor their sum are significantly different zero. Thus, the results suggest that the influence of net short-term debt on investment during the financial crisis operated more through short-term debt, for a given level of cash, than the other way round. It also worth noting that according to these estimates the marginal effect of short-term debt on investment, for a given level of cash holdings, is larger than according to the specification with net short-term debt in Table 6. More specifically, a 10 percentage point increase short-term debt relative to total assets would reduced investment intensity by 1.9%. Finally, it is worth pointing out that the reason why the estimates in Table 5 suggest that short-term debt has no influence on investment is that cash holdings are not controlled for. Thus, the results therein may reflect not only the influence of short-term debt but also partly that of cash.

5.8 Relation of the results to the literature

We conclude the discussion of our results by comparing them to the most closely related literature. This allows us to highlight their economic significance and how they shape our understanding of the role of financial factors for investment. We begin by relating our findings to those in Duchin, Ozbas and Sensoy (2010), as their econometric approach is similar to ours and we follow their variable definitions. Subsequently, we discuss the relationship of our results with other closely related works.

Instead of relying on instrumental variables, Duchin, Ozbas and Sensoy (2010) employ lagged values of their financial variables of interest as proxies for the contemporaneous values of these variables. Given that the correlation between investment and the contemporaneous values of financial variables is plausibly larger than the correlation between investment and the lagged values of financial variables, their estimates are to be interpreted as lower bounds on their marginal effects of interest. Moreover, Duchin, Ozbas and Sensoy (2010) do not allow either the coefficients of other explanatory variables or the unobserved firm-specific component of investment to change with the onset of the financial crisis. With these caveats in mind, let us compare the magnitudes of their coefficients to ours. As to Tobin's Q, Duchin, Ozbas and Sensoy (2010) obtain coefficient estimates around 0.2 whereas ours vary predominantly between 0.25 and 0.45. As regards the influence of financial variables, let us focus on net short-term debt as according to our preferred specification CRC-IV-CUH cash and short-term debt were not, when considered separately, significant determinants of investment. We obtain coefficient estimates on net short-term debt which are approximately an order of magnitude larger than the estimate in Duchin, Ozbas and Sensoy (2010). Although this difference could partly reflect the on average higher level of short-term debt relative to total assets in our sample than theirs (0.083 vs. 0.035), it also suggests that net short-term debt was economically considerably more significant determinant of investment among the firms we analyse than those of theirs.

To conclude the comparison of our results with those of Duchin, Ozbas and Sensoy (2010), we present a set of additional results which make our estimates more comparable to theirs. Namely, we estimate the influence of net short-term debt on investment when including cash flow as an additional control.[11] Table 31 contains the results of this exercise. One notices that the estimates are little changed from the baseline results in Table 6. Hence, the observations made above about the economic significance of net short-term suggested by our estimates relative to those in Duchin, Ozbas and Sensoy (2010) continue to hold.

Let us continue by relating our results to the literature on the influence of financial variables on investment which does not distinguish between crisis and non-crisis periods. Within this literature, Cummins, Hassett and Oliner (2006) address the potential bias arising from using Tobin's Q as a measure of investment opportunities. Using earnings forecasts to measure investment opportunities, they find coefficients on Tobin's Q most of which lie between 0.1 and 0.15. The fact that our estimates during the non-crisis period are approximately twice theirs suggests that the sensitivity of investment to fundamentals in our sample was relatively high even during the pre-crisis years.

[11] Cash flow is defined as Duchin, Ozbas and Sensoy (2010). The source is the Standard and Poor's Capital IQ database.

Cummins, Hassett and Oliner (2006) investigate the robustness of their findings by also estimating a dynamic specification in first differences.[12] Although the variables of our interest are unlikely to exhibit pronounced dynamics over the relatively short pre-crisis and crisis periods, we conclude by doing likewise.

Including lagged investment intensity as a covariate in our model is not straightforward as the consistency of the CRC-IV-CUH estimator relies on a strict exogeneity assumption for the instrumental variables which explicitly rules out lagged dependent variables (Murtazashvili and Wooldridge, 2008). To overcome this limitation we employ the following estimation procedure. First, we remove unobserved heterogeneity by first differencing, ignoring the observations for the period when the unobserved component of investment is allowed to change.[13] Then we estimate the resulting equation with instrumental variables, using values of investment which pre-date the sample period as instruments for one-period lagged investment. Assuming sequential exogeneity of regressors this procedure yields consistent estimates in a model which assumes constant effects across firms. Consequently, in this exercise, we estimate a model which differs from the specification in (1) in that the coefficients β_h^k are not allowed to differ across firms.

The results from estimating the dynamic specifications with fixed coefficients β_h^k across firms, which have been accordingly renamed FE (Fixed Effects), FE-IV (FE-Instrumental Variables), and FE-IV-ISS (FE-IV-Individual Specific Slopes), are presented in Tables 32 (cash reserves), 33 (short-term debt) and 34 (net short-term debt). One notes that the coefficient estimates on Tobin's Q and the financial variables are somewhat different than those in Tables 4, 5 and 6. Although the coefficients on q and $q \times d$ are not individually significant, their sum is significant almost at the 10% level according to the FE-IV-ISS estimates in all three specifications (p-values are equal to 0.025, 0.11 and 0.0081). That is, also according to these results, Tobin's Q was a significant determinant of investment during the financial crisis with approximately the same magnitude (sum of q and $q \times d$) of Table 4, 5 and 6. Moreover, although the influence of net short-term debt is, probably due to weaker instruments and to the reduced degrees of freedom involved by the introduction of the lagged outcome as regressor, less precisely estimated, it remains an economically significant determinant of investment.

Stronger assumptions are required to estimate the dynamic model, namely sequential exogeneity of regressors and fixed coefficients β_h^k, which are instead completely relaxed in our proposed specification (1). We argue the differences observed in the pre-crisis period in the levels of Tobin's Q and

[12] A dynamic model of investment is also estimated by Bond and Cummins (2002).

[13] That is, after taking first differences, we drop the observations for 2008:Q3, which is the first period of the crisis subsample.

net short-term debt in comparison to the CRC-IV-CUH model, are the signal of asymmetric and/or large variance distributions of the coefficients across firms which, when not appropriately taken into account like in a model with fixed coefficients β_h^k, can act as a potential source of bias.

6 CONCLUSION

In this paper, we have examined whether there was a conditional dependence between corporate investment and firms' financial positions, how it changed with the onset of the financial crisis and when moving from the financial crisis to the sovereign debt crisis period. We have employed a panel of listed firms in the euro area and the United Kingdom, economies which experienced steep falls in aggregate investment. The main hypothesis we have investigated is whether financial resources were a significant determinant of investment during the financial crisis, but not prior to its onset. Following the previous literature, we have focused on short-term liquidity and indebtedness, as they can be expected to influence the investment decisions of firms which cannot entirely fund their capital expenditures by raising external funds.

We have utilised an econometric specification which belongs to the family of correlated random coefficient panel data models (Murtazashvili and Wooldridge, 2008). Given that we have let not only the observed independent variables but also the unobserved heterogeneity at the firm level to interact with a crisis indicator, the conditional dependencies between investment and all the explanatory variables are allowed to change when moving from the pre-crisis to the crisis period. Moreover, the family of correlated random coefficient models allows each β_{hi}^k coefficient to vary across firms ($i = 1, 2, \ldots, N$). In order to address the possible endogeneity issues arising from changes in cash holdings and short-term debt being correlated with unobserved variations in investment opportunities, we have instrumented firms' financial resources with their lagged values, choosing the lag lengths to ensure that the instruments pre-date our sample period.

Our analysis has yielded the following results. First, we have found that to attain plausible identification it is necessary to allow unobserved firm-level heterogeneity of investment to change with the onset of the financial crisis. In other words, assuming that the unobserved firm-specific component of investment remained constant throughout the sample period appears to induce biased coefficient estimates of the financial variables of our interest. Second, our results suggest that neither cash reserves nor short-term debt were significant determinants of investment over our sample period (2006:Q3–2012:Q2). Moreover, no evidence has been found that the effect of these two variables on investment was different before and after the onset of the financial crisis. However, we have found that investment depended negatively on short-term debt net of cash reserves during the financial

crisis, while there was no such negative conditional dependence in the pre-crisis period. Also, no significant relationship between net short-term debt and investment has been detected during the sovereign debt crisis.

Our insights, pointing to a negligible role played by cash holdings and short-term debt, considered individually, in accounting for investment dynamics, sharpen our understanding about the role of leverage and available internal funds in shaping firms' investment decisions. Namely, our findings suggest that during the financial crisis neither short-term liquidity nor indebtedness ceteris paribus affected firms' ability to invest. Rather, we find that investment declined particularly markedly for those publicly-traded firms with high levels of short-term debt net of their cash holdings, or conversely for firms with low cash reserves relative to the level of their short-term indebtedness. Given that net short-term liquidity measures a firm's capability to repay all short-term obligations if it was called to do so at once, our results support the hypothesis that firms were either unwilling or unable to roll over their short-term liabilities in the midst of the financial crisis, which in turn constrained their investment decisions.

Our study is new in highlighting the particular attention that policy makers should pay to the interaction between the levels of short-term debt and liquidity. Both variables, considered separately rather than in conjunction, exert a small economic impact on corporate investment, which also most of the times turns out to be statistically insignificant. Our results also suggest that, in order to gauge the vulnerability of the corporate sector to external financial shocks and subsequent real effects on firm's investment, one relevant variable whose developments should be carefully monitored is represented by short-term indebtedness net of cash reserves. Going beyond, in our view, this latter indicator might also be used for classifying firms according to their exposure to stress scenarios.

In our analysis, we have been able to identify the parameters of interest by interacting firm-level heterogeneity with a crisis indicator. In terms of future research, a possible strand of investigation is to adopt a fully nonparametric framework allowing to capture unobserved heterogeneity in an even more flexible fashion than traditional models with additive individual unobserved components.

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TABLES AND FIGURES

Table 1: Descriptive statistics

Variable	N. obs.	Mean	St. Dev.	Min	Max
Capital expenditure / total assets (%)	37193	1.128	1.244	-0.436	8.462
Cash reserves / total assets	43778	0.141	0.158	0.001	0.890
Short-term debt / total assets	37612	0.083	0.088	0.000	0.512
Net short-term debt / total assets	37389	-0.0304	0.157	-0.713	0.441
Tobin's Q	30809	1.341	0.674	0.029	9.608
Market capitalization (EUR millions)	35472	2682	8812	40.01	124251

Notes. This table presents summary statistics for the main variables used in the empirical analysis. The statistics are calculated over the sample period 2006:Q3–2012:Q2 and refer to values obtained for adjusted data. Abbreviations: N. obs., number of observations; St. Dev., standard deviation; Max, maximum; Min, minimum.

Table 2: Distribution of firms by country

Country	Number of firms
Austria	54
Belgium	92
Cyprus	30
Estonia	14
Finland	100
France	536
Germany	470
Greece	146
Ireland	82
Italy	213
Latvia	15
Lithuania	18
Luxembourg	49
Malta	16
Netherlands	121
Portugal	35
Slovakia	21
Slovenia	16
Spain	112
United Kingdom	1112
Total	3252

Figure 1: Average investment and Tobin's Q: 2006:Q3–2012:Q2

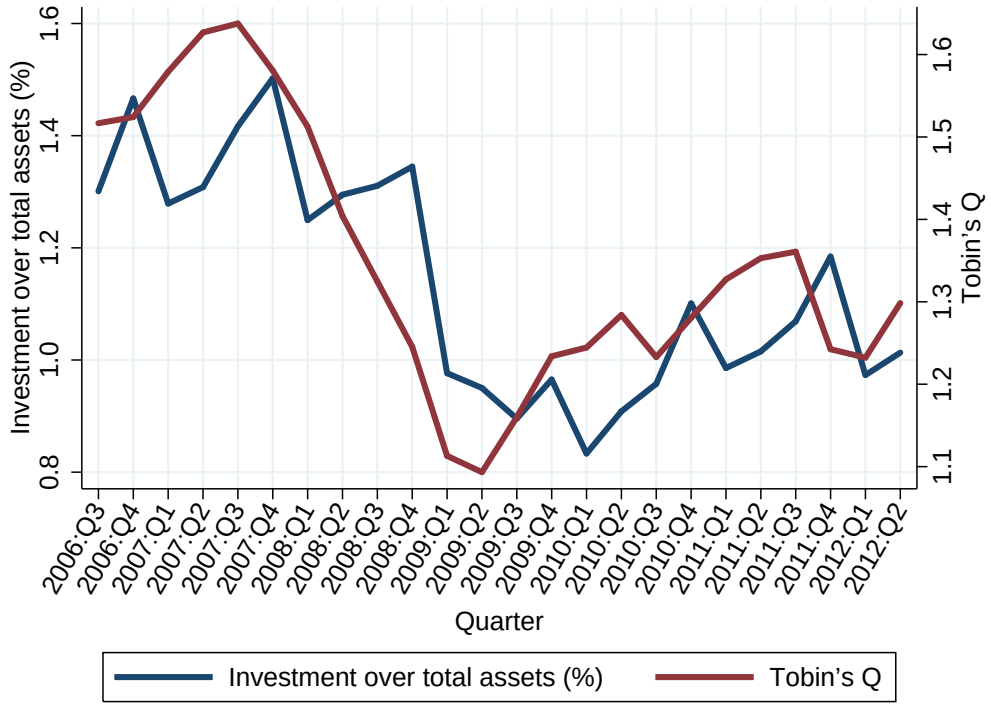

Figure 2: Average cash reserves and short-term debt: 2006:Q3–2012:Q2

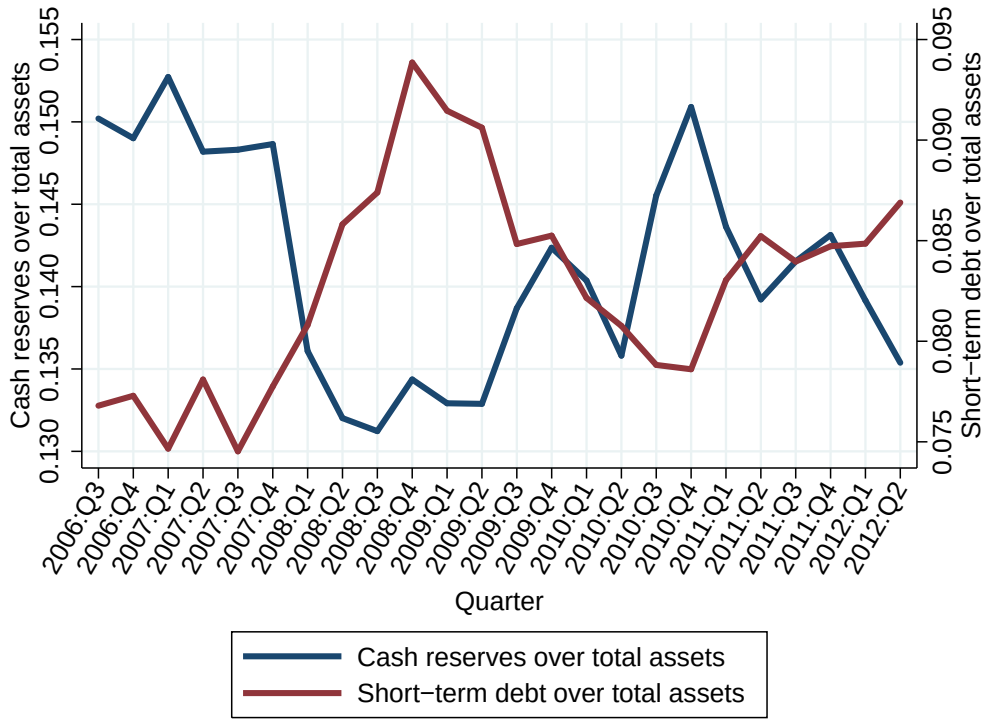

Figure 3: Average net short-term debt: 2006:Q3–2012:Q2

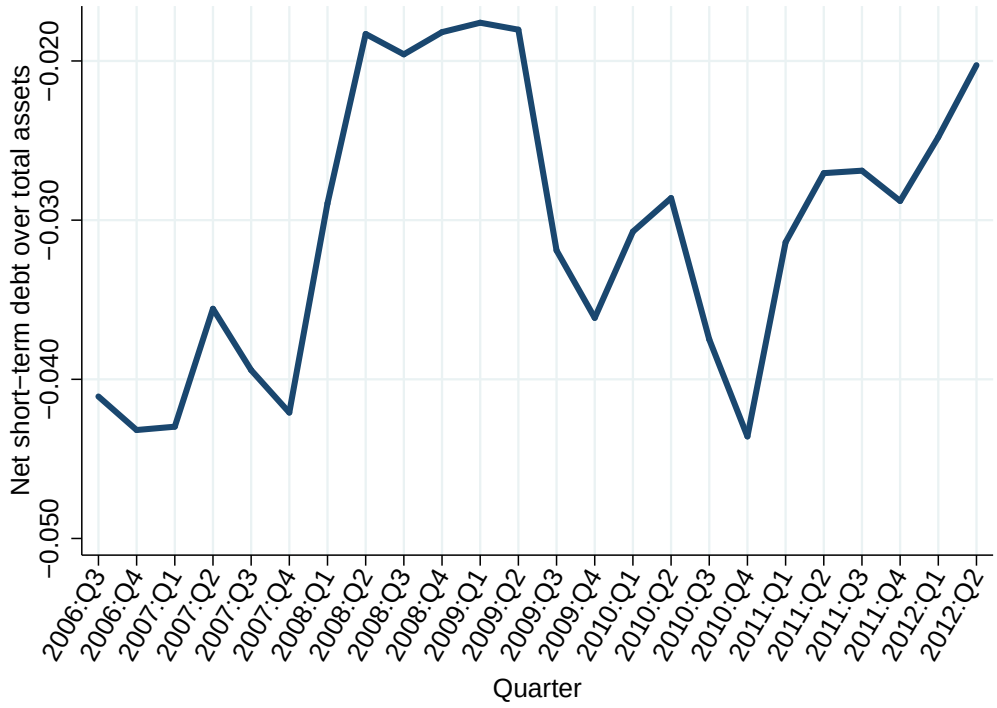

Table 3: Investment before and after the crisis: average investment and mean-comparison t-tests

	Before crisis	Financial crisis	difference (before vs. financial)	Sovereign debt crisis	difference (financial vs. sovereign)
Panel A: Cash reserves and average investment					
Low cash reserves	1.446	1.020	0.426	1.046	-0.026
			(13.22)		(-0.963)
Medium cash reserves	1.320	0.987	0.333	0.972	0.015
			(11.51)		(0.583)
High cash reserves	1.283	0.989	0.294	0.997	-0.008
			(8.833)		(-0.275)
Panel B: Short-term debt and average investment					
Low ST debt	1.278	0.984	0.294	0.953	0.031
			(9.131)		(1.085)
Medium ST debt	1.383	1.026	0.356	1.025	0.001
			(10.81)		(0.047)
High ST debt	1.477	1.047	0.431	1.037	0.010
			(12.03)		(0.341)
Panel C: Net short-term debt and average investment					
Low net ST debt	1.332	1.030	0.302	0.979	0.051
			(8.759)		(1.709)
Medium net ST debt	1.275	0.923	0.352	0.933	-0.010
			(12.02)		(-0.408)
High net ST debt	1.523	1.095	0.427	1.093	0.002
			(11.57)		(0.062)

Note: "Before crisis" refers to the period 2006:Q3–2008:Q2. "Financial crisis" refers to the period 2008:Q3–2010:Q2, while "Sovereign debt crisis" to the period 2010:Q3–2012:Q2. Low, medium and high indicate the first, second, and third terciles of cash reserves, short-term debt and net short-term debt as of 2006:Q2. In parentheses, t-tests on the equality of means in different periods. The null hypothesis is that the two means are equal. Variances in the groups are not assumed to be equal to each other.

Figure 4: Euribor-OIS spread

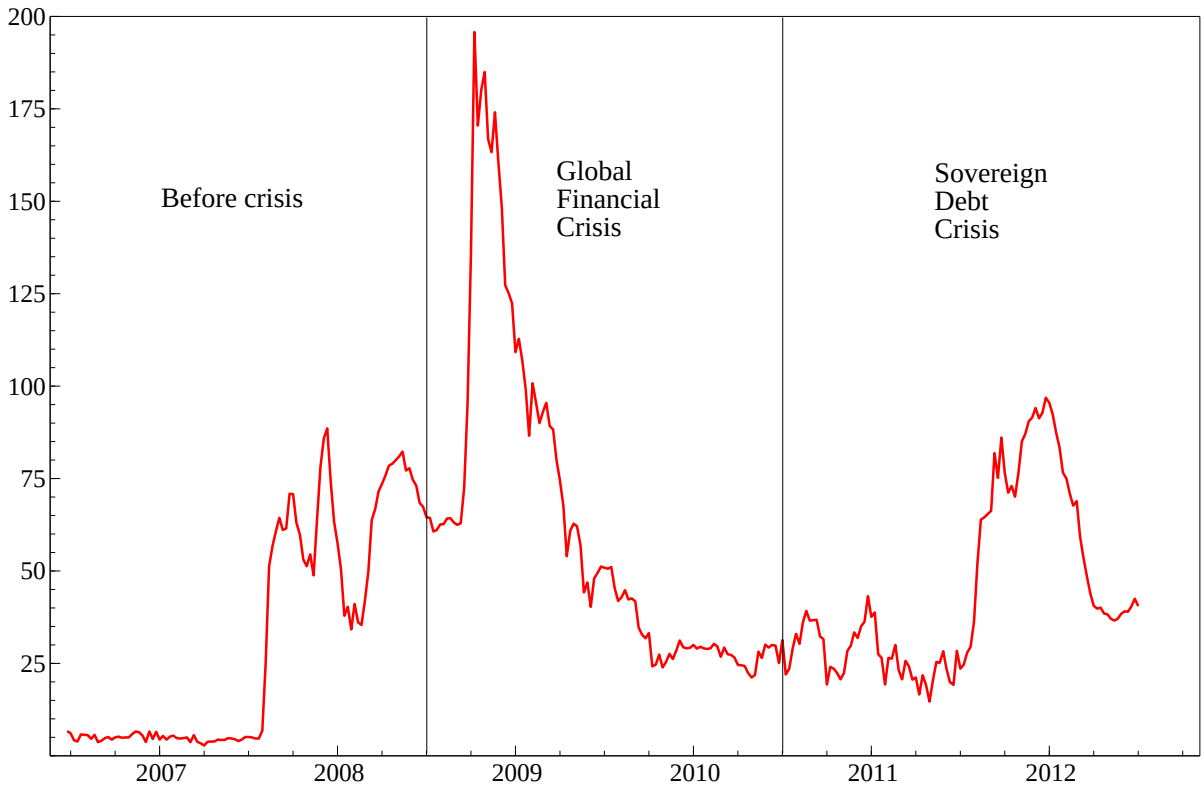

Figure 5: Different samples used for estimation

	1st SAMPLE		2nd SAMPLE		3rd SAMPLE		4th SAMPLE
	2006:Q3		2006:Q3		2006:Q3		2006:Q3
	2006:Q4		2006:Q4		2006:Q4		2006:Q4
	2007:Q1		2007:Q1		2007:Q1		2007:Q1
	2007:Q2		2007:Q2		2007:Q2		2007:Q2
PRE-CRISIS	2007:Q3		2007:Q3		2007:Q3		2007:Q3
	2007:Q4		2007:Q4		2007:Q4		2007:Q4
	2008:Q1		2008:Q1		2008:Q1		2008:Q1
	2008:Q2		2008:Q2		2008:Q2		2008:Q2
	2008:Q3		2008:Q3		2008:Q3		2008:Q3
	2008:Q4		2008:Q4		2008:Q4		2008:Q4
	2009:Q1		2009:Q1		2009:Q1		2009:Q1
FINANCIAL	2009:Q2		2009:Q2		2009:Q2		2009:Q2
CRISIS	2009:Q3		2009:Q3		2009:Q3		2009:Q3
	2009:Q4		2009:Q4		2009:Q4		2009:Q4
	2010:Q1		2010:Q1		2010:Q1		2010:Q1
	2010:Q2		2010:Q2		2010:Q2		2010:Q2
	2010:Q3		2010:Q3		2010:Q3		2010:Q3
	2010:Q4		2010:Q4		2010:Q4		2010:Q4
SOVEREIGN	2011:Q1		2011:Q1		2011:Q1		2011:Q1
DEBT	2011:Q2		2011:Q2		2011:Q2		2011:Q2
CRISIS	2011:Q3		2011:Q3		2011:Q3		2011:Q3
	2011:Q4		2011:Q4		2011:Q4		2011:Q4
	2012:Q1		2012:Q1		2012:Q1		2012:Q1
	2012:Q2		2012:Q2		2012:Q2		2012:Q2

	(1) CRC	(2) CRC-IV	(3) CRC-IV-CUH
q	0.410***	0.423***	0.249**
	(8.25)	(5.55)	(2.69)
$q \times d$	-0.178***	-0.130	0.0622
	(-7.21)	(-1.73)	(0.50)
$cash$	-1.218***	4.639	2.425
	(-5.64)	(1.17)	(0.60)
$cash \times d$	0.483**	1.901*	0.578
	(2.67)	(2.13)	(0.12)
p-value on $\mathbb{E}[\beta_{1i}^f + \beta_{2i}^f] = 0$	0.000431	0.166	0.404
N	16910	12134	12134
Kleibergen-Paap LM stat.		7.494	6.721
p-value (Chi-sq(1))		0.00619	0.00953

t statistics, based on robust standard errors clustered in the firm level, in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4: Estimates of the sensitivity of investment to cash reserves. Full sample. Pre-crisis: 2006:Q3–2008:Q2, crisis: 2008:Q3–2010:Q2

Notes to the table. CRC: Correlated random coefficients, IV: 2SLS Instrumental variables, CUH: Compound unobserved heterogeneity. Explanatory variables: Tobin's Q and cash reserves. Excluded instruments: $cash_{t-18}$ and $cash_{t-18} \times d_t$. Estimates refer to the population averaged effects for each explanatory variable.

	(1) CRC	(2) CRC-IV	(3) CRC-IV-CUH
q	0.371***	0.487***	0.301**
	(7.57)	(3.54)	(2.68)
$q \times d$	-0.0710**	-0.0927	-0.00345
	(-3.12)	(-0.42)	(-0.03)
st_debt	0.827**	12.37	4.743
	(3.26)	(1.92)	(0.60)
$st\_debt \times d$	-1.628***	3.685	-4.077
	(-6.14)	(0.31)	(-0.43)
p-value on $\mathbb{E}[\beta_{1i}^f + \beta_{2i}^f] = 0$	0.000200	0.188	0.837
N	15652	10278	10278
Kleibergen-Paap LM stat.		2.956	9.067
p-value (Chi-sq(1))		0.0856	0.00260

t statistics, based on robust standard errors clustered in the firm level, in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 5: Estimates of the sensitivity of investment to short-term debt. Full sample. Pre-crisis: 2006:Q3–2008:Q2, crisis: 2008:Q3–2010:Q2

Notes to the table. CRC: Correlated random coefficients, IV: 2SLS Instrumental variables, CUH: Compound unobserved heterogeneity. Explanatory variables: Tobin's Q and short-term debt. Excluded instruments: $cash_{t-20}$ and $cash_{t-22} \times d_t$. Estimates refer to the population averaged effects for each explanatory variable.

	(1) CRC	(2) CRC-IV	(3) CRC-IV-CUH
q	0.415***	0.505***	0.411**
	(7.89)	(6.30)	(2.89)
$q \times d$	-0.169***	-0.0907	0.0470
	(-8.46)	(-1.38)	(0.25)
net_st_debt	0.781***	2.975	5.610
	(4.22)	(1.45)	(1.80)
$net\_st\_debt \times d$	-0.941***	-1.384	-12.42*
	(-5.34)	(-1.84)	(-2.51)
p-value on $\mathbb{E}[\beta_{1i}^f + \beta_{2i}^f] = 0$	0.355	0.541	0.0802
N	15683	9615	9615
Kleibergen-Paap LM stat.		8.314	5.617
p-value (Chi-sq(1))		0.00393	0.0178

t statistics, based on robust standard errors clustered in the firm level, in parentheses

$^{*}\ p < 0.05$, $^{**}\ p < 0.01$, $^{***}\ p < 0.001$

Table 6: Estimates of the sensitivity of investment to net short-term debt. Full sample. Pre-crisis: 2006:Q3–2008:Q2, crisis: 2008:Q3–2010:Q2

Notes to the table. CRC: Correlated random coefficients, IV: 2SLS Instrumental variables, CUH: Compound unobserved heterogeneity. Explanatory variables: Tobin's Q and net short-term debt. Excluded instruments: $cash_{t-24}$ and $cash_{t-24} \times d_t$. Estimates refer to the population averaged effects for each explanatory variable.

	(2) CRC-IV		(3) CRC-IV-CUH	
	net_st_debt	$net\_st\_debt \times d$	net_st_debt	$net\_st\_debt \times d$
q	0.003	0.014	-0.012	0.000
	(0.57)	(1.42)	(-1.20)	(1.58)
$q \times d$	-0.007	-0.014**	0.031*	0.019*
	(-1.82)	(-2.61)	(2.33)	(2.25)
$cash_{t-24}$	-0.106***	0.066*	-0.103**	omitted
	(-3.73)	(2.10)	(-3.28)	
$cash_{t-24} \times d$	0.111***	-0.352***	0.017	-0.086*
	(3.68)	(-7.99)	(0.37)	(-2.32)
F stat.	10.07	13.15	10.41	6.68
N	9615	9615	9615	9615

t statistics, based on robust standard errors clustered in the firm level, in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 7: First-stage estimation results relative to Table 6. Full sample. Pre-crisis: 2006:Q3–2008:Q2, crisis: 2008:Q3–2010:Q2

Notes to the table. CRC: Correlated random coefficients, IV: 2SLS Instrumental variables, CUH: Compound unobserved heterogeneity. Excluded instruments: $cash_{t-24}$ and $cash_{t-24} \times d_t$.

	(1)	(2)	(3)	(4)
	CRC-IV-CUH	CRC-IV-CUH	CRC-IV-CUH	CRC-IV-CUH
q	0.411**	0.458*	0.399*	0.472*
	(2.89)	(1.99)	(2.33)	(2.43)
$q \times d$	0.0470	-0.00602	0.0777	0.153
	(0.25)	(-0.03)	(0.40)	(0.54)
net_st_debt	5.610	13.31	8.709	10.62
	(1.80)	(1.21)	(1.13)	(1.25)
$net\_st\_debt \times d$	-12.42*	-19.95	-14.36	-17.87
	(-2.51)	(-1.52)	(-1.49)	(-1.70)
p-value on $\mathbb{E}[\beta_{1i}^f + \beta_{2i}^f] = 0$	0.0802	0.0941	0.102	0.243
N	9615	10172	9480	5701
Kleibergen-Paap LM stat.	5.617	4.081	4.475	3.960
p-value (Chi-sq(1))	0.0178	0.0434	0.0344	0.0466
Instruments	$cash_{t-24}$	$cash_{t-20}$	$cash_{t-20}$	$net\_st\_debt_{t-25}$
	$cash_{t-24} \times d_t$	$cash_{t-24} \times d_t$	$net\_st\_debt_{t-18} \times d_t$	$cash_{t-24} \times d_t$

t statistics, based on robust standard errors clustered in the firm level, in parentheses. $^{*}\ p < 0.05$, $^{**}\ p < 0.01$, $^{***}\ p < 0.001$

Table 8: Estimates of the sensitivity of investment to net short-term debt (different instruments used). Full sample. Pre-crisis: 2006:Q3–2008:Q2, crisis: 2008:Q3–2010:Q2

Notes to the table. CRC: Correlated random coefficients, IV: 2SLS Instrumental variables, CUH: Compound unobserved heterogeneity. Explanatory variables: Tobin's Q and net short-term debt. Estimates refer to the population averaged effects for each explanatory variable.

	(1) CRC	(2) CRC-IV	(3) CRC-IV-CUH
q	0.401***	0.463***	0.355**
	(8.37)	(6.54)	(2.62)
$q \times d$	-0.158***	-0.0793	-0.0302
	(-6.84)	(-1.32)	(-0.19)
$cash$	-0.969***	-2.138	-8.034
	(-4.56)	(-0.54)	(-1.50)
$cash \times d$	0.221	1.021	12.30
	(1.19)	(1.20)	(1.56)
p-value on $\mathbb{E}[\beta_{1i}^f + \beta_{2i}^f] = 0$	0.0000273	0.811	0.468
N	26592	16396	16396
Kleibergen-Paap LM stat.		3.540	3.119
p-value (Chi-sq(1))		0.0599	0.0774

t statistics, based on robust standard errors clustered in the firm level, in parentheses

$^{*}\ p < 0.05$, $^{**}\ p < 0.01$, $^{***}\ p < 0.001$

Table 9: Estimates of the sensitivity of investment to cash reserves. Full sample. Pre-crisis: 2006:Q3–2008:Q2, crisis: 2008:Q3–2012:Q2

Notes to the table. CRC: Correlated random coefficients, IV: 2SLS Instrumental variables, CUH: Compound unobserved heterogeneity. Explanatory variables: Tobin's Q and cash reserves. Excluded instruments: $cash_{t-24} \times (1 - d_t)$ and $cash_{t-28} \times d_t$. Estimates refer to the population averaged effects for each explanatory variable.

	(1) CRC	(2) CRC-IV	(3) CRC-IV-CUH
q	0.363***	0.533*	0.288**
	(7.52)	(2.51)	(2.62)
$q \times d$	-0.0637**	0.127	0.221
	(-3.11)	(1.29)	(1.40)
st_debt	0.925***	16.35*	0.900
	(3.46)	(2.40)	(0.20)
$st\_debt \times d$	-1.840***	-1.328	7.615
	(-6.71)	(-0.11)	(0.86)
p-value on $\mathbb{E}[\beta_{1i}^f + \beta_{2i}^f] = 0$	0.00000028	0.300	0.302
N	24459	15160	15160
Kleibergen-Paap LM stat.		2.395	4.313
p-value (Chi-sq(1))		0.122	0.0378

t statistics, based on robust standard errors clustered in the firm level, in parentheses

$^{*}\ p < 0.05$, $^{**}\ p < 0.01$, $^{***}\ p < 0.001$

Table 10: Estimates of the sensitivity of investment to short-term debt. Full sample. Pre-crisis: 2006:Q3–2008:Q2, crisis: 2008:Q3–2012:Q2

Notes to the table. CRC: Correlated random coefficients, IV: 2SLS Instrumental variables, CUH: Compound unobserved heterogeneity. Explanatory variables: Tobin's Q and short-term debt. Excluded instruments: $cash_{t-20} \times (1 - d_t)$ and $cash_{t-30} \times d_t$. Estimates refer to the population averaged effects for each explanatory variable.

	(1) CRC	(2) CRC-IV	(3) CRC-IV-CUH
q	0.418***	0.605***	0.648*
	(7.84)	(7.35)	(2.35)
$q \times d$	-0.165***	-0.0194	-0.178
	(-8.58)	(-0.21)	(-0.64)
net_st_debt	0.632***	4.395	5.425
	(3.51)	(1.23)	(0.66)
$net\_st\_debt \times d$	-0.857***	-0.112	-0.551
	(-4.90)	(-0.07)	(-0.06)
p-value on $\mathbb{E}[\beta_{1i}^f + \beta_{2i}^f] = 0$	0.111	0.371	0.250
N	24502	12933	12933
Kleibergen-Paap LM stat.		5.267	4.444
p-value (Chi-sq(1))		0.0217	0.0350

t statistics, based on robust standard errors clustered in the firm level, in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 11: Estimates of the sensitivity of investment to net short-term debt. Full sample. Pre-crisis: 2006:Q3–2008:Q2, crisis: 2008:Q3–2012:Q2

Notes to the table. CRC: Correlated random coefficients, IV: 2SLS Instrumental variables, CUH: Compound unobserved heterogeneity. Explanatory variables: Tobin's Q and net short-term debt. Excluded instruments: $cash_{t-30} \times (1 - d_t)$ and $cash_{t-30} \times d_t$. Estimates refer to the population averaged effects for each explanatory variable.

	(1) CRC	(2) CRC-IV	(3) CRC-IV-CUH
q	0.404***	0.505***	0.351*
	(8.29)	(6.31)	(2.42)
$q \times d^f$	-0.155***	-0.105	-0.00788
	(-6.48)	(-1.11)	(-0.04)
$q \times d^s$	-0.157***	-0.139	-0.0821
	(-5.49)	(-1.82)	(-0.41)
$cash$	-0.961***	2.265	6.527
	(-4.49)	(0.75)	(0.85)
$cash \times d^f$	0.295	1.019	-0.247
	(1.61)	(1.63)	(-0.03)
$cash \times d^s$	0.119	1.319	-8.465
	(0.51)	(1.46)	(-0.97)
p-value on $\mathbb{E}[\beta_{1i}^f + \beta_{2i}^f] = 0$	0.000438	0.321	0.209
p-value on $\mathbb{E}[\beta_{1i}^f + \beta_{3i}^f] = 0$	0.000102	0.324	0.705
N	26592	13551	13551
Kleibergen-Paap LM stat.		13.78	5.978
p-value (Chi-sq(1))		0.000206	0.0145

t statistics, based on robust standard errors clustered in the firm level, in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 12: Estimates of the sensitivity of investment to cash reserves. Full sample. Pre-crisis: 2006:Q3–2008:Q2, financial crisis: 2008:Q3–2010:Q2, sovereign debt crisis: 2010:Q3–2012:Q2

Notes to the table. CRC: Correlated random coefficients, IV: 2SLS Instrumental variables, CUH: Compound unobserved heterogeneity. Explanatory variables: Tobin's Q and cash reserves. Excluded instruments: $cash_{t-18} \times (1 - d_t^f - d_t^s)$, $cash_{t-18} \times d_t^f$ and $cash_{t-30} \times d_t^s$. Estimates refer to the population averaged effects for each explanatory variable.

	(1) CRC	(2) CRC-IV	(3) CRC-IV-CUH
q	0.363***	0.672***	0.359**
	(7.48)	(3.90)	(2.88)
$q \times d^f$	-0.0645**	0.0315	0.0366
	(-2.90)	(0.28)	(0.23)
$q \times d^s$	-0.0609*	0.0481	-0.104
	(-2.55)	(0.49)	(-0.57)
st_debt	0.937***	15.84	10.36
	(3.50)	(1.60)	(1.26)
$st\_debt \times d^f$	-1.609***	0.137	-13.00
	(-6.02)	(0.06)	(-1.26)
$st\_debt \times d^s$	-2.145***	4.617	-14.26
	(-6.52)	(1.05)	(-1.29)
p-value on $\mathbb{E}[\beta_{1i}^f + \beta_{2i}^f] = 0$	0.000328	0.142	0.644
p-value on $\mathbb{E}[\beta_{1i}^f + \beta_{3i}^f] = 0$	0.0000003	0.118	0.579
N	24459	12497	12497
Kleibergen-Paap LM stat.		4.934	3.175
p-value (Chi-sq(1))		0.0263	0.0748

t statistics, based on robust standard errors clustered in the firm level, in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 13: Estimates of the sensitivity of investment to short-term debt. Full sample. Pre-crisis: 2006:Q3–2008:Q2, financial crisis: 2008:Q3–2010:Q2, sovereign debt crisis: 2010:Q3–2012:Q2

Notes to the table. CRC: Correlated random coefficients, IV: 2SLS Instrumental variables, CUH: Compound unobserved heterogeneity. Explanatory variables: Tobin's Q and short-term debt. Excluded instruments: $cash_{t-25} \times (1 - d_t^f - d_t^s)$, $st\_debt_{t-20} \times d_t^f$ and $net\_st\_debt_{t-30} \times d_t^s$. Estimates refer to the population averaged effects for each explanatory variable.

	(1) CRC	(2) CRC-IV	(3) CRC-IV-CUH
q	0.422***	0.501***	0.411**
	(7.87)	(6.44)	(2.89)
$q \times d^f$	-0.151***	-0.139	0.0470
	(-7.69)	(-1.29)	(0.25)
$q \times d^s$	-0.177***	-0.194	-0.109
	(-7.92)	(-1.71)	(-0.60)
net_st_debt	0.636***	-0.224	5.610
	(3.53)	(-0.06)	(1.80)
$net\_st\_debt \times d^f$	-0.786***	-2.653	-12.42*
	(-4.53)	(-1.95)	(-2.51)
$net\_st\_debt \times d^s$	-0.957***	-2.269	-7.482
	(-4.41)	(-1.10)	(-1.71)
p-value on $\mathbb{E}[\beta^f_{1i} + \beta^f_{2i}] = 0$	0.296	0.578	0.0802
p-value on $\mathbb{E}[\beta^f_{1i} + \beta^f_{3i}] = 0$	0.0804	0.672	0.505
N	24502	13665	13665
Kleibergen-Paap LM stat.		2.082	5.617
p-value (Chi-sq(1))		0.149	0.0178

t statistics, based on robust standard errors clustered in the firm level, in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 14: Estimates of the sensitivity of investment to net short-term debt. Full sample. Pre-crisis: 2006:Q3–2008:Q2, financial crisis: 2008:Q3–2010:Q2, sovereign debt crisis: 2010:Q3–2012:Q2

Notes to the table. CRC: Correlated random coefficients, IV: 2SLS Instrumental variables, CUH: Compound unobserved heterogeneity. Explanatory variables: Tobin's Q and net short-term debt. Excluded instruments: $cash_{t-24} \times (1 - d^f_t - d^s_t)$, $cash_{t-24} \times d^f_t$ and $net\_st\_debt_{t-30} \times d^s_t$. Estimates refer to the population averaged effects for each explanatory variable.

	(1) CRC	(2) CRC-IV	(3) CRC-IV-CUH
q	0.545***	0.440***	0.146
	(10.76)	(4.98)	(1.07)
$q \times d$	-0.0598**	-0.0809	0.249
	(-2.90)	(-1.10)	(1.57)
$cash$	-1.235***	5.116	3.670
	(-5.21)	(1.24)	(0.49)
$cash \times d$	0.295	1.570	-1.747
	(1.55)	(1.34)	(-0.21)
p-value on $\mathbb{E}[\beta_{1i}^f + \beta_{2i}^f] = 0$	0.0000109	0.197	0.612
N	16910	11891	11891
Kleibergen-Paap LM stat.		5.632	5.530
p-value (Chi-sq(1))		0.0176	0.0187

t statistics, based on robust standard errors clustered in the firm level, in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 15: Estimates of the sensitivity of investment to cash reserves. Full sample. Pre-crisis: 2006:Q3–2007:Q2, crisis: 2007:Q3–2010:Q2

Notes to the table. CRC: Correlated random coefficients, IV: 2SLS Instrumental variables, CUH: Compound unobserved heterogeneity. Explanatory variables: Tobin's Q and cash reserves. Excluded instruments: $cash_{t-21} \times (1 - d_t)$ and $cash_{t-18} \times d_t$. Estimates refer to the population averaged effects for each explanatory variable.

	(1) CRC	(2) CRC-IV	(3) CRC-IV-CUH
q	0.503***	0.514***	0.540
	(9.05)	(5.47)	(1.52)
$q \times d$	0.00520	-0.0900	-0.0385
	(0.27)	(-1.47)	(-0.10)
st_debt	0.803**	8.332	-13.92
	(2.58)	(1.72)	(-1.17)
$st\_debt \times d$	-1.223***	-1.226	14.25
	(-4.12)	(-0.82)	(1.17)
p-value on $\mathbb{E}[\beta_{1i}^f + \beta_{2i}^f] = 0$	0.0365	0.179	0.909
N	15652	9639	9639
Kleibergen-Paap LM stat.		8.723	15.16
p-value (Chi-sq(1))		0.00314	0.0000987

t statistics, based on robust standard errors clustered in the firm level, in parentheses

$^{*}\ p < 0.05$, $^{**}\ p < 0.01$, $^{***}\ p < 0.001$

Table 16: Estimates of the sensitivity of investment to short-term debt. Full sample. Pre-crisis: 2006:Q3–2007:Q2, crisis: 2007:Q3–2010:Q2

Notes to the table. CRC: Correlated random coefficients, IV: 2SLS Instrumental variables, CUH: Compound unobserved heterogeneity. Explanatory variables: Tobin's Q and short-term debt. Excluded instruments: $st\_debt_{t-20} \times (1 - d_t)$ and $cash_{t-22} \times d_t$. Estimates refer to the population averaged effects for each explanatory variable.

	(1) CRC	(2) CRC-IV	(3) CRC-IV-CUH
q	0.561***	0.536***	0.0422
	(10.30)	(6.05)	(0.20)
$q \times d$	-0.0584***	-0.108	0.537*
	(-3.47)	(-1.82)	(2.28)
net_st_debt	0.805***	2.627	6.388
	(3.92)	(1.33)	(1.51)
$net\_st\_debt \times d$	-0.644***	-1.007	-12.88
	(-3.44)	(-1.03)	(-1.94)
p-value on $\mathbb{E}[\beta_{1i}^f + \beta_{2i}^f] = 0$	0.344	0.549	0.242
N	15683	9615	9615
Kleibergen-Paap LM stat.		7.399	3.042
p-value (Chi-sq(1))		0.00652	0.0811

t statistics, based on robust standard errors clustered in the firm level, in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 17: Estimates of the sensitivity of investment to net short-term debt. Full sample. Pre-crisis: 2006:Q3–2007:Q2, crisis: 2007:Q3–2010:Q2

Notes to the table. CRC: Correlated random coefficients, IV: 2SLS Instrumental variables, CUH: Compound unobserved heterogeneity. Explanatory variables: Tobin's Q and net short-term debt. Excluded instruments: $cash_{t-24}$ and $cash_{t-24} \times d_t$. Estimates refer to the population averaged effects for each explanatory variable.

	(1) CRC	(2) CRC-IV	(3) CRC-IV-CUH
q	0.274***	0.239*	0.223
	(4.35)	(2.42)	(1.59)
$q \times d$	-0.0141	0.0475	0.214
	(-0.70)	(1.06)	(0.98)
$cash$	-0.805*	3.218	1.161
	(-2.57)	(0.45)	(0.21)
$cash \times d$	0.274	-0.247	-1.722
	(1.43)	(-0.22)	(-0.18)
p-value on $\mathbb{E}[\beta_{1i}^f + \beta_{2i}^f] = 0$	0.0719	0.719	0.916
N	7777	5323	5323
Kleibergen-Paap LM stat.		2.687	6.646
p-value (Chi-sq(1))		0.101	0.00994

t statistics, based on robust standard errors clustered in the firm level, in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 18: Estimates of the sensitivity of investment to cash reserves. Full sample. Pre-crisis: 2006:Q3–2007:Q2, crisis: 2007:Q3–2008:Q2

Notes to the table. CRC: Correlated random coefficients, IV: 2SLS Instrumental variables, CUH: Compound unobserved heterogeneity. Explanatory variables: Tobin's Q and cash reserves. Excluded instruments: $cash_{t-12}$ and $cash_{t-22} \times d_t$. Estimates refer to the population averaged effects for each explanatory variable.

	(1) CRC	(2) CRC-IV	(3) CRC-IV-CUH
q	0.243***	0.287**	0.184
	(3.57)	(2.74)	(0.94)
$q \times d$	0.00644	-0.0421	-0.149
	(0.36)	(-1.18)	(-0.48)
st_debt	-0.0193	-3.124	8.308
	(-0.05)	(-0.45)	(0.90)
$st\_debt \times d$	-0.0184	4.472	-27.64
	(-0.06)	(1.16)	(-1.66)
p-value on $\mathbb{E}[\beta_{1i}^f + \beta_{2i}^f] = 0$	0.928	0.784	0.170
N	7239	5787	5787
Kleibergen-Paap LM stat.		11.49	5.196
p-value (Chi-sq(1))		0.000699	0.0226

t statistics, based on robust standard errors clustered in the firm level, in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 19: Estimates of the sensitivity of investment to short-term debt. Full sample. Pre-crisis: 2006:Q3–2007:Q2, crisis: 2007:Q3–2008:Q2

Notes to the table. CRC: Correlated random coefficients, IV: 2SLS Instrumental variables, CUH: Compound unobserved heterogeneity. Explanatory variables: Tobin's Q and short-term debt. Excluded instruments: $cash_{t-10} \times (1 - d_t)$ and $cash_{t-11} \times d_t$. Estimates refer to the population averaged effects for each explanatory variable.

	(1) CRC	(2) CRC-IV	(3) CRC-IV-CUH
q	0.260***	0.445**	0.0422
	(3.77)	(3.12)	(0.20)
$q \times d$	-0.000592	-0.0658	0.319
	(-0.04)	(-1.32)	(1.23)
net_st_debt	0.329	5.649	6.388
	(1.11)	(1.85)	(1.51)
$net\_st\_debt \times d$	-0.217	0.666	-4.670
	(-1.07)	(0.65)	(-0.90)
p-value on $\mathbb{E}[\beta_{1i}^f + \beta_{2i}^f] = 0$	0.711	0.0888	0.605
N	7253	4009	4009
Kleibergen-Paap LM stat.		9.264	6.161
p-value (Chi-sq(1))		0.00234	0.0131

t statistics, based on robust standard errors clustered in the firm level, in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 20: Estimates of the sensitivity of investment to net short-term debt. Full sample. Pre-crisis: 2006:Q3–2007:Q2, crisis: 2007:Q3–2008:Q2

Notes to the table. CRC: Correlated random coefficients, IV: 2SLS Instrumental variables, CUH: Compound unobserved heterogeneity. Explanatory variables: Tobin's Q and net short-term debt. Excluded instruments: $cash_{t-24}$ and $cash_{t-24} \times d_t$. Estimates refer to the population averaged effects for each explanatory variable.

	(1) CRC	(2) CRC-IV	(3) CRC-IV-CUH
q	0.461***	0.425***	0.225*
	(8.14)	(4.67)	(2.10)
$q \times d$	-0.166***	-0.0794	0.0560
	(-5.61)	(-0.88)	(0.40)
$cash$	-1.155***	1.774	-1.364
	(-5.11)	(0.42)	(-0.39)
$cash \times d$	0.561**	1.135	2.729
	(3.00)	(1.27)	(0.63)
p-value on $\mathbb{E}[\beta_{1i}^f + \beta_{2i}^f] = 0$	0.00604	0.558	0.697
N	12779	9586	9586
Kleibergen-Paap LM stat.		3.891	4.909
p-value (Chi-sq(1))		0.0485	0.0267

t statistics, based on robust standard errors clustered in the firm level, in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 21: Estimates of the sensitivity of investment to cash reserves. Sample: Core countries (Austria, Belgium, France, Germany, Netherlands, UK). Pre-crisis: 2006:Q3–2008:Q2, crisis: 2008:Q3–2010:Q2

Notes to the table. CRC: Correlated random coefficients, IV: 2SLS Instrumental variables, CUH: Compound unobserved heterogeneity. Explanatory variables: Tobin's Q and cash reserves. Excluded instruments: $cash_{t-18}$ and $cash_{t-18} \times d_t$. Estimates refer to the population averaged effects for each explanatory variable.

	(1) CRC	(2) CRC-IV	(3) CRC-IV-CUH
q	0.443***	0.494**	0.307**
	(7.32)	(3.15)	(2.65)
$q \times d$	-0.0545	-0.120	-0.000435
	(-1.95)	(-0.31)	(-0.00)
st_debt	0.823**	7.130	1.566
	(2.76)	(0.59)	(0.25)
$st\_debt \times d$	-1.527***	7.087	-1.460
	(-4.44)	(0.32)	(-0.19)
p-value on $\mathbb{E}[\beta_{1i}^f + \beta_{2i}^f] = 0$	0.00484	0.313	0.974
N	11651	8067	8067
Kleibergen-Paap LM stat.		1.186	11.39
p-value (Chi-sq(1))		0.276	0.000740

t statistics, based on robust standard errors clustered in the firm level, in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 22: Estimates of the sensitivity of investment to short-term debt. Sample: Core countries (Austria, Belgium, France, Germany, Netherlands, UK). Pre-crisis: 2006:Q3–2008:Q2, crisis: 2008:Q3–2010:Q2

Notes to the table. CRC: Correlated random coefficients, IV: 2SLS Instrumental variables, CUH: Compound unobserved heterogeneity. Explanatory variables: Tobin's Q and short-term debt. Excluded instruments: $cash_{t-20}$ and $cash_{t-22} \times d_t$. Estimates refer to the population averaged effects for each explanatory variable.

	(1) CRC	(2) CRC-IV	(3) CRC-IV-CUH
q	0.494***	0.488***	0.380*
	(8.37)	(4.97)	(2.39)
$q \times d$	-0.145***	-0.0546	0.0318
	(-6.14)	(-0.67)	(0.17)
net_st_debt	0.772***	2.629	4.937
	(4.02)	(1.48)	(1.51)
$net\_st\_debt \times d$	-0.922***	-1.078	-9.043*
	(-4.56)	(-1.38)	(-2.20)
p-value on $\mathbb{E}[\beta_{1i}^f + \beta_{2i}^f] = 0$	0.437	0.492	0.103
N	11690	7526	7526
Kleibergen-Paap LM stat.		9.045	7.009
p-value (Chi-sq(1))		0.00263	0.00811

t statistics, based on robust standard errors clustered in the firm level, in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 23: Estimates of the sensitivity of investment to net short-term debt. Sample: Core countries (Austria, Belgium, France, Germany, Netherlands, UK). Pre-crisis: 2006:Q3–2008:Q2, crisis: 2008:Q3–2010:Q2

Notes to the table. CRC: Correlated random coefficients, IV: 2SLS Instrumental variables, CUH: Compound unobserved heterogeneity. Explanatory variables: Tobin's Q and net short-term debt. Excluded instruments: $cash_{t-24}$ and $cash_{t-24} \times d_t$. Estimates refer to the population averaged effects for each explanatory variable.

	(1) CRC	(2) CRC-IV	(3) CRC-IV-CUH
q	0.394***	0.466***	0.292**
	(6.45)	(4.06)	(2.76)
$q \times d$	-0.152***	-0.134	0.0773
	(-5.45)	(-1.13)	(0.46)
$cash$	-1.087***	9.020	3.430
	(-4.02)	(1.00)	(0.67)
$cash \times d$	0.114	2.760	3.176
	(0.50)	(1.23)	(0.32)
p-value on $\mathbb{E}[\beta_{1i}^f + \beta_{2i}^f] = 0$	0.000379	0.288	0.494
N	11696	8367	8367
Kleibergen-Paap LM stat.		2.329	1.874
p-value (Chi-sq(1))		0.127	0.171

t statistics, based on robust standard errors clustered in the firm level, in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 24: Estimates of the sensitivity of investment to cash reserves. Sample: Firms in the construction, manufacturing, transportation, communications sectors. Pre-crisis: 2006:Q3–2008:Q2, crisis: 2008:Q3–2010:Q2

Notes to the table. CRC: Correlated random coefficients, IV: 2SLS Instrumental variables, CUH: Compound unobserved heterogeneity. Explanatory variables: Tobin's Q and cash. Excluded instruments: $cash_{t-18}$ and $cash_{t-18} \times d_t$. Estimates refer to the population averaged effects for each explanatory variable.

	(1) CRC	(2) CRC-IV	(3) CRC-IV-CUH
q	0.364***	0.467***	0.285*
	(6.11)	(3.88)	(1.98)
$q \times d$	-0.0546*	-0.0509	0.0817
	(-2.29)	(-0.34)	(0.49)
st_debt	0.847**	5.423	-0.313
	(2.82)	(1.21)	(-0.03)
$st\_debt \times d$	-1.864***	1.335	1.616
	(-5.97)	(0.18)	(0.11)
p-value on $\mathbb{E}[\beta_{1i}^f + \beta_{2i}^f] = 0$	0.0000354	0.410	0.792
N	10962	7152	7152
Kleibergen-Paap LM stat.		3.561	4.289
p-value (Chi-sq(1))		0.0591	0.0384

t statistics, based on robust standard errors clustered in the firm level, in parentheses

$^{*}\ p < 0.05$, $^{**}\ p < 0.01$, $^{***}\ p < 0.001$

Table 25: Estimates of the sensitivity of investment to short-term debt. Sample: Firms in the construction, manufacturing, transportation, communications sectors. Pre-crisis: 2006:Q3–2008:Q2, crisis: 2008:Q3–2010:Q2

Notes to the table. CRC: Correlated random coefficients, IV: 2SLS Instrumental variables, CUH: Compound unobserved heterogeneity. Explanatory variables: Tobin's Q and short-term debt. Excluded instruments: $cash_{t-20}$ and $cash_{t-22} \times d_t$. Estimates refer to the population averaged effects for each explanatory variable.

	(1) CRC	(2) CRC-IV	(3) CRC-IV-CUH
q	0.410***	0.502***	0.396*
	(6.11)	(5.14)	(1.97)
$q \times d$	-0.160***	-0.0749	0.200
	(-7.34)	(-1.39)	(0.73)
net_st_debt	0.581**	1.341	8.298
	(2.77)	(0.33)	(1.41)
$net\_st\_debt \times d$	-0.811***	-0.999	-18.84*
	(-3.92)	(-0.71)	(-1.98)
p-value on $\mathbb{E}[\beta_{1i}^f + \beta_{2i}^f] = 0$	0.269	0.949	0.148
N	10958	6715	6715
Kleibergen-Paap LM stat.		2.074	2.574
p-value (Chi-sq(1))		0.150	0.109

t statistics, based on robust standard errors clustered in the firm level, in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 26: Estimates of the sensitivity of investment to net short-term debt. Sample: Firms in the construction, manufacturing, transportation, communications sectors. Pre-crisis: 2006:Q3–2008:Q2, crisis: 2008:Q3–2010:Q2

Notes to the table. CRC: Correlated random coefficients, IV: 2SLS Instrumental variables, CUH: Compound unobserved heterogeneity. Explanatory variables: Tobin's Q and net short-term debt. Excluded instruments: $cash_{t-24}$ and $cash_{t-24} \times d_t$. Estimates refer to the population averaged effects for each explanatory variable.

	(1) CRC	(2) CRC-IV	(3) CRC-IV-CUH
q	0.409***	0.425***	0.251**
	(8.11)	(5.48)	(2.64)
$q \times d$	-0.182***	-0.135	0.0463
	(-7.14)	(-1.81)	(0.36)
$cash$	-1.251***	4.201	2.541
	(-5.67)	(1.12)	(0.65)
$cash \times d$	0.509**	1.924*	0.505
	(2.77)	(2.21)	(0.11)
p-value on $\mathbb{E}[\beta_{1i}^f + \beta_{2i}^f] = 0$	0.000502	0.173	0.404
N	16164	11501	11501
Kleibergen-Paap LM stat.		7.931	6.543
p-value (Chi-sq(1))		0.00486	0.0105

t statistics, based on robust standard errors clustered in the firm level, in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 27: Estimates of the sensitivity of investment to cash reserves. Sample: State-owned firms excluded. Pre-crisis: 2006:Q3–2008:Q2, crisis: 2008:Q3–2010:Q2

Notes to the table. CRC: Correlated random coefficients, IV: 2SLS Instrumental variables, CUH: Compound unobserved heterogeneity. Explanatory variables: Tobin's Q and cash reserves. Excluded instruments: $cash_{t-18}$ and $cash_{t-18} \times d_t$. Estimates refer to the population averaged effects for each explanatory variable.

	(1) CRC	(2) CRC-IV	(3) CRC-IV-CUH
q	0.369***	0.466***	0.310**
	(7.42)	(3.79)	(2.64)
$q \times d$	-0.0727**	-0.0607	-0.0292
	(-3.08)	(-0.33)	(-0.21)
st_debt	0.867**	14.50*	5.226
	(3.29)	(2.11)	(0.68)
$st\_debt \times d$	-1.650***	1.100	-4.732
	(-6.04)	(0.11)	(-0.50)
p-value on $\mathbb{E}[\beta_{1i}^f + \beta_{2i}^f] = 0$	0.000299	0.143	0.879
N	14911	9677	9677
Kleibergen-Paap LM stat.		4.065	9.812
p-value (Chi-sq(1))		0.0438	0.00173

t statistics, based on robust standard errors clustered in the firm level, in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 28: Estimates of the sensitivity of investment to short-term debt. Sample: State-owned firms excluded. Pre-crisis: 2006:Q3–2008:Q2, crisis: 2008:Q3–2010:Q2

Notes to the table. CRC: Correlated random coefficients, IV: 2SLS Instrumental variables, CUH: Compound unobserved heterogeneity. Explanatory variables: Tobin's Q and short-term debt. Excluded instruments: $cash_{t-20}$ and $cash_{t-22} \times d_t$. Estimates refer to the population averaged effects for each explanatory variable.

	(1) CRC	(2) CRC-IV	(3) CRC-IV-CUH
q	0.413***	0.503***	0.406**
	(7.74)	(6.11)	(2.82)
$q \times d$	-0.173***	-0.102	0.0386
	(-8.36)	(-1.51)	(0.21)
net_st_debt	0.806***	2.941	5.332
	(4.25)	(1.42)	(1.76)
$net\_st\_debt \times d$	-0.964***	-1.478	-11.80*
	(-5.41)	(-1.96)	(-2.43)
p-value on $\mathbb{E}[\beta_{1i}^f + \beta_{2i}^f] = 0$	0.367	0.575	0.0942
N	14941	9025	9025
Kleibergen-Paap LM stat.		8.194	5.382
p-value (Chi-sq(1))		0.00420	0.0203

t statistics, based on robust standard errors clustered in the firm level, in parentheses

$^{*}\ p < 0.05$, $^{**}\ p < 0.01$, $^{***}\ p < 0.001$

Table 29: Estimates of the sensitivity of investment to net short-term debt. Sample: State-owned firms excluded. Pre-crisis: 2006:Q3–2008:Q2, crisis: 2008:Q3–2010:Q2

Notes to the table. CRC: Correlated random coefficients, IV: 2SLS Instrumental variables, CUH: Compound unobserved heterogeneity. Explanatory variables: Tobin's Q and net short-term debt. Excluded instruments: $cash_{t-24}$ and $cash_{t-24} \times d_t$. Estimates refer to the population averaged effects for each explanatory variable.

	(1) CRC	(2) CRC-IV	(3) CRC-IV-CUH
q	0.308***	0.557***	0.270*
	(6.39)	(6.02)	(2.28)
$q \times d$	-0.0313	-0.162	0.422
	(-0.83)	(-1.53)	(1.45)
st_debt	0.328	1.977	1.747
	(1.29)	(0.33)	(0.33)
$st\_debt \times d$	-1.277***	0.880	-20.47
	(-4.81)	(0.64)	(-1.71)
$cash$	-0.987***	2.579	5.581
	(-3.95)	(0.66)	(1.14)
$cash \times d$	0.513*	2.365	-4.483
	(2.17)	(1.89)	(-0.43)
p-value on $\mathbb{E}[\beta_{1i}^{f1} + \beta_{2i}^{f1}] = 0$	0.0000055	0.671	0.0923
p-value on $\mathbb{E}[\beta_{1i}^{f2} + \beta_{2i}^{f2}] = 0$	0.0646	0.314	0.899
N	15476	8625	8625
Kleibergen-Paap LM stat.		6.029	3.350
p-value (Chi-sq(1))		0.0141	0.0672

t statistics, based on robust standard errors clustered in the firm level, in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 30: Estimates of the sensitivity of investment to short-term debt and cash reserves. Full sample. Pre-crisis: 2006:Q3–2008:Q2, crisis: 2008:Q3–2010:Q2

Notes to the table. CRC: Correlated random coefficients, IV: 2SLS Instrumental variables, CUH: Compound unobserved heterogeneity. Explanatory variables: Tobin's Q, cash and short-term debt. Excluded instruments: $cash_{t-20} \times (1 - d_t)$, $cash_{t-26} \times d_t$, $cash_{t-18} \times (1 - d_t)$ and $net\_st\_debt_{t-18} \times d_t$. Estimates refer to the population averaged effects for each explanatory variable.

	(1) CRC	(2) CRC-IV	(3) CRC-IV-CUH
q	0.410***	0.521***	0.395**
	(7.62)	(6.10)	(2.85)
$q \times d$	-0.182***	-0.111	0.0889
	(-7.43)	(-1.79)	(0.48)
$cash\_flow$	0.00324	-0.0120	0.0220
	(0.35)	(-0.79)	(0.83)
$cash\_flow \times d$	0.00950	0.0106	-0.0492
	(1.00)	(0.63)	(-1.66)
net_st_debt	0.812***	3.098	5.761
	(4.47)	(1.48)	(1.78)
$net\_st\_debt \times d$	-0.935***	-1.414	-12.54*
	(-5.31)	(-1.95)	(-2.53)
p-value on $\mathbb{E}[\beta_{1i}^f + \beta_{2i}^f] = 0$	0.471	0.521	0.0757
N	15681	9613	9613
Kleibergen-Paap LM stat.		8.542	5.831
p-value (Chi-sq(1))		0.00347	0.0157

t statistics, based on robust standard errors clustered in the firm level, in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 31: Estimates of the sensitivity of investment to net short-term debt, with cash flow as an additional control. Full sample. Pre-crisis: 2006:Q3–2008:Q2, crisis: 2008:Q3–2010:Q2

Notes to the table. CRC: Correlated random coefficients, IV: 2SLS Instrumental variables, CUH: Compound unobserved heterogeneity. Explanatory variables: Tobin's Q, cash flow and net short-term debt. Excluded instruments: $cash_{t-24}$ and $cash_{t-24} \times d_t$. Estimates refer to the population averaged effects for each explanatory variable.

	(1) FE	(2) FE-IV	(3) FE-IV-ISS
$L.investment$	-0.256***	0.406	0.626
	(-10.34)	(0.27)	(0.42)
$L.investment \times d$	-0.0474	-0.187	0.00712
	(-1.71)	(-0.11)	(0.01)
q	0.207***	0.221	0.0756
	(4.32)	(0.94)	(0.24)
$q \times d$	0.0886**	0.109	0.210
	(2.79)	(0.21)	(0.59)
$cash$	-1.134***	1.576	-11.39
	(-4.32)	(0.21)	(-0.64)
$cash \times d$	-0.211	-0.193	13.25
	(-0.96)	(-0.06)	(0.61)
p-value on $\beta_1^f + \beta_2^f = 0$	0.00000995	0.790	0.762
N	13678	6016	5639
Kleibergen-Paap LM stat.		0.198	3.175
p-value (Chi-sq(1))		0.656	0.0748

t statistics, based on robust standard errors clustered in the firm level, in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 32: Estimates of the sensitivity of investment to cash reserves using a dynamic model of investment. Full sample. Pre-crisis: 2006:Q3–2008:Q2, crisis: 2008:Q3–2010:Q2

Notes to the table. FE: Fixed effects, IV: 2SLS Instrumental variables, ISS: Individual specific slopes. Explanatory variables: Tobin's Q, lagged investment and cash. Excluded instruments: $cash_{t-24}$, $cash_{t-18} \times d_t$, $investment_{t-19}$ and $investment_{t-18} \times d_t$.

	(1)	(2)	(3)
	FE	FE-IV	FE-IV-ISS
$L.investment$	-0.259***	-2.295	1.149
	(-9.82)	(-0.06)	(0.61)
$L.investment \times d$	-0.0361	0.538	-0.698
	(-1.23)	(0.07)	(-0.40)
q	0.232***	0.906	0.213
	(4.28)	(0.09)	(0.69)
$q \times d$	0.0746*	0.0876	0.0129
	(2.43)	(0.06)	(0.04)
st_debt	0.100	63.27	0.360
	(0.33)	(0.07)	(0.04)
$st\_debt \times d$	-0.231	-177.0	3.367
	(-0.78)	(-0.07)	(0.31)
p-value on $\beta_1^f + \beta_2^f = 0$	0.608	0.944	0.464
N	12558	5949	5582
Kleibergen-Paap LM stat.		0.00486	1.595
p-value (Chi-sq(1))		0.944	0.207

t statistics, based on robust standard errors clustered in the firm level, in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 33: Estimates of the sensitivity of investment to short-term debt using a dynamic model of investment. Full sample. Pre-crisis: 2006:Q3–2008:Q2, crisis: 2008:Q3–2010:Q2

Notes to the table. FE: Fixed effects, IV: 2SLS Instrumental variables, ISS: Individual specific slopes. Explanatory variables: Tobin's Q, lagged investment and short-term debt. Excluded instruments: $cash_{t-20}$, $cash_{t-22} \times d_t$, $investment_{t-19}$ and $investment_{t-18} \times d_t$.

	(1) FE	(2) FE-IV	(3) FE-IV-ISS
$L.investment$	-0.260***	0.123	-0.257
	(-9.88)	(0.20)	(-0.24)
$L.investment \times d$	-0.0375	-0.229	0.545
	(-1.28)	(-0.35)	(0.56)
q	0.229***	0.189	0.226
	(4.27)	(1.66)	(1.03)
$q \times d$	0.0644*	0.179	0.283
	(2.12)	(0.67)	(0.91)
net_st_debt	0.565*	-0.826	13.15
	(2.55)	(-0.24)	(1.21)
$net\_st\_debt \times d$	-0.104	1.461	-23.37
	(-0.49)	(0.73)	(-1.42)
p-value on $\beta_1^f + \beta_2^f = 0$	0.0478	0.817	0.146
N	12575	5402	5068
Kleibergen-Paap LM stat.		0.969	4.107
p-value (Chi-sq(1))		0.325	0.0427

t statistics, based on robust standard errors clustered in the firm level, in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 34: Estimates of the sensitivity of investment to net short-term debt using a dynamic model of investment. Full sample. Pre-crisis: 2006:Q3–2008:Q2, crisis: 2008:Q3–2010:Q2

Notes to the table. FE: Fixed effects, IV: 2SLS Instrumental variables, ISS: Individual specific slopes. Explanatory variables: Tobin's Q, lagged investment and net short-term debt. Excluded instruments: $cash_{t-24}$, $cash_{t-21} \times d_t$, $investment_{t-19}$ and $investment_{t-18} \times d_t$.

	(1) CRC	(2) CRC-IV	(3) CRC-IV-CUH
q	0.371***	0.427***	0.261
	(7.57)	(4.09)	(1.29)
$q \times d$	-0.0710**	0.0000145	0.0990
	(-3.12)	(0.00)	(0.42)
st_debt	0.827**	9.175	-0.656
	(3.26)	(1.51)	(-0.06)
$st\_debt \times d$	-1.628***	-3.283**	-1.600
	(-6.14)	(-2.67)	(-0.10)
p-value on $\mathbb{E}[\beta_{1i}^f + \beta_{2i}^f] = 0$	0.000200	0.312	0.792
N	15652	6151	6151
Kleibergen-Paap LM stat.		4.223	4.281
p-value (Chi-sq(1))		0.0399	0.0385

t statistics, based on robust standard errors clustered in the firm level, in parentheses

$^{*}\ p < 0.05$, $^{**}\ p < 0.01$, $^{***}\ p < 0.001$

Table 35: Estimates of the sensitivity of investment to short-term debt. Full sample. Pre-crisis: 2006:Q3–2008:Q2, crisis: 2008:Q3–2010:Q2

Notes to the table. CRC: Correlated random coefficients, IV: 2SLS Instrumental variables, CUH: Compound unobserved heterogeneity. Explanatory variables: Tobin's Q and short-term debt. Excluded instruments: st_debt_{t-20} and $st\_debt_{t-28} \times d_t$. Estimates refer to the population averaged effects for each explanatory variable.

	(1) CRC	(2) CRC-IV	(3) CRC-IV-CUH
q	0.415***	0.477***	0.466**
	(7.89)	(3.65)	(2.60)
$q \times d$	-0.169***	-0.0253	0.110
	(-8.46)	(-0.39)	(0.46)
net_st_debt	0.781***	5.319	9.395
	(4.22)	(1.39)	(1.11)
$net\_st\_debt \times d$	-0.941***	1.072	-15.32
	(-5.34)	(0.93)	(-1.57)
p-value on $\mathbb{E}[\beta_{1i}^f + \beta_{2i}^f] = 0$	0.355	0.187	0.105
N	15683	5365	5365
Kleibergen-Paap LM stat.		6.438	4.975
p-value (Chi-sq(1))		0.0112	0.0257

t statistics, based on robust standard errors clustered in the firm level, in parentheses

$^{*}\ p < 0.05$, $^{**}\ p < 0.01$, $^{***}\ p < 0.001$

Table 36: Estimates of the sensitivity of investment to net short-term debt. Full sample. Pre-crisis: 2006:Q3–2008:Q2, crisis: 2008:Q3–2010:Q2

Notes to the table. CRC: Correlated random coefficients, IV: 2SLS Instrumental variables, CUH: Compound unobserved heterogeneity. Explanatory variables: Tobin's Q and net short-term debt. Excluded instruments: $net\_st\_debt_{t-25}$ and $net\_st\_debt_{t-18} \times d_t$. Estimates refer to the population averaged effects for each explanatory variable.

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2017

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