Debt Overhang, Rollover Risk, and Corporate Investment: Evidence from the European Crisis

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Abstract

We quantify the role of financial leverage behind the sluggish post-crisis investment performance of European firms. We use a cross-country firm-bank matched database to identify separate roles for firm leverage, bank balance sheet weaknesses arising from sovereign risk, and aggregate demand conditions. We find that firms entering the crisis with higher debt levels reduce their investment more after the crisis. This negative effect is stronger for firms holding short-term debt in countries whose banks were weak due to sovereign stress, consistent with rollover risk being an important channel influencing investment. The negative effect of firm leverage on investment is also persistent for several years after the shock in the countries with sovereign stress. The corporate leverage channel can explain about 20% of the cumulative decline in aggregate private sector investment over the crisis period. (JEL: E22, E32, E44, F34, F36, G32)

Keywords: Firm Investment, Corporate Debt, Bank-Sovereign Nexus.

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1. Introduction

Investment expenditure in Europe experienced a dramatic collapse in the aftermath of the 2008 global financial crisis. Net corporate investment as a share of GDP in the euro area more than halved from its peak in 2008, with even sharper declines in the most affected periphery countries, and by the end of 2017 had still not recovered to pre-crisis levels (Figure 1, panel A). By contrast, the U.S. recovered much faster over the same period, reaching its 2008 peak by 2014. This

collapse in corporate investment in Europe followed a boom period during which the corporate sector borrowed heavily (Figure 1, panel B). Indebtedness of euro area non-financial corporations, measured as debt liabilities to GDP, increased 30 percentage points since 1999 on average, and 90 percentage points for the countries in the periphery.

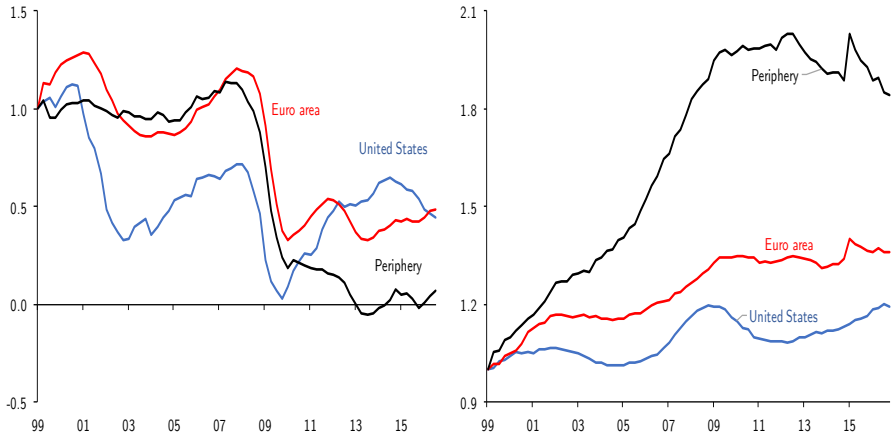

FIGURE 1. Evolution of Net Corporate Investment and Corporate Leverage. Net fixed capital formation of non-financial corporations, scaled by total economy GDP (left-hand side panel A) and credit to nonfinancial corporations granted by banks and non-banks, scaled by total economy GDP (right-hand side panel B). Quarterly data for the period 1999 to 2016. Values are indexed at 1 for 1999Q1. Periphery group of economies comprises Greece, Ireland, Italy, Portugal, and Spain. Sources: Eurostat, BEA, and BIS.

Thus far both the theoretical and the empirical literatures have primarily focused on two channels to explain the depth of the crisis in Europe: a collapse in aggregate demand, partly induced by excessive household borrowing (e.g., Martin and Philippon, 2017), and weak bank-sovereign linkages, with bank balance

sheets being weakened on account of exposures to risky sovereign debt (e.g., Gennaioli et al., 2014; Acharya et al., 2014; Popov and Van Horen, 2015).

We are the first to consider the role of financial leverage in explaining the decline in firm-level and aggregate corporate investment during the European crisis. Specifically, we investigate whether corporate debt accumulated during the boom years holds back investment in the aftermath of the crisis. We refer to a situation where debt holds back investment as "debt overhang". Our debt overhang channel is distinct from the aggregate demand and bank-sovereign channels previously identified in the literature. Myers (1977) shows that debt overhang leads to under-investment by firms, as new capital cannot be raised when profits primarily benefit existing debt holders, instead of the new investors. More generally, debt overhang can crowd out private investment in general equilibrium via higher borrowing costs (e.g. Krugman, 1988). Either way, the result will be a firm de-leveraging process during which firms cut down investment.

We use a difference-in-difference approach to identify the effect of corporate debt overhang and rollover risk on investment, assessing the differential (relative) impact on investment of different levels of (short and long-term) leverage and between the pre-crisis and post-crisis periods. Consistent with the literature, we consider the year 2008 as the start of the financial crisis. We run various panel

regressions of corporate investment over the period 2000 to 2012, where we distinguish between the crisis period (2008-2012) and the pre-crisis period (2000-2007). Specifically, we run a panel regression of triple interactions, where we interact a crisis dummy that takes the value of one for the crisis period, with the interaction of a periphery dummy for firms in the periphery and a high-leverage indicator indicating whether firm leverage prior to the crisis was above the sample median.

We measure leverage as the ratio of debt to total assets and distinguish between short-term and long-term debt. To mitigate concerns about reverse causality, we measure leverage and bank-firm relationships prior to the crisis. Because some firms deleveraged during and in the aftermath of the crisis, our conservative approach, if anything, underestimates the effect of high leverage on investment. We limit the analysis to firms in the euro area. The advantage of this setup is that we limit the analysis to firms that were subject to the same monetary policy but experienced diverging sovereign risk and banking conditions during the crisis. The analysis controls for the usual determinants of investment such as firm size and profitability and also for debt service to account for differences in payment terms on the debt.

To control for aggregate demand shocks we use four-digit industry $\times$ country $\times$ year fixed effects. These effects will absorb the impact of changes in credit demand for the four-digit sector that our firms operate in as well as any changes in country-level demand conditions, including those arising from changes in sovereign risk and general uncertainty conditions. We also control for bank fixed effects to capture the role of pre-existing bank relationships. We assume that most of the fluctuations in aggregate demand derive from country-specific and narrowly defined industry-specific factors, not idiosyncratic firm-specific factors. We include firm fixed effects to absorb permanent productivity differences across firms.

We obtain firm-level data from the Orbis-Bureau Van Dijk/Moody's database, also known as the AMADEUS database. The database has detailed firm-level balance sheet information on investment, indebtedness, debt service, and debt maturity across a large number of European countries. The database also incorporates information on each firm's main relationship bank(s), including the names and address of the bank, which we use to match firms and banks. For each bank, we obtain bank balance sheet information, including data on total sovereign bond holdings, from BANKSCOPE. In order to distinguish between banks' exposure to their *own* sovereign as opposed to other sovereigns, we

use confidential ECB data which has nationality information on the sovereign exposure. We use a firm-bank matched dataset since the deteriorations in firm and bank balance sheets have to be measured simultaneously to separate shifts in bank weakness and firm weakness. A big advantage of our data set is its representative coverage of SMEs. SMEs tend to be informationally opaque and dependent on banks for their external financing, and therefore more likely to be affected by debt overhang (e.g. Kashyap et al., 1993, 1994b,a) and they make up a large part of the aggregate economic activity in Europe.[1]

We measure weakness in bank balance sheets during the crisis using the ratio of the bank's overall holdings of sovereign bonds to the bank's total assets. In Europe, where banks hold sovereign bonds and firms depend on banks for their lending, sovereign risk can affect firm investment through bank-sovereign linkages. Following an increase in sovereign risk, banks with large exposures to risky sovereigns will experience a deterioration in their balance sheets, reducing the supply of loans to firms via a traditional bank lending channel. This will lead to an increase in debt overhang and rollover risk, especially for firms that

1. In Europe, SMEs account for around 70% of aggregate employment and over 50% of aggregate output on average (see Gopinath et al. (2017) and Kalemli-Özcan et al. (2019)) and in most European countries these firms are required to file their financial data with public registers.

financed themselves primarily with short-term debt during the boom years. It is also possible that weak banks continue to lend to risky borrowers in an effort to preserve relationships, consistent with loan evergreening or zombie lending.

Our findings, conditional on other channels mentioned above, are as follows. First, high *ex ante* debt levels depress investment during crisis times, consistent with debt overhang. Second, the negative relationship between leverage and investment during the crisis is more pronounced for firms with high short-term leverage in the periphery, consistent with theories of short-term debt implying greater rollover risk. Third, the debt overhang effect remains when controlling for aggregate demand effects and the influence of sovereign-bank linkages, suggesting that the debt overhang channel we focus on operates independently from aggregate demand and bank-sovereign channels. These results are economically significant. A one standard deviation increase in firm leverage during the boom reduces firm investment by 20% during the bust.

Finally, we show that the effect of firm leverage on investment is dynamic and persistent, explaining about 20% of the decline in *aggregate* investment over the crisis period. To this end, we run local projections à la Jordà (2005) using our firm panel dataset and obtain firm-level impulse response functions. We then aggregate the firm-level responses based on the relative weight of high leverage firms and the

periphery in the euro area economy, abstracting from general equilibrium effects. The overall decline in investment over the crisis period that is explained by high leverage can then be computed as 2.8 percentage points, which is 20% of the official aggregate decline in corporate sector investment of 14.0 percentage points. If we focus on periphery countries, then our estimates can account for 41% of the aggregate decline in corporate investment.

Our key contribution to the literature is establishing the role of firm leverage in boom-bust cycles. The traditional macro literature on boom-bust cycles relies on aggregate data and by construction cannot capture the importance of firm heterogeneity in financial leverage and aggregate investment. We identify the role of financial leverage in explaining the collapse in corporate investment during the European crisis. We show that firm heterogeneity in financial leverage is an economically important channel over and above the aggregate demand and bank-sovereign channels previously identified in the literature. Our analysis also shows that short-term debt exacerbates the debt overhang problem, as argued by Diamond and He (2014). Our paper is also the first to provide an explanation for the persistently low investment in the periphery of Europe, as evidenced by the dynamic response of firm-level investment to leverage up to 4 years after the shock.

We proceed as follows. Section 2 reviews related literature on corporate debt and firm investment. Section 3 presents the data used in the paper and reports descriptive statistics. Section 4 introduces the empirical framework and identification methodology. Section 5 presents our empirical results. Section 6 concludes.

2. Literature

There is a large theoretical literature on debt overhang[2] and how financially distressed firms, when protected by limited liability, have an incentive to gamble by investing in risky projects (e.g., Jensen and Meckling, 1976; Admati et al., 2018). The empirical literature does not find strong results in either direction (under- or over-investment)[3]. Moreover, recent theoretical work by Aragón (2019) argues for mitigating factors arising from the firm losing access to credit when a creditor becomes insolvent. In his model, the bank can either liquidate the firm or continue lending. Funding new investment has the disadvantage that it will

2. Hennessy (2004), Titman and Tsyplakov (2007), Moyen (2007), Diamond and Rajan (2011), and Occhino and Pescatori (2015).

3. See De Jong and Van Dijk (2007), Eisdorfer (2008), and Gilje (2016).

incentivize the firm to take more risk, decreasing the overall value for the bank. Hence, zombie-lending and under-investment can co-exist.[4]

Our paper also relates to an extensive empirical literature on corporate debt and firm investment. For instance, Whited (1992) shows that adding debt capacity variables to a standard investment model improves the model fit. Similarly, Bond and Meghir (1994) find an empirical role for debt in standard investment models. This literature generally finds a negative relationship between firm leverage and investment. For instance, for listed firms in the U.S., Lang et al. (1996) document a negative relationship between debt and investment for firms without valuable growth opportunities. More recently, Giroud and Mueller (2017) and Ottonello and Winberry (2018) analyse the impact of firm leverage on employment and investment in the U.S., respectively. Both of these papers focus on financial leverage of listed firms. In fact, none of the empirical papers use a representative firm level data set covering SMEs to study real outcomes

4. See Hoshi et al. (1990), Almeida et al. (2011) and Barnea et al. (1980) for theoretical models of zombie lending. The empirical literature on the significance of zombie lending in Europe during the recent crisis finds mixed results (e.g., Andrews and Petroulakis, 2019 and Schivardi et al., 2017). The literature that focuses on Japan finds strong results as in Peek and Rosengren (2000, 2005) and Caballero et al. (2008).

during an aggregate shock like financial crisis. Using a similar firm-level dataset encompassing small firms but without matching it to firms' banks' balance sheets, Gopinath et al. (2017) show the importance of firm leverage on misallocation and aggregate productivity dynamics during the boom period, whereas our focus is on investment dynamics during the bust period.

Our work also relates to the theoretical literature on the maturity structure of debt. In the benchmark model of Myers (1977), short-term debt reduces the debt overhang problem, while in recent work by Diamond and He (2014), short-term debt can increase debt overhang. Darst and Refayet (2017) develops a model where a combination of short-term and long-term debt emerges as the optimal contract to deal with agency problems and bankruptcy costs. In their model, long-term debt insulates the firm from changes in credit spreads while short-term debt exposes the firm to credit spread fluctuations. However, short-term debt comes at the advantage of risk-free financing. Firms optimally choose the maturity structure of debt to inter-temporally manage how much risky debt to issue. The sovereign debt literature has developed models of debt contracts with bankruptcy costs and agency costs for debtholders, where short-term debt will generally be preferred because it is cheaper, except when self-fulfilling rollover crises are probable (Chaterjee and Eyigungor, 2012). As debt accumulated during

the boom period is mostly short-term, rollover risk will increase because lenders are reluctant to renew expiring credit lines during a crisis when collateral values drop (e.g. Diamond, 1991; Acharya et al., 2011).[5]

In related work on the implications of debt overhang, Lamont (1995) shows that the effect of debt overhang varies with economic conditions. Debt overhang binds when the economy is in a downturn since investment returns are low. As a result, high levels of debt can create multiple equilibria in which the profitability of investment varies with economic conditions. Hennessy (2004) shows that debt overhang distorts the level and composition of investment, with a severe problem of underinvestment for long-lived assets. A significant debt overhang effect is found, regardless of firms' ability to issue additional secured debt. Hennessy et al. (2007) corroborate large debt overhang effects of long-term debt on investment, especially for firms with high default risk.

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5. Debt maturity may also affect the debt overhang by altering incentives to invest. According to Myers (1977), short-term debt reduces the debt overhang problem because the value of shorter debt is less sensitive to the value of the firm and thus receives a much smaller benefit from new investment. However, Diamond and He (2014) show that reducing maturity can increase debt overhang. For firms with future investment opportunities, shorter-term debt may impose stronger debt overhang in bad times since less risk is shared by shorter-term debt.

3. Data

In this section, we describe the data and variables used in the paper, before turning to the empirical framework and identification of the effects we are interested in.

3.1. Firm-Level Data

We use the Orbis global database, from Bureau van Dijk (BvD)—a Moody's Analytics company. Orbis is the largest cross-country firm-level database, covering over 200 countries and 200 million firms that can be used for research focusing on linking firms' financial accounts, ownership structure and production decisions. The database includes all industries and both private and public firms. BvD collects data from various sources, in particular, publicly available national company registries, and harmonizes the data into an internationally comparable format.

The coverage of firms varies both by country and time and across variables. The main reason for variation in firm coverage by country is that different countries have different laws in terms of which firms are required to file their

financial accounts.[6] For countries where the law requires every firm to file with the national company registry, the data obtained via Orbis will be identical to that contained in the country's financial accounts prepared by official statistical offices.[7]

There is an additional reason why coverage of firms in Orbis database vary over time. The cause of this problem is the common practice in the literature of using a single vintage of Orbis database (or a single download from Wharton Research Data Services (WRDS)). As explained in detail in Kalemli-Özcan et al.

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6. There is a common misconception that data from countries' national statistical offices always have better coverage than Orbis. If the country regulation is such that all firms have to file with the business registry then the coverage obtained from Orbis will be representative. For the other countries where the regulation is such that firms over a certain size threshold file their financial accounts, then the national statistical offices might have administrative surveys that can cover some of the differences in coverage of firms' financial accounts. A case in point is the United States, where private firms are not required to file financial accounts but there are select surveys covering certain set of firms in certain years such as the Federal Reserve Board of Governors' survey on "small business finance," which is a repeated cross-section that comes in four waves and covers only 3000-5000 firms and is not nationally representative.

7. Country censuses are administrative datasets and will cover the universe of firms in a country; however, census datasets typically do not provide information on individual firms' financial accounts as company registries do.

(2019), the only way to get around this problem and have consistent coverage of firms over time is to use the historical vintages and match the firm data over time using unique firm identifiers. If a single vintage is used, firms will be missing since Orbis drops firms over a certain period of time from the database and also some variables, such as value-added and intermediate inputs, will be missing since every vintage does not cover all the variables. The industry classification will also be misleading since these classifications change over time due to firms' expanding their operations and/or firm and industry ID changes made by the national statistical offices. Due to such missing information, Orbis single vintage data will generally over-represent larger firms and under-represent smaller firms, requiring imputations and re-weighing of the data to ensure an adequate representation of small firms. As shown in Kalemli-Özcan et al. (2019), there is no need to re-weigh and impute the data if the historical vintages are used, as this produces the nationally representative data mimicking the firm size distributions of the official statistics of each country.

We follow Kalemli-Özcan et al. (2019) to construct and clean our firm-level data. The main financial variables used in the analysis are total assets, sales, operating revenue (gross output), tangible fixed assets, intangible fixed

assets, liabilities, and cash flow. We distinguish between short-term and long-term liabilities, with short-term liabilities being defined as debt liabilities with a remaining maturity of up to 1 year. A large fraction of short-term liabilities constitute trade credits that originate outside the financial system, we also construct a measure of short-term liabilities that excluded trade credits. We transform nominal financial variables into real variables using country-specific consumer price indices with 2005 base and converting to U.S. dollars using the end-of-year 2005 U.S. dollar/national currency exchange rate. In other words, the value of variables is expressed in constant prices at constant exchange rates. We drop financial firms and government-owned firms, and keep all the other sectors. As shown in Kalemli-Özcan et al. (2019), the coverage of our sample when compared to official statistics is extensive, ranging from roughly 70% to over 90% depending on the country.

3.2. Matching Firm- and Bank-Level Data

We create a novel data set of bank-firm relationships in Europe by matching our firm-level data to their banks. For each firm, there is a variable called *bank* in our firm-level database showing the name(s) of the firm's main bank(s), which, following the literature on firm-bank lending relationships, we assume to be the

main bank(s) that the firm borrows from. We obtain this information through our firm-level database but the original source is KOMPASS.[8] This data has been used before by Giannetti and Ongena (2012), among others, to study bank-firm relationships. We use the 2013 data entries by firms of their main banks, including both the primary and secondary bank-firm relationships. We checked the stability of bank-firm relationships with the 2015 data entries and confirmed that bank-firm relationships are sticky and do not significantly change over short periods of time.[9]

For each main bank, we obtain bank balance sheet data from BANKSCOPE. This data set is also from Bureau Van Dijk, containing balance sheet information about more than 30,000 banks spanning most countries and data up to 16

8. KOMPASS provides the bank-firm connections in 70 countries including firm address, executive names, industry, turnover, date of incorporation and, most importantly the firms' primary bank relationships. KOMPASS collects data using the information provided by chambers of commerce and firm registries, but also conducts phone interviews with firm representatives. Firms are also able to voluntarily register with the KOMPASS directory, which is mostly sold to companies searching for customers and suppliers.

9. Giannetti and Ongena (2012) use both the 2005 and 2010 vintages and also find that bank-firm relationships are sticky. Other research has shown that these relationships are sticky also in the United States (see, for instance, Chodorow-Reich, 2014).

years. Linking the main bank name to its equivalent in BANKSCOPE is a significant hurdle since there is no standardized procedure to match KOMPASS and BANKSCOPE bank names. We make use of the programs *OpenRefine* and *OpenReconcile* that offer several approximate-matching algorithms. We use these programs to match the *bank* variable to the bank names in BANKSCOPE. Our match rate is very high: 87.6% of all bank name observations. Most of the unmatched observations correspond to small cooperative banks for which financial data is anyway not available in BANKSCOPE.

3.3. Matching Bank-Level Data to Sovereigns

Banks in the BANKSCOPE database are all recorded as domestic legal entities, including the subsidiaries of foreign parent companies. To determine the country of origin of each bank in our sample, we need to trace its ownership information to the ultimate owner. We set the country of origin of each bank equal to the country of origin of the ultimate owner of the bank, even if this entity is incorporated in a foreign country, under the assumption that it is the strength of the parent bank that determines the strength of each subsidiary. We trace this information using the Global Ultimate Owner (GUO) variable. Then, we use its consolidated balance sheet reported directly in BANKSCOPE.

Whenever the GUO information is missing, a couple of criteria are used. First, some of the banks listed are actually branches of foreign banks. These are matched by hand to their GUO abroad. Second, some banks are reported to be independent or "single location" (i.e., they have only one branch). For these banks, the GUO is the bank itself. And finally, using the independence indicator provided by Bureau Van Dijk, for banks with a high degree of independence (i.e., values B-, B or B+), the GUO will be also the bank itself, as in the previous case. The sovereign of each bank is defined as the sovereign country of the entity that is the ultimate owner of the bank.

Data on total sovereign bond holdings come from BANKSCOPE. The limitation of these data is that they do not indicate the nationality of the sovereign. We therefore complement this data with data on *own* sovereign's holdings of the bank from the European Central Bank (ECB)'s proprietary database of Individual Balance-Sheet Items (IBSI). The difference between the two datasets is that the BANKSCOPE data captures all sovereign bonds while the IBSI data captures domestic bonds only. In practice, the difference between the two data series should be small since most of a bank's total sovereign bond holdings consist of domestic bonds. Indeed, according to the IBSI data for our sample of banks, around 70%

of euro area banks' sovereign bond holdings are domestic, with an even higher percentage in the periphery.

We define the crisis period as the period 2008 to 2012, where 2012 is the last year of our sample. We create a post-crisis variable that is a dummy variable that takes on the value of one for the period 2008 to 2012, and zero otherwise.

3.4. Descriptive Statistics

Investment in real capital expenditures can be measured on a gross or net basis (i.e., with or without depreciation). If investment expenditures just match the depreciation of capital equipment, then gross investment is positive, but net investment remains unchanged. Therefore, net investment matters most for future productivity. Consequently, we use net investment rate in our empirical work, computed as the annual change in fixed tangible assets.[10]

We capture firm leverage using the ratio of total liabilities to total assets. Total liabilities are measured as the sum of long-term debt, loans, trade credit, and other

10. Using net investment is common in the literature; see, for example, Lang et al. (1996). We measure net investment rate as the ratio between net fixed capital stock increase and the initial net fixed capital stock, i.e., $\Delta K_t / K_{t-1}$. Fixed capital is measured as the firm's gross capital stock minus depreciation.

current liabilities. To capture the drag on finances stemming from debt payments, we include the debt service ratio calculated as total interest paid by the firm over its earnings before taxes, depreciation and amortization of capital (EBITDA).

We distinguish between long-term and short-term liabilities. Long-term liabilities comprise all loans and bonds with residual maturities above one year. Short-term liabilities comprise all current liabilities, i.e., loans, trade credits and other current liabilities, with residual maturities up to 1 year. We also construct alternative measures of liabilities that exclude trade credits since these originate outside the financial system. When excluding trade credits, we lose about one-tenth of observations due to missing data on trade credits.

Previous literature has found that firm size is an important determinant of firm leverage (e.g Dinlersoz et al. (2018)). We control for firm size, *Size*, using the log of total assets. Figure 2 shows the importance of including small and medium-sized firms (SMEs) in the sample when analyzing the maturity structure of debt. On average, SMEs have much higher leverage in terms of short-term leverage, indicating access to finance issues for long-term debt. SMEs short-term debt based leverage is 38.5%, whereas their long-term debt based leverage is only 30.5%.

We control for growth opportunities using net sales growth. We cannot use Tobin's Q or other market-based proxies for growth opportunities because market

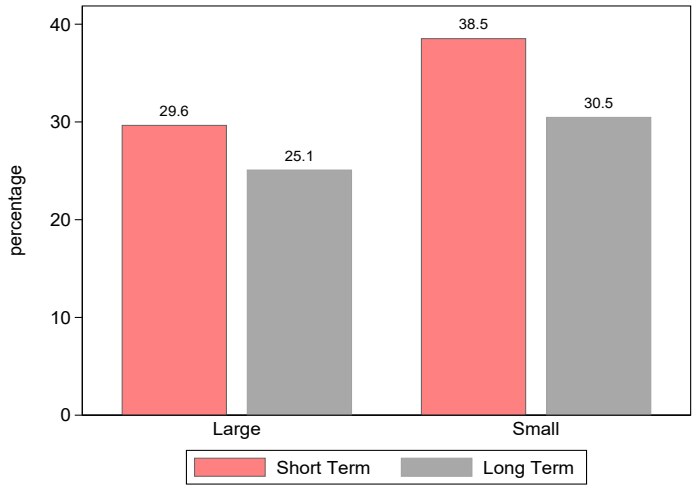


FIGURE 2. Firm Leverage by Size Class. This figure shows averages of the leverage (measured as a ratio of either short-term debt to assets or long-term debt to assets) of each firm for large firms and SMEs. Small and medium-sized firms (SMEs) are firms with fewer than 250 employees and/or firms with total assets lower than 43 million euros at 2005 prices.

values are only available for listed firms which are less than 1% of our sample. We also control for cash flow as is standard in these regressions.

We measure bank weakness of the firm's main bank, *WeakBank*, as the ratio of total sovereign bond holdings of the bank to total assets of the bank. We use both BANKSCOPE and IBSI data on sovereign bond holdings to construct this variable since IBSI data starts only in the fourth quarter of 2007 and covers fewer banks. In an extension, we consider only the holdings of own (i.e., home country) sovereign bonds for banks in the periphery because exposure to own sovereigns

in center (i.e., non-periphery) countries need not indicate weakness. This variable is limited by data coverage.

We also explored alternative measures of bank weakness based on bank leverage and total capital ratio. However, given that most bank assets and liabilities are not marked to market, these balance sheet variables are very stable and do not register large enough movements over time to qualify as reliable measures of bank weakness. Moreover, sovereign bond holdings are a more direct measure of exposure to sovereign risk of each bank, and therefore more directly captures bank-sovereign linkages, which previous literature has shown to be an important channel through which bank weaknesses surfaced during the European financial crisis.

All firm-level variables are winsorized such that their kurtosis falls below a threshold of 10. This implies that net investment to lagged capital, (short-term/long-term) liabilities to assets ratio, interest paid to EBITDA, cash flow to assets, sales growth and log of capital stock are winsorized at the 5%, 3%, 3%, 2%, 2%, and 1% level respectively.

Table A.1 presents how many of the firm-bank relationships in the sample are multiple relationships (i.e., with more than one bank) and cross-border (i.e., with banks whose parent company is foreign). It is quite common for European firms

to have multiple bank relationships although the data shows quite some variation across countries, with the fraction of firms having relationships with more than one bank ranging from a low of 0.0% in France to 50.4% Greece. Having a foreign bank is very rare in this sample. The one exception in our sample is Portugal but even there only 2.1% of firms have relationships with any foreign bank. In the case where multiple bank relationships are reported, the first listed bank is considered the main bank. For Italy, information on bank relationships is missing and we therefore exclude this country from the analysis.

Table 1 shows descriptive statistics for the main regression variables. Investment rates average about 10.4 percentage points during the sample period but declined by about 8.4 percentage points during the crisis period relative to the pre-crisis period. On average, debt liabilities account for about 75% of assets, and about 60% of total liabilities are short term (i.e., with a remaining maturity up to 1 year). Only a small fraction of short-term liabilities is made up of trade credits (about 14%). Financial expenses account for about 15% of EBITDA on average, with much variation across firms and over time. Exposures to sovereign bond holdings are modest on average, at about 4% of total assets, but there is much variation with some banks holding more than one-third of their assets in

sovereign bonds. Firms in countries in the periphery comprise about 30% of the sample.

4. Empirical Framework and Identification

In this section we explain the framework and identification strategy we use to investigate the role of financial leverage in affecting corporate investment in Europe.

Our baseline model of corporate investment builds on a standard investment model with financial factors, similar to those used in Whited (1992), Bond and Meghir (1994), and Lang et al. (1996). In these models, debt enters on account of bankruptcy and agency costs. Let the standard model for firm i be:

$$\left(\frac{\text{Investment}}{\text{Capital}}\right)_i = \beta \left(\frac{\text{Debt}}{\text{Assets}}\right)_i + \mathbf{X}_i{}' \gamma + \alpha + \varepsilon_i$$

where Investment/Capital is the net investment ratio, Debt/Assets is the ratio of total debt to total assets, capturing the financial leverage of the firm, and α is a constant. The vector $\mathbf{X}_i$ contains control variables, such as sales growth, cash flow ratio, and the debt service ratio. The model includes the usual determinants of investment as well as the debt service ratio since the debt to assets ratio may not

TABLE 1. Summary Statistics

(a) Overall sample

Variables	Obs.	Mean	St. Dev.	Min.	Median	Max.
Net investment/Capital[1]	7,962,577	0.104	0.621	-0.539	-0.060	2.383
Liabilities/Assets	9,389,076	0.749	0.414	0.091	0.723	2.311
Fin.Expenses/EBITDA[2]	4,763,675	0.152	0.387	-1.188	0.083	1.566
Cash Flow/Assets	5,337,854	0.075	0.124	-0.600	0.065	0.534
Sales growth[3]	5,536,637	0.013	0.324	-1.410	-0.003	1.595
Size[4]	9,389,078	13.547	1.713	0.104	13.459	26.245
Banks' sovereign bonds/Assets	5,624,503	0.043	0.041	0	0.032	0.382
Periphery[5]	9,389,082	0.304	0.460	0	0	1

(b) Period 2002-2007

	Low leverage			High leverage		
	Mean	Median	St. Dev.	Mean	Median	St. Dev.
Fin.Expenses/EBITDA[2]	0.1082	0.0529	0.2734	0.2121	0.1577	0.3979
Cash Flow/Assets	0.1079	0.0942	0.0955	0.0647	0.0565	0.1019
Sales growth[3]	0.0160	0.0141	0.2705	0.0437	0.0315	0.3045
Size[4]	14.3361	14.1672	1.5062	14.1451	13.9595	1.5496
Observations	1,669,427					

(c) Period 2008-2012

	Low leverage			High leverage		
	Mean	Median	St. Dev.	Mean	Median	St. Dev.
Fin. Expenses/EBITDA[2]	0.1116	0.0489	0.3668	0.1926	0.1294	0.4556
Cash Flow/Assets	0.0661	0.0600	0.1064	0.0489	0.0453	0.1144
Sales growth[3]	-0.0514	-0.0274	0.2804	-0.0605	-0.0312	0.3105
Size[4]	14.4840	14.3076	1.6039	14.2283	14.0480	1.6231
Observations	1,185,011					

Notes: Based on unbalanced sample of firms matched to their primary banks. In the case of panels (b) and (c), the sample is restricted to observations without missing values. High leverage firms are those whose average liabilities to assets ratio until 2007 is greater than the median in the sample. Net Investment/Capital is computed as the increase in real capital stock over lagged real capital stock. Fin. Expenses denotes interest paid. Sales growth denotes the logarithmic change of real sales. Size is computed as the logarithm of total real assets. Periphery is a binary variable equal to 1 if the firm is located in a peripheral economy.

fully capture the effects of lingering debt overhang when debt is measured at book value.

Our baseline model of corporate investment extends this standard model in several ways. First, we estimate the above model using panel data, with all control variables lagged one period to mitigate reverse causality concerns. Second, we use a predetermined variable of financial leverage, constructed over the pre-crisis period, to explain the evolution of investment, thereby mitigating endogeneity concerns of the relationship between leverage and investment. Third, we allow for time-varying coefficients on the leverage variable by interacting the leverage variable with year dummies to capture possible pre-crisis trends in the relationship between leverage and investment. Fourth, we include a host of fixed effects, including firm fixed effects, country-sector-year fixed effects, at four-digit sector level, and main bank fixed effects.

Our baseline model of corporate investment is then as follows:

$$\left(\frac{\text{Investment}}{\text{Capital}}\right)_{i,s,c,t} = \beta_t \lambda_t \times \text{High Leverage}_{i,s,c} + \mathbf{X}_{i,s,c,t-1}{}'\gamma + \alpha_i + \alpha_{s,c,t} + \alpha_b + \varepsilon_{i,s,c,t} \quad (1)$$

where λ_t are year dummy variables for the years 2002 through 2012 (with the exception of reference year 2007) to estimate the time-varying coefficients β_t on leverage. Our main variable of interest is High Leverage$_i$ which is a dummy variable that is equal to one if the firm's average liabilities to assets ratio is greater than its sample median during the pre-crisis period 2000 to 2007. The reason why we use a dummy variable as opposed to a continuous variable is because we want to identify the extensive margin of the effect of leverage from changes over time induced by the crisis shock. Hence we do not let firm leverage change with the shock but rather see how investment responds to the shock differentially for firms with high and low leverage ex-ante. This is a cleaner difference-in-difference exercise as it does not confound the effects of boom leverage with that of deleveraging during bust. This is a standard approach in difference-in-difference settings to make sure that the shock originates from the event (crisis) and the treatment variable (leverage) is not varying over time (see Katz and Murphy (1992) and Card and Levine (1994)). [11]

11. In results that are available upon request, we use the actual leverage ratio which will also capture de-leveraging of the firms after the crisis. These results are larger in magnitudes as they combine the effects of pre-crisis leverage and de-leveraging during the crisis.

To capture differential effects across the periphery and the center, we make two modifications to the baseline model. First, we allow the effect of financial leverage to vary between peripheral countries and center countries. Second, we distinguish between post-crisis and pre-crisis periods by replacing the year dummy variables with a post-crisis dummy variable, including interaction terms of the financial leverage variable and this post-crisis dummy variable. This aggregation of year dummy variables into crisis periods eases interpretation and is motivated by the fact that (as we will show in the next section) pre-crisis trends in the relationship between leverage and investment are rather weak once we account for aggregate demand effects through the inclusion of fixed effects and include firm controls.

Our extended baseline model of corporate investment is then as follows:

$$\left(\frac{\text{Investment}}{\text{Capital}}\right)_{i,s,c,t} = \beta_1 POST_t \times \text{Periphery}_c \times \text{High Leverage}_{i,s,c} + \quad (2)$$

$$\beta_2 POST_t \times \text{High Leverage}_{i,s,c} +$$

$$\mathbf{X}_{i,s,c,t-1}{}'\gamma + \alpha_i + \alpha_{s,c,t} + \alpha_b + \varepsilon_{i,s,c,t}$$

where $POST_t$ is a dummy variable that takes a value of one for the post-crisis years 2008 to 2012 and zero otherwise, and $Periphery_c$ is a dummy variable that takes a value of one for periphery countries, and zero otherwise.

Our main coefficients of interest are formed by the vector β. We expect β_1 and β_2 to be negative on account of debt overhang effects, that are more pronounced during the crisis period and for peripheral countries. $\mathbf{X}_{it-1}$ is the vector of control variables including sales growth, firm size, cash flow ratio, and debt coverage ratio. α_i are firm-specific fixed effects, and $\alpha_{s,c,t}$ are four-digit sector×country×year fixed effects. This specification allows to test for differential effects of financial leverage during the crisis, and the direct effect of leverage is absorbed by firm fixed effects as we define this variable as a time-invariant dummy at the firm-level. The direct effect of the crisis ($POST$) and the differential effect of crisis for periphery countries ($POST \times PERIPHERY$) will be absorbed by the time and time-country fixed effects, but we also show specifications without these fixed effects to establish the direct negative effects of crisis on firm investment. The baseline model boils down to a difference-in-difference approach to identify the effect of high leverage on investment by assessing the differential impact on investment of different levels of leverage between the pre- and post-crisis periods, where we define the pre-crisis period

as 2000–2007 and the post-crisis period as 2008–2012, with 2012 being the last year in our sample. We also control for bank fixed effects to capture the role of pre-existing bank relationships.

Our identification approach requires that any remaining variation in *ex post* firm-specific demand conditions does not vary systematically with the *ex ante* level of the firm's indebtedness. We think this is a reasonable assumption. After all, it is more likely that firms operating in the same four-digit sector tend to be hit by similar demand shocks over time. In addition, we limit the analysis to firms in the euro area. These firms were subject to the same monetary policy when they experienced diverging conditions in terms of banking and sovereign risk during the crisis.

As a robustness check, we incorporate the lagged investment rate as an explanatory variable into the extended baseline model and estimate using the Arellano and Bond (1991) two-step GMM procedure to account for Nickell (1981) bias. We transform the variables using forward deviations as in Arellano and Bover (1995) to reduce the amount of observations dropped from our sample.

In the first extension of the extended baseline model, we consider the role of weak banks where the "weakness" variable is time-varying and hence cannot be captured by the bank fixed effects. We do this by including the variable

Weak Bank$_{i,t-1}$ in the set of control variables $X_{i,t-1}$, where *Weak Bank* is the firm *i*'s main bank's ratio of sovereign bond holdings to total assets, lagged one period. The *Weak Bank* variable captures the role of bank-sovereign linkages. These can affect firm investment via a bank lending channel when increases in sovereign risk weaken bank balance sheets, reducing the supply of loans to firms and increasing rollover risk.

In a second extension of the extended baseline model, we consider whether the effects are different for long-term liabilities as opposed to short-term liabilities. The benchmark model of Myers (1977) predicts that debt overhang effects are more pronounced for long-term debt, on account of higher agency costs. However, Diamond and He (2014) develop a model where debt overhang can increase with shorter term debt. Moreover, short-term debt could negatively affect investment on account of rollover risk, which manifests itself during bust periods.[12] In practice, there may be a possible tradeoff in the use of short-term debt, being cheaper than long-term debt during boom periods but turning costly during busts. The impact of debt maturity on investment during crises is therefore ultimately an empirical question. We define long-term liabilities as all bank loans and debt

12. See Chaterjee and Eyigungor (2012) for a model of self-fulfilling rollover crises.

with a remaining maturity over 1 year and short-term liabilities as all loans, trade credits and other current liabilities with a remaining maturity of up to 1 year.

Finally, to investigate the dynamic responses in the extended baseline model, we run the following regressions by local projections (Jordà, 2005):

$$\begin{aligned}\left(\frac{\text{Investment}}{\text{Capital}}\right)_{it+h} =& \beta_{1h} POST_t + \\ & \beta_{2h} POST_t \times \text{Periphery}_i + \\ & \beta_{3h} POST_t \times \text{High Leverage}_i + \\ & \beta_{4h} POST_t \times \text{Periphery}_i \times \text{High Leverage}_i + \\ & \mathbf{X}_{it-1}{}' \beta_h + \alpha_i + \alpha_{c,s} + \alpha_b + \varepsilon_{it} \end{aligned} \tag{3}$$

where horizons are given by h = 0, 1, 2, 3, 4; α_i and α_b are firm and bank fixed effects, respectively; and $\alpha_{c,s}$ are country×industry fixed effects. $\mathbf{X}_{it-1}$ includes a lagged investment rate $(\text{Investment}/\text{Capital})_{it-1}$ and other controls (sales growth,

firm size, cash flow ratio, and debt coverage ratio). We do not include year fixed effects since we are interested in how the crisis affects firm investment differentially, depending on the level of firm leverage and country status. The High Leverage and Periphery dummies are absorbed by firm fixed effects. We use two-way clustered standard errors by firm and year. The estimated impulse coefficient $\hat{\beta}_{1h} + \hat{\beta}_{2h} + \hat{\beta}_{3h} + \hat{\beta}_{4h}$ is a response of investment to the crisis for highly leveraged firms in the periphery. Similarly, we estimate impulse coefficients $\hat{\beta}_{1h} + \hat{\beta}_{2h}$ for lowly leveraged firms in the periphery, $\hat{\beta}_{1h} + \hat{\beta}_{3h}$ for highly leveraged firms in the center, and $\hat{\beta}_{1h}$ for lowly leveraged firms in the center.

5. Empirical Results

This section presents the results for the estimations outlined in the previous section. We will begin with the baseline dynamic investment model using annual data to explore how the crisis affects the relationship between investment and leverage. We then estimate the differential effect for the post-crisis period and the periphery. Then we will account for the role of weak bank balance sheets and consider the differential effects of short–term and long-term liabilities. We conclude with several robustness checks and the linear projection analysis to gauge the persistence of the leverage effect.

5.1. Debt Overhang and Rollover Risk

The results of estimating our baseline dynamic model of corporate investment and financial leverage are shown in Table 2. Column 1 in Table 2 includes only firm and year fixed effects, while column 2 also includes country×sector×year fixed effects to account for aggregate demand effects and banker fixed effects to account for credit supply effects. All regressions include lagged firm controls.

We find that high leverage firms have higher investment rates before the crisis and have lower investment rates after the crisis (i.e., we estimate positive β_ts before crisis years and negative β_ts after crisis years). This implies that leverage during booms helps to finance investment and during the bust de-leveraging hurts investment. It is noticeable how strong the bust effect is, with similar magnitude coefficients regardless of fixed effects and controls. The pre-crisis relationship is dampened when we control for country-sector and firm factors (especially when including lagged controls), as these controls all capture fluctuations in demand.

A tight identification requires that high and low leverage firms have the same investment trend before the crisis (the so-called parallel trend assumption). The presence of such pre-trends would imply that we should caution against giving a causal interpretation to our results. A standard way to test for such parallel trends is to produce an event study difference-in-difference graph of the time-varying

TABLE 2. Baseline Model of Investment and Financial Leverage

Dependent variable: Net investment/Capital$_{i,c,s,t}$

	(1)	(2)
2002×High Leverage$_{i,c,s}$	0.010***	0.013***
	(0.003)	(0.004)
2003×High Leverage$_{i,c,s}$	0.008**	0.008**
	(0.003)	(0.003)
2004×High Leverage$_{i,c,s}$	0.008**	0.007**
	(0.003)	(0.003)
2005×High Leverage$_{i,c,s}$	0.010***	0.009***
	(0.003)	(0.003)
2006×High Leverage$_{i,c,s}$	0.008***	0.007**
	(0.003)	(0.003)
2008×High Leverage$_{i,c,s}$	-0.010***	-0.006**
	(0.003)	(0.003)
2009×High Leverage$_{i,c,s}$	-0.028***	-0.024***
	(0.003)	(0.003)
2010×High Leverage$_{i,c,s}$	-0.026***	-0.022***
	(0.003)	(0.003)
2011×High Leverage$_{i,c,s}$	-0.034***	-0.029***
	(0.003)	(0.003)
2012×High Leverage$_{i,c,s}$	-0.037***	-0.030***
	(0.003)	(0.003)
Fin. Expenses$_{i,c,s,t-1}$	-0.016***	-0.015***
	(0.001)	(0.001)
Cash Flow$_{i,c,s,t-1}$	0.276***	0.260***
	(0.006)	(0.006)
Sales$_{i,c,s,t-1}$	0.066***	0.058***
	(0.002)	(0.002)
Size$_{i,c,s,t-1}$	-0.239***	-0.243***
	(0.002)	(0.002)
Total effect: High Leverage$_{i,c,s}$	-0.091***	-0.066***
	(0.023)	(0.024)
Firm FE	Yes	Yes
Year FE	Yes	No
Sector-country-year FE	No	Yes
Banker FE	No	Yes
F-test: High Leverage	0.000	0.005
Obs.	2,431,265	2,426,548
R^2	0.173	0.185
Within-R^2	0.028	0.021
Adjusted-R^2	0.032	0.033
Within-adjusted-R^2	0.028	0.021

Notes: Standard errors in parentheses. Clustered errors at the firm level. High leverage is equal 1 if the firm average of total liabilities to assets is greater than the median of the sample until 2007. Fin. Expenses is equal to the ratio of interest paid to EBITDA. Interest Paid is scaled by EBITDA, and corresponds to the coverage ratio. Sales is the change in logarithm of sales. Size is measured by the logarithm of total assets. Cash flow is scaled by total assets. Total effects corresponds to the marginal effect of a variable calculated at a value of 1 for the each of the dummies present in the interaction. $^{*}p < 0.10,^{**}p < 0.05,^{***}p < 0.01$.

regression coefficients, showing the differential evolution of investment through the years for high leverage firms relative to low leverage firms. If the pre-crisis coefficients are relatively stable and around zero this provides evidence in support of the parallel trend assumption. Figure 3 graphically depicts the time-varying regression coefficients of the baseline model, with confidence intervals at a 95% confidence level. Panel (a) of Figure 3 reports the results when including only firm fixed effects, panel (b) adds country$\times$sector$\times$year fixed effects to account for aggregate demand effects, and panel (c) includes both sets of fixed effects and adds lagged firm controls.

While we do observe some positive trend during the boom period, this effect is much reduced and only borderline significant after accounting for demand effects through the inclusion of country-sector and lagged firm controls, in panel (c). One way to read this is that it is exactly the exposure to high leverage that puts firms that invested more during the boom period at risk during the bust. Credit constraints of high leverage firms will be tightened during the bust, forcing these firms to deleverage and thus reduce their investment. Moreover, when we allow the effects of leverage to differentiate between center and periphery firms, there remains at best a very weak pre-trend in the case of center firms and no significant pre-trend in the case of periphery firms, where, as we will see next, also most of

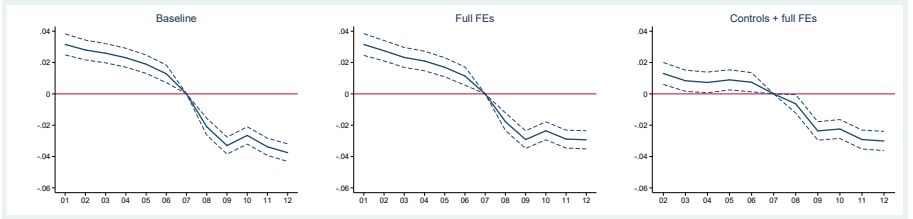


FIGURE 3. Evolution of net investment rates of high-leverage vs low-leverage firms. This figure illustrates results of the estimation of the model given in equation (1). 'Baseline' model features firm-level FE; 'Full FEs' model adds country-sector-year FE; and 'Controls + full FEs' model adds lagged firm-level control variables. Dashed lines corresponds to the confidence intervals at 5% significance.

the effect is concentrated (see panel (c) of figure A.1). Taken together, this exercise does not provide compelling evidence to suggest that the interpretation we give to our result is invalid.

Table 3 shows the results of estimating our extended baseline model where we first estimate the post-crisis effect of firm leverage, and then condition this post-crisis effect on whether the firm is located in the periphery or not. All regressions include firm fixed effects.

The results in Column 1 of Table 3 indicate that high leverage is a substantial drag on investment during the post-crisis period. Highly levered firms, defined as those with liabilities to assets above the sample average in the pre-crisis period, have a 3.3 percentage point lower investment rate during the crisis period compared to firms that are not highly levered. This is a large effect compared to the average investment rate of 10.4%. This result remains when accounting

TABLE 3. Post-crisis Effects and the Periphery

Dependent variable: (Net investment/Capital)$_{i,s,c,t}$

	(1)	(2)	(3)	(4)
$\text{Post}_t \times \text{Periphery}_c \times \text{High Leverage}_{i,s,c}$			-0.029***	-0.022***
			(0.003)	(0.003)
$\text{Post}_t \times \text{Periphery}_c$			-0.037***	
			(0.002)	
$\text{Post}_t \times \text{High Leverage}_{i,s,c}$	-0.033***	-0.028***	-0.017***	-0.017***
	(0.001)	(0.002)	(0.002)	(0.002)
Post_t	-0.020***		-0.002	
	(0.001)		(0.001)	
Fin. Expenses$_{i,s,c,t-1}$	-0.016***	-0.015***	-0.015***	-0.015***
	(0.001)	(0.001)	(0.001)	(0.001)
Cash Flow$_{i,s,c,t-1}$	0.280***	0.259***	0.277***	0.259***
	(0.006)	(0.006)	(0.006)	(0.006)
Sales$_{i,s,c,t-1}$	0.067***	0.058***	0.064***	0.058***
	(0.001)	(0.002)	(0.001)	(0.002)
Size$_{i,s,c,t-1}$	-0.235***	-0.243***	-0.234***	-0.242***
	(0.002)	(0.002)	(0.002)	(0.002)
Total effect: Post_t	-0.053***	-0.028***	-0.085***	-0.039***
	(0.001)	(0.002)	(0.001)	(0.002)
Total effect: Periphery_c			-0.066***	-0.022***
			(0.002)	(0.003)
Total effect: High Leverage$_{i,s,c}$	-0.033***	-0.028***	-0.046***	-0.039***
	(0.001)	(0.002)	(0.002)	(0.002)
Firm FE	Yes	Yes	Yes	Yes
Country-sector-year FE	No	Yes	No	Yes
Bank FE	No	Yes	No	Yes
Obs.	2,431,265	2,426,548	2,431,265	2,426,548
R^2	0.17	0.18	0.17	0.18
Within-R^2	0.03	0.02	0.03	0.02
Adjusted-R^2	0.03	0.03	0.03	0.03
Within-adjusted-R^2	0.03	0.02	0.03	0.02

Notes: Standard errors clustered at the firm level are in parentheses. Post is a dummy variable equal to 1 starting in 2008. Periphery is a binary variable equal to 1 if the firm comes from a peripheral economy, and 0 otherwise. High leverage is equal to 1 if the firm average of liabilities to assets is greater than the median of the sample until 2007. Financial expenses are equal to the ratio of interest paid to EBITDA. Sales are the change in the logarithm of sales. Size is measured by the logarithm of total assets. Cash flow is scaled by total assets. Total effects corresponds to the marginal effect of a variable calculated at a value of 1 for the each of the dummies present in the interaction.

$^{*}p < 0.10, ^{**}p < 0.05, ^{***}p < 0.01$.

for aggregate demand effects and the average impact of weak banks through the inclusion of country-sector-year and bank fixed effects, as seen in Column 2. The coefficient estimate is slightly lower but still statistically significant. These results point to significant debt overhang during the crisis.

All control variables enter with the expected sign. We find that sales growth enters positively, as expected, signifying the positive effect of growth opportunities on firm investment. Firm size enters negatively, as expected, capturing the presence of decreasing returns to scale in investment, and the interest coverage ratio enters negatively indicating that firms with higher financial expenses invest less.

Next, we consider whether firms in peripheral countries are differentially affected by including interaction terms with a Periphery dummy variable. The results are presented in Columns 3 and 4, with the difference being that in Column 4 we also include fixed effects at the country-sector-year and bank levels. We find that the debt overhang effect is more pronounced for firms in peripheral countries. This is not surprising given that sovereign stress was concentrated in these countries. The investment rate of highly levered firms during the crisis is 2.2 percentage points lower for firms in peripheral countries as compared to firms in the center, and the total effect of high leverage for firms in peripheral countries

during the crisis is 3.9 percentage points. However, the effect of high leverage during the crisis remains negative also for firms in center countries, being 1.7 percentage points lower than during pre-crisis times. These results indicate that there was significant debt overhang during the crisis in both peripheral and center countries but that the effects of debt overhang were more pronounced (i.e., at least two times larger) in peripheral countries.

Our results thus far may be affected by autocorrelation in investment rates. To address this concern, we expand the extended baseline model of investment by including a one period lag of the dependent variable. We then estimate this model using GMM methods based on Arellano and Bond (1991), with two-step robust errors and a collapsed matrix of instruments, and forward-demeaned variables as in Arellano and Bover (1995). Table A.2 shows results when including the lagged investment rate as explanatory variable. The autocorrelation of the investment rate is relatively low across all specifications, in line with evidence from the existing empirical literature on firm level investment. The coefficients on our main variables of interest remain broadly unchanged compared to to Table 3, and their magnitudes slightly increase in the case of binary variables. In other words, accounting for the low persistence of investment leads to a small upward revision of our estimates of the negative effects from debt overhang problems,

both for centre and periphery economies in the euro area. Given the lack of strong autocorrelation, in the remainder of our paper we turn back to OLS estimation.

5.2. The Role of Weak Banks

Table 4 accounts for the role of weak banks by including the Weak bank variable, which is time variant. The results in Column 1 of Table 4 show that investment is lower when the main banking relationship of the firm is with a weak bank (i.e., a bank with large exposure to sovereign bonds). This finding is consistent with the role of weak sovereign-bank linkages identified previously in the literature. Importantly, however, our main result on high leverage is robust to the inclusion of the Weak bank variable. We continue to find that highly levered firms have lower investment rates during the crisis. Results on our main variable of interest are unaltered when including country-sector-year and bank fixed effects in Column 2. However, the coefficient on the Weak bank variable turns insignificant upon the inclusion of bank fixed effects because there is not much variation over time in bank relationships. Our results on the more pronounced effects in peripheral countries also remain when controlling for the Weak bank variable, as seen in Columns 3 and 4, even though the size of the effect is somewhat reduced.

TABLE 4. Role of Weak Banks

Dependent variable: (Net investment/Capital)$_{i,s,c,t}$

	(1)	(2)	(3)	(4)
Post$_t$ × Periphery$_c$ × High Leverage$_{i,s,c}$			-0.034***	-0.026***
			(0.005)	(0.006)
Post$_t$ × Periphery$_c$			-0.041***	
			(0.004)	
Post$_t$ × High Leverage$_{i,s,c}$	-0.032***	-0.027***	-0.008*	-0.010**
	(0.003)	(0.003)	(0.004)	(0.005)
Post$_t$	-0.035***		-0.009***	
	(0.002)		(0.003)	
Fin. Expenses$_{i,s,c,t-1}$	-0.012***	-0.011***	-0.011***	-0.011***
	(0.001)	(0.001)	(0.001)	(0.001)
Cash Flow$_{i,s,c,t-1}$	0.298***	0.261***	0.293***	0.261***
	(0.009)	(0.009)	(0.009)	(0.009)
Sales$_{i,s,c,t-1}$	0.063***	0.052***	0.061***	0.052***
	(0.002)	(0.002)	(0.002)	(0.002)
Size$_{i,s,c,t-1}$	-0.312***	-0.319***	-0.311***	-0.319***
	(0.003)	(0.003)	(0.003)	(0.003)
Weak bank$_{i,t-1}$	-0.212***	0.037	-0.241***	0.038
	(0.022)	(0.030)	(0.022)	(0.030)
Total effect: Post$_t$	-0.067***	-0.027***	-0.091***	-0.036***
	(0.002)	(0.003)	(0.002)	(0.003)
Total effect: Periphery$_c$			-0.074***	-0.026***
			(0.004)	(0.006)
Total effect: High Leverage$_{i,s,c}$	-0.032***	-0.027***	-0.042***	-0.036***
	(0.003)	(0.003)	(0.003)	(0.003)
Firm FE	Yes	Yes	Yes	Yes
Country-sector-year FE	No	Yes	No	Yes
Bank FE	No	Yes	No	Yes
Obs.	1,052,146	1,048,091	1,052,146	1,048,091
R^2	0.26	0.28	0.26	0.28
Within-R^2	0.03	0.03	0.03	0.03
Adjusted-R^2	0.05	0.05	0.05	0.05
Within-adjusted-R^2	0.03	0.03	0.03	0.03

Notes: Standard errors clustered at the firm level are in parentheses. Post is a dummy variable equal to 1 starting in 2008. Periphery is a binary variable equal to 1 if the firm comes from a peripheral economy, and 0 otherwise. High leverage is equal to 1 if the firm average of liabilities to assets is greater than the median of the sample until 2007. Financial expenses are equal to the ratio of interest paid to EBITDA. Sales are the change in the logarithm of sales. Size is measured by the logarithm of total assets. Cash flow is scaled by total assets. Weak bank corresponds to the banker's average sovereign bondholdings scaled by total assets. Total effects corresponds to the marginal effect of a variable calculated at a value of 1 for the each of the dummies present in the interaction.
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

TABLE 5. Additional Role of Weak Banks in Periphery Countries

Dependent variable: (Net investment/Capital)$_{i,s,c,t}$

	(1)	(2)	(3)	(4)
Post$_t$ × Periphery$_c$ × High Leverage$_{i,s,c}$			-0.034***	-0.027***
			(0.004)	(0.004)
Post$_t$ × High Leverage$_{i,s,c}$	-0.034***	-0.029***	-0.011***	-0.011***
	(0.002)	(0.002)	(0.003)	(0.003)
Post$_t$ × Periphery$_c$			-0.036***	
			(0.003)	
Post$_t$	-0.025***		-0.002	
	(0.001)		(0.002)	
Post$_t$ × Periphery$_c$ × Weak bank$_i$			-0.003	0.002
			(0.004)	(0.004)
Post$_t$ × Weak bank$_i$	-0.001	-0.002	-0.002	-0.003
	(0.002)	(0.002)	(0.003)	(0.003)
Fin. Expenses$_{i,s,c,t-1}$	-0.014***	-0.013***	-0.013***	-0.013***
	(0.001)	(0.001)	(0.001)	(0.001)
Cash Flow$_{i,s,c,t-1}$	0.251***	0.223***	0.246***	0.224***
	(0.007)	(0.007)	(0.007)	(0.007)
Sales$_{i,s,c,t-1}$	0.066***	0.056***	0.064***	0.056***
	(0.002)	(0.002)	(0.002)	(0.002)
Size$_{i,s,c,t-1}$	-0.231***	-0.239***	-0.230***	-0.239***
	(0.002)	(0.002)	(0.002)	(0.002)
Total effect: Post$_t$	-0.060***	-0.031***	-0.089***	-0.040***
	(0.002)	(0.003)	(0.002)	(0.003)
Total effect: Periphery$_c$			-0.074***	-0.025***
			(0.004)	(0.006)
Total effect: High Leverage$_{i,s,c}$	-0.034***	-0.029***	-0.045***	-0.039***
	(0.002)	(0.002)	(0.002)	(0.002)
Total effect: Weak bank$_i$	-0.001	-0.002	-0.005**	-0.001
	(0.002)	(0.002)	(0.002)	(0.002)
Firm FE	Yes	Yes	Yes	Yes
Country-sector-year FE	No	Yes	No	Yes
Bank FE	No	Yes	No	Yes
Obs.	1,582,082	1,577,267	1,582,082	1,577,267
R^2	0.18	0.20	0.18	0.20
Within-R^2	0.03	0.02	0.03	0.02
Adjusted-R^2	0.04	0.04	0.04	0.04
Within-adjusted-R^2	0.03	0.02	0.03	0.02

Notes: Standard errors clustered at the firm level are in parentheses. Post is a dummy variable equal to 1 starting in 2008. Periphery is a binary variable equal to 1 if the firm comes from a peripheral economy, and 0 otherwise. High leverage is equal to 1 if the firm average of liabilities to assets is greater than the median of the sample until 2007. Financial expenses are equal to the ratio of interest paid to EBITDA. Sales are the change in the logarithm of sales. Size is measured by the logarithm of total assets. Cash flow is scaled by total assets. Weak bank is equal to 1 if the firm's main banker's average sovereign bondholdings before 2008 is greater than its country-specific median until 2007. Total effects corresponds to the marginal effect of a variable calculated at a value of 1 for the each of the dummies present in the interaction.

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

In Table 5, we consider whether the impact of weak banks differentially affects the investment of firms during the crisis and in peripheral countries through the inclusion of interaction terms of the Weak bank variable and the Post and Periphery dummy variables. Our main results on High leverage are robust to including these additional interaction terms. And the coefficients on these additional interaction terms do not enter with significant signs. Taken together, the results in Tables 4 and 5 show that the financial leverage effect we identify is robust to accounting for the weak bank channel identified in the literature.

5.3. The Role of Debt Maturity

In Tables 6 and 7, we contrast the effects of short-term and long-term leverage. The regressions in Table 6 mirror those in Table 3 with the exception that we replace the High leverage variable based on total financial leverage with a High leverage variable based on short-term leverage. Similarly, in Table 7 we include a High leverage variable based on long-term leverage. In constructing the short-term leverage variable we abstract from trade credit. We find that the main result on the more negative effect of high leverage for peripheral countries during the crisis is mainly due to the presence of short-term debt, as seen when contrasting the results in Columns 3 and 4 of Tables 6 and 7. The difference is materially substantial.

In the richest model specification presented in Column 4 where we include country-sector-year and bank fixed effects, the differential effect of high short-term leverage in peripheral versus center countries is -1.9 percentage points while it is not significant for long-term leverage. Firms with high short-term leverage in peripheral countries reduced investment more than those in center countries during the crisis. This is consistent with an increase in rollover risk during the bust period of peripheral countries and with theories in which short-term debt increases debt overhang problems during bust periods (such as Diamond and He, 2014). At the same time, the total effect of shocks in bust periods for the average country is more negative for long-term leverage (about -6.3 percentage points), compared to that of short-term leverage (-1.0 percentage points), within the group of highly leveraged firms in peripheral countries. To sum up, long-term debt has a bigger quantitative role in explaining overall debt overhang effects, whereas short-term debt accounts for differential effects between center and peripheral countries due to rollover risk.

5.4. Alternative Channels

One possibility is that the crisis affects firms' investment through other channels that are correlated with leverage. If the crisis interacts with firms' observable

TABLE 6. Benchmark Results with Firm's Short-Term Financial Leverage

Dependent variable: (Net investment/Capital)$_{i,s,c,t}$

	(1)	(2)	(3)	(4)
Post$_t$ × Periphery$_c$ × High Leverage$_{i,s,c}$			-0.034***	-0.019***
			(0.003)	(0.003)
Post$_t$ × Periphery$_c$			-0.033***	
			(0.002)	
Post$_t$ × High Leverage$_{i,s,c}$	-0.021***	-0.000	0.008***	0.010***
	(0.001)	(0.002)	(0.002)	(0.002)
Post$_t$	-0.026***		-0.013***	
	(0.001)		(0.001)	
Fin. Expenses$_{i,s,c,t-1}$	-0.016***	-0.015***	-0.015***	-0.015***
	(0.001)	(0.001)	(0.001)	(0.001)
Cash Flow$_{i,s,c,t-1}$	0.275***	0.253***	0.271***	0.253***
	(0.006)	(0.006)	(0.006)	(0.006)
Sales$_{i,s,c,t-1}$	0.067***	0.059***	0.065***	0.059***
	(0.001)	(0.002)	(0.001)	(0.002)
Size$_{i,s,c,t-1}$	-0.236***	-0.243***	-0.234***	-0.243***
	(0.002)	(0.002)	(0.002)	(0.002)
Total effect: Post$_t$	-0.047***	-0.000	-0.072***	-0.010***
	(0.001)	(0.002)	(0.001)	(0.002)
Total effect: Periphery$_c$			-0.067***	-0.019***
			(0.002)	(0.003)
Total effect: High Leverage$_{i,s,c}$	-0.021***	-0.000	-0.026***	-0.010***
	(0.001)	(0.002)	(0.002)	(0.002)
Firm FE	Yes	Yes	Yes	Yes
Country-sector-year FE	No	Yes	No	Yes
Bank FE	No	Yes	No	Yes
Obs.	2,420,571	2,415,809	2,420,571	2,415,809
R^2	0.17	0.18	0.17	0.18
Within-R^2	0.03	0.02	0.03	0.02
Adjusted-R^2	0.03	0.03	0.03	0.03
Within-adjusted-R^2	0.03	0.02	0.03	0.02

Notes: Standard errors clustered at the firm level are in parentheses. Post is a dummy variable equal to 1 starting in 2008. Periphery is a binary variable equal to 1 if the firm comes from a peripheral economy, and 0 otherwise. High leverage is equal to 1 if the firm average of short-term liabilities to assets (excluding trade credit) is greater than the median of the sample until 2007. Financial expenses are equal to the ratio of interest paid to EBITDA. Sales are the change in the logarithm of sales. Size is measured by the logarithm of total assets. Cash flow is scaled by total assets. Total effects corresponds to the marginal effect of a variable calculated at a value of 1 for the each of the dummies present in the interaction.
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

TABLE 7. Benchmark Results with Firm's Long-Term Leverage

Dependent variable: (Net investment/Capital)$_{i,s,c,t}$

	(1)	(2)	(3)	(4)
Post$_t$ × Periphery$_c$ × High Leverage$_{i,s,c}$			-0.011***	0.001
			(0.003)	(0.003)
Post$_t$ × Periphery$_c$			-0.037***	
			(0.002)	
Post$_t$ × High Leverage$_{i,s,c}$	-0.063***	-0.064***	-0.049***	-0.065***
	(0.001)	(0.002)	(0.002)	(0.002)
Post$_t$	-0.005***		0.010***	
	(0.001)		(0.001)	
Fin. Expenses$_{i,s,c,t-1}$	-0.016***	-0.015***	-0.015***	-0.015***
	(0.001)	(0.001)	(0.001)	(0.001)
Cash Flow$_{i,s,c,t-1}$	0.277***	0.258***	0.274***	0.258***
	(0.006)	(0.006)	(0.006)	(0.006)
Sales$_{i,s,c,t-1}$	0.067***	0.058***	0.065***	0.058***
	(0.001)	(0.002)	(0.001)	(0.002)
Size$_{i,s,c,t-1}$	-0.235***	-0.242***	-0.234***	-0.242***
	(0.002)	(0.002)	(0.002)	(0.002)
Total effect: Post$_t$	-0.068***	-0.064***	-0.087***	-0.063***
	(0.001)	(0.002)	(0.001)	(0.002)
Total effect: Periphery$_c$			-0.048***	0.001
			(0.002)	(0.003)
Total effect: High Leverage$_{i,s,c}$	-0.063***	-0.064***	-0.060***	-0.063***
	(0.001)	(0.002)	(0.002)	(0.002)
Firm FE	Yes	Yes	Yes	Yes
Country-sector-year FE	No	Yes	No	Yes
Bank FE	No	Yes	No	Yes
Obs.	2,430,249	2,425,533	2,430,249	2,425,533
R^2	0.17	0.19	0.17	0.19
Within-R^2	0.03	0.02	0.03	0.02
Adjusted-R^2	0.03	0.03	0.03	0.03
Within-adjusted-R^2	0.03	0.02	0.03	0.02

Notes: Standard errors clustered at the firm level are in parentheses. Post is a dummy variable equal to 1 starting in 2008. Periphery is a binary variable equal to 1 if the firm comes from a peripheral economy, and 0 otherwise. High leverage is equal to 1 if the firm average of long-term liabilities to assets is greater than the median of the sample until 2007. Financial expenses are equal to the ratio of interest paid to EBITDA. Sales are the change in the logarithm of sales. Size is measured by the logarithm of total assets. Cash flow is scaled by total assets. Total effects corresponds to the marginal effect of a variable calculated at a value of 1 for the each of the dummies present in the interaction.
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

characteristics that are correlated with leverage, this is not accounted for by the inclusion of firm fixed effects. While our regressions so far already control for observable firm characteristics, and we include country-sector-year fixed effects that control for such alternative channels to the extent that they operate at the sectoral level, we perform two additional tests to address the concern that not accounting for such interactions between the crisis and firm observable characteristics drives our result.

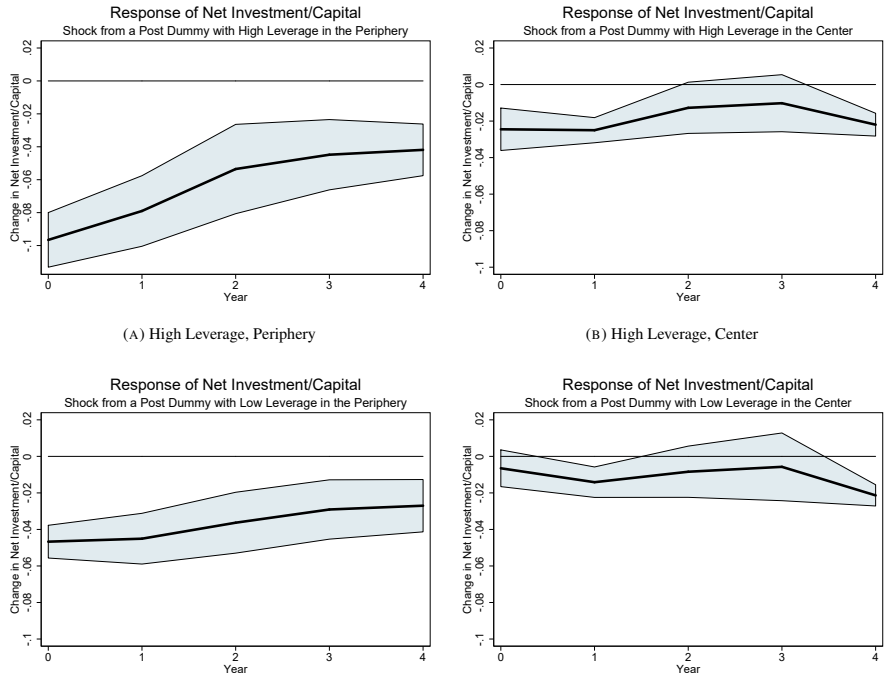
First, we account for such time-varying interactions by interacting the crisis and leverage variables with all observable firm variables that we thus far only included in levels as control variables in the regression. The results are presented in table A.4.

Second, we address this concern by using a propensity score matching model where we match firms on every observable firm characteristic (except leverage). Estimates are weighted using propensity scores which are estimated with propensity score matching using a logit model that includes one-period lags of the observable firm characteristics (interest expense/EBITDA, cash flow to total assets, sales growth and the log of total assets) together with 2-digit sector dummies. The propensity score matching results are presented in table A.3. In both cases, our main results on high leverage after the crisis are robust.

5.5. Sluggish Investment and Persistent Effects of Leverage

Figure 4 plots estimated impulse coefficients based on the estimation of the local projection equation (3) of each group for each horizon h. We find persistent effects of leverage on investment, especially for firms in the periphery. Firms with high leverage in the periphery reduce investment for up to 4 years after the crisis, and this effect is much larger than that of low leverage firms in the periphery or high leverage firms in the center. Panel (a) shows that firms with high leverage in the periphery reduce their investment rate on impact and in each of the four years that follow: they reduce investment by about 10 percentage points on impact, another 8 percentage points in the first year after the crisis, and another 4 percentage points in the fourth year after the crisis. Magnitudes of the impulse coefficients are smaller in firms with high leverage in the center (panel (b)), low leverage in the periphery (panel (c)), and low leverage in the center (panel (d)) compared to those reported in panel (a). The estimated cumulative impact on investment of high leverage in the periphery over the crisis period (2008-2012) is very large: a decline of about 32 percentage points compared to the level in 2007. This contrasts sharply with the estimated cumulative decline for low leverage firms of 20 percentage points over the same period. The cumulative decline in investment

in the center is estimated to be 6% for high leverage firms and 4% for low leverage firms.



(A) High Leverage, Periphery

(B) High Leverage, Center

(C) Low Leverage, Periphery

(D) Low Leverage, Center

FIGURE 4. Impulse Responses of Investment. We apply the local projections method by Jordà (2005) to run the following regressions: $(\text{Investment}/\text{Capital})_{it+h} = \beta_{1h}POST_t + \beta_{2h}POST_t \times \text{Periphery}_i + \beta_{3h}POST_t \times \text{High Leverage}_i + \beta_{4h}POST_t \times \text{Periphery}_i \times \text{High Leverage}_i + \mathbf{X}_{it-1}{}'\beta_h + \alpha_i + \alpha_{c,s} + \alpha_b + \varepsilon_{it}$, where horizons are given by h = 0, 1, 2, 3, 4; α_i and α_b are firm and bank fixed effects, respectively; and $\alpha_{c,s}$ are country×industry fixed effects. $\mathbf{X}_{it-1}$ includes a lagged investment $(\text{Investment}/\text{Capital})_{it-1}$ and other controls (sales growth, firm size, cash flow ratio, and debt coverage ratio). For each horizon h, this figure plots estimated impulse coefficients $\hat{\beta}_{1h} + \hat{\beta}_{2h} + \hat{\beta}_{3h} + \hat{\beta}_{4h}$ for highly leveraged firms in the periphery, $\hat{\beta}_{1h} + \hat{\beta}_{2h}$ for lowly leveraged firms in the periphery, $\hat{\beta}_{1h} + \hat{\beta}_{3h}$ for highly leveraged firms in the center, and $\hat{\beta}_{1h}$ for lowly leveraged firms in the center. We plot 95% confidence interval (calculated using two-way clustered standard errors by firm and year) as a shaded area.

In order to quantify the aggregate impact of the corporate leverage channel, we use the differential responses of highly levered firms and lowly levered firms in both the periphery and the center. We do this back-of-the-envelope calculation by assuming that we can extend the partial equilibrium estimates to the whole economy, thus abstracting from general equilibrium effects.

The difference in the cumulative decline in investment between high leverage and low leverage firms over the crisis period is 12% for firms in the periphery and 2% for firms in the center. According to official Eurostat statistics for the year 2007, the share in euro area GDP is 35.6% for the periphery and 64.4% for the center. High leverage firms by construction make up half the economy because we defined high leverage using the median value in the sample. It then follows that the overall decline in investment that is due to the debt overhang channel is 2.8 percentage points ($= 0.5 \times 0.356 \times 12 + 0.5 \times 0.644 \times 2$) in the euro area and 12 percentage points in the periphery. According to official Eurostat statistics, the aggregate decline in private sector investment (measured as gross fixed capital formation of the non-financial private sector, in constant prices) over the period 2008-2012 (compared to base year 2007) was 14.0 percentage points in the euro area and 29.2 percentage points in the periphery, as shown in Figure A.2 in the Appendix. The debt overhang channel can therefore explain 20% (=2.8/14.0)

of the aggregate decline in private sector investment in the euro area and 41% (=12/29.2) of the decline in private sector investment in the periphery.

6. Conclusions

We quantify the role of financial factors that have contributed to sluggish investment in Europe in the aftermath of the 2008–2009 crisis. We use a very large pan-European firm-bank-time level dataset, in which we match the firms to their banks based on banking relationships in 8 countries over time. Our identification relies on a difference-in-difference estimation approach, where we compare the investment of high debt firms with low debt firms between crisis and normal times, while absorbing demand shocks through country-(four-digit) industry-year fixed effects. Furthermore, we distinguish between short-term and long-term debt to account for the effect of debt maturity on debt overhang and rollover risk, and use confidential ECB data on the exposures of banks to (own) sovereign debt together with information on the main bank relationship of each firm to identify the role of sovereign-bank linkages in driving the effect of debt overhang and rollover risk. Regressions also include bank fixed effects alongside firm fixed effects to abstract from any unobserved bank and firm characteristics.

Our results highlight the important role of firm leverage and debt maturity in determining firm investment following a crisis. Firms with higher leverage reduce investment more and this effect is stronger for firms in peripheral countries. Firms from peripheral countries that borrowed more short-term suffer from rollover risk and decrease investment relatively more. However, this effect is dominated for the average firm by the negative effect of long-term debt. These results are robust to accounting for weak bank and aggregate demand effects. The negative effect of firm leverage on investment is persistent for up to four years after the crisis in countries with sovereign stress, resulting in a cumulative decline in investment for these firms of about 32 percentage points. A simple back of the envelope calculation based on our firm-level estimates suggests that the debt overhang channel explains about 20% (41%) of the actual decline in aggregate corporate investment in the euro area (periphery countries) during the crisis.

Our results are complementary to the existing explanations in the literature that have focused on aggregate demand, banking health, and sovereign-bank linkages to explain the severity of the crisis. Our results also point to the dangers of the rise in corporate financial distress during the ongoing COVID crisis. While governments have provided ample liquidity to cash-strapped firms during the lockdown periods, it can be expected that these liquidity problems will turn

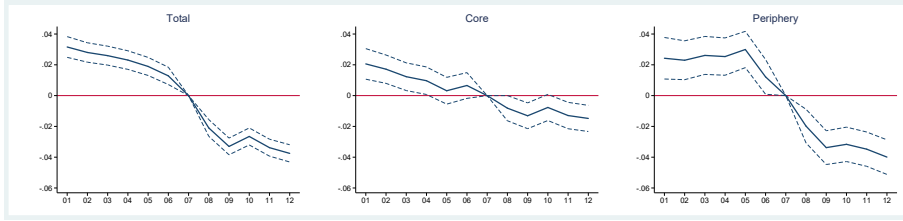
into solvency problems for many firms, especially highly indebted firms (e.g., Gourinchas et al., 2021; Ding et al., 2021). Our results on the potentially strong persistent effects of firm debt overhang on firm investment, while based on a different type of crisis, can therefore be seen as informative for the evolution of firm investment going forward. The results also point to the dangers of an overreliance on short-term debt to finance investment during good times, especially in countries with a high degree of financial frictions.

Appendix

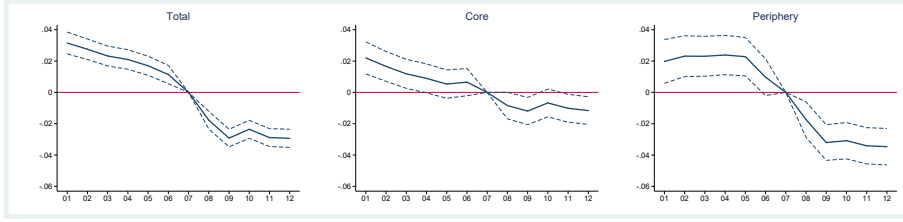
TABLE A.1. Firm-Bank Relationships
(percentage of the total number of firms)

Country	With more than one bank[1] (percent)	Without any foreign bank[2] (percent)
Austria	20.4	99.5
France	0.0	100.0
Germany	32.2	99.8
Greece	50.4	99.9
Ireland	25.5	100.0
Netherlands	0.4	100.0
Portugal	37.9	97.9
Spain	40.3	99.0

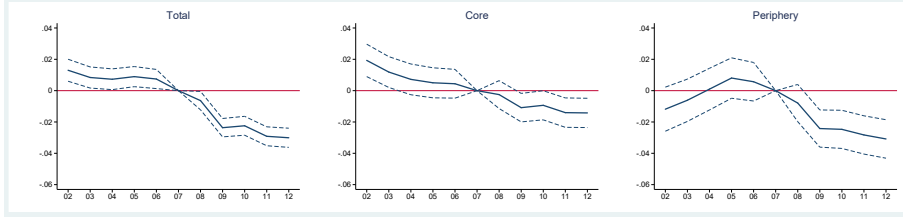
[1] Share of firms in matched sample reporting more than one bank they have relationship with.
[2] Share of firms that report having relationships only with domestic banks.



(a) Benchmark model



(b) Benchmark model, including firm and sector-country-year fixed effects



(c) Benchmark model, including firm and sector-country-year fixed effects, and firm controls

FIGURE A.1. Evolution of net investment rates of high-leverage vs low-leverage firms. Total figure uses a double interaction model; Core and Periphery figures use coefficients estimated using a triple interaction model with a Periphery binary variable. Dashed lines corresponds to the confidence intervals at 5% significance.

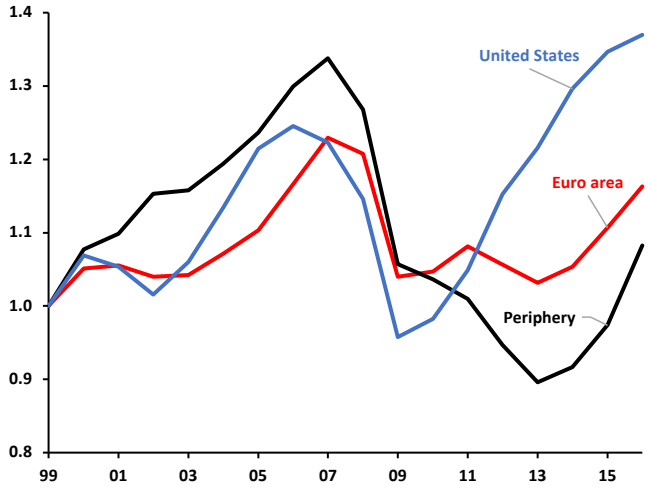


FIGURE A.2. Evolution of Real Gross Corporate Investment. Gross fixed capital formation of non-financial corporations, adjusted for inflation using the economy-wide price deflator for gross fixed capital formation, and indexed at 1 for 1999. Annual data for the period 1999 to 2016 from the European Commission's AMECO3 database. Original source of data is Eurostat for Euro area and periphery, and BEA for US. Periphery group of economies comprises Greece, Ireland, Italy, Portugal, and Spain. Sources: European Commission, Eurostat, and BEA.

TABLE A.2. GMM Estimation of Post-crisis Effects and the Periphery

Dependent variable: (Net investment/Capital)$_{i,s,c,t}$

	(1)	(2)	(3)	(4)
Post$_t$ × Periphery$_c$ × High Leverage$_{i,s,c}$			-0.031***	-0.032***
			(0.003)	(0.003)
Post$_t$ × Periphery$_c$			-0.024***	-0.023***
			(0.002)	(0.002)
Post$_t$ × High Leverage$_{i,s,c}$	-0.048***	-0.047***	-0.019***	-0.018***
	(0.001)	(0.001)	(0.002)	(0.002)
Post$_t$	-0.010***		-0.002	
	(0.001)		(0.001)	
(Net Investment/Capital)$_{i,c,s,t-1}$	0.030***	0.030***	0.030***	0.029***
	(0.001)	(0.001)	(0.001)	(0.001)
Fin. Expenses$_{i,c,s,t-1}$	-0.016***	-0.015***	-0.015***	-0.015***
	(0.001)	(0.001)	(0.001)	(0.001)
Cash Flow$_{i,c,s,t-1}$	0.287***	0.283***	0.283***	0.278***
	(0.006)	(0.006)	(0.006)	(0.006)
Sales$_{i,c,s,t-1}$	0.061***	0.060***	0.059***	0.059***
	(0.002)	(0.002)	(0.002)	(0.002)
Size$_{i,c,s,t-1}$	-0.241***	-0.245***	-0.240***	-0.243***
	(0.002)	(0.002)	(0.002)	(0.002)
Total effect: Post$_t$	-0.058***	-0.047***	-0.076***	-0.073***
	(0.001)	(0.001)	(0.001)	(0.002)
Total effect: Periphery$_i$			-0.055***	-0.055***
			(0.002)	(0.002)
Total effect: High Leverage$_{i,c,s}$	-0.048***	-0.047***	-0.050***	-0.050***
	(0.001)	(0.001)	(0.002)	(0.002)
Firm FE	Yes	Yes	Yes	Yes
Year FE	No	Yes	No	Yes
Obs.	2,066,491	2,066,491	2,066,491	2,066,491
AR(1) test statistic	-261.49***	-261.78***	-261.45***	-261.74***
AR(2) test statistic	-1.60	-1.90*	-1.70*	-2.03**
Wald χ^2 statistic	35,218***	36,262***	36,429***	37,507***

Notes: Standard errors in parentheses. Estimation performed following Arellano and Bond (1991), using two-step robust errors and a collapsed matrix of instruments, with forward-demeaned variables as in Arellano and Bover (1995). Post is a dummy variable equal 1 starting 2008. Periphery is a binary variable equal to 1 if the firm comes from a Periphery economy, and 0 from a Centre economy. High leverage is equal 1 if the firm average of liabilities to assets is greater than the median of the sample until 2007. Fin. Expenses is equal to the ratio of interest paid to EBITDA, and corresponds to the coverage ratio. Sales is the change in logarithm of sales. Size is measured by the logarithm of total assets. Cash flow is scaled by total assets. Total effects corresponds to the marginal effect of a variable calculated at a value of 1 for the each of the dummies present in the interaction.

$^{*}p < 0.10,^{**}p < 0.05,^{***}p < 0.01$

TABLE A.3. Robustness on firm controls

Dependent variable: Net investment/Capital$_{i,c,s,t}$

	(1)	(2)	(3)	(4)
Post$_t$ ×High Leverage$_{i,c,s}$ ×Fin. Expenses$_{i,c,s,t-1}$			-0.008**	-0.005
			(0.004)	(0.004)
Post$_t$ ×High Leverage$_{i,c,s}$ ×Cash Flow$_{i,c,s,t-1}$			-0.083***	-0.064***
			(0.018)	(0.018)
Post$_t$ ×High Leverage$_{i,c,s}$ ×Sales$_{i,c,s,t-1}$			0.009	0.008
			(0.006)	(0.006)
Post$_t$ ×High Leverage$_{i,c,s}$ ×Size$_{i,c,s,t-1}$			0.004***	0.003**
			(0.001)	(0.001)
Post$_t$ ×High Leverage$_{i,c,s}$			-0.070***	-0.055***
			(0.014)	(0.015)
High Leverage$_{i,c,s}$ ×Fin. Expenses$_{i,c,s,t-1}$			0.012***	0.010***
			(0.003)	(0.003)
High Leverage$_{i,c,s}$ ×Cash Flow$_{i,c,s,t-1}$			-0.008	-0.010
			(0.015)	(0.015)
High Leverage$_{i,c,s}$ ×Sales$_{i,c,s,t-1}$			0.027***	0.027***
			(0.004)	(0.004)
High Leverage$_{i,c,s}$ ×Size$_{i,c,s,t-1}$			-0.031***	-0.030***
			(0.003)	(0.003)
Post$_t$ ×Fin. Expenses$_{i,c,s,t-1}$	-0.001	0.007***	0.011***	0.017***
	(0.002)	(0.002)	(0.003)	(0.003)
Post$_t$ ×Cash Flow$_{i,c,s,t-1}$	0.089***	0.032***	0.108***	0.045***
	(0.009)	(0.009)	(0.012)	(0.013)
Post$_t$ ×Sales$_{i,c,s,t-1}$	0.030***	0.022***	0.037***	0.026***
	(0.003)	(0.003)	(0.004)	(0.004)
Post$_t$ ×Size$_{i,c,s,t-1}$	0.004***	0.006***	0.002***	0.004***
	(0.000)	(0.001)	(0.001)	(0.001)
Post$_t$	-0.100***		-0.058***	
	(0.007)		(0.010)	
Fin. Expenses$_{i,c,s,t-1}$	-0.016***	-0.020***	-0.027***	-0.029***
	(0.002)	(0.002)	(0.003)	(0.003)
Cash Flow$_{i,c,s,t-1}$	0.217***	0.227***	0.248***	0.256***
	(0.007)	(0.008)	(0.011)	(0.011)
Sales$_{i,c,s,t-1}$	0.049***	0.046***	0.032***	0.029***
	(0.002)	(0.002)	(0.003)	(0.003)
Size$_{i,c,s,t-1}$	-0.247***	-0.254***	-0.223***	-0.230***
	(0.002)	(0.002)	(0.002)	(0.002)
Firm FE	Yes	Yes	Yes	Yes
Sector-country-year FE	No	Yes	No	Yes
Obs.	2,628,311	2,623,671	2,431,265	2,426,548
R^2	0.192	0.204	0.172	0.185
Within-R^2	0.027	0.021	0.028	0.022
Adjusted-R^2	0.036	0.039	0.032	0.034
Within-adjusted-R^2	0.027	0.021	0.028	0.022

Notes: Standard errors in parentheses. Two-step robust errors. Periphery is a binary variable equal to 1 if the firm comes from a Peripheral economy, and 0 otherwise. High leverage is equal 1 if the firm average of liabilities to assets is greater than the median of the sample until 2007. Fin. Expenses is equal to the ratio of interest paid to EBITDA. Interest Paid is scaled by EBITDA, and corresponds to the coverage ratio. Sales is the change in logarithm of sales. Size is measured by the logarithm of total assets Cash flow is scaled by total assets. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

TABLE A.4. Propensity Score Matching Robustness

Dependent variable: Net investment rate difference between high-leverage (treated) and low-leverage (control) firms

	(1)	(2)	(3)	(4)
$2003 \times \text{Periphery}_c$		0.021**		0.018**
		(0.009)		(0.009)
$2004 \times \text{Periphery}_c$		0.031***		0.024***
		(0.009)		(0.009)
$2005 \times \text{Periphery}_c$		0.024***		0.019**
		(0.009)		(0.009)
$2006 \times \text{Periphery}_c$		0.016*		0.009
		(0.009)		(0.009)
$2007 \times \text{Periphery}_c$		-0.009		-0.015
		(0.009)		(0.009)
$2008 \times \text{Periphery}_c$		-0.079***		-0.082***
		(0.009)		(0.009)
$2009 \times \text{Periphery}_c$		-0.081***		-0.074***
		(0.009)		(0.009)
$2010 \times \text{Periphery}_c$		-0.085***		-0.078***
		(0.009)		(0.009)
$2011 \times \text{Periphery}_c$		-0.109***		-0.105***
		(0.009)		(0.009)
$2012 \times \text{Periphery}_c$		-0.104***		-0.091***
		(0.009)		(0.009)
2003	-0.005	-0.016**	-0.001	-0.010
	(0.005)	(0.007)	(0.005)	(0.006)
2004	0.009*	-0.008	0.012***	-0.001
	(0.005)	(0.007)	(0.005)	(0.007)
2005	0.004	-0.010	0.006	-0.005
	(0.004)	(0.007)	(0.004)	(0.007)
2006	0.000	-0.010	0.004	-0.003
	(0.004)	(0.007)	(0.004)	(0.007)
2007	-0.008*	-0.004	-0.005	0.003
	(0.005)	(0.007)	(0.005)	(0.007)
2008	-0.063***	-0.016**	-0.058***	-0.010
	(0.004)	(0.007)	(0.004)	(0.007)
2009	-0.099***	-0.052***	-0.082***	-0.040***
	(0.004)	(0.007)	(0.004)	(0.007)
2010	-0.090***	-0.041***	-0.062***	-0.019***
	(0.004)	(0.007)	(0.004)	(0.007)
2011	-0.099***	-0.035***	-0.085***	-0.025***
	(0.004)	(0.007)	(0.004)	(0.007)
2012	-0.114***	-0.055***	-0.100***	-0.048***
	(0.004)	(0.007)	(0.004)	(0.007)
Periphery_c		0.044***		0.045***
		(0.007)		(0.007)
$\text{Fin.Expenses}_{i,s,c,t-1}$			-0.027***	-0.028***
			(0.002)	(0.002)
$\text{Cash Flow}_{i,s,c,t-1}$			0.143***	0.141***
			(0.013)	(0.013)
$\text{Sales}_{i,s,c,t-1}$			0.108***	0.105***
			(0.004)	(0.004)
$\text{Size}_{i,s,c,t-1}$			-0.002**	-0.002***
			(0.001)	(0.001)
Obs.	1,219,528	1,219,528	1,219,528	1,219,528
R^2	0.004	0.006	0.008	0.009
Adjusted-R^2	0.004	0.006	0.008	0.009

Notes: Standard errors in parentheses. Estimates are weighted using propensity scores, which in turn, are estimated with propensity score matching using a logit model, firm controls lagged one period, and 2-digit sector dummies and without replacement. The treatment variable is being a high leverage firm, if the firm average of liabilities to assets is greater than the median of the sample until 2007. The outcome variable is the net investment rate. The firm controls are the following: Fin. Expenses is equal to the ratio of interest paid to EBITDA. Interest Paid is scaled by EBITDA, and corresponds to the coverage ratio. Sales is the change in logarithm of sales. Size is measured by the logarithm of total assets. Cash flow is scaled by total assets. Periphery is a binary variable equal to 1 if the firm comes from a Peripheral economy, and 0 otherwise. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

TABLE A.5. Weak Banks Robustness

Dependent variable: Net investment/Capital$_{i,c,s,t}$

	(1)	(2)	(3)	(4)	(5)	(6)
	A/E	A/E	RWA/C	RWA/C	RWA/T1C	RWA/T1C
Post$_t$ × Periphery$_c$ × High Leverage$_{i,c,s}$		-0.021***		-0.027***		-0.028***
		(0.003)		(0.004)		(0.004)
Post$_t$ × Periphery$_c$ × Weak bank$_b$		0.004		-0.002		-0.007
		(0.003)		(0.012)		(0.015)
Post$_t$ × High Leverage$_{i,c,s}$	-0.030***	-0.017***	-0.029***	-0.011***	-0.029***	-0.011***
	(0.002)	(0.003)	(0.002)	(0.004)	(0.002)	(0.004)
Post$_t$ × Weak bank$_b$	0.001	-0.002	0.001	0.002	-0.001	0.004
	(0.002)	(0.003)	(0.002)	(0.011)	(0.005)	(0.014)
Fin. Expenses$_{i,c,s,t-1}$	-0.014***	-0.014***	-0.014***	-0.014***	-0.014***	-0.014***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Cash Flow$_{i,c,s,t-1}$	0.239***	0.239***	0.223***	0.223***	0.224***	0.224***
	(0.006)	(0.006)	(0.008)	(0.008)	(0.008)	(0.008)
Sales$_{i,c,s,t-1}$	0.057***	0.057***	0.056***	0.056***	0.056***	0.056***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Size$_{i,c,s,t-1}$	-0.242***	-0.242***	-0.236***	-0.236***	-0.236***	-0.236***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Total effect: Periphery$_c$		-0.017***		-0.029**		-0.034**
		(0.005)		(0.012)		(0.015)
Total effect: Post$_t$	-0.029***	-0.036***	-0.028***	-0.038***	-0.030***	-0.041***
	(0.002)	(0.003)	(0.003)	(0.003)	(0.006)	(0.006)
Total effect: High Leverage$_{i,c,s}$	-0.030***	-0.039***	-0.029***	-0.038***	-0.029***	-0.038***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Total effect: Weak bank$_b$	0.001	0.003	0.001	0.001	-0.001	-0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.005)	(0.006)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Sector-Country-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Banker FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	2,075,531	2,075,531	1,443,194	1,443,194	1,427,686	1,427,686
R^2	0.191	0.191	0.196	0.196	0.195	0.195
Within-R^2	0.022	0.022	0.021	0.021	0.021	0.021
Adjusted-R^2	0.038	0.038	0.041	0.041	0.041	0.041
Within-adjusted-R^2	0.022	0.022	0.021	0.021	0.021	0.021
F-Test:Periphery		0.000		0.019		0.026
F-Test:Post	0.000	0.000	0.000	0.000	0.000	0.000
F-Test:High-Leverage	0.000	0.000	0.000	0.000	0.000	0.000
F-Test:Weak-Bank	0.565	0.204	0.768	0.790	0.830	0.688

Notes: Standard errors in parentheses. Clustered errors at the firm level. Post is a dummy variable equal 1 starting 2008. Periphery is a binary variable equal to 1 if the firm comes from a Peripheral economy, and 0 otherwise. High leverage is equal 1 if the firm average of liabilities to assets is greater than the median of the sample until 2007. Fin. Expenses is equal to the ratio of interest paid to EBITDA. Sales is the change in logarithm of sales. Size is measured by the logarithm of total assets. Cash flow is scaled by total assets. Weak bank is equal to 1 if the average before 2008 of the banker weakness indicator is greater than its country-specific median until 2007.Banker weakness indicators corresponds to the following ratios: bank assets to equity (A/E),risk-weighted assets to capital (RWA/C), and risk-weighted assets to tier 1 capital (RWA/T1C). Total effects corresponds to the marginal effect of a variable calculated at a value of 1 for the each of the dummies present in the interaction.

$*p < 0.10$, $**p < 0.05$, $***p < 0.01$

TABLE A.6. Benchmark Results with Total Firm Leverage

Dependent variable: Net investment/Capital$_{i,s,c,t}$

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
2002×Periphery$_c$×High Leverage$_{i,c,s}$					0.023***	0.023***	-0.013*	-0.012*
					(0.006)	(0.007)	(0.007)	(0.007)
2003×Periphery$_c$×High Leverage$_{i,c,s}$					0.026***	0.023***	-0.005	-0.006
					(0.006)	(0.006)	(0.007)	(0.007)
2004×Periphery$_c$×High Leverage$_{i,c,s}$					0.025***	0.024***	-0.001	0.001
					(0.006)	(0.006)	(0.007)	(0.007)
2005×Periphery$_c$×High Leverage$_{i,c,s}$					0.030***	0.023***	0.013**	0.008
					(0.006)	(0.006)	(0.006)	(0.007)
2006×Periphery$_c$×High Leverage$_{i,c,s}$					0.012**	0.010	0.008	0.006
					(0.006)	(0.006)	(0.006)	(0.006)
2008×Periphery$_c$×High Leverage$_{i,c,s}$					-0.020***	-0.017***	-0.013**	-0.008
					(0.006)	(0.006)	(0.006)	(0.006)
2009×Periphery$_c$×High Leverage$_{i,c,s}$					-0.034***	-0.032***	-0.029***	-0.024***
					(0.006)	(0.006)	(0.006)	(0.006)
2010×Periphery$_c$×High Leverage$_{i,c,s}$					-0.032***	-0.031***	-0.029***	-0.025***
					(0.006)	(0.006)	(0.006)	(0.006)
2011×Periphery$_c$×High Leverage$_{i,c,s}$					-0.035***	-0.034***	-0.033***	-0.028***
					(0.006)	(0.006)	(0.006)	(0.006)
2012×Periphery$_c$×High Leverage$_{i,c,s}$					-0.040***	-0.035***	-0.040***	-0.031***
					(0.006)	(0.006)	(0.006)	(0.006)
2002×High Leverage$_{i,c,s}$	0.028***	0.028***	0.010***	0.013***	0.017***	0.017***	0.019***	0.019***
	(0.003)	(0.003)	(0.003)	(0.004)	(0.005)	(0.005)	(0.005)	(0.005)
2003×High Leverage$_{i,c,s}$	0.026***	0.023***	0.008**	0.008**	0.012***	0.012**	0.011**	0.012**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.005)	(0.005)	(0.005)	(0.005)
2004×High Leverage$_{i,c,s}$	0.023***	0.021***	0.008**	0.007**	0.010**	0.009*	0.009*	0.007
	(0.003)	(0.003)	(0.003)	(0.003)	(0.005)	(0.005)	(0.005)	(0.005)
2005×High Leverage$_{i,c,s}$	0.019***	0.017***	0.010***	0.009***	0.003	0.005	0.004	0.005
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.005)	(0.005)	(0.005)
2006×High Leverage$_{i,c,s}$	0.013***	0.011***	0.008***	0.007**	0.007	0.007	0.004	0.004
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.005)	(0.005)
2008×High Leverage$_{i,c,s}$	-0.021***	-0.018***	-0.010***	-0.006**	-0.008*	-0.008*	-0.002	-0.003
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.005)
2009×High Leverage$_{i,c,s}$	-0.033***	-0.029***	-0.028***	-0.024***	-0.013***	-0.012***	-0.011**	-0.011**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.005)
2010×High Leverage$_{i,c,s}$	-0.027***	-0.024***	-0.026***	-0.022***	-0.008*	-0.007	-0.009**	-0.009**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.005)	(0.005)	(0.005)
2011×High Leverage$_{i,c,s}$	-0.034***	-0.029***	-0.034***	-0.029***	-0.013***	-0.010**	-0.015***	-0.014***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.005)	(0.005)	(0.005)
2012×High Leverage$_{i,c,s}$	-0.038***	-0.029***	-0.037***	-0.030***	-0.015***	-0.012***	-0.015***	-0.014***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.005)	(0.005)	(0.005)
2002×Periphery$_c$					0.003		-0.012***	
					(0.004)		(0.004)	
2003×Periphery$_c$					0.017***		0.004	
					(0.004)		(0.004)	
2004×Periphery$_c$					0.009**		-0.001	
					(0.004)		(0.004)	
2005×Periphery$_c$					-0.000		-0.009**	
					(0.004)		(0.004)	
2006×Periphery$_c$					0.005		0.000	
					(0.004)		(0.004)	
2008×Periphery$_c$					-0.043***		-0.044***	
					(0.004)		(0.004)	
2009×Periphery$_c$					-0.033***		-0.028***	
					(0.004)		(0.004)	
2010×Periphery$_c$					-0.044***		-0.031***	
					(0.004)		(0.004)	
2011×Periphery$_c$					-0.065***		-0.054***	
					(0.004)		(0.004)	
2012×Periphery$_c$					-0.052***		-0.042***	
					(0.004)		(0.004)	
Fin. Expenses$_{i,c,s,t-1}$			-0.016***	-0.015***			-0.015***	-0.015***
			(0.001)	(0.001)			(0.001)	(0.001)
Cash Flow$_{i,c,s,t-1}$			0.276***	0.260***			0.271***	0.261***
			(0.006)	(0.006)			(0.006)	(0.006)

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TABLE A.6. – continued from previous page

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\text{Sales}_{i,c,s,t-1}$			0.066***	0.058***			0.064***	0.058***
			(0.002)	(0.002)			(0.002)	(0.002)
$\text{Size}_{i,c,s,t-1}$			-0.239***	-0.243***			-0.237***	-0.242***
			(0.002)	(0.002)			(0.002)	(0.002)
Total effect: High $\text{Leverage}_{i,c,s}$	-0.011	0.003	-0.091***	-0.066***	-0.006	-0.004	-0.148***	-0.122***
	(0.023)	(0.024)	(0.023)	(0.024)	(0.031)	(0.033)	(0.030)	(0.031)
Total effect: Periphery_c					-0.234***	-0.027	-0.359***	-0.119**
					(0.035)	(0.049)	(0.034)	(0.048)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	No	Yes	No	Yes	No	Yes	No
Sector-Country-Year FE	No	Yes	No	Yes	No	Yes	No	Yes
F-test: High $\text{Leverage}_{i,c,s}$	0.628	0.898	0.000	0.005	0.841	0.900	0.000	0.000
F-test: Periphery_c					0.000	0.587	0.000	0.012
Obs.	2,960,961	2,955,588	2,431,265	2,426,548	2,960,961	2,955,588	2,431,265	2,426,548
R^2	0.142	0.154	0.173	0.185	0.143	0.154	0.173	0.185
Within-R^2	0.001	0.000	0.022	0.021	0.002	0.001	0.023	0.021
Adjusted-R^2	0.013	0.016	0.032	0.034	0.014	0.016	0.033	0.034
Within-adjusted-R^2	0.001	0.000	0.022	0.021	0.002	0.001	0.023	0.021

Notes: Standard errors in parentheses. Clustered errors at the firm level. In specifications without firm controls, the year 2001 is included. Periphery is a binary variable equal to 1 if the firm comes from a Peripheral economy, and 0 otherwise. High leverage is equal 1 if the firm average of liabilities to assets is greater than the median of the sample until 2007. Financial Expenses is equal to the ratio of interest paid to EBITDA. Sales is the change in logarithm of sales. Size is measured by the logarithm of total assets. Cash flow is scaled by total assets. Total effects corresponds to the marginal effect of a variable calculated at a value of 1 for the each of the dummies present in the interaction. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

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