BACKGROUND PAPER

DEBT OVERHANG, ROLLOVER RISK, AND CORPORATE INVESTMENT: EVIDENCE FROM THE EUROPEAN CRISIS

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

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Abstract

We quantify the role of financial factors that have contributed to sluggish investment in Europe in the aftermath of the 2008–2009 crisis. Using a big data approach, we match the firms to their banks based on banking relationships in 8 European countries over time, obtaining over 2 million observations. We document four stylized facts. First, the decline in investment in the aftermath of the crisis can be linked to higher leverage, increased debt service, and having a relationship with a weak bank—once we condition on aggregate demand shocks. Second, the relation between leverage and investment depends on the maturity structure of debt: firms with a higher share of long-term debt have higher investment rates since the rollover risk for those firms is lower. Third, the negative effect of leverage is more pronounced when firms are linked to weak banks with high exposure to sovereign risk. This is also the case for the positive effect of longer maturity debt on investment, where firms linked to weak banks increase investment more if they have a higher share of long-term debt. This finding indicates that firms that have borrowed more long term are less affected by bank weakness as they do not need to rollover loans. This result also suggests that loan evergreening by weak banks to firms facing higher rollover risk played a limited role during the crisis as these firms decreased investment more. Fourth, the direct negative effect of weak banks on the *average* firm's investment disappears once demand shocks are controlled for, although the differential effects with respect to leverage and the maturity of debt remain.

JEL-Codes: E22, E32, E44, F34, F36, G32
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1 Introduction

Investment expenditure in Europe collapsed in the aftermath of the 2008 global financial crisis. Figure 1 shows that, by the end of 2016, net corporate investment as a share of GDP across the euro area still has not fully recovered, with higher declines in the most affected periphery countries. By contrast, the US recovered much faster over the same period, reaching its 2008 peak by 2014, though there was a slowdown later on. This collapse in investment in Europe followed a boom period during which corporate sector borrowed heavily. Figure 2 shows that 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 periphery countries.

We investigate whether corporate debt holds back investment in non-financial corporate private sector in the aftermath of the global financial crisis, and how this effect interacts with weak credit supply in a period of tightening of lending conditions. We refer to this situation as "debt overhang". [1] Debt overhang can lead to sluggish investment via two main channels. First, there is the standard de-leveraging narrative, where firms that over-borrowed during boom years have to de-lever. This will increase their debt service. Second, if the debt accumulated during the boom years is mostly short-term, there will be an increase in the rollover risk as lenders are often unwilling to renew expiring credit lines during a crisis when collateral values drop and lenders' own financing conditions deteriorate.[2]

We argue that two data requirements are needed to investigate the effect of debt overhang

[1] In the finance literature, debt overhang is typically defined as high levels of debt that are curtailing investments because the benefits from additional investment in firms financed with risky debt accrue largely to existing debt holders rather than shareholders (Myers, 1977). This reduced incentive to invest implies that firms with high levels of debt face an underinvestment problem. In the macro literature, debt overhang is often more loosely referred to as a situation where high levels of public debt are crowding out private investment. See for example Aguiar et al. (2009), Krugman (1988), Bulow and Rogoff (1991).

[2] See Diamond (1991) and Acharya et al. (2011). Debt maturity may also affect the debt overhang by altering incentives to invest and the net effect is ambiguous. 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. In the extreme, if all debt matures before the investment decision, then the firm can make investment decisions as if an all-equity firm. However, Diamond and He (2014) show that reducing maturity can increase debt overhang. They show for immediate investment, shorter-term debt typically imposes lower overhang. But 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, which implies more volatile earnings and equity, and hence more debt overhang.

and rollover risk on firms' investment outcomes. First, we need a firm-bank matched dataset since the deterioration in both firms' and banks' balance sheets have to be measured simultaneously to be able to understand deterioration in factors that lead to lower credit demand and lower credit supply separately. Second, we need to have firm-level balance sheet data on SMEs since these firms are informationally opaque and hence dependent on bank financing and subject to associated debt overhang. Unlike big listed firms, where most of the literature focuses on, small firms cannot easily obtain non-bank financing.[3] Banks need to invest time in acquiring knowledge about each SME. This leads to "relationship banking." Previous research has shown that these relationships are sticky even in developed financial markets such as the US.[4] These relationships are valuable, especially for smaller firms for which monitoring costs tend to be high.[5] Small firms make up a large fraction of economic activity in Europe[6] and they are likely to suffer more from debt overhang given the fact that European economies are bank-dominated.

We use a comprehensive firm-level data set including small private firms from the ORBIS/AMADEUS database. The database has detailed firm-level balance sheet information including on investment, indebtedness, debt service, and debt maturity. The database also incorporates information on the firms' main relationship bank from another database called KOMPASS. The database provides the firms' main relationship banks' name and address information, which we use to match these banks to BANKSCOPE to obtain banks balance sheets that includes information on total sovereign holdings. In order to separate banks' exposure to their *own* versus other sovereigns, we use confidential ECB data which has nationality information on sovereign exposure for a subset of banks in our sample.

The reason why we measure a deterioration in bank balance sheets with exposure to sovereign risk is as follows. Government bond yields are an important driver of corporate bond yields and bank lending rates, either through standard interest arbitrage conditions or through sovereign bonds directly serving as a benchmark for the pricing of loans and other assets. In the Euro-

[3] See Kashyap et al. (1994b,a, 1993).
[4] See Chodorow-Reich (2014).
[5] See Hoshi et al. (1990); Bae et al. (2002).
[6] Firms with less than 250 employees make up 70 percent of employment and value added in Europe. See official statistics as of 2013 from Eurostat's Structural Business Statistics.

pean context, banks hold sovereign bonds and firms depend on banks for their lending, and hence sovereign risk can affect firm investment through bank-sovereign linkages via a bank lending channel, where a deterioration in the balance sheets of banks could reduce the supply of loans to firms, leading to an increase in debt overhang and rollover risk. It is also possible that weak banks continue to lend to risky borrowers in an effort to preserve relationships, consistent with loan evergreening and resulting in a reduction in rollover risk.[7]

We use a difference-in-difference approach to identify the effect of corporate debt overhang and rollover risk on investment, assessing the differential impact on investment of different levels of leverage and debt maturity pre-post crisis, where we define the pre period as 2000–2007 and the post period as 2008–2012. We measure leverage as the ratio of debt to total assets and debt maturity as the ratio of long-term debt to total debt. The analysis controls for the usual determinants of investment and also for debt service since the debt to assets ratio may not fully capture the effects of lingering debt overhang when debt is measured at the book value. We condition on aggregate demand shocks since it is possible that firms decreased investment due to negative demand (or productivity) shocks rather than the debt overhang and rollover risk channels we focus on.

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 and also country-level demand conditions, including those arising from changes in sovereign risk and general uncertainty conditions. We assume that most of the fluctuations in aggregate demand derive from country and narrowly defined industry-specific factors, not idiosyncratic firm-specific factors. To the best of our knowledge we are the first to allow these demand effects to vary at a very granular level (four-digit) of industry classification and also across countries and over time. Our identification approach is valid if any remaining variation in firm specific demand conditions ex-post, does not vary systematically by the level and maturity structure of the firm's indebtedness ex-ante. One can envision that firms with positive demand shocks during the boom years accumulated a lot of debt to be able to produce and meet that demand. To invalidate our identification strategy, however,

[7] See Peek and Rosengren (2000) and Peek and Rosengren (2005); Caballero et al. (2008).

these firms should a) suffer from negative demand shocks, b) operate in a different four-digit industry, c) have accumulated more long-term than short-term debt during boom years. We think it is not plausible that all these conditions are met since it is more likely that firms with positive demand shocks in the boom years accumulated more short-term debt and that firms operating in the same four-digit sector were hit simultaneously by either positive or negative shocks during the pre and post crisis periods. We control for bank fixed effects to capture the role of pre-existing bank relationships.

We limit the analysis to firms in the euro area, i.e. firms that were subject to the same monetary policy but experienced diverging sovereign risk and banking conditions during the crisis. We run two sets of regressions: First, a cross sectional regression of differences in average investment rates between the crisis period (2008-2012) and the pre-crisis period (2000-2007) on differences in our explanatory variables. Second, a panel regression of triple interactions, where we interact a crisis dummy that takes the value of one starting in 2008, with the interaction variables of our measure of weak banks with the leverage, debt service, and maturity variables. To mitigate concerns about reverse causality, we measure leverage, debt service, maturity, and bank-firm relationships prior to the crisis. Because some firms deleveraged during the crisis, our conservative approach, if anything, underestimates the effect of high leverage on investment.

Our findings are as follows. First, high ex-ante debt levels depress investment during crisis times, consistent with debt overhang, where both high leverage and high debt service affect investment negatively. Thus, this result is due to increased debt service that is associated with de-leveraging but also due to a negative balance sheet shock to firms who enter the crisis with high leverage. These firms have low net worth due to their high leverage and might be financially constrained in terms of obtaining new loans to finance investment. Second, firms with a shorter maturity of debt reduce investment more during the crisis (or firms with longer maturity of debt increase investment more), consistent with an increase in rollover risk. An increase in default risk during the crisis raises borrowing costs, making it more difficult to refinance maturing debt. Third, the debt overhang and rollover effects are influenced by sovereign-bank linkages. Firms whose main bank's balance sheet deteriorated because of large

exposure to sovereign risk have significantly lower investment rates, and experience more debt overhang but less rollover risk during the crisis. The latter result indicates that firms that have borrowed more long term are less affected by bank weakness as they do not need to rollover loans. This result also suggests that loan evergreening by weak banks to firms facing higher rollover risk played a limited role during the crisis, as these firms decreased investment more.

There is an extensive literature on the real effects of the European crisis. Closest to our paper is the work by Acharya et al. (2014b) who use data on syndicated loans in Europe, matched to AMADEUS database, to estimate the effect of shocks to periphery banks on investment of firms who borrow from these banks in the syndicated loan market. They find that firms that tend to borrow from banks in peripheral countries decreased their investment more. Similarly, using the same syndicated loans data, Becker and Ivashina (2014) shows that the increase in holdings of sovereign bonds led to a crowding out of corporate lending, while Popov and Van Horen (2014) show that banks with exposure to stressed sovereign debt also cut cross-border lending. The advantage of data on syndicated loans is a direct link between firms and the banks and how much firms borrow from these banks. The disadvantage is that these papers will be limited to only large firms since only few large firms can borrow in the syndicated loans market in Europe. Because smaller firms are likely to be more financially constrained to begin with and hit harder during the crisis, these papers might underestimate the quantitative role of financial factors for firm investment during the crisis. Moreover none of these papers focus on debt overhang and rollover risk arising from exposure to sovereign risk, which is the focus of our paper.

In terms of the theoretical literature on investment and debt, 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. More recently, Occhino and Pescatori (2010) show that the debt overhang effect on investment is higher during recessions when default risk is higher, in a calibrated model. Whited (1992) shows that adding debt capacity variables to a standard investment model im-

proves the model fit. Similarly, Bond and Meghir (1994) finds an empirical role for debt in standard investment models. Empirically, for listed firms in the US, Lang et al. (1996) document a negative relationship between debt and investment for firms without valuable growth opportunities. 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.

Our work also relates to recent empirical literature on the sovereign-bank nexus. Sovereign-bank linkages can arise through different channels. One direct channel, which is the one we focus on, arises from banks holding significant amounts of sovereign debt. As sovereign default risk increases and sovereign ratings get downgraded, the net worth of banks holding such sovereign debt will be negatively affected (Gennaioli et al., 2014; Baskaya and Kalemli-Özcan, 2014). A second sovereign-to-bank linkage arises from the role of the government in (explicitly or implicitly) backstopping the financial system, through guarantees and bank bailouts (Laeven and Valencia, 2013). Such bailouts can add significantly to sovereign debt, increasing sovereign risk (Acharya et al., 2014a). Weaknesses in the banking sector can reinforce these sovereign-bank linkages as in Acharya and Steffen (2014), Gennaioli et al. (2013).

Our paper proceeds as follows. Section 2 presents the data set used in the paper. Section 3 presents the identification methodology. Section 4 presents our main results, extensions and robustness tests of our main results. Section 5 concludes.

2 Data and Measurement

2.1 Firm-Level Data

Our firm-level data comes from the ORBIS database (compiled by Bureau van Dijk Electronic Publishing, BvD, a Moody's company). ORBIS is an umbrella product that provides firm-level data covering more than 100 countries worldwide, both developed and emerging, since

2005. Certain subsets of the database covering different country regions (such as Europe) go back to 1996. This is a commercial data set, which contains administrative data on 130 million firms worldwide. The data set has financial accounting information from detailed, harmonized balance-sheets, income statements and profit/loss accounts of financial and non-financial firms. This data set is crucially different from other data sets that are commonly-used in the literature such as COMPUSTAT for the United States, Compustat Global, and Worldscope databases, since 99 percent of the companies in ORBIS are private, whereas former data sets contain mainly information on large listed companies.

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 transform nominal financial variables into real variables using country-specific consumer price indices with 2005 base and converting to US dollars using the end-of-year 2005 US 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 use all the other sectors. We clean the data following the guidelines in Kalemli-Özcan et al. (2015). As explained in that paper, our firm level data coverage in terms of the aggregate economy ranges from roughly 50 to over 90 percent depending on the country.

2.2 Matching Firm- and Bank-Level Data

Our analysis uses a novel data set of bank-firm relationships in Europe. Our data set includes, for each firm, a variable called BANK showing the name(s) of the firm's main bank(s), which, following the literature on firm-bank lending relationship, we assume to be the main bank(s) that the firm borrows from. We obtain this information through the AMADEUS database but the original source is KOMPASS. This data has been used before by Giannetti and Ongena (2012), among others, to study bank-firm relationships in emerging markets. Instead, we use information on bank relationships in Europe. We use 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 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. We use the 2013 vintage of the database as built in AMADEUS 2013 vintage and take both the primary and secondary firm-bank relationship. We checked with 2015 vintage and confirmed (as many others in the literature) that firm-bank relationships are sticky and do not change over shorter periods of time.[8]

We combine firm-level data from AMADEUS with bank-level data from BANKSCOPE. The latter is a data set, also from Bureau Van Dijk, containing balance sheet information about more than 30,000 banks spanning most countries and data up to 16 years. A significant hurdle is to match bank information to firm data, since the name of the bank is the only information available to do so, and there is no standardized procedure to match 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 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 data is not available in BANKSCOPE.

Table 1, focusing on euro-area countries again, describes how many of these firm-bank relations are multiple relationships (with more than one bank) and cross-border (with banks whose parent company is foreign). More than one bank is not very common across the euro-area countries with the exception of Greece. Having a foreign bank is even less common in this sample since we do not have Eastern European countries. In the case where multiple bank relationships are reported, the first listed bank is considered the main bank.

We focus solely on the euro area in our econometric strategy, to keep monetary policy constant across countries. Since our firm-level sample is representative, we worry less about the selection issue caused by the reporting bias in bank names by firms. In Italy no firm reports their bank names so this country will not be included in the analysis.

[8] Giannetti and Ongena (2012) use both 2005 and 2010 vintages confirming the same result on sticky bank-firm relationships.

2.3 Matching Bank-Level Data to Banks' Sovereigns

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 and the safety net provided by the home country of the parent bank that together determine the strength of each subsidiary rather than that of the host country. Banks in the BANKSCOPE database are all recorded as domestic legal entities, including the subsidiaries of foreign parent companies. We therefore need to take an extra step to identify the ultimate sovereign country of each bank, i.e., the sovereign country of the entity that is the ultimate owner of the bank. We trace this information using the Global Ultimate Owner (GUO) variable. Then, we use its consolidated balance sheet reported directly in BANKSCOPE. This is important to capture the internal capital markets of the bank.

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 high degree of independence (i.e., values B-, B or B+), the GUO will be also the bank itself, as in the previous case.

2.4 Construction of Regression Variables and 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 regarding future productivity. Consequently, we use net investment rate in our empirical work, computed as the annual change in fixed tangible assets.[9] An additional advantage of using net investment is that we retain observations that otherwise would

[9] Using net investment is common in the literature; see for example Lang et al. (1996).

be lost due to missing data on depreciation. Hence 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.

We capture debt overhang using the ratio of total debt to total assets as a proxy for firm indebtedness. Total debt is measured as the sum of long-term debt, loans, credit, and other 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 amortisation of capital (EBITDA).

To capture rollover risk we use the share of long-term debt in total debt, which in the tables we refer to as "maturity". Long-term debt comprises all borrowing from credit institutions (loans and credits) and bonds, whose residual maturities are longer than one year. Short-term debt comprises all current liabilities, i.e. loans, trade credits and other current liabilities, with residual maturities shorter than one 1 year. An increase in short-term debt (i.e., a decrease in maturity) poses increased rollover risk during bad times. Moreover, small firms finance investment predominantly with short-term debt and hence there is an inherent negative correlation between long-term debt share in total debt and investment during regular times. It is therefore important to also control for firm size to assess the independent effect of debt maturity on firm investment. We thus use log of total assets as a control for firm size, labeled as "size."

Figure 3 shows the importance of studying medium and small firms focusing on the maturity structure of debt. Even though most of the total debt in the euro area is held by large firms, small firms hold a large fraction, 41 percent of the short term debt on average.

We control for growth opportunities using net sales growth, and control separately by cash flow as a measure of financing constraints by smaller firms especially.

We measure bank weakness of the firm's main bank, WEAK BANK, using the share of total sovereign holdings of the bank over total assets of the bank. The rationale for measuring bank weakness using data on sovereign exposure is that the European crisis was triggered by a surge in sovereign risk directly affecting banks through their sovereign bond holdings. While banks were undoubtedly affected also by other channels, the negative shock from sovereign

bond holdings can be precisely measured and can be treated as broadly exogenous to the increase in sovereign risk. Data on total sovereign holdings comes from BANKSCOPE, without indicating the nationality of the sovereign. Hence, we complement this dataset using *own* sovereign's holdings of the bank from the proprietary database of Individual Balance-Sheet Items (IBSI), from the European Central Bank (ECB). The difference between the two variables is that the BANKSCOPE-based variable captures all sovereign bonds while the IBSI -based variable captures domestic bonds only. In practice, the difference between the two variables should be small since most of a bank's total sovereign bond holdings are 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 a even higher percentage in peripheral countries. We use both BANKSCOPE and IBSI data to construct the variable WEAK BANK since IBSI data starts only in the fourth quarter of 2007 and covers fewer banks. In an extension, we restrict the exposure to own sovereigns to banks from peripheral countries only because exposure to own sovereigns in core countries need not indicate weakness. While this is our preferred specification it is also the most limited in terms of 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.

All firm-level variables are winsorized such that their kurtosis falls below a threshold of 10. This implies that net investment to lagged capital, debt 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 2 shows descriptive statistics for the sample of cross-sectional changes and also for the panel for the matched firm-bank sample.

3 Framework and Identification

We run a cross sectional regression using changes and a panel differences-in-differences regression with firm and bank fixed effects. The cross-sectional regressions include country×sector and the panel regressions include country×sector×year effects to control for aggregate demand shocks, where "sector" is a 4-digit sector. We use average changes for each firm level variable between the period 2000–2007 to 2008–2012 for the cross-sectional regression for investment changes as follows:

$$\Delta\left(\frac{\text{Investment}}{\text{Capital}}\right)_i = \beta\,\Delta\left(\frac{\text{Debt}}{\text{Assets}}\right)_i + \delta\,\Delta\text{Maturity}_i + \phi\,\Delta\left(\frac{\text{Interest Paid}}{\text{EBITDA}}\right)_i + \theta\,\Delta\text{Weak Bank}_b + \mathbf{\Delta X}_i{}'\,\boldsymbol{\gamma} + \alpha_{c,s} + \varepsilon_i \quad (1)$$

where $\alpha_{c,s}$ is a country×sector fixed effect. The vector $\mathbf{X}_i$ contains control variables, such as changes in sales growth, cash flow and firm size. Maturity is the ratio of long-term debt to total debt. Weak Bank is the amount of sovereign bond holdings on the balance sheet of the firm's main bank.

This regression setup can be motivated using an extension of the theoretical model in Miao (2005), which is detailed in Appendix A. Our main contribution over their setting is that we add long-term debt by means of stochastically maturing debt as in Chaterjee and Eyigungor (2012), and then transform the expected capital into an linear error-correction model of investment following the lines of Bloom et al. (2007), but focusing on debt variables rather than uncertainty. To this investment equation we add the Weak Bank variable to capture the role of bank-sovereign linkages on investment during the crisis.

To gauge the impact of the crisis and the role of sovereign exposures, we run the following difference-in-difference regression, where we interact all variables with the variable $POST_t$ and Weak Bank$_{t-1}$. The former is a binary variable equal to 1 starting in the year 2008, which

we take as the beginning of the global financial crisis:[10]

$$\left(\frac{\text{Investment}}{\text{Capital}}\right)_i = POST_t \times \text{Weak Bank}_{b,t-1} \times \mathbf{W}_{i,t-1}{}'\boldsymbol{\beta} + POST_t \times \mathbf{W}_{i,t-1}{}'\boldsymbol{\delta} + \text{Weak Bank}_{b,t-1} \times \mathbf{W}_{i,t-1}{}'\boldsymbol{\theta} + POST_t \times \text{Weak Bank}_{b,t-1} + \alpha_i + \alpha_b + \delta_{c,s,t} + \varepsilon_i \quad (2)$$

where α_i is a firm-specific fixed effect, α_b is a bank-specific fixed effect and δ_{cst} is a country$\times$sector$\times$year fixed effects. The vector $\mathbf{W}_{i,t-1}$ contains main variables, such as the ratio of total debt to assets, the ratio of long-term debt to total debt (Maturity), and the debt service ratio (Interest Paid/EBITDA); and control variables, including sales growth (Δ log Sales), cash flow and firm size measured as log of total assets.

An important assumption underlying the use of the difference-in-difference methodology is that there is a parallel trend in the dependent variable for different cross sections of the data over which the difference in explanatory variables is taken and that this difference diverges after the shock (i.e., crisis). Figures 4 and 5 show the behavior of the average net investment rate for firms with high and low leverage and high and low maturity, respectively. A firm is considered to have high leverage (maturity) if its leverage (maturity) before 2008 is above the median of the sample. It is clear from these charts that the investment behavior of these different sets of firms was similar before the crisis but diverged after the crisis. This provides supporting evidence of the parallel trend assumption and the empirical approach we take. Figure 4 shows that the investment of highly leveraged firms dropped markedly during the crisis while that of firms with low leverage stayed broadly unchanged. Before the crisis, the investment of highly leveraged firms was slightly higher than that of firms with low leverage, with the gap between the two staying broadly constant, while during the crisis the investment of highly leveraged firms dropped to levels below that of firms with low leverage. A similar pattern is found in figure 5 for debt maturity. Before the crisis, investment was relatively higher for firms with longer debt maturity. During the crisis, the investment rates of these

[10]For most countries in our sample, this is also the starting year of a major recession. When using IBSI data on sovereign exposure, we start the variable POST in 2009 due to data limitations: the IBSI data starts only in the fourth quarter of 2007.

firms dropped markedly to levels below those of firms with shorter debt maturity.[11]

4 Regression Results

4.1 Cross-Sectional Evidence of Debt Overhang and Rollover Risk

Table 3 shows our benchmark cross-sectional results where we include our main variables of interest–leverage, interest coverage, debt maturity, and bank sovereign exposure–one-at-a-time to limit the impact of collinearity among these four variables. All regressions include sector-country fixed effects to absorb demand effects. All variables are expressed as first-differences, resulting in a fully balanced panel sample of firms, essentially absorbing firm-fixed effects on the same variables in levels. First-differences are computed as average changes for each firm level variable between the crisis period (2008–2012) and the pre-crisis period (2000–2007). The total numbers of observations is 377,576 firms across 8 countries.

The results in Column 1 of 3 indicate that an increase in firm indebtedness (leverage) impacts negatively and significantly on the growth of investment in the average firm during the crisis. The same is true for an increase in the associated debt service burden, as captured by the ratio of interest expenses to EBITDA, as seen in Column 2. An increase in debt maturity between the pre- and post-crisis periods, however, is associated with higher investment, as seen in Column 3. This result points to increased rollover risk during the crisis associated with the accumulation of short-term debt. The significance of bank-sovereign linkages is seen in Column 4. A weakening of the balance sheet of the firm's main bank through sovereign debt exposures reduces investment during the crisis period, as indicated by a negative coefficient on the Weak Bank variable. These results depict a situation where debt overhang becomes a drag on investment during the crisis and rollover risk associated with short term debt surfaces.

In terms of the control variables, sales growth enters positively, as expected, signifying the

[11] Notice that firms with a higher share of long term debt decreasing investment more in the aftermath of the crisis is totally consistent with total effect of maturity being negative on average firm as we show below. Our regressions will also show that the partial differential effect of maturity is positive during the crisis, meaning firms who entered the crisis with a higher share of long term debt increases investment relatively more than the firms who entered the crisis with a higher share of short term debt. This is due to increased rollover risk associated with short term debt during the crisis for the firms who borrowed ex-ante from weak banks.

positive effect of growth opportunities on firm investment. Firm size enters positively capturing increasing returns to scale or possibly that small firms are more affected by financial shocks. Cash flow enters with a negative sign, showing that internally generatead cash flows did not reflect binding constraints on firms' investment decisions during the crisis, as otherwise this coefficient would have been positive.

Table 4 runs multivariate regressions where each column uses a different definition of the weak bank variable, based on total sovereign holdings, domestic sovereign holdings, and periphery country sovereign holdings, respectively. Periphery countries include Greece, Ireland, Italy, Portugal, and Spain. Results on the four variables of interest are qualitatively similar across specifications, although the statistical significance on the weak bank variable increases when using own sovereign bond holdings instead of total bond holdings, arguably because this increases precision. This confirms previous findings that the difference between the different weak bank variables should be small since most of a bank's total sovereign bond holdings are domestic bonds ((Gennaioli et al., 2014)).

Our results are economically significant. A one standard-deviation increase in the debt variable—capturing worsening debt overhang—implies a decrease in the investment rate equivalent to 11% of its average change. [12] Similarly, a rise of one standard deviation in interest paid to EBITDA, maturity, and weak bank can explain -5%, 11%, and -2 to -3% of the average change in the investment rate, respectively. The economic effect of the Weak bank variable is as significant as that of the sales growth variable, denoting the comparable forces of (reductions in) credit supply and growth opportunities during the crisis.

Next, we want to understand what drives these changes from regular to crisis times, meaning what is the key shock underlying the crisis. Therefore, we investigate the role of weak sovereigns and weak banks as potential drivers of these changes. Thus far we have the considered the direct effects of weak bank on investment but not its interaction with leverage,

[12] This economic effect is computed as follows: we first obtain the standard deviation of the variable of interest for the sample being used in the estimation; then, we calculate the product of the coefficient (shown in table 4) of a given independent variable with its standard deviation; then we produce a ratio by dividing this number by the absolute value of the mean of the left-hand-side variable, since we are interested in scaling the effects. This produces an estimate of the effect of a standard-deviation change in the value of an independent variable on the average of the dependent variable.

debt service and maturity.

4.2 Panel Evidence on the Role of Weak Sovereigns and Weak Banks

In our panel difference-in-difference specifications, we run a triple interaction where we interact firm variables with a crisis (post) dummy and also with our weak bank variable. This specification compares firms' investment before and after the crisis as a function of the debt overhang and rollover risk variables, differentiating between firms that are linked to weak banks and those that are not. In table 5, we measure weak bank as total sovereign bond-holdings over total assets of the firm's main bank. Each column adds a different set of fixed effects: Column 1 includes firm fixed effects; Column 2 adds also sector-country-year effects to more effectively control for demand effects; and Column 3 adds also bank fixed effects. The sample period covers the years 2000 to 2012 and the Post crisis dummy variable takes on a value of one starting in the year 2008. The bottom panel reports the total effects of our key variables: leverage, debt service, maturity and weak bank.

We find that firms with high leverage reduced their investment rates disproportionately during the crisis if their main bank is a weak bank as a result of exposure to sovereign debt. The differential effect of debt service is insignificant and the differential effect of debt maturity also turns insignificant once we include sector-country-year fixed effects to control for demand shocks.

The total effects of leverage and debt service remain strongly negative and significant, whereas the total effect of being linked to a weak bank on average investment is no longer significant once we control for time varying aggregate demand shocks (as shown in bottom part of the table). The total effect of maturity is negative, indicating that investment is predominantly financed with short-term debt. Interestingly, the results on debt maturity are the opposite of those found in the cross-sectional regression results where variables are expressed in first-differences and results are identified off one-time changes rather than time series dynamics. One explanation is that rollover risk is reduced over time even though an increasing share of debt is financed with short-term debt.

In order to understand this result better, we refine our measure of weak banks. In Table 6 we measure weak bank as domestic sovereign bond holdings to total assets. Using data on domestic holdings has the advantage that one can more accurately measure exposure to weak sovereigns, though this comes at the cost of a reduced sample size due to data availability. Although the total effects stay the same, we now obtain a differential effect of debt maturity: a higher share of long-term debt is associated with higher net investment rates during the crisis for firms linked to weak banks, relative to firms whose banks are not weak. These results imply that, although short term debt generates rollover risk during the crisis for the average firm, firms who are linked to weak banks exhibit higher investment rates if they have a higher share of long-term debt. This finding indicates that firms that have borrowed predominantly long term are less affected by bank weakness as they do not need to rollover loans. This result also suggests that loan evergreening by weak banks to firms facing higher rollover risk played a limited role during the crisis as these firms decreased investment more.

Table 7 repeats the panel regressions using a weak bank variable defined based on periphery banks' domestic sovereign bond holdings. The results are broadly similar to those in Table 6. The differential effect on leverage is negative and the differential effect on debt maturity is positive, while the total effects on leverage and maturity are negative. This means that the results in Table 6 are driven by exposure to periphery sovereigns. This provides evidence in support of our hypothesis that the debt overhang and rollover risk effects are in part driven by increases in sovereign risk transmitted to firms through firm-bank linkages. Next, we investigate the quantitative role of these effects and their aggregate implications.

4.3 Aggregate Implications

Our results imply that debt overhang and rollover risk negatively affected firm investment during the crisis, in part because of an increase in sovereign risk. How much of the decline in aggregate corporate investment since the onset of the crisis is due to debt overhang and rollover risk? Since our data has extensive coverage and representative of the official data from Eurostat, we track aggregate patterns reasonably well. Hence we can use a back of the

envelope calculation to link our micro estimates to the actual macro level decline in investment.

According to official macroeconomic statistics from Eurostat, the average net investment rate (net investment over GDP) of the non-financial corporate sector in the Euro area fell by 60 percent during the crisis period compared to its pre crisis average level. Since our estimates are predicting the decline in investment over capital for the average firm, we compare our predictions to the decline in aggregate gross fixed capital formation for business investment, which is 20 percentage points. Using our preferred estimates from column (3) of Table 6, we calculate the total effects of each our variables, leverage, debt service, and maturity, for the average value of the weak bank variable and report them in the second panel of the Table. Next we calculate the predicted total effects for one standard deviation change in each of our variables, which are 3, 0.1, and 9 percentage points respectively. Thus, the sum of the predicted percentage point changes is 12 percentage point. As a result, our coefficients can explain 60 percent of the decline in aggregate investment, where the rest of the decline is probably due to aggregate demand shocks.

5 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, where 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 (maturity) firms with low debt (maturity) firms between crisis and normal times, and absorbing demand shocks through country-industry-year fixed effects. Furthermore we use confidential ECB data on the exposures of banks to (own) sovereign debt together with information on the main bank relation of each firm to identify the role of sovereign-bank linkages in driving the effect of debt overhang and rollover risk. Regressions also include banker fixed effects alongside firm fixed effects.

Our results are as follows: First, the decline in investment in the aftermath of the crisis can

be linked to higher leverage, increased debt service, and having a relationship with a weak bank—once we condition on aggregate demand shocks. Second, the relation between leverage and investment depends on the maturity structure of debt: firms with a higher share of long-term debt increase their investment (rather than decrease) since the rollover risk for those firms is lower. Third, the negative effect of leverage is more pronounced when firms are linked to weak banks with high exposure to sovereign risk. This is also the case for the positive effect of longer maturity debt on investment, where firms linked to weak banks increase investment more if they have a higher share of long-term debt, suggesting these firms are less exposed to rollover risk. Alternatively firms who are linked to weak banks and who borrowed more short term ex ante and have high rollover risk, decrease investment more suggesting evergreening of these loans by weak banks is limited. Fourth, the direct negative effect of weak banks on the *average* firm's investment disappears once demand shocks are controlled for, although the differential effects with respect to leverage and the maturity of debt remain. So although aggregate demand shocks seem to be more important during the crisis in terms of average investment, credit supply still have an important role in intensifying the negative effects of debt overhang at the firm level and hence contributing to the sluggish investment which has been persistent since the crisis.

In quantitative terms, the debt overhang and rollover risk channels are important channels. A simple back of the envelope calculation based on our firm-level estimates suggests that the debt overhang and rollover risk channels explain about 60 percent of the actual decline in aggregate corporate investment during the crisis.

These results highlight that debt overhang played a significant role in holding back corporate investment during the European debt crisis despite unprecedented monetary policy measures that have brought interest rates down to the zero lower bound. This suggests that other growth-enhancing policies, such as the long-term refinancing and asset purchase programs recently implemented by the European Central bank, are needed to reduce the debt overhang and stimulate the real economy.

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Appendix A Model

A.1 Setting

This Appendix presents a theoretical model building on Miao (2005) that motivates our empirical specification. In this setting, there is a large number of identical firms. Information is perfect and investors are risk-neutral. They discount future cash flows at a constant risk-free rate $r > 0$. Time $t \in [0, 1]$ is continuous, and uncertainty is represented by a probability space $(\Omega, \mathcal{F}, \mathbb{P})$ over which all stochastic processes will be defined.

There is perfect competition where all firms are price takers. The price of the product is denoted p. Firms use capital in order to produce output using a production function $F: \mathbb{R}_+ \to \mathbb{R}_+$, $F(k) = k^\nu$, where $\nu \in (0, 1)$. Capital depreciates at a constant rate $\delta > 0$.

The technology shock process for a given firm $(z_t)_{t \geq 0}$ follows a geometric Brownian motion

$$\frac{dz_t}{z_t} = \mu_z dt + \sigma_z dW_t,$$

where μ_z and σ_z are positive, and $(W_t)_{t \geq 0}$ is a standard Brownian motion representing the firm-specific uncertainty.[13]

A.2 Firm profits

We define the operating profits as the value of total output valued minus the costs on its inputs usage:

$$\pi(z, p) = pzk^\nu - (r + \delta)k$$

where by optimality we obtain

$$k = z^\gamma \left(\frac{p\nu}{r + \delta} \right)^\gamma$$

where $\gamma \equiv (1 - \nu)^{-1}$. Hence output y will be given by

$$y = z^\gamma \left(\frac{p\nu}{r + \delta} \right)^{\gamma\nu}.$$

We can define

$$a(p) \equiv p^\gamma (1 - \nu) \left(\frac{\nu}{r + \delta} \right)^{\nu\gamma},$$

[13] Since the process $(z_t)_{t \geq 0}$ is non-stationary, Miao (2005) includes an exogenous Poisson firm-death process with arrival rate η. However, for our purposes of studying an average firm, we will not consider it. Additionally, we abstract from taxes as well. Even though taxes are necessary in this type of models to obtain positive amounts of debt, in order to have tax shields, we will not include them in order to facilitate calculations. It is important to say that adding taxes and firm-death processes does not alter the sign of results.

such that the profits can be expressed as a function of price, technology shocks and other parameters

$$\pi(z,p) = a(p)\, z^{\gamma}.$$

A.3 Corporate debt

In order to stay in a time homogeneous setting, we shall use infinite-term debt contracts. Departing from Miao (2005), the firm pays a constant coupon b only under a shock that has arrival rate φ, as in Chaterjee and Eyigungor (2012), i.e. at any given moment, there is an instantaneous probability φ of having to pay the debt in full. This parameter represents the term of the debt, i.e., the time to maturity. Under any exponential distribution, the expected duration under no-default is given by $1/\varphi$. This means that the higher the parameter φ, the shorter the duration.

After paying debt, the shareholders receives remainder cash flows. If the firm defaults, it is immediately liquidated and the proceeds go to the existing creditors; the shareholders receive nothing in return.

A.4 Liquidation value and the value of the unlevered firm

After default, the firm is immediately liquidated and exits the industry. The liquidation value is a fraction $\alpha \in (0,1)$ of the value without leverage of the firm $A(z,p)$. Since we have set fixed costs of entry to zero,[14] we can readily find this value as

$$A(z,p) = \frac{a(p)}{\lambda} z^{\gamma}, \quad \lambda \equiv r - \mu_z \gamma - \frac{1}{2}\sigma_z^2 \gamma(\gamma - 1) > 0.$$

Notice that the value of liquidation $A(z,p)$ corresponds to the discounted present value of profits without leverage $\Pi(z,p)$.

A.5 Liquidation decision and value of equity under leverage

At each date t, after servicing the debt b, the residual cash flows are distributed to shareholders as dividends. The shareholders choose investment and default policy to maximize the value of their claims taking price p as given. Assume that default is triggered when the shareholders diced to cease raising additional equity to meet the payments. So the value of their claims is represented by

$$e(z,b,p) = \sup_{T \in \mathcal{T}} E^z \left[\int_0^T e^{-rt} \pi(z_t,p)\, dt - \int_0^T e^{-(r+\varphi)} b dt \right]$$

[14] In Miao (2005), the abandonment threshold is a function of costs of entry. When this is zero, this threshold for z is zero.

where $\mathcal{T}$ is the set of all stopping times, over which maximization takes place, relative to the filtration generated by the Brownian motion $(W_t)_{t\geq 0}$. As Miao (2005) shows, the value of equity is increasing in z, and hence default will be triggered when z falls below a threshold z_d, which will be determined endogenously. Investment only happens under the no-default region $z > z_d(b;p)$. This threshold is determined by the smooth-pasting condition:

$$\left.\frac{\partial e(z,b;p|z_d)}{\partial z}\right|_{z=z_d} = 0$$

which determines the value of equity as:

$$e(z,b,p) = \left[\Pi(z;p) - \frac{b}{r+\varphi} + \left(\frac{b}{r+\varphi} - \Pi(z_d;p)\right)\left(\frac{z}{z_d}\right)^{\vartheta}\right], \; z > z_d$$

where

$$\vartheta = \frac{1}{\sigma_z^2}\left[\left(\frac{1}{2}\sigma_z^2 - \mu_z\right) - \sqrt{2(r+\varphi)\sigma_z^2 + \left(\frac{1}{2}\sigma_z^2 - \mu_z\right)^2}\right] < 0,$$

and

$$z_d = \left[\frac{\vartheta\lambda b}{(\vartheta-\gamma)(r+\varphi)a(p)}\right]^{\frac{1}{\gamma}}$$

Notice that the higher the debt and the longer its maturity, the higher its threshold, and hence, the higher its probability of default. The value of liquidation of the firm is given by

$$\Pi(z_d,p) = \frac{\vartheta}{\vartheta-\gamma}\frac{b}{r+\varphi}$$

A.6 Expected investment

The expected stock of capital at any given moment is given by

$$Ek = \left[1 - \left(\frac{z}{z_d}\right)^{\vartheta}\right]\left(\frac{y}{z}\right)^{\frac{1}{\gamma}}$$

where it can be easily seen that the capital stock will be increasing in output, decreasing in debt and decreasing in debt maturity, i.e., $1/\varphi$.

We can linearize the previous equation by using a first-order Taylor approximation of the log of the variable around its steady state, those variables being y, b, and φ, respectively. Define the coefficients

$$\alpha_x = E\left.\frac{\partial k}{\partial x}\right|_{\mathbf{x}=\mathbf{x}^*}, \; \forall x \in \mathbf{x}$$

where $\mathbf{x} = y, b, \varphi$ and x^* correspond to the deterministic steady state. With these, we obtain:

$$Ek = \alpha_0 + \alpha_b b + \alpha_y y + \alpha_\varphi \varphi$$

Where $\alpha_0 = k^* \left(1 + \alpha_b b^* + \alpha_y y^* + \alpha_\varphi \varphi^*\right)$, and $\alpha_y, \alpha_\varphi > 0$ and $\alpha_b < 0$. We can subtract k_{-1} to the above expression, normalize by the steady state capital k^* and manipulate terms to obtain:

$$E\left(\frac{\Delta k}{k^*}\right) = \hat{\alpha}_b \frac{\Delta b}{y*} + \hat{\alpha}_{\varphi^*} \frac{\Delta \varphi}{y^*} + \hat{\alpha}_{k^*} \frac{\Delta y}{y^*}$$

Where $\hat{\alpha_x} = \alpha_x y^*/k^*, \forall x \in \mathbf{x}$. As in Bloom et al. (2007), we can go further and add an error correction representation:

$$\frac{\Delta k}{k^*} = \theta\alpha_0 + \hat{\alpha}_b \frac{\Delta b}{y*} + \hat{\alpha}_\varphi \frac{\Delta \varphi}{y^*} + \hat{\alpha}_y \frac{\Delta y}{y^*} - \left(\theta k - \theta_b \frac{b}{k^*} - \theta_y \frac{y}{k^*} - \theta_\varphi \varphi\right) + v \tag{3}$$

Where $\theta_x = \theta\alpha_x k^*$ for $x = \{b, y\}$ and $\theta_\varphi = \theta\alpha_\varphi$ Notice that the left hand side corresponds to net investment rate of the firm. On the right hand side, the second and third term can be captured by the ratio of financial expenses to earnings before interest, taxes, depreciation and amortization (i.e., EBITDA); the third term can be captured by the growth of operating revenue or sales; and the terms in the error correction model proxy for size (k), leverage (b/k^*), cash flow (y/k^*), and the inverse of debt maturity (φ). The idiosyncratic shock v can contain fixed effects, as in Bloom et al. (2007):

$$v_{i,t} = A_i + B_{c,s,t} + \varepsilon_{i,t}$$

The expression in equation 3 motivates our main empirical specifications in equations 1 and 2 in the main text.

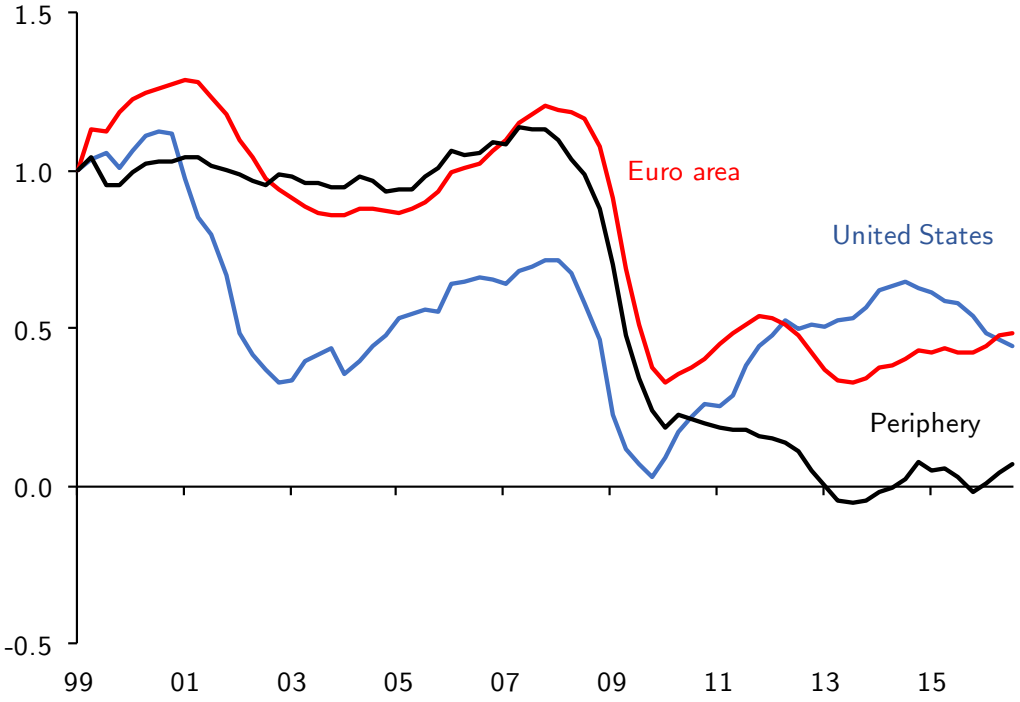

Figure 1: Evolution of Net Investment

Note: Net-of-consumption fixed capital formation of non-financial corporations, scaled by total economy GDP. Index 1999q1=1. Periphery group of economies comprises Greece, Ireland, Italy, Spain, and Portugal.

Sources: Eurostat and BEA.

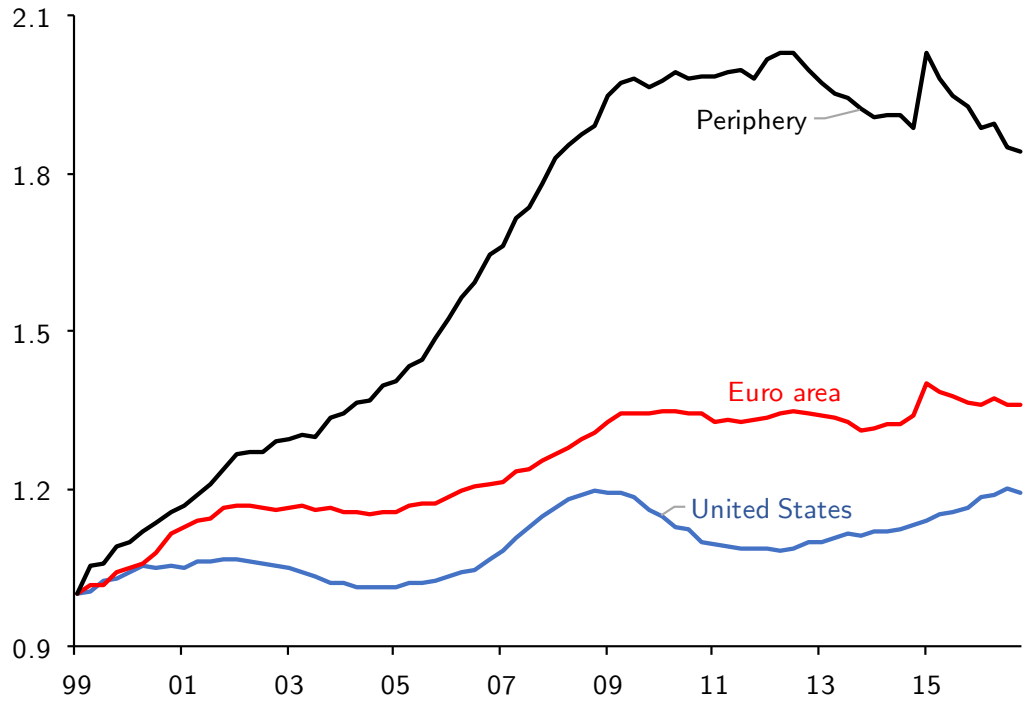

Figure 2: Evolution of Non-Financial Corporate Debt to GDP

Note: Credit to non financial corporations granted by banks and non-banks, scaled by total economy GDP. Index 1999q1=1. Periphery group of economies comprises Greece, Ireland, Italy, Spain, and Portugal. Data for Ireland begins at 2002q1, and produces a break in Euro area and Periphery aggregates at 2015q1.

Source: Bank of International Settlements.

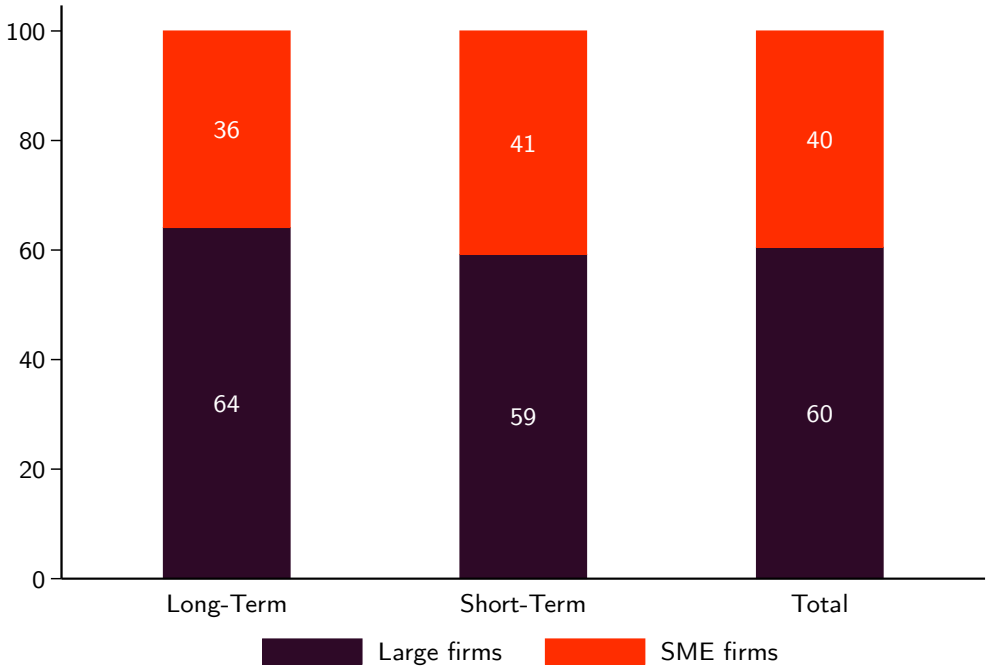

Figure 3: Debt by Maturity and Firm Size

Note: Aggregated from firm-level data. SMEs are firms with fewer than 250 employees and/or firms with total assets lower than 43 million euros at 2005 prices.

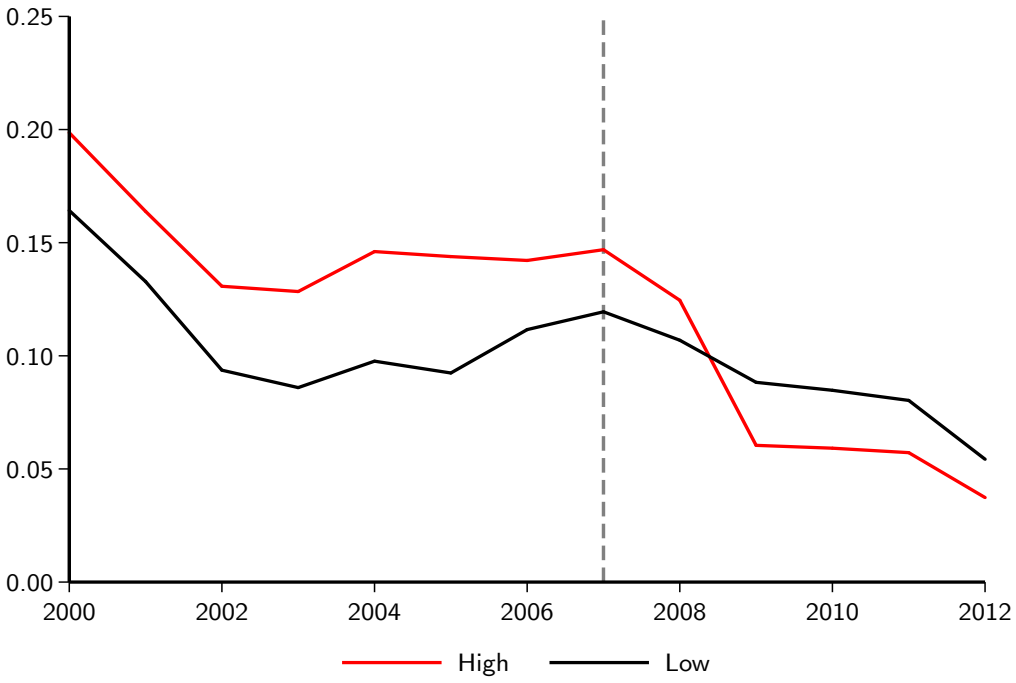

Figure 4: Evolution of Average Net Investment Rate by Leverage

Note: A firm is considered to have a high leverage if its ratio of total debt to total assets before 2008 is above the median.

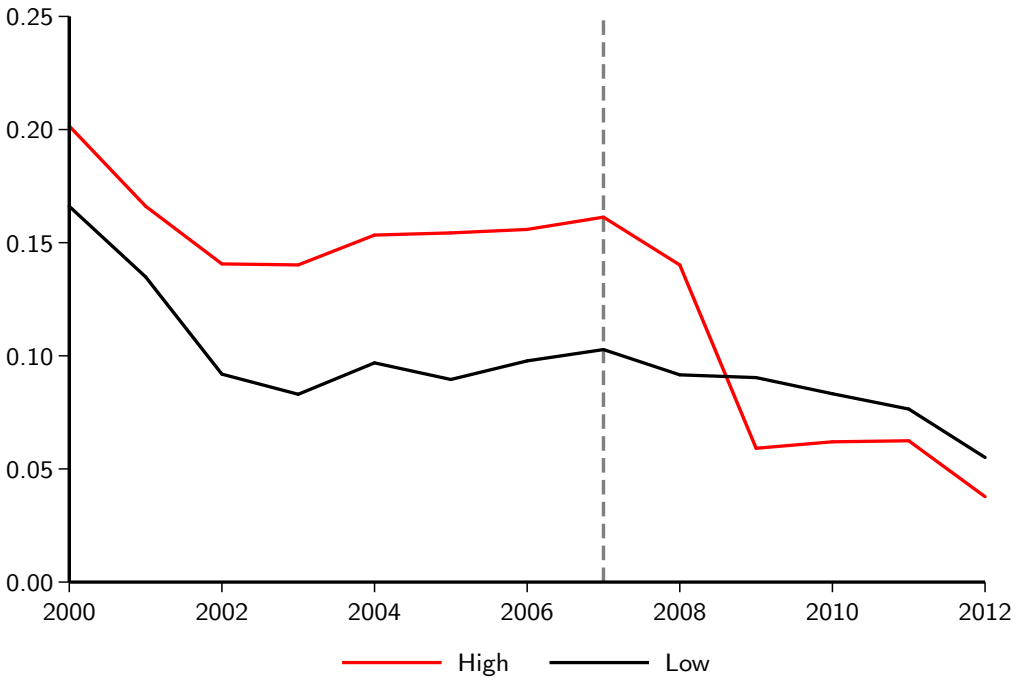

Figure 5: Evolution of Average Net Investment Rate by Debt Maturity

Note: A firm is considered to have a high maturity if the share of its long-term debt of total debt before 2008 is above the median.

Table 1: Multiple and Cross-Border 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	0.0	100.0
Netherlands	0.4	100.0
Portugal	37.9	97.9
Spain	40.3	99.0

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

Table 2: Summary Statistics[†]

Variables	Obs.	Mean	St. Dev.	Min.	Median	Max.
			Cross-section[1]			
Δ Net investment/Capital[2]	1,283,890	-0.084	0.596	-2.922	-0.028	2.922
Δ Sales growth[3]	690,327	-0.127	0.321	-3.005	-0.076	3.005
Δ Maturity[4]	1,455,245	-0.002	0.275	-1.000	0.000	1.000
Δ Size[5]	1,456,994	0.086	0.599	-11.548	0.049	12.476
Δ Debt/Assets	1,456,615	-0.025	0.267	-2.119	-0.027	2.119
Δ Int. Paid/EBITDA	692,081	-0.010	0.354	-2.754	-0.004	2.754
Δ Cash Flow/Assets	743,292	-0.030	0.104	-1.134	-0.023	1.134
Δ Bank's own sovereign bonds/Assets	628,067	0.012	0.019	-0.070	0.010	0.111
Δ Bank's total sovereign bonds/Assets	1,077,232	0.006	0.027	-0.296	0.004	0.256
			Panel			
Net investment/Capital[2]	11,088,755	0.104	0.608	-0.539	-0.056	2.383
Sales growth[3]	7,763,804	0.011	0.324	-1.410	-0.003	1.595
Maturity[4]	13,006,719	0.338	0.384	0.000	0.160	1.000
Size[5]	13,033,680	13.766	1.750	0.104	13.682	26.245
Debt/Assets	13,020,803	0.674	0.401	0.050	0.658	2.170
Interest Paid/EBITDA	6,824,180	0.170	0.397	-1.188	0.100	1.566
Cash Flow/Assets	7,497,526	0.073	0.119	-0.600	0.063	0.534
Bank's own sovereign bonds/Assets	3,902,994	0.030	0.025	0.000	0.023	0.175
Bank's total sovereign bonds/Assets	7,950,132	0.043	0.041	0.000	0.031	0.382

[†] Based on unbalanced sample of matched firms in the euro area.
[1] Cross section variables are calculated as the difference between the mean for the period starting 2008 and the mean before 2008 (2009 for own sovereign bonds).
[2] Increase in real capital stock over lagged real capital stock.
[3] Logarithmic change of real sales.
[4] Long-term share of total debt.
[5] Logarithm of total real assets.

Table 3: Cross-Sectional Results

Dependent variable: Δ Net investment / Capital				
	(1)	(2)	(3)	(4)
Δ Debt/Assets	-0.0569***			
	(0.0060)			
Δ Int. Paid/EBITDA		-0.0161***		
		(0.0031)		
Δ Maturity			0.0563***	
			(0.0069)	
Δ Weak Bank				-0.1357***
				(0.0390)
Δ Cash Flow	-0.1443***	-0.1274***	-0.1041***	-0.1864***
	(0.0178)	(0.0179)	(0.0166)	(0.0212)
Δ Sales growth	0.2963***	0.2921***	0.2942***	0.2509***
	(0.0164)	(0.0169)	(0.0163)	(0.0190)
Δ Size	0.0308***	0.0345***	0.0287***	0.0647***
	(0.0037)	(0.0048)	(0.0038)	(0.0055)
Sector-Country FE	Yes	Yes	Yes	Yes
Observations	377,576	340,054	377,550	314,476
R^2	0.06	0.06	0.06	0.05
Within R^2	0.03	0.03	0.03	0.03
Adjusted R^2	0.05	0.05	0.05	0.04
Within-adjusted R^2	0.03	0.03	0.03	0.03

Standard errors are in parentheses, clustered at the sector-country level.
All variables are expressed in differences between their pre-2008 firm-specific mean and their firm-specific mean starting 2008. Debt/Assets is total debt scaled by total assets. Interest paid is scaled by EBITDA, ratio that corresponds to the coverage ratio. Maturity is the ratio of long-term debt to total debt. Weak Bank measures the exposition of a bank to all sovereign bondholdings scaled by the bank's total assets. 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 4: Cross-Sectional Results
(Alternative Sovereign Exposures)

Dependent variable: Δ Net investment / Capital

	(1)	(2)	(3)
	Δ All Sovereign	Δ Own Sovereign	Δ Own Sovereign (Periphery)
Δ Debt/Assets	-0.0559***	-0.0536***	-0.0535***
	(0.0086)	(0.0095)	(0.0095)
Δ Int. Paid/EBITDA	-0.0131***	-0.0119***	-0.0119***
	(0.0037)	(0.0040)	(0.0040)
Δ Maturity	0.0531***	0.0575***	0.0575***
	(0.0081)	(0.0083)	(0.0083)
Δ Weak Bank	-0.0670*	-0.2754***	-0.2581**
	(0.0358)	(0.0992)	(0.1075)
Δ Cash Flow	-0.1793***	-0.1770***	-0.1769***
	(0.0230)	(0.0238)	(0.0238)
Δ Sales growth	0.2905***	0.2957***	0.2957***
	(0.0192)	(0.0175)	(0.0175)
Δ Size	0.0143***	0.0146***	0.0146***
	(0.0044)	(0.0047)	(0.0047)
Sector-Country FE	Yes	Yes	Yes
Observations	294,255	226,412	226,412
R^2	0.07	0.07	0.07
Within R^2	0.03	0.03	0.03
Adjusted R^2	0.06	0.06	0.06
Within-adjusted R^2	0.03	0.03	0.03

Standard errors are in parentheses, clustered at the sector-country level.
All variables are expressed in differences between their pre-2008 firm-specific mean and their firm-specific mean starting 2008 (2009 for the case where weak banker corresponds to own-sovereign bondholdings of the bank). Debt/Assets is total debt scaled by total assets. Interest paid is scaled by EBITDA, ratio that corresponds to the coverage ratio. Maturity is the ratio of long-term debt to total debt. Weak bank measures the exposure of the firm's main bank to sovereign bonds, scaled by total assets. In column 1, it includes all sovereign bondholdings; in column 2, it includes only own-sovereign bondholdings (domestic sovereign bonds); and lastly, in column 3, it includes own-sovereign bondholdings if the parent bank of the firm's main bank (or the main bank itself in case it does not have a parent bank) is located in a Periphery country (Periphery domestic sovereign bonds), and otherwise it is set equal to 0. Sales growth 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 5: Weak Bank and Crisis Results
(All-Sovereign Bondholdings)

Dependent variable: Net investment$_t$ / Capital$_{t-1}$

	(1)	(2)	(3)
Interaction effects:†			
Post$_t$ × Weak Bank$_{t-1}$ × Debt/Assets$_{t-1}$	-0.3507***	-0.4378***	-0.4383***
	(0.0783)	(0.0823)	(0.0905)
Post$_t$ × Weak Bank$_{t-1}$ × Int. Paid/EBITDA$_{t-1}$	0.0276	0.0423	0.0404
	(0.0501)	(0.0499)	(0.0557)
Post$_t$ × Weak Bank$_{t-1}$ × Maturity$_{t-1}$	-0.2916***	-0.1061	-0.1104
	(0.0693)	(0.0692)	(0.0765)
Post$_t$ × Weak Bank$_{t-1}$ × Cash Flow$_{t-1}$	0.4737*	-0.0187	-0.0201
	(0.2522)	(0.2555)	(0.2791)
Post$_t$ × Weak Bank$_{t-1}$ × Sales growth$_{t-1}$	0.1947***	0.1977***	0.198***
	(0.067)	(0.0671)	(0.0746)
Post$_t$ × Weak Bank$_{t-1}$ × Size$_{t-1}$	0.0384***	-0.0162	-0.0142
	(0.0092)	(0.0123)	(0.0138)
Total effects:‡			
Debt/Assets$_{t-1}$	-0.0746***	-0.1165***	-0.1165***
	(0.0056)	(0.0057)	(0.0052)
Int. Paid/EBITDA$_{t-1}$	-0.0075***	-0.0072***	-0.0072***
	(0.0014)	(0.0014)	(0.0012)
Maturity$_{t-1}$	-0.2501***	-0.2404***	-0.2404***
	(0.0039)	(0.0039)	(0.0034)
Weak Bank$_{t-1}$	-0.1497***	0.007	0.0364
	(0.0108)	(0.0099)	(0.0231)
Firm FE	Yes	Yes	Yes
Sector-Country-Year FE	No	Yes	Yes
Bank FE	No	No	Yes
Observations	2,138,618	2,135,224	2,135,137
R^2	0.30	0.32	0.32
Within-R^2	0.04	0.03	0.03
Adjusted-R^2	0.16	0.17	0.17
Within-adjusted-R^2	0.04	0.03	0.03

† Value of the coefficient of the corresponding triple interaction.
‡ Total effects of a variable are calculated as the sum of all coefficients where the variable is present using the mean value of the corresponding weak-banker variable.
Standard errors are in parentheses, clustered at the firm level if no banker fixed effect is used and at firm-bank level otherwise. Post is a dummy variable equal 1 starting 2008 (2009 in the case of domestic sovereign bonds, due to data availability). Debt/Assets is the ratio of total debt to total assets. Interest paid is scaled by EBITDA, ratio that corresponds to the coverage ratio. Maturity is the ratio of long-term debt to total debt. Weak bank is measured as the exposure to all sovereign bonds of the firm's main bank, scaled by the bank's total assets. 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 6: Weak Bank and Crisis Results
(Domestic Sovereign Holdings)

Dependent variable: Net investment / Capital	(1)	(2)	(3)
Interaction effects:†			
$\text{Post}_t \times$ Weak $\text{Bank}_{t-1} \times$ Debt/Assets_{t-1}	-1.3694***	-0.9501***	-0.9515***
	(0.2477)	(0.2586)	(0.2902)
$\text{Post}_t \times$ Weak $\text{Bank}_{t-1} \times$ Int. Paid/EBITDA_{t-1}	0.0244	0.1603	0.159
	(0.1562)	(0.1567)	(0.1734)
$\text{Post}_t \times$ Weak $\text{Bank}_{t-1} \times \text{Maturity}_{t-1}$	1.1579***	0.5139**	0.5232**
	(0.2208)	(0.2194)	(0.2512)
$\text{Post}_t \times$ Weak $\text{Bank}_{t-1} \times$ Cash Flow_{t-1}	-1.3263*	-1.3768*	-1.3726
	(0.7669)	(0.7876)	(0.8645)
$\text{Post}_t \times$ Weak $\text{Bank}_{t-1} \times$ Sales growth_{t-1}	0.6321***	0.5257**	0.5248**
	(0.2173)	(0.2182)	(0.241)
$\text{Post}_t \times$ Weak $\text{Bank}_{t-1} \times \text{Size}_{t-1}$	-0.1067***	0.0037	0.0038
	(0.0321)	(0.0439)	(0.0492)
Total effects:‡			
Debt/Assets_{t-1}	-0.069***	-0.092***	-0.092***
	(0.007)	(0.0072)	(0.007)
Int. Paid/EBITDA_{t-1}	-0.0033**	-0.0046***	-0.0046***
	(0.0016)	(0.0016)	(0.0015)
Maturity_{t-1}	-0.2301***	-0.2229***	-0.2229***
	(0.0049)	(0.0049)	(0.0046)
Weak Bank_{t-1}	-0.1316***	0.0297	0.0609
	(0.0259)	(0.0256)	(0.05)
Firm FE	Yes	Yes	Yes
Sector-Country-Year FE	No	Yes	Yes
Bank FE	No	No	Yes
Observations	1,316,624	1,315,060	1,315,060
R^2	0.33	0.34	0.34
Within- R^2	0.03	0.03	0.03
Adjusted- R^2	0.15	0.15	0.15
Within-adjusted- R^2	0.03	0.03	0.03

† Value of the coefficient of the corresponding triple interaction.
‡ Total effects of a variable are calculated as the sum of all coefficients where the variable is present using the mean value of the corresponding weak banker variable.
Standard errors are in parentheses, clustered at the firm level if no bank fixed effect is used and at firm-bank level otherwise. Post is a dummy variable equal 1 starting 2008 (2009 in the case of domestic sovereign bonds, due to data availability). Debt/Assets is total debt scaled by total assets. Interest paid is scaled by EBITDA, ratio that corresponds to the coverage ratio. Maturity is the ratio of long-term debt to total debt. Weak bank is measured as the exposure to domestic sovereign bonds of the firm's main bank, scaled by the bank's total assets. 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 7: Weak Bank and Crisis Results
(Periphery Domestic Sovereign Holdings)

Dependent variable: Net investment$_t$ / Capital$_{t-1}$

	(1)	(2)	(3)
Interaction effects:†			
Post$_t$ × Weak Bank$_{t-1}$ × Debt/Assets$_{t-1}$	-1.6240***	-1.1084***	-1.1088***
	(0.2345)	(0.246)	(0.268)
Post$_t$ × Weak Bank$_{t-1}$ × Int. Paid/EBITDA$_{t-1}$	-0.0252	0.1654	0.1654
	(0.1519)	(0.1522)	(0.1642)
Post$_t$ × Weak Bank$_{t-1}$ × Maturity$_{t-1}$	1.6169***	0.9235***	0.9303***
	(0.2175)	(0.2217)	(0.2416)
Post$_t$ × Weak Bank$_{t-1}$ × Cash Flow$_{t-1}$	-1.3500*	-1.2486*	-1.2479
	(0.7125)	(0.7333)	(0.7884)
Post$_t$ × Weak Bank$_{t-1}$ × Sales growth$_{t-1}$	0.5703***	0.4547**	0.4543**
	(0.2081)	(0.2092)	(0.2268)
Post$_t$ × Weak Bank$_{t-1}$ × Size$_{t-1}$	-0.0619*	0.0353	0.0337
	(0.0346)	(0.0426)	(0.0459)
Total effects:‡			
Debt/Assets$_{t-1}$	-0.0693***	-0.092***	-0.0921***
	(0.007)	(0.0072)	(0.007)
Int. Paid/EBITDA$_{t-1}$	-0.0034**	-0.0047***	-0.0047***
	(0.0016)	(0.0016)	(0.0015)
Maturity$_{t-1}$	-0.2309***	-0.2235***	-0.2235***
	(0.0049)	(0.005)	(0.0046)
Weak Bank$_{t-1}$	-0.1317***	0.0240	0.0603
	(0.0255)	(0.0248)	(0.0504)
Firm FE	Yes	Yes	Yes
Sector-Country-Year FE	No	Yes	Yes
Bank FE	No	No	Yes
Observations	1,316,624	1,315,060	1,315,060
R^2	0.33	0.34	0.34
Within-R^2	0.03	0.03	0.03
Adjusted-R^2	0.15	0.15	0.15
Within-adjusted-R^2	0.03	0.03	0.03

† Value of the coefficient of the corresponding triple interaction.
‡ Total effects of a variable are calculated as the sum of all coefficients where the variable is present using the mean value of the corresponding weak banker variable.
Standard errors are in parentheses, clustered at the firm level if no banker fixed effect is used and at firm-banker level otherwise. Post is a dummy variable equal 1 starting in 2009, in this case, due to data availability. Debt/Assets is total debt scaled by total assets. Interest paid is scaled by EBITDA, ratio that corresponds to the coverage ratio. Maturity is the ratio of long-term debt to total debt. Weak bank is measured as the exposure to domestic sovereign bonds of the firm's main bank, scaled by the bank's total assets, and is set to zero if the parent bank of the firm's main bank is not located in a Periphery country (i.e., Greece, Ireland, Italy, Portugal and Spain). Sales is the change in logarithm of sales. Size is measured by the logarithm of total assets. Cash flow is scaled by total assets.
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.