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Corporate investment and bank-dependent borrowers during the recent financial crisis

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Abstract

We use the recent financial crisis period to analyse the effect of bank credit tightening on real firm investment. We derive a new set of credit tightening indexes from the ECB Bank Lending Survey. Combining these with annual balance sheet data from Germany, France, Italy, Spain, Belgium and Portugal, we exploit the heterogeneity in the dependence on bank finance of different industries to identify real effects of credit tightening. We show that in response to tightening, investment falls substantially more in bank-dependent industries.

Key words: corporate investment, financial crisis, credit crunch

JEL:E22, E44, G01

NON-TECHNICAL SUMMARY

In the period 2007-2009 the euro area has experienced a widespread financial crisis. Banks had to be rescued and aggregate output and investment dropped significantly. There exists substantial evidence that banks reduced their willingness to extend credit to firms during this period. For instance, in the Bank Lending Survey of the European Central Bank, where senior loan officers of a representative sample of euro area banks are asked questions on developments regarding their lending policies, one can observe a significant tightening of credit around the time of the crisis. The question this paper tries to answer is whether the bank credit supply reductions reported by loan officers in the euro area led to reduced investment of firms. A reduction in lending by banks could ultimately lead firms to adapt their investment plans, as they need financing to exercise these. Our question is an important one, as it is conceivable that firms substitute other credit for bank credit when they are faced with a loan supply reduction of banks. For instance, firms could issue more bonds. However, in a bank-based economy as the euro area, this is less likely than in a more market-based economy as the US.

To answer our question, we use a panel dataset of aggregated balance sheet data for different manufacturing industries from six euro area countries (Germany, France, Italy, Spain, Belgium, Portugal). For each manufacturing industry, in each country, we are able to track aggregate investment and aggregate indebtedness for three segments: small, medium and large firms. In addition, the dataset contains information on how much these industry segments are financed with bank debt and non-bank debt. The degree to which different industries use bank debt differs substantially both across industries and across countries. Some industries are more bank-dependent then others. In this paper, we use this difference in dependence on bank loans to identify whether the tightening reported by loan officers had real effects on the spending of those industries. One should expect a priori that when banks reduce the supply of credit, investment spending of borrowers dependent on bank finance should be reduced much more than spending by borrowers that are largely independent of bank finance.

For the identification of bank credit tightening, we use the answers to the ECB Bank Lending Survey to construct a new set of indexes of credit tightening that vary across time and across countries. Using the balance sheet information, we measure the reliance of industries on bank debt by constructing a variable for each segment which we call bank debt leverage, defined as bank debt on total assets. In our regression analysis, we measure the sensitivity of investment with respect to the interaction between the relevant (country and size specific) credit tightening index, and the bank debt leverage of the segment.

In our analysis, we carefully control for demand factors. As the crisis coincided with a recession it would be natural that firms reduced their investment, irrespective of the bank loan tightening. We find that, after controlling for demand factors, that investment by bank-dependent borrowers drops significantly relative to that of non-bank-dependent borrowers after bank credit tightening. We show that it is not the level of indebtedness per se that matters, but only the indebtedness with bank credit. This last finding shows that it was the bank credit tightening that mattered but not a general reduction in credit supply irrespective of the source of finance.

Our findings contribute to our understanding of the determinants of the sharp fall in investment during the financial crisis in the euro area. The reduced market access of banks after the Lehman bankruptcy led to a reduction in loan supply and increased lending standards. Bank-dependent borrowers were the most exposed to a reduction in bank credit and could not costlessly substitute bank debt with non-bank debt. As a result, bank-dependent borrowers reduced spending more, resulting in reductions of investment spending much larger than those of non bank-dependent borrowers. As an explanation of the magnitude of output loss during the Great Depression, research before us has argued that shocks to the banking system propagated to the real economy and increased the depth of the Great Depression. Our findings for the recent financial crisis echo this earlier research, namely that due to shocks to the intermediation process of banks, certain borrowers, those that are bank-dependent, faced a credit squeeze.

That bank-dependent industries are more affected than others, has important implications for policy-makers. A recession coinciding with a banking crisis can lead to a large output-loss. To the extent that this takes the form of large investment cancelations, the future growth path is potentially affected. For policymakers, taking measures to shorten a banking crisis and restoring credit flow seems to have first order effects on spending.

1 Introduction

Do bank credit supply reductions lead to reduced investment of firms? The recent financial crisis has revived interest into the investigation of real effects of supply reductions in bank intermediated credit. If bank credit is special for at least some borrowers in the economy, bank loan supply shifts will have real effects on the spending of those bank-dependent borrowers. In particular, in a financial crisis when banks reduce the supply of credit, investment spending of borrowers dependent on bank finance is expected to be reduced much more than spending by borrowers that are largely independent of bank finance.

The 2007Q4-09Q2 recession in the US and the 2008Q1-09Q2 recession in the euro area coincided with a widespread financial crisis in which bank balance sheets were affected.[1] The findings of Ivashina and Scharfstein (2010) and Iyer, Lopes, Peydró and Schoar (2014), among others, provide evidence that banks reacted to the crisis with a tightening of credit. Tightening for euro area banks is for instance also visible in the evolution of the answers of bank loan officers to the Bank Lending Survey of the European Central Bank. In this survey, senior loan officers of a representative sample of euro area banks are asked questions on developments regarding their lending policies. We show below that loan officers reported a significant tightening around the time of the crisis.

While the studies above show that credit was tightened during the crisis, they do not establish tightening had real effects. It is conceivable, for example, that firms had access to different sources of finance. In this article, we examine whether the bank lending tightening reported by euro area banks during the financial crisis reduced investment spending of borrowers. Our identification strategy is based on the asymmetric investment behaviour of different types of borrowers. If bank credit supply is tight, bank-dependent borrowers should reduce investment more.

Controlling for differential demand shocks, we indeed find that, after tightening, investment by bank-dependent borrowers drops significantly relative to that of non-bank-dependent borrowers. The effects we find are sizeable. A one standard deviation tightening results in a reduced investment of bank-dependent borrowers between 6 and 14 percent relative to non-bank-dependent borrowers. At the peak of the crisis the increase

[1] A more detailed story on what happened in the financial sector is provided in Brunnermeier (2009).

in tightening was around 1.5 standard deviations. These results are obtained using a panel dataset of aggregated balance sheet data for different manufacturing industries from six euro area countries (Germany, France, Italy, Spain, Belgium, Portugal). For each manufacturing industry, in each country, we are able to track aggregate investment and aggregate indebtedness for three segments: small, medium and large firms. In addition, the dataset contains information on how much these industry segments are financed with bank debt and non-bank debt. In our empirical analysis we show that, in a reaction to tightening of credit standards by banks, segments of the economy that rely heavily on bank debt reduce investment relative to those that use little bank debt. We further show that it is not the level of indebtedness per se that matters, but only the indebtedness with bank credit. This last finding is consistent with the commonly held view that gives a large causal role to bank credit supply reductions for the crisis in the euro area, but does not support theories of weak firm balance sheets as a propagation mechanism during the crisis.

Our study is linked to various literatures on the real effects of financial crises. First, earlier studies have found heterogeneous real effects of the recent crisis, but do not provide direct evidence that these effects are related to bank credit tightening. Campello, Graham and Harvey (2010) survey 1050 Chief Financial Officers (CFOs) in 39 countries in the fourth quarter of 2008. They ask them whether the firms are financially constrained. They find that financially constrained firms are planning to cut spending more than non-financially constrained firms along a number of dimensions (tech spending, investment, marketing, etc.). Whereas Campello, Graham and Harvey (2010) use a survey to gauge the intentions of firms' CFOs in a reaction to the crisis, and verify whether they feel financially constrained, they do not use actual investment data as we do. Carvalho, Ferreira and Matos (2015) measure bank relationships of publicly traded firms using the syndicated bank loan data from Dealscan. They find that during the recent crisis firms with only one main lender reduced investment more then those with multiple lenders. Although this is suggestive of credit supply effects, the evidence is not directly based on a credit tightening measure. Duchin, Ozbas and Sensoy (2010) also document heterogeneity in the effects of the financial crisis, not necessarily related to bank tightening. They show that among US listed firms (using COMPUSTAT data) the decline in investment was largest among firms with low cash reserves, high short term debt or that operated in industries that depend on external finance. Also for public firms in the US, Kahle and Stulz (2013) find no evidence of different investment behaviour for firms with bank relationships versus other firms in the early part of the crisis or directly after the Lehman bankruptcy, but do find lower investment for those firms in the last year of the crisis. They argue that bank loans for public firms have steadily become a less important source of finance. As bank finance is indeed becoming less important for these large listed firms it is likely that the current literature which uses publicly listed firms underestimates the importance of bank credit tightening.

In contrast, our dataset is broadly representative of the manufacturing sector in six euro area countries. Industry segments are constructed including both private and public firms, giving us a wide variation in the dependence on banks. In addition our findings are based on direct measures of credit tightening.[2] Our study is, to our knowledge, the first study on the recent financial crisis that directly links credit tightening of euro area banks with real investment outcomes of euro area industries. It is the first to document the large heterogeneity of investment behaviour between bank-dependent and non-bank-dependent industries during the crisis.

Second, our study also fits into a wider empirical literature that examines how credit-market frictions or shocks from the financial sector are *differently* propagated, leading to divergent real sector outcomes. Chava and Purnanandam (2011) provide evidence of corporate behavior in the US after the shock to the banking system from the Russian crisis in the Fall of 1998. They show that firms that financed themselves primarily with bank credit had higher stock market valuation losses and suffered larger declines in investment than firms that had access to public debt markets. Their investment findings are consistent with our findings in that they also show that a different dependence of borrowers towards the banking sector leads to differences in vulnerability to shocks stemming from that sector. Khwaja and Mian (2008) show that shocks to the banking sector are propagated

[2]Some part of the literature looks at employment. Chodorow-Reich (2014) provides firm-level evidence that bank relationships in the US mattered after the Lehman Brothers bankruptcy. Firms with less healthy lenders had a lower likelihood of obtaining new loans and reduced employment more than firms with healthy lenders.

in reduced lending. They show that borrowers differ in their ability to react to loan supply reduction, i.e. smaller borrowers have less ability to offset loan supply shocks, leading to different real outcomes. They look at financial distress as a measure of real outcomes but have, in contrast to us, no information on the investment of borrowers. Peek and Rosengren (2000) find differential effects on US state level construction activity of loan reductions by Japanese banks, in reaction to a Japanese banking crisis.

Our empirical strategy has three parts. First, we identify bank credit tightening and bank dependence at the industry-segment level for our panel of manufacturing industries from six countries. Second, we establish that real investment reacts more to bank credit tightening in industry-segments more dependent on bank financing. Third, we make sure that this reaction is not due to other effects, in particular to differential demand shocks, a general credit supply shock (for all sources of finance not only bank finance) or weak balance sheets.

For the identification of bank credit tightening, we use the answers to the ECB Bank Lending Survey to construct a new set of indexes of credit tightening that vary across time and across countries. Using the balance sheet information, we measure the reliance of industries on bank debt by constructing a variable for each segment which we call bank debt leverage, defined as bank debt on total assets. In our regression analysis, we measure the sensitivity of investment with respect to the interaction between the relevant (country and size specific) credit tightening index, and the bank debt leverage of the segment. We interpret the *differential* investment behaviour of industry segments with different bank dependence after credit tightening as stemming from credit supply restrictions. We make sure that our results can indeed be interpreted this way by controlling for differential demand shocks and weak balance sheets. In a first specification, we control for investment demand using an error correction model. This model has been used in the micro data investment literature among others by Bond, Elston, Mairesse and Mulkay (2003) to investigate the effect of financing constraints. In a second specification, we follow Gilchrist and Himmelberg (1995) and add 'fundamental Q', a proxy for Tobin's Q, to the regression to control for demand factors. Controlling for overall indebtedness of the industries we are able to show that for the investment reduction in the crisis only bank-dependence matters, but not the total leverage of the industry, giving more support to a bank lending supply shock story than a general credit supply shock or weak balance sheets story. We perform a number of further robustness checks such as using instruments for our bank dependence and GMM estimation. The high sensitivity of investment with respect to bank debt leverage when banks tighten remains robust to these checks.

Our findings contribute to our understanding of the determinants of the sharp fall in investment during the financial crisis. Aggregate nominal investment, as measured by national accounts data, of non-financial corporations slowed down to a growth rate if 1.5 percent in 2008 and dropped by a remarkable 15 percent in 2009. We find that during that period bank-dependent borrowers reduced investment relative to non-bank-dependent ones by 6 to 14 percent after a one standard deviation tightening. Our results uncover the large heterogeneity in investment related to bank dependence.

The rest of the article is structured as follows. In section 2 we describe the data. In section 3 we show our regression framework. Section 4 shows results and section 5 concludes.

2 The data

2.1 The BACH-database

We combine two datasets: the BACH-database and the ECB Bank Lending Survey. The BACH database is constructed by the European Committee of Central Balance Sheet Data Offices (ECCBSO) in cooperation with the European Commission. It exploits the statistical records from national entities that collect annual firm level accounting data. These entities are often central banks or government statistical agencies, which for legal, administrative or statistical reasons collect individual firm level accounting data.

The BACH-database is constructed through the aggregation of a large number of individual annual firm balance sheets and profit and loss accounts. Aggregated firm balance sheets and profit and loss accounts are constructed per country per year for different industries (NACE Rev 2)[3]. For each individual industry the data is constructed

[3]The NACE Rev 2 is the official Statistical classification of economic activities in the European Union. The classification uniformly applies across all member states. It is based on the United Nations

for three firm size classes. Each industry within a particular country has therefore three time series: one for small, one for medium and one for large firms. Firm size used for aggregation has been defined according to net turnover, with small firms having a turnover of less than 10 million euro, medium firms having a turnover from 10 million euro to 50 million euro and large firms having a turnover over 50 million euro.

We include only countries for which we have data over the period 2000-2009: Germany, France, Italy, Spain, Belgium and Portugal. In this article, we focus on the entire manufacturing sector, which in NACE Rev 2 consists of 24 manufacturing industries. These are listed in Appendix A.4.

We have maximum 72 times series per country (24 industries times 3 size classes). However, a small number of industries or industry-size combinations are not reported for some countries. We assume that the main reason for non-reporting is that there is a lack of existing or sampled firms in that category. To give an example, Portugal does not report time series for the tobacco manufacturing industry.

A unit of observation (or segment as it is named in this article) is thus defined by size, industry and country (e.g. small firms in the textile industry in Germany is one segment). Usually, the number of firms used in the aggregation for each segment differs from year to year, but in general it is quite large. There are 393 firms per segment on average. Making each segment as representative as possible is one of the goals of the ECCBSO in order to make possible meaningful cross-country comparisons. This is done in two ways. First, a great number of firms are used in the aggregation to form a unit of observation. Second, the data is constructed by harmonizing across countries the balance sheet and profit and loss account items. This implies that the BACH database is broadly representative of the manufacturing sector in these six euro area countries.

Important for our analysis, the balance sheet data makes a distinction between bank debt (called "Amounts owed to credit institutions"), trade debt (called "Trade creditors") and other debt.[4] The fact that our dataset allows us to identify bank debt as a source of finance separately, combined with the coverage of small non-listed firms sets us apart

International Standard Industrial Classification of All Economic Activities (ISIC Rev. 4). The NACE Rev 2 classification contains 24 manufacturing industries.

[4]The balance sheet information does not provide more details about "other debt". Thus other debt can technically include all other sources of debt such as debt from friends and family, debt from affiliated enterprises, liabilities to tax and social security authorities or market debt.

from other datasets used in the literature. In the earlier literature, either publicly listed firms have been used (Worldscope or COMPUSTAT) which are not only less dependent on banks but also a select sample of firms per definition having access to public equity markets or when small firms are included (such as the AMADEUS database from Bureau Van Dijk) crucial information that allows to separate bank debt versus non-bank debt is not available.

As our credit tightening indexes are constructed from the Bank Lending Survey which is only available since 2003, and we use lagged variables in our regressions, our investment regressions are over the period 2004-2009. However, we use the year 2000 from the BACH database to construct our long-lagged bank-dependence dummy and our long lagged instruments for bank debt leverage. To estimate fundamental Q we also use the data up to the year 2000.

2.2 The ECB Bank lending survey

We also use the quarterly ECB Bank Lending Survey.[5] The first survey was carried out in January 2003. In this survey, senior loan officers of a representative sample of euro area banks are asked a number of qualitative questions on past and expected future developments regarding lending policies. We use the first question of this survey, which refers to the past quarter. The question is:*"Over the past three months, how have your bank's credit standards as applied to the approval of loans or credit lines to enterprises changed?"* The loan officer is asked to answer the same question twice: once for "loans to small and medium-sized enterprises" and once for "loans to large enterprises." The loan officer can choose between 5 possible answers: *tightened considerably*, *tightened somewhat*, *remained basically unchanged*, *eased somewhat* and *eased considerably*. We believe the answers can give us a good indication on the stance of the banking sector with respect to the easiness with which new loans (or credit lines) are given. [6] The individual answers

[5] A detailed description of the methodology and content of the survey is given in Berg, van Rixtel, Ferrando, de Bondt and Scopel (2005).

[6] The ECB survey is very similar to the Federal Reserve Board's Senior loan officer opinion survey on Bank lending practices. In a similar spirit as this paper, Lown and Morgan (2006) and Bassett, Chosak, Driscoll and Zakrajsek (2014) among others have used the lending standards question to construct a type of tightening index to investigate business cycle effects of credit standard tightening. What sets us apart from this literature is that we do not try to isolate aggregate effects of tightening but *differential* effects according to the bank-dependence of borrowers.

of the individual banks are not available but we obtained for each quarter and each country the percentage share of the five possible answers (once for loans to small and medium sized enterprises and once for loans to large enterprises). Using those quarterly percentage shares, country and loan destination specific measures of a tightening index can be build. We use an ordered probit model to construct both quarterly and annual tightening indexes.[7] Details of this calculation are given in the Appendix A.2.

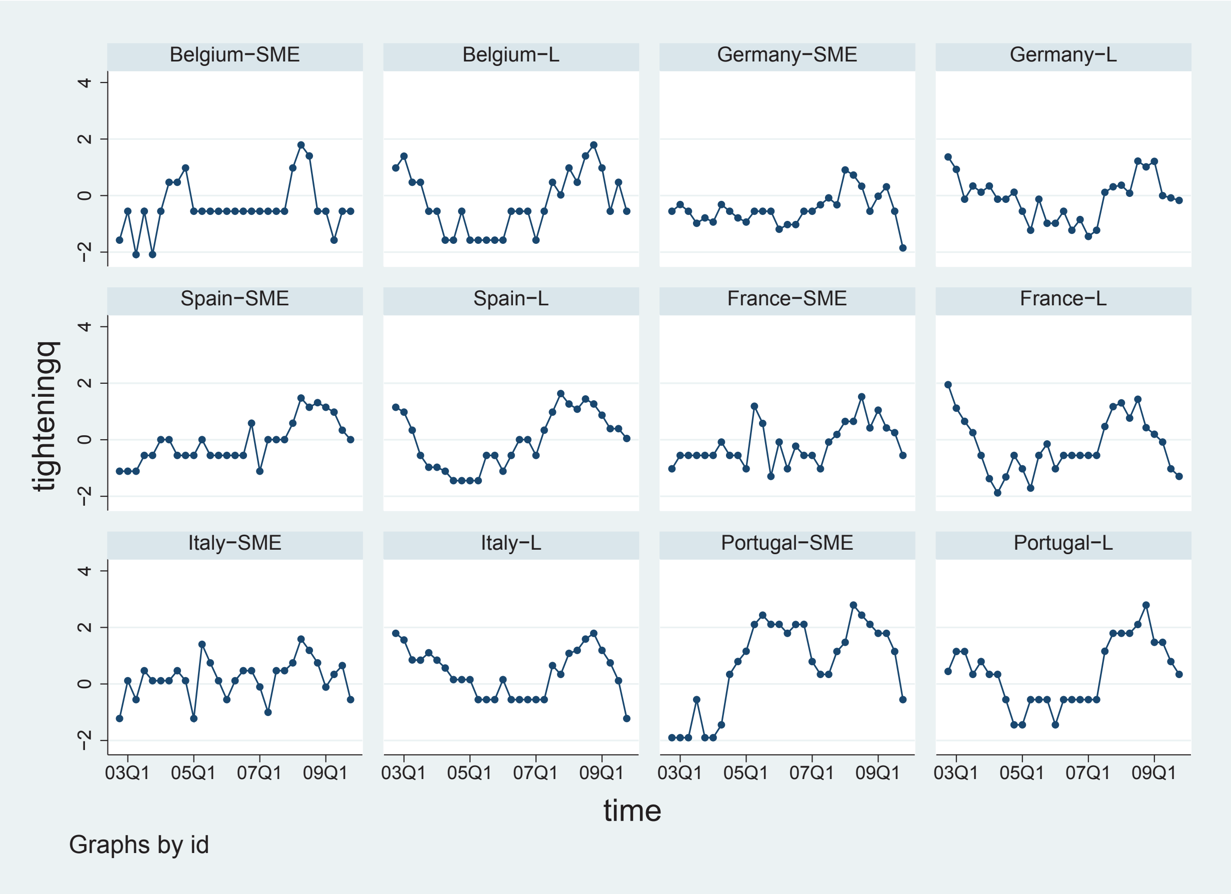

Figure 1: Tightening indexes (Quarterly):
SME = small and medium sized firms L = large firms

Figures 1 and 2 respectively show the quarterly and annual credit tightening indexes. There are two indexes per country, one for loans to small and medium size (SME) and one for loans to large size enterprises (L). Figure 1 depicts the quarterly indexes from the first quarter in 2003 to the fourth quarter of 2009. Evident from this figure is the large variation in credit tightening, over time, across country and across loan destination. Figure 1 also makes visible the widespread increase in tightening starting, with some

[7]The quarterly percentage shares we used are not publicly available. The European Central Bank only publishes more aggregated time series.

variation, around 2007 continuing in 2008 and tapering off in 2009. As our investment and balance sheet data is annual, we construct annual tightening indexes to have matched frequencies. The annual tightening indexes are presented in Figure 2. An annual index at year t is calculated using the answers to the Bank Lending Survey for the 4 quarters of year t. It therefore represents the accumulated tightening over the year. Every annual tightening index is normalized to range between zero and one.

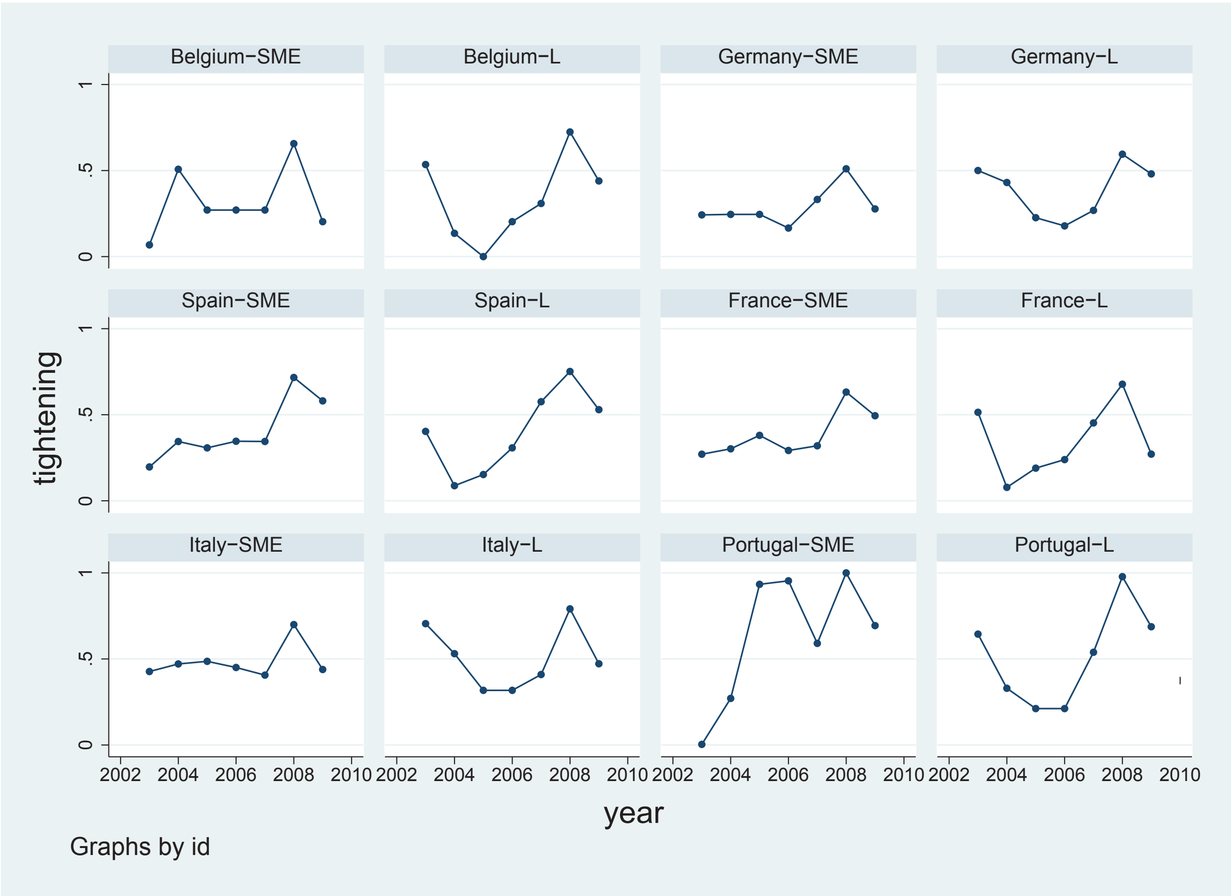

Figure 2: Tightening indexes (Annual)
SME = small and medium sized firms L = large firms

Table 1 presents the variation in the value of the annual tightening index according to country, size and year. There is a large variation across countries in the average level of the index. The index average for Portugal is 0.59 compared to 0.31 in Germany, more than a one standard deviation difference in the index. Also within countries, over time, there is large variation. Note that there is also some variation across size classes. Most notably is the variation across time. Regressing our tightening indexes on a full set of country-time dummies (i.e. a separate set of time dummies for each country) explains 72.5 percent of the variation in our tightening indexes.

TABLE 1

Variation of tightening index according to country, size and year

Variable	MEAN	ST.DEV	MINIMUM	MEDIAN	MAXIMUM
BE	0.34	0.21	0.00	0.27	0.72
DE	0.31	0.13	0.17	0.25	0.60
ES	0.36	0.18	0.09	0.34	0.75
FR	0.36	0.16	0.08	0.30	0.68
IT	0.50	0.13	0.32	0.45	0.79
PT	0.59	0.36	0.00	0.59	1.00
SMALL	0.41	0.23	0.00	0.34	1.00
MEDIUM	0.41	0.21	0.00	0.34	1.00
LARGE	0.40	0.23	0.00	0.40	0.98
2003	0.32	0.20	0.00	0.27	0.71
2004	0.33	0.14	0.08	0.33	0.53
2005	0.35	0.22	0.00	0.31	0.93
2006	0.35	0.22	0.17	0.29	0.95
2007	0.39	0.11	0.27	0.34	0.59
2008	0.71	0.14	0.51	0.70	1.00
2009	0.46	0.15	0.20	0.48	0.69

Notes: Variable is $T_{l,t}$. Index level. Total sample.

3 Tightening of credit standards, bank debt leverage and the level of investment

3.1 Benchmark regression

We are interested in analyzing whether bank credit supply tightening had real effects on investment. A problem in identification is that credit tightening happened during a period of recession, therefore finding that industry segments invest less when faced with stronger tightening could be caused by lower investment demand, rather than tighter credit conditions. We therefore do not attempt to identify the total effect of credit tightening on an industry segment. Instead, we use the cross-section implication of credit supply tightening, namely that after credit tightening by banks, it should be the segments identified *a priori* as bank-dependent that should reduce investment the most. In our benchmark specification we regress the investment rate on the relevant tightening index, bank debt leverage and the interaction term between these two variables.

Our benchmark regression is:

$$IK_{it} = \alpha + \theta_T T_{lt-1} + \theta_B Bank\ debt\ leverage_{i,t-1} + \theta_{TB} T_{lt-1} * Bank\ debt\ leverage_{i,t-1} + \epsilon_{i,t} \quad (1)$$

where IK_{it} is the investment-rate of segment i at time t (i.e. investment capital ratio), T_{lt-1} is the credit standards tightening index (subscript l) and $Bank\ debt\ leverage_{i,t-1}$ is the bank debt leverage measure at (the end of) time t-1. Bank debt leverage, $Bank\ debt\ leverage_{i,t-1}$, is defined as book value of bank debt on total book value of assets (excluding trade debt).[8] Note that the tightening index has a different subscript l than the segment subscript i. For each country two indexes are defined, one for small and medium size enterprises and one for large enterprises. We match these indexes with our corresponding segments (subscript i).

The total effect on investment with respect to a change in credit standards tightening is measured by $\Delta T_{lt-1}(\theta_T + \theta_{TB} * Bank\ debt\ leverage_{i,t-1})$. Our main interest however is not in the total effect of tightening but in the relative effect comparing segments with different bank dependence. A negative and significant θ_{TB} indicates that industry segments that are more bank-dependent (i.e. have a higher bank debt leverage) reduce investment relative to less bank-dependent segments after a tightening shock. The difference in the effect on investment of a change in tightening between segment i and j is given by $\Delta T_{lt} * \theta_{TB} * (Bank\ debt\ leverage_{i,t-1} - Bank\ debt\ leverage_{j,t-1})$. We expect θ_{TB} to be significantly negative. In that case, bank tightening affects segments with high levels of bank debt more than segments with low levels of bank debt.

[8]Trade debt is likely not a source of investment finance. It is also quite often offset by trade credit given. In addition, trade debt and trade credit is used in quite different degree among industries and countries. Because of these reasons Rajan and Zingales (1995) argue in favor of a leverage measure excluding trade debt in comparative exercises.

To control for unobserved heterogeneity and aggregate shocks we experiment with the inclusion of year dummies, country dummies, size dummies (small, medium, large), country-year dummies (i.e. a full set of time dummies for each country separately) and fixed effects (i.e. a dummy variable for each segment). This should reduce concerns about omitted variable bias. Below we will show that the estimated total effect is highly sensitive to the set of dummies variables that enters the regression (in line with our view that tightening was correlated with aggregate shocks), but that the relative effect comparing segments with different bank dependence is very robust to this.

3.2 Controlling for segment specific demand

A possible concern is that our benchmark regression does not control for segment specific demand factors. The interpretation of a negative θ_{TB} could potentially be confounded by tightening shocks that are positively correlated with negative demand shocks that are specific to the bank-dependent borrowers. The control for segment specific demand should purge our analysis from the interpretation that bank-dependence was somehow positively correlated with negative demand shocks during the crisis.

We use two different specifications to control for investment demand. In the first specification, we control for demand by using an error correction model that incorporates all demand factors. Error correction in the investment literature has been introduced by Bean (1981) and used in the micro data investment literature among others by Bond, Elston, Mairesse and Mulkay (2003) and Bloom, Bond and Van Reenen (2007). Such a model nests a long run equilibrium relationship of the capital stock with short run investment dynamics. A derivation of this model is provided in Appendix A5.

In the second specification, we control for investment demand using a regression containing a proxy for Tobin's Q. The relationship between investment and Tobin's Q follows from a standard neo-classical investment model with convex adjustment costs. We follow Gilchrist and Himmelberg (1995) and construct for each segment a time-varying proxy for Tobin's Q, which is called fundamental Q. Fundamental Q is an estimate of the present discounted value of future marginal profits. It is estimated using a vector autoregression (VAR) in profits, the sales capital ratio and bank debt leverage. We explicitly include bank debt leverage as one of the variables in the construction of fundamental Q. Any information on future marginal profitability of investment contained in our bank debt leverage should therefore be contained in our fundamental Q measure. We can therefore more readily interpret the sensitivity of investment to our credit tightening-bank leverage interaction as the effect of credit supply constraints (rather than simply demand effects). More details on the estimation of our fundamental Q measure are in Appendix A.7.

Thus, we augment our benchmark specification either with error correction terms or with our estimated fundamental Q measure. Our first specification controlling for segment specific demand is:

$$\begin{aligned} IK_{it} &= \beta IK_{it-1} + \gamma \triangle y_{it} + \rho(y-k)_{it-1} + \lambda CK_{it-1} \\ &\quad + \theta_T T_{lt-1} + \theta_B Bank\ debt\ leverage_{i,t-1} + \theta_{TB} T_{lt-1} * Bank\ debt\ leverage_{i,t-1} \\ &\quad + \delta_{kt} + u_i + \epsilon_{i,t}, \end{aligned} \tag{2}$$

where $\triangle y_{it}$ is sales growth at time t; $(y-k)_{it-1}$ is the log of the output-capital ratio; CK_{it-1} is the cash flow capital ratio at time t-1; $Bank\ debt\ leverage_{i,t-1}$ is the bank debt leverage measure at (the end of) time t-1; T_{lt-1} is the credit standards tightening index, δ_{kt} is a country k time t fixed effect; u_i is an unobserved segment fixed effect and $\epsilon_{i,t}$ is the error term. Cash flow is added to the regression as another measure of profit opportunities.

Our second specification controlling for segment specific demand is:

$$\begin{aligned} IK_{it} &= \gamma Q_{it} \\ &\quad + \theta_T T_{lt-1} + \theta_B Bank\ debt\ leverage_{i,t-1} + \theta_{TB} T_{lt-1} * Bank\ debt\ leverage_{i,t-1} \\ &\quad + \delta_{kt} + u_i + \epsilon_{i,t}, \end{aligned} \tag{3}$$

where Q_{it} is fundamental Q.

3.3 Controlling for weak balance sheets

Kahle and Stulz (2013) have emphasized the difference between a bank lending supply shock and a general credit supply shock. A bank lending supply shock originates in the banking system and should affect bank-dependent borrowers. A general credit supply shock affects all types of lending. After a general credit supply shock we should expect borrowers dependent on credit, i.e. highly leveraged firms to be reducing their investment, not only bank-dependent ones. In addition, in a crisis when asset values fall, firms net worth and collateral is affected, making firms with high leverage more risky and therefore less creditworthy. Firms with weak balance sheets, proxied by highly levered firms, would therefore see lending and investment spending go down. It could therefore be that firms that are highly indebted with bank debt simply proxy for highly leveraged firms. Finding out whether it is bank-dependent (i.e. have high bank debt leverage) or highly leveraged firms that reduced investment can therefore help us in distinguishing different theories of the financial crisis, i.e. whether the reduction in investment was caused by a bank lending shock, a general credit supply shock or weak balance sheets.

The interpretation of a negative θ_{TB} would be that highly leveraged firms are the most vulnerable in a tightening if bank debt leverage proxies for leverage per se. To exclude this interpretation, we include an interaction term of total leverage with our tightening index to the regression. This way we are able to test whether the bank debt leverage interaction or the total leverage interaction with tightening matters. The new variable, total leverage, $total\ leverage_{i,t-1}$ is defined as total book value of debt (including all sources of debt, including bank debt, but excluding trade debt) on total book value of assets (excluding trade debt). Controlling for total leverage, equation 2 becomes:

$$\begin{aligned} IK_{it} \ = \ & \beta IK_{it-1} + \gamma \triangle y_{it} + \rho (y-k)_{it-1} + \lambda CK_{it-1} \\ & + \theta_T T_{lt-1} + \theta_B Bank\ debt\ leverage_{i,t-1} + \phi_L\ total\ leverage_{i,t-1} \\ & + \theta_{TB} T_{lt-1} * Bank\ debt\ leverage_{i,t-1} + \phi_{TL} T_{lt-1} * total\ leverage_{i,t-1} \\ & + \delta_{kt} + u_i + \epsilon_{i,t}, \qquad (4) \end{aligned}$$

We add the same control variables to equation (3) and re-estimate it as well. We apply the same denominator for both bank debt leverage and total leverage. The numerators only differ in the sense that total leverage includes all sources of debt (including bank debt as well). Note that an increase in bank debt leverage, *keeping total leverage fixed*, is only possible if bank debt is used to substitute for other debt (i.e the firm becomes more bank-dependent). So we use equation (4) to test whether bank-dependence or high leverage matters. For instance, in equation (4), θ_{TB} has to be interpreted as the extra sensitivity in response to credit standards tightening of being more bank-dependent, i.e. having a larger share of bank-debt, *keeping total leverage fixed*. Similarly, ϕ_{TL} has to be interpreted as the extra sensitivity in response to credit standards tightening of having higher leverage *keeping bank debt leverage fixed*. If now we find that θ_{TB} is significant but ϕ_{TL} not, we can be confident of our interpretation that bank-dependence matters after bank tightening, but high leverage does not.

4 Estimation results

4.1 Summary statistics

Table 2 provides summary statistics of the variables used in the estimations: the investment rate IK_{it}, sales growth $\triangle y_{it}$, cash flow ratio CK_{it-1}, the log of the output-capital ratio $(y-k)_{it-1}$, the tightening indexes T_{lt-1}, bank debt leverage $\textit{bank debt leverage}_{it-1}$, total leverage $\textit{total leverage}_{it-1}$ and the interaction term between the tightening index and the leverage variables. The average investment rate in the sample is 21 percent with a standard deviation of 12 percentage points. The average bank debt leverage in the sample is 19 percent with a standard deviation of 10.48 percentage points.

TABLE 2

Summary statistics of the regression variables

Variable	MEAN	ST.DEV	MEDIAN	MINIMUM	MAXIMUM
IK_{it}	21.00	12.01	20.02	-16.72	60.01
$\triangle y_{it}$	0.39	8.62	0.80	-48.00	31.91
CK_{it-1}	32.57	22.56	27.39	-17.28	141.43
$(y-k)_{it-1}$	1.69	0.53	1.67	0.23	3.08
$bank\ debt\ leverage_{it-1}$	19.04	10.48	17.97	0.00	73.14
$total\ leverage_{it-1}$	46.45	10.04	46.98	0.24	96.67
T_{lt-1}	0.41	0.22	0.34	0.00	1.00
T_{lt-1} *$bank\ debt\ leverage_{it-1}$	8.04	6.66	5.93	0.00	52.81
T_{lt-1} *$total\ leverage_{it-1}$	19.09	11.80	16.03	0.00	76.99

Notes: Numbers in percentages, except log of output-capital ratio,

T_{lt-1}, T_{lt-1} *$bank\ debt\ leverage_{it-1}$ and T_{lt-1} *$total\ leverage_{it-1}$ Total sample (2004-2009).

Who are the bank-dependent borrowers? Bank debt leverage has an important country, size and industry dimension. Table 3 shows the variation of bank debt leverage according to country and size. The use of bank debt is heterogenous across countries. The average bank debt leverage ranges from 10.99 percent in France to 30.20 percent in Italy, almost a factor of three larger. Spain and Portugal also have high bank debt leverage at an average of 22.74 percent and 18.56 percent respectively. Germany retains an intermediate position at 16.96 percent. Belgium is closer to the low level of France, with an average of 14.87. However the variation within each country is large. Equally so, the use of bank debt is heterogenous across size classes. The small size class has the highest bank dependence at an average of 23.41 percent. Medium size companies have an average bank debt leverage of 20 percent. and the large firms have the lowest bank dependence at 13 percent. Again here, the averages hide a large amount of heterogeneity within each size class. Table A.1 in the appendix shows the variation of the bank debt leverage across industries. There is large heterogeneity across industries, but also within industries. Time variation is much less important (shown in table A.2 in the Appendix).

TABLE 3

Variation of bank debt leverage according to country and size

Variable	MEAN	ST.DEV	MINIMUM	MEDIAN	MAXIMUM
BE	14.87	9.38	0.28	13.64	73.14
DE	16.96	8.03	1.20	17.15	38.95
ES	22.74	9.49	0.68	25.13	47.37
FR	10.99	5.25	1.01	10.30	31.42
IT	30.20	8.93	4.40	31.92	46.90
PT	18.56	8.29	0.00	19.67	38.44
SMALL	23.41	9.35	0.82	23.50	57.42
MEDIUM	20.00	9.83	0.02	18.45	46.08
LARGE	13.00	9.51	0.00	10.88	73.14

Notes: Variable is $\textit{bank debt leverage}_{it-1}$. Numbers in percentages. Total sample.

An analysis of variance[9] shows that the country alone explains 37.5 percent of the variation in bank debt leverage in our sample. The second most important factor is size which explains 17 percent on its own. The sector explains 12.9 percent. Finally time (i.e. the year) explains only 0.3 percent of the variation.

4.2 Benchmark results

In this section we present the results of our benchmark regression. We are interested in the cross-sectional effects of tightening. Tightening is expected to have larger effects for more bank-dependent segments. The more bank debt leverage a segment has, the more it is expected to reduce investment after tightening. In the benchmark specification, we regress the investment rate on the interaction term between the tightening index and lagged bank leverage, including the tightening index and bank debt leverage separately as well. Here we do not yet control for segment specific demand factors. However, we experiment with including different sets of dummy variables to control for unobserved heterogeneity and/or unobserved aggregate demand factors. In these regressions the interaction term is the main interest.

[9] We regress bank debt leverage on a set of dummies and report the R-squared of these regressions.

TABLE 4

Effect of tightening, bank debt leverage and their interaction on investment ratio

Ordinarly least squares regression: $IK_{it} = \alpha + \theta_T T_{lt-1} + \theta_B bank\ debt\ leverage_{i,t-1} + \theta_{TB} T_{lt-1} * bank\ debt\ leverage_{i,t-1} + \epsilon_{i,t}$

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
T_{lt-1}	−2.51	−6.37**	4.79**	−4.04	9.01***	7.24***	4.30**	9.93***	8.70***
	(2.74)	(2.87)	(2.11)	(2.77)	(2.26)	(2.51)	(2.13)	(2.11)	(2.15)
$bank\ debt\ leverage_{i,t-1}$	0.14**	0.17***	0.24***	0.04	0.22***	0.20***	0.04	0.12*	0.06
	(0.06)	(0.06)	(0.05)	(0.06)	(0.05)	(0.05)	(0.07)	(0.07)	(0.08)
$T_{lt-1} * bank\ debt\ leverage_{i,t-1}$	−0.75***	−0.78***	−0.51***	−0.65***	−0.54***	−0.50***	−0.49***	−0.56***	−0.43***
	(0.14)	(0.14)	(0.10)	(0.14)	(0.10)	(0.11)	(0.10)	(0.10)	(0.11)
year dummies	No	Yes	No	No	Yes	X	No	Yes	X
country dummies	No	No	Yes	No	Yes	X	No	No	X
size dummies	No	No	No	Yes	Yes	Yes	No	No	X
country-year dummies	No	No	No	No	No	Yes	No	No	Yes
fixed effects	No	No	No	No	No	No	Yes	Yes	Yes
N. of Observations	2018	2018	2018	2018	2018	2018	2018	2018	2018
R2	0.13	0.16	0.52	0.15	0.54	0.56	–	–	–
R2-within							0.04	0.11	0.16
Effect of 1 standard deviation tightening, $\Delta T_{lt-1} = 0.22$, on investment ratio of segments with different bank debt leverage:									
low bank debt leverage (25th percentile)									
($bank\ debt\ leverage_{i,t-1} = 10.57$)	−2.29***	−3.21***	−0.13	−2.40***	0.72	0.42	−0.19	0.89**	0.91**
	(0.54)	(0.57)	(0.42)	(0.55)	(0.45)	(0.52)	(0.42)	(0.42)	(0.43)
average bank debt leverage (50th percentile)									
($bank\ debt\ leverage_{i,t-1} = 17.97$)	−3.50***	−4.47***	−0.95**	−3.46***	−0.16	−0.40	−0.98**	−0.02	0.20
	(0.60)	(0.63)	(0.45)	(0.61)	(0.49)	(0.57)	(0.46)	(0.45)	(0.49)
high bank debt (75th percentile)									
($bank\ debt\ leverage_{i,t-1} = 26.81$)	−4.95***	−5.98***	−1.94***	−4.72***	−1.21**	−1.38**	−1.93***	−1.11**	−0.64
	(0.77)	(0.78)	(0.56)	(0.78)	(0.59)	(0.69)	(0.56)	(0.56)	(0.61)
Difference in the effect between 75th and									
25th percentile of bank debt leverage	−2.66***	−2.78***	−1.81***	−2.32***	−1.93***	−1.80***	−1.74***	−2.00***	−1.55***
	(0.49)	(0.48)	(0.35)	(0.50)	(0.35)	(0.39)	(0.36)	(0.34)	(0.38)

Notes: Sample period is 2004-2009. Standard errors are heteroscedasticity consistent. "X" Spanned by country-year dummies or fixed effects.

*** Significant at 1% level, ** at 5% level,* at 10% level

Table 4 shows the results. The upper part of the table presents the regression estimates, the lower part of the table shows the effect of a one standard deviation tightening on the investment rate (for different levels of bank debt leverage) implied by the regression estimates. Column 1 of Table 4 shows the basic results without any dummy variable controls. The coefficient of the tightening index is estimated to be negative but not statistically significant. The coefficient of bank debt leverage is estimated to be positive and significant. Most importantly, the interaction term has a negative statistically significant coefficient. The estimates indicate that a one standard deviation tightening ($\Delta T_{lt-1} = 0.22$) reduces the investment rate by a significant 2.3 percentage points for a segment with bank debt leverage at the 25th percentile, whereas it reduces it by a significant 4.95 percentage point for a segment with a bank debt leverage at the 75th percentile. This implies a statistical significant difference in the effect between the 75th and 25th percentile of bank debt leverage of -2.66 percentage points. So tightening has a *differential* effect on investment, depending on the bank debt leverage, with effects that are economically quite large. Including year dummies (column 2 results) does not substantially change the results. The effect of tightening even become somewhat larger. Adding country dummies however reduces the estimated total effects of tightening substantially (column 3), which is to be expected as the country dummies remove average country-level effects of tightening. Now a one standard deviation tightening reduces the investment rate by a non-statistically significant -0.13 percentage points for a segment with bank debt leverage at the 25th percentile and reduces it by a statistically significant 1.94 percent for a segment with a bank debt leverage at the 75th percentile. This implies a statistical significant difference in the effect between the 75th and 25th percentile of bank debt leverage of -1.81 percentage points. So the *differential* effect across segments with different bank debt leverage remains large.

Adding year, country and size dummies all at once reduces the total effect of tightening even more (column 5), but again does not substantially change the differential effect. Now a one standard deviation tightening (i.e. $= 0.22$) increases the investment rate by (a statistically insignificant) 0.72 percentage points for a segment with bank debt leverage at the 25th percentile and reduces it by a statistically significant 1.93 percent for a segment with a bank debt leverage at the 75th percentile. Note the, at first sight, somewhat peculiar result in columns (8) and (9) that a tightening *increases* the investment rate for segments with low bank debt leverage. However, these regressions include year dummies (column 8) or country-time dummies (column 9). This implies that any aggregate time effect of tightening, whose magnitude is unknown, is removed from this regression. Therefore, these results have to be read as follows: segments with low bank debt leverage reduce investment less (then the average), whereas high bank debt leverage reduce investment more (then the average).

Importantly, the results in table 4 show that the coefficient on the interaction term is always statistically significant, negative and of roughly the same magnitude, no matter what type of unobserved heterogeneity one controls for. The point estimate of the coefficient on the interaction term ranges from -0.43 to -0.78. If we call segments with below median bank leverage "non-bank-dependent" and those above the median "bank-dependent", then segments at the 25th percentile are "representative" non-bank-dependent and those at the 75th percentile are "representative" bank-dependent. The point estimates on the interaction term imply that a one standard deviation tightening (0.22) leads to a wedge in the investment rate of 1.55 to 2.78 percentage points. At an average investment rate of 21 percent this implies a lower investment of bank dependent segments (relative to non-bank-dependent) between 7 and 13 percent, a very significant difference. These magnitudes are large, but quite reasonable during the crisis. Note for instance that national accounts data show that aggregate investment of non-financial corporations of the six countries considered here dropped by 15 percent in 2009 (with a drop ranging from 27 percent in Spain to 8 percent in Belgium). Our tightening indexes show that this drop happened after an average increase in tightening of 0.32 (a 1.5 standard deviation tightening increase in 2008). Our results uncover the large heterogeneity driven by bank-dependence.

A robust result of the regressions in Table 4 is that tightening drives a substantive wedge in the investment rate between bank dependent borrowers and less bank dependent borrowers. These simple regressions do not yet control for other variables at the segment level. In the next section, we will demonstrate that even controlling for these, and using various estimation methods, the interaction term coefficient remains statistically significant, negative and with a similar magnitude as above.

4.3 Controlling for segment specific demand

In this section, we augment our benchmark specification with segment specific demand factors. We first present the regression results using the error correction model. In this specification, demand of the segment is controlled for by the error correction model terms, namely sales growth, output-capital ratio and cash flow ratio. We also include a full set of country-time dummies (a different set of time dummies for each country), so effects of unobserved macro-economic shocks are allowed to differ across countries and years. Table 5 shows the estimation results.

Column 1 shows OLS results without fixed effects, column 2 shows the results including fixed effects. Column 3 and 4 show GMM results. In column 3 we use the standard GMM lagged predetermined variables as instruments. In column 4 we drop the lagged bank leverage variable and replace it with bank debt leverage in the year 2000. Bank leverage in the year 2000 is highly correlated[10] with leverage at the time of the crisis, making it a good instrument. Our industry level data is used as an advantage. Bank leverage at the industry level is relatively persistent as differences in leverage across industries are to some extent determined by time-invariant industry characteristics. By using bank leverage in the year 2000 we avoid that endogenous decisions of the firm with respect to bank leverage even a few years before the crisis influence our results. This change in the instrument set has little effect. The test statistics of both GMM estimation results suggests no problems with the specification nor with the instruments. For both regressions the m2 specification test (Arellano and Bond, 1991) indicates that we can safely reject second order serial correlation of the first differenced residuals. Also, the Hansen test (Hansen, 1982) does not reject the null of validity of the instrument set for both the results. So in principle, replacing the lagged bank debt leverage variable with bank debt leverage in the year 2000 does not seem necessary. The regression is well specified. Coefficient estimates on the standard determinants of investment are very much in line with those usually found in the investment literature (i.e. positive coefficient on sales growth, output-capital ratio

[10] The correlation of bank leverage in 2000 with bank leverage in 2008 is 0.71.

and cash flow).

As expected and discussed in Bond (2002), the coefficient on lagged investment is estimated to be larger in the OLS regression than in the WITHIN regression and the GMM estimates lies in between. The main coefficient of interest is the one on the interaction between the tightening index and bank debt leverage. The coefficient is negative and statistically significant for all regressions and the point estimates range between -0.34 and -0.84 very much in line with our earlier benchmark results from Table 4. This implies that a one standard deviation tightening index ($T_{lt-1} = 0.22$) is associated with a lower investment rate of bank dependent segments (relative to bank dependent segments) between 1.2 and 3 percentage points. Compared to an average investment rate of 21 percent this is a substantial effect in the order of reduced investment by 6 to 14 percent.

TABLE 5

Tightening, bank debt leverage and investment: error correction model

	Dependent variable is IK_{it}			
	(1)	(2)	(3)	(4)
Variable	OLS	WITHIN	DIFF-GMM	DIFF-GMM
IK_{it-1}	0.38^{***}	-0.06	0.14^{**}	0.10
	(0.03)	(0.04)	(0.06)	(0.06)
$\triangle y_{it}$	0.02	0.03	0.19^{**}	0.29^{**}
	(0.02)	(0.02)	(0.09)	(0.11)
$(y-k)_{it-1}$	1.28^{**}	10.29^{***}	10.29	15.56^{**}
	(0.51)	(1.96)	(6.59)	(7.18)
CK_{it-1}	0.04^{***}	0.04^{*}	0.02	0.02
	(0.01)	(0.02)	(0.06)	(0.07)
T_{lt-1}	8.19^{***}	8.21^{***}	13.81^{**}	15.74^{***}
	(2.41)	(2.61)	(5.56)	(6.07)
$bank\ debt\ leverage_{it-1}$	0.24^{***}	0.09	0.28	0.37
	(0.05)	(0.08)	(0.18)	(0.28)
T_{lt-1}*$bank\ debt\ leverage_{it-1}$	-0.42^{***}	-0.34^{***}	-0.70^{*}	-0.84^{**}
	(0.11)	(0.13)	(0.36)	(0.40)
N. of Observations	1884	1884	1495	1495
N. of Cross-section	349	349	335	335
N. of Instruments			102	92
m2 (p-value)			0.87	0.68
H-test (p-value)			0.16	0.18

Notes: Sample period is 2004-2009. All regressions contain country-time dummies.

Standard errors are heteroscedasticity consistent. Columns 3 and 4: Two step GMM estimates.

Instrument set column (3) IK_{it-j}, $\triangle y_{it-j}$, CK_{it-j}, T_{lt-j}, $bank\ debt\ leverage_{it-j}$,$T_{lt-j}$ j=2,3,4

Instrument set column (4) IK_{it-j}, $\triangle y_{it-j}$, CK_{it-j}, T_{lt-j} j=2,3,4 and $bank\ debt\ leverage_{it_0}$ $t_0 = 2000$

m2 is second order serial correlation tests, asymptotically N(0,1).

H-test is Hansen test of overidentifying restrictions.

*** Significant at 1% level, ** at 5% level,* at 10% level

Note that bank debt leverage itself is not a significant determinant of investment, except for the OLS results, which indicate that more highly bank debt levered segments invest more.

We also present the regression results of our other specification, using fundamental Q (estimated following Gilchrist and Himmelberg, 1995) to control for investment demand. In this specification, demand of the segment is controlled for by fundamental Q. Fundamental Q is derived from a VAR used to forecast future marginal product of the segment. In the VAR we use the profit ratio, the sales capital ratio and bank debt leverage. Including the bank debt leverage as one of the variables in the construction of Q is done on purpose. Any information on future marginal profitability of investment contained in our bank debt leverage should therefore be contained in our fundamental Q measure. Otherwise said, information in bank debt leverage that is useful to predict future profits, which determine investment demand will end up in our estimate of fundamental Q. We can therefore more readily interpret the sensitivity of investment to our credit tightening-bank leverage interaction as the effect of credit supply constraints (rather than simply demand effects). More detail on the estimation of fundamental Q is given in Appendix A.7. Here, we also include a full set of country-time dummies. Table 6 shows the estimation results.

TABLE 6

Tightening, bank debt leverage and investment: fundamental Q model

	Dependent variable is IK_{it}			
	(1)	(2)	(3)	(4)
Variable	OLS	WITHIN	DIFF-GMM	DIFF-GMM
Q_{it}	0.06^{***}	0.04^{***}	0.02	0.05
	(0.01)	(0.02)	(0.04)	(0.04)
$bank\ debt\ leverage_{it-1}$	0.32^{***}	0.08	0.38^{***}	0.52^{**}
	(0.08)	(0.09)	(0.14)	(0.23)
T_{lt-1}	9.13^{***}	9.38^{***}	10.86^{***}	8.78^{*}
	(2.24)	(2.27)	(4.10)	(4.92)
$T_{lt-1}{*}bank\ debt\ leverage_{it-1}$	-0.55^{***}	-0.43^{***}	-0.56^{**}	-0.44
	(0.13)	(0.12)	(0.24)	(0.29)
N. of Observations	1944	1944	1562	1562
N. of Cross-section	350	350	340	340
N. of Instruments			87	77
m2 (p-value)			0.21	0.34
H-test (p-value)			0.32	0.37

Notes: Sample period is 2004-2009. All regressions contain country-time dummies

Bootstrapped standard errors. Columns 3 and 4 : Two step GMM estimates.

Instrument set column (3) T_{lt-j}, π_{it-j}, $(y-k)_{it-j}$, $bank\ debt\ leverage_{it-j}$, j=2,3,4

Instrument set column (4) T_{lt-j}, π_{it-j}, $(y-k)_{it-j}$, $bank\ debt\ leverage_{it_0}$ j=2,3,4 $t_0 = 2000$

m2 is second order serial correlation tests, asymptotically N(0,1).

H-test is Hansen test of overidentifying restrictions.

*** Significant at 1% level, ** at 5% level,* at 10% level

As fundamental Q is an estimated variable, we provide bootstrapped standard errors. This leads generally to somewhat less precise estimates. In the OLS and WITHIN regressions fundamental Q is significant and positive. Its estimate is in line with the earlier literature. Most importantly, the point estimates of our main coefficient of interest, the interaction between tightening and bank debt leverage, remains in a similar range as our earlier estimates, between -0.44 and -0.56. Only for the GMM estimation with bank debt leverage instrumented with bank debt leverage in the year 2000, the effect is estimated less precisely. These results are very much in line with our results of the error correction model and thus also our earlier benchmark results. So controlling for demand factors, industry-segments with more bank debt on their balance sheet reduce investment considerably more after bank tightening.

4.4 Bank dependence or weakness of balance sheet?

The results thus far support a bank loan supply reduction story but might still be consistent with a general credit supply shock story or a weak balance sheet story. However, a general credit supply shock or weak balance sheet story is not restricted to bank-dependent borrowers but should affect highly leveraged firms more generally. To exclude the possible interpretation that bank debt leveraged firms proxy for highly indebted firms, we rerun the regressions above including an interaction term between our tightening index and total leverage. We present the regression results when we control for total leverage in Table 7. The definition of total leverage contains both bank and non-bank debt. The introduction of total leverage in the regression implies that the coefficient of our interaction term between tightening and bank debt leverage now strictly can be interpreted as the effect of an increasing reliance on bank debt keeping total leverage constant. This allows us to test whether it is bank-dependence or high leverage that matters after tightening.

Regression results presented in Table 7 are in line with our earlier results. The coefficient estimates on the standard determinants of investment, namely lagged investment, sales growth, cash flow and the error correction term are very similar with our earlier results. Importantly our main coefficient of interest, the interaction between the tightening index and bank debt leverage, is little affected. Total leverage and the interaction between total leverage and tightening is insignificant.

TABLE 7

Tightening, bank debt leverage and investment

error correction model controlling for total leverage

	Dependent variable is IK_{it}			
	(1)	(2)	(3)	(4)
Variable	OLS	WITHIN	DIFF-GMM	DIFF-GMM
IK_{it-1}	0.37^{***}	-0.06^{*}	0.15^{***}	0.11^{*}
	(0.03)	(0.04)	(0.06)	(0.07)
$\triangle y_{it}$	0.03	0.03	0.23^{***}	0.31^{**}
	(0.02)	(0.02)	(0.09)	(0.12)
$(y-k)_{it-1}$	1.17^{**}	10.19^{***}	9.26	12.83^{*}
	(0.51)	(1.98)	(7.55)	(7.36)
CK_{it-1}	0.05^{***}	0.04^{*}	0.03	0.04
	(0.01)	(0.02)	(0.07)	(0.06)
T_{lt-1}	13.54^{***}	10.51^{**}	19.89^{*}	13.74
	(4.23)	(4.48)	(10.42)	(14.43)
$bank\ debt\ leverage_{it-1}$	0.21^{***}	0.05	0.10	0.44
	(0.05)	(0.10)	(0.18)	(0.29)
$total\ leverage_{it-1}$	0.08^{**}	0.05	0.04	-0.25
	(0.04)	(0.06)	(0.12)	(0.21)
$T_{lt-1}{*}bank\ debt\ leverage_{it-1}$	-0.38^{***}	-0.35^{***}	-0.80^{**}	-0.90^{**}
	(0.11)	(0.13)	(0.33)	(0.40)
$T_{lt-1}{*}total\ leverage_{it-1}$	-0.13	-0.05	-0.10	0.04
	(0.09)	(0.09)	(0.19)	(0.29)
N. of Observations	1882	1882	1492	1492
N. of Cross-section	349	349	335	335
N. of Instruments			117	97
m2 (p-value)			0.93	0.66
H-test (p-value)			0.27	0.19

Notes: Sample period is 2004-2009. All regressions contain country-time dummies.

Standard errors are heteroscedasticity consistent. Columns 3 and 4: Two step GMM estimates.

Instrument set column (3) IK_{it-j}, $\triangle y_{it-j}$, CK_{it-j}, T_{jt-1} $bank\ debt\ leverage_{it-j}$, $total\ debt\ leverage_{it-j}$, j=2,3,4

Instrument set column (4), IK_{it-j}, $\triangle y_{it-j}$, CK_{it-j}, T_{jt-1}, j=2,3,4

and $total\ debt\ leverage_{it_0}$, $bank\ debt\ leverage_{it_0}$ $t_0 = 2000$

m2 is second order serial correlation tests, asymptotically N(0,1).

H-test is Hansen test of overidentifying restrictions.

*** Significant at 1% level, ** at 5% level,* at 10% level

Tightening causes investment to become sensitive to bank debt leverage, but not to total leverage. Bank dependence matters, but not total leverage. This strengthens our interpretation that banks reduce credit supply which hurt bank-dependent borrowers, but not highly levered ones. Our results are consistent with a bank lending supply shock, but not with a general credit supply shock or weak balance sheet story.

We rerun the regressions of the fundamental Q specification including an interaction term of the tightening index with total leverage. Results are presented in Table 8. Again, the interaction between the tightening index and bank debt leverage, is little affected. The interaction between tightening and bank debt leverage is estimated to range between -0.42 and -0.62. Total leverage and the interaction between total leverage and tightening is insignificant (except for the OLS results). All in all, controlling for total leverage using the error correction model or fundamental Q changes results little. The effect on investment of the interaction between tightening and bank debt dependence is a robust feature of the data.

TABLE 8

Tightening, bank debt leverage and investment

fundamental Q model controlling for total leverage

	Dependent variable is IK_{it}			
	(1)	(2)	(3)	(4)
Variable	OLS	WITHIN	DIFF-GMM	DIFF-GMM
Q_{it}	0.06^{***}	0.04^{**}	0.04	0.04
	(0.01)	(0.02)	(0.04)	(0.04)
T_{lt-1}	18.90^{***}	12.47^{***}	12.17	9.10
	(4.63)	(4.26)	(7.76)	(11.10)
$bank\ debt\ leverage_{it-1}$	0.27^{***}	0.09	0.37^{**}	0.55^{**}
	(0.08)	(0.11)	(0.14)	(0.26)
$T_{lt-1}{*}bank\ debt\ leverage_{it-1}$	-0.44^{***}	-0.42^{***}	-0.62^{***}	-0.61^{**}
	(0.13)	(0.13)	(0.24)	(0.30)
$total\ leverage_{it-1}$	0.11^{**}	-0.01	0.05	-0.23
	(0.05)	(0.06)	(0.10)	(0.20)
$T_{lt-1}{*}total\ leverage_{it-1}$	-0.25^{**}	-0.07	-0.00	0.05
	(0.11)	(0.10)	(0.17)	(0.26)
N. of Observations	1942	1942	1560	1560
N. of Cross-section	350	350	340	340
N. of Instruments			102	82
m2 (p-value)			0.16	0.22
H-test (p-value)			0.36	0.55

Notes: Sample period is 2004-2009. All regressions contain country-time dummies.

Bootstrapped standard errors. Columns 3 and 4 : Two step GMM estimates.

Instrument set column (3) T_{lt-j}, π_{it-j}, $(y-k)_{it-j}$, $bank\ debt\ leverage_{it-j}$, $total\ debt\ leverage_{it-j}$ j=2,3,4

Instrument set column (4) T_{lt-j}, π_{it-j}, $(y-k)_{it-j}$, $bank\ debt\ leverage_{it_0}$, $total\ debt\ leverage_{it_0}$ j=2,3,4 $t_0 = 2000$

m2 is second order serial correlation tests, asymptotically N(0,1).

H-test is Hansen test of overidentifying restrictions.

*** Significant at 1% level, ** at 5% level,* at 10% level

So summarizing, the results in tables 5, 6, 7 and 8 show that bank debt leverage has a negative effect on investment when banks tighten credit standards, controlling for demand factors such as sales growth, the sales capital ratio and cash flow or fundamental Q. This result is robust across estimation methods and across instrumentation. Higher total leverage, holding bank debt constant, however does not affect investment negatively. Taken together, this evidence shows that credit tightening caused a divergence in the economy. Bank dependent borrowers were much more severely hit than non- bank dependent borrowers because of their bank-dependence not because of a general credit tightening or weak balance sheets (i.e. total leverage didn't matter).

4.5 Further robustness checks

One possible remaining concern is that bank leverage might endogenously change over the cycle because of demand factors. As our main interaction variable also changes with bank debt leverage over time, this could potentially confound our interpretation. We further test for robustness with a time-invariant measure of bank-dependence. Here we use the fact that the bank debt ratio is relatively stable over time within segments. We define a segment to be bank-dependent when in the year 2000 it has a bank debt leverage above the country- specific median of the year 2000. Effectively this is a split within each country of the industry-segments into two groups of above and below country specific median bank debt leverage. Our new interaction variable is our tightening index with a bank-dependence dummy (equal to one for the above median group).

The results using the error correction model are presented in Table 9. Note that the bank dependence dummy itself only enters individually as a regressor in the OLS case. It is removed by the fixed effects in the within and difference GMM case. Interestingly, it is statistically significant and positive indicating that bank dependent segments (independent of tightening) have on average higher investment rates by 2.21 percentage points. We find the interaction between tightening and our bank-dependence dummy to be significant for the OLS, within and difference GMM results. The coefficient ranges from -3.45 to -9.58, indicating a difference in the investment rate between a bank-dependent and non-bank dependent segment in the presence of a one standard deviation tightening between 0.76 and 2.11 percentage points (or 4 to 10 percent in terms of investment), in line with our earlier results.

TABLE 9

Tightening, bank debt leverage and investment: error correction model

bank-dependence defined using dummy variable

	Dependent variable is IK_{it}		
	(1)	(2)	(3)
Variable	OLS	WITHIN	DIFF-GMM
IK_{it-1}	0.39***	−0.06	0.11*
	(0.03)	(0.04)	(0.06)
$\triangle y_{it-j}$	0.03	0.04	0.30***
	(0.02)	(0.02)	(0.11)
$(y-k)_{it-1}$	1.18**	10.64***	19.36***
	(0.50)	(1.97)	(6.17)
CK_{it-j}	0.04***	0.04	−0.00
	(0.01)	(0.02)	(0.06)
BD_i	2.71***		
	(0.77)		
T_{lt-1}	3.72**	4.30**	5.98***
	(1.80)	(1.67)	(2.17)
$T_{lt-1} * BD_i$	−4.95***	−3.45*	−9.58*
	(1.78)	(1.90)	(4.94)
N. of Observations	1884	1884	1495
N. of Cross-section	349	349	335
N. of Instruments			92
m2 (p-value)			0.84
H-test (p-value)			0.14

Notes: Sample period is 2004-2009. All regressions contain country-time dummies.

Standard errors are heteroscedasticity consistent. Columns 3: Two step GMM estimates.

Instrument set column (3) IK_{it-j}, $\triangle y_{it-j}$, CK_{it-j},T_{lt-j} *bank debt leverage*$_{it_0}$ j=2,3,4 $t_0 = 2000$

m2 is second order serial correlation tests, asymptotically N(0,1).

H-test is Hansen test of overidentifying restrictions.

*** Significant at 1% level, ** at 5% level,* at 10% level

TABLE 10

Tightening, bank debt leverage and investment: fundamental Q model

bank-dependence defined using dummy variable

	Dependent variable is IK_{it}		
	(1)	(2)	(3)
Variable	OLS	WITHIN	DIFF-GMM
Q_{it}	0.06^{***}	0.04^{**}	0.06
	(0.01)	(0.02)	(0.04)
BD_i	4.27^{***}		
	(0.98)		
T_{lt-1}	3.73^{**}	4.14^{***}	6.37^{***}
	(1.88)	(1.35)	(1.83)
$T_{lt-1} * BD_i$	-7.62^{***}	-5.28^{***}	-11.70^{***}
	(2.02)	(1.99)	(3.79)
N. of Observations	1970	1970	1575
N. of Cross-section	355	355	343
N. of Instruments			77
m2 (p-value)			0.35
H-test (p-value)			0.47

Notes: Sample period is 2004-2009. All regressions contain country-time dummies.

Bootstrapped standard errors. Columns 3: Two step GMM estimates.

Instrument set column (4) T_{lt-j}, π_{it-j}, $(y-k)_{it-j}$, $bank\ debt\ leverage_{it_0}$,j=2,3,4 $t_0 = 2000$

m2 is second order serial correlation tests, asymptotically N(0,1).

H-test is Hansen test of overidentifying restrictions.

*** Significant at 1% level, ** at 5% level,* at 10% level

The results remain similar for the fundamental Q regressions. The results using the fundamental Q specification are presented in Table 10. We find the interaction between tightening and our bank-dependence dummy again to be significant, the coefficient ranging from -5.28 to -11.70, indicating a difference in the investment rate between a bank-dependent and non-bank dependent segment in the presence of a one standard deviation tightening between 1.16 and 2.57 percentage points (or 6 to 12 percent in terms of investment), in line with our earlier results. The results change little when we again control for total leverage (results are in Appendix A.8)

5 Conclusion

Combining newly constructed bank tightening indexes with industry-segment level data, we have shown that bank-dependent borrowers reduced investment much more than less bank-dependent borrowers after bank credit tightening during the financial crisis. We found effects of 6 to 14 percent reduced investment of bank-dependent borrowers relative to non bank-dependent ones after a one standard deviation tightening. The financial crisis at its peak saw an increase in tightening of around 1.5 standard deviations. The effects we find are large but very reasonable. National accounts data show that aggregate investment of non-financial corporations dropped by a remarkable (and unprecedented) 15 percent in 2009 year on year. Our results uncover the heterogeneity behind the aggregate numbers.

We used data for six euro area countries that covered the manufacturing sector. Our findings are based on industry-segment level data, which shows that effects from restricted bank finance are not just a micro firm level phenomenon that disappears in the aggregate. Rather our evidence attest to the macro-importance of credit shocks coming from the banking sector. Negative bank credit supply shocks affect most those segments in the economy that are most reliant on bank debt. Our evidence attests to the importance of bank-dependence in the euro area to understand corporate real behaviour and aggregate real outcomes. Our results strongly suggest that the euro area recession of 2008Q1-09Q2 would not have been so deep if industries were less dependent on bank finance (or if the tightening would have been less severe). Our results are in line with the earlier literature that shows that shocks originating in the banking sector can have large and differential effects, such as the findings of Chava and Purnanandam (2011) after the Russian crisis or Peek and Rosengren (2000) after the Japanese banking crisis. The combination of the large bank dependence of euro area industries combined with the significant credit tightening that occurred have led to these large effects.

Our results are not consistent with theories that emphasize a general credit tightening for all types of finance or weak balance sheets of borrowers as a propagation mechanism during the crisis (Bernanke, Gertler, Gilchrist, 1989). We do not find that highly levered industries react to tightening, only industries levered with bank debt do. Our results are consistent with a bank credit supply story. Indeed, our results support the conclusion that theories of financial frictions and financial crisis should make a clear distinction between the sources of debt and sources of the origins of the shocks.

As an explanation of the magnitude of output loss during the Great Depression, Bernanke (1983) has argued that shocks to the banking system propagated to the real economy and increased the depth of the Great Depression. Essentially our findings for the recent financial crisis echo the claims made by Bernanke (1983) for the Great Depression, namely that due to shocks to the intermediation process of banks, certain borrowers faced a credit squeeze. We find very large differences in investment according the degree to which segments are bank dependent or not. In this respect, the Great Recession and the Great Depression have this in common.

The fact that bank-dependent industries are more affected than others also has important implications for policy-makers. A recession coinciding with a banking crisis can lead to a large output-loss. To the extent that the output loss takes the form of large investment cancelations, the future growth path is potentially affected. For policymakers this suggest that taking measures to shorten a banking crisis and restore credit flow seems to have first order effects on spending.

A APPENDIX

A.1 Construction of the sample

The source of the data is the BACH-database from the European Commission. It contains annual aggregated balance sheet and profit and loss account information for different industries and size classes of firms. The sizes classes are defined as follows: small firms have sales less than 10 millions euro; medium firms have sales from 10 millions euro to 50 millions euro; large firms have sales over 50 millions euro.

Initially the 24 manufacturing industries (see A.4.) and 3 size classes for Germany, France, Italy, Spain, Belgium and Portugal where selected for the years 2004-2009. This gives a maximum 72 "representative firms" for each country (not all countries have all industries). The 1% outliers of the variables used in the regression are removed. This leads to a total of 346 "representative firms."

A.2 Construction of the tightening indexes

We use the quarterly ECB Bank lending survey to construct country and size specific tightening indexes. We use the first question of this survey which refers to the past quarter. The question is: *"Over the past three months, how have your bank's credit standards as applied to the approval of loans or credit lines to enterprises changed?"* The loan officer is asked to answer the same question twice: once for "loans to small and medium-sized enterprises" and once for "Loans to large enterprises." The loan officer can choose between 5 possible answers: *Tightened considerably*, *Tightened somewhat*, *remained basically unchanged*, *eased somewhat* and *eased considerably*. We did not have available the individual answers of the individual banks but for each quarter we have available for each country the percentage share of the five possible answers (once for loans to small and medium sized enterprises and once for loans to large enterprises). We define the following ordered probit model. Let s take on the values 0 or 1 (0 indicating the answer for small and medium sized enterprises, 1 large enterprises), c represent the country and t time. Let D_{sct} be a dummy variable for size category s, country c and time t. Let S_{icst} be the observed share of the answers (i indicating the 5 possible answers). Unobserved tightening is then given by the following model

$$y^* = \sum_{sct} \alpha_{sct} D_{sct} + \epsilon_{sct} \tag{5}$$

Observed answers to the Bank lending survey are then

$$\begin{array}{lll} \text{y="Eased considerably"=(i=0)} & \text{if} & -\infty = \mu_0 \leq y^* \leq \mu_1 \\ \text{y="Eased somewhat"=(i=1)} & \text{if} & \mu_1 \leq y^* \leq \mu_2 \\ \text{y="remained basically unchanged"=(i=2)} & \text{if} & \mu_2 \leq y^* \leq \mu_3 \\ \text{y="tightening somewhat"=(i=3)} & \text{if} & \mu_3 \leq y^* \leq \mu_4 \\ \text{y="tightening considerably"=(i=4)} & \text{if} & \mu_4 \leq y^* \leq \mu_5 = +\infty \end{array} \tag{6}$$

The probability of answer i is given by:

$$P(y = i) = F(\mu_{i+1} - \sum_{sct} \alpha_{sct} D_{sct}) - F(\mu_i - \sum_{sct} \alpha_{sct} D_{sct}) \tag{7}$$

with F the CDF of the Normal distribution.

The log-likelihood of the data is given by

$$\sum_{i} \sum_{sct} S_{isct}[F(\mu_{i+1} - \sum_{sct} \alpha_{sct} D_{sct}) - F(\mu_i - \sum_{sct} \alpha_{sct} D_{sct})] \tag{8}$$

The model is estimated by maximum likelihood. The tightening index of country c and size class s at the quarterly level is then given by $\hat{\alpha}_{sct}$. The tightening index at the annual level is simply the sum of $\hat{\alpha}_{sct}$ over the year. Finally the indexes are standardized to range between zero and 1.

A.3 Construction of the variables

Below we present the construction of the variables. In italics are the names of the BACH-database items.

IK_{it}: Investment capital ratio. Investment is measured as *Acquisition of tangible fixed assets* minus *sales and disposals*. Capital stock is measured by book value of *fixed assets*.

$\triangle y_{it}$: Sales growth: Is measured as the log growth rate of *turnover*.

$(y-k)_{it-1}$: the log of the output capital ratio: Is measured as the log of *turnover* over book value of *fixed assets*.

CK_{it-1}: Cash flow capital ratio: Cash flow is measured as *Gross operating profit* minus *Interest and similar charges* minus *Taxes on profits*. Capital stock is measured by book value of *fixed assets*.

$bank\ debt\ leverage_{it-1}$: Bank debt leverage: *Amounts owed to credit institutions (amounts becoming due and payable within one year)+Amounts owed to credit institutions (amount becoming due and payable after more than one year)* divided by "*total assets* minus *trade creditors*".

$total\ leverage_{it-1}$: Total leverage: *Creditors: amounts becoming due and payable within one year* plus *Creditors: amount becoming due and payable after more than one year* minus *trade creditors* divided by "*total assets* minus *trade creditors*".

$cash_{it-1}$: Cash to asset ratio: Is measured as "*Current investments*" plus "*Cash at bank and in hand*" to *total assets*.

π_{it-1}: profit rate: Is measured as "*Gross operating profits*" minus "*Taxes on profits*" to *Tangible fixed assets*.

A.4 List of the industries used

The following industries are used. They are listed with their NACE Rev 2 code.

10: Manufacture of food products

11: Manufacture of beverages

12: Manufacture of tobacco products

13: Manufacture of textiles

14: Manufacture of wearing apparel

15: Manufacture of leather and related products

16: Manufacture and production of wood and cork etc.

17: Manufacture of paper and paper products

18: Printing and reproduction of recorded media

19: Manufacture of coke and refined petroleum products

20: Manufacture of chemicals and chemical products

21: Manufacture of basic pharmaceutics products and pharmaceutics preparations

22: Manufacture of rubber and plastic products

23: Manufacture of other non-metallic mineral products

24: Manufacture of basic metals

25: Manufacture of fabrication metal products except machinery and equipment

26: Manufacture of computer, electronic and optical products

27: Manufacture of electrical equipment

28: Manufacture of machinery and equipment N.E.C

29: Manufacture of motor vehicles, trailers and semi-trailers

30: Manufacture of other transport equipment

31: Manufacture of furniture

32: Other manufacturing

33: Repair and installation of machinery and equipment

A.5 Derivation of the error correction specification

The error correction model has been used in the micro investment literature by Bond, Elston, Mairesse and Mulkay (2003) and Bloom, Bond and Van Reenen (2007) among others. A derivation and discussion can be found both in these papers and in Bond and Van Reenen (2007). We show how the equation used in our paper can be derived.

Start with the standard result of a profit maximizing capital stock in the absence of adjustment costs, derived from a constant returns to scale CES production function for firm i at time t. It is given by

$$k_{it} = \alpha_i + y_{it} - \sigma v_{it} \tag{9}$$

where k_{it} is the log of the capital stock, y_{it} is the log of output, v_{it} is the user cost of capital, α_i is a function of production function parameters and σ is the elasticity of capital with respect to the user cost.

Due to adjustment costs we assume that capital will not be equal to its profit maximizing level in the absence of adjustment costs at all times, but moves according to this in the long run. We allow for adjustment lags flexibly and assume that capital moves according to the equation:

$$k_{it} = \pi_1 k_{it-1} + \pi_2 k_{it-2} + \kappa_1 y_{it} + \kappa_2 y_{it-1} + \alpha_i + \delta_{jt} + \epsilon_{it} \tag{10}$$

where ϵ_{it} is an error term. This equation nests the long run equation 6 if we assume that $\kappa_1 + \kappa_2 = 1 - \pi_1 - \pi_2$. We have replaced the user cost with country-time dummies δ_{jt}. Equation 7 can be written as:

$$\triangle k_{it} = -\pi_2 \triangle k_{it-1} + \kappa_1 \triangle y_{it} - (1 - \kappa_1 - \kappa_2)(y_{it-1} - k_{it-1}) + \alpha_i + \delta_{jt} + \epsilon_{it} \tag{11}$$

We can then replace the growth rate of the capital stock $\triangle k_{it}$ by the net investment rate $IK_{it} - \delta_i$, where δ_i is the (firm specific) depreciation rate. When we augment equation 8 with cash flow and leverage terms, this leads us to the basic specification in equation 1.

A.6 Variation of bank debt leverage: further tables

TABLE A.1

Variation of bank debt leverage according to sector

NACE Rev2	MEAN	ST.DEV	MINIMUM	MEDIAN	MAXIMUM
10	24.83	8.31	10.44	24.48	42.32
11	19.47	9.21	0.76	17.35	37.01
12	12.94	13.75	0.28	8.72	47.37
13	22.41	8.88	6.14	20.99	41.86
14	21.68	10.97	5.03	20.49	46.90
15	25.37	13.89	6.41	24.95	46.08
16	25.55	10.70	4.30	24.57	45.44
17	19.83	9.36	1.00	19.82	41.98
18	22.83	8.12	7.95	22.83	36.84
19	16.52	15.93	0.82	13.71	73.14
20	15.77	9.43	2.29	13.25	38.64
21	13.39	8.83	1.22	11.13	37.45
22	19.57	9.76	3.59	19.49	38.38
23	19.63	8.65	5.01	17.66	36.73
24	18.70	11.53	2.18	14.27	42.23
25	20.77	8.15	5.13	20.28	36.50
26	13.02	8.67	0.76	11.15	34.60
27	15.86	8.96	2.85	14.91	37.26
28	15.81	8.34	0.00	16.24	33.07
29	16.55	10.06	1.25	15.41	57.42
30	15.59	11.40	0.68	12.16	39.93
31	22.28	10.76	6.95	20.71	43.76
32	22.83	10.33	4.94	23.64	39.74
33	13.39	8.82	0.02	11.66	30.50

Notes: Variable is $bank\ debt\ leverage_{it-1}$. Numbers in percentages. Total sample.

TABLE A.2

Variation of bank debt leverage according to year

YEAR	MEAN	ST.DEV	MINIMUM	MEDIAN	MAXIMUM
2004	20.11	10.48	0.76	19.70	46.90
2005	19.48	10.54	0.28	18.48	57.42
2006	18.93	10.37	0.76	17.55	45.38
2007	18.65	10.42	0.04	17.08	47.37
2008	18.52	10.82	0.00	17.13	73.14
2009	18.57	10.22	0.36	17.72	72.91

Notes: Variable is $bank\ debt\ leverage_{it-1}$. Numbers in percentages. Total sample.

A.7 Construction of fundamental Q

We follow closely the method by Gilchrist and Himmelberg (1995). Consider a standard neo-classical investment problem (for segment i) with convex adjustment costs,

$$V(K_{it-1}, \theta_{it}) = \max_{\{I_{i\tau}\}_{\tau=t}^{\infty}} E\{\sum_{\tau=t}^{\infty} \beta^{\tau} \big[\Pi(K_{i\tau}, \theta_{i\tau}) - C(I_{i\tau}, K_{i\tau}, \zeta_{i\tau}) - I_{i\tau}\big] | \Omega_{it}\} \tag{12}$$

subject to $K_{i\tau} = (1-\delta)K_{i\tau-1} + I_{i\tau}$; where $K_{i\tau}$ is the capital stock, $I_{i\tau}$ investment, θ_{it} a shock to the profit function, $\zeta_{i\tau}$ a shock to the adjustment cost function and Ω_{it} the information set at time t.

The cost of adjustment follows the standard convex form,

$$C(I_{i\tau}, K_{i\tau}, \zeta_{i\tau}) = (\frac{\alpha}{2})(\frac{I_{i\tau}}{K_{i\tau}} - \gamma_i - \zeta_{i\tau})^2 K_{i\tau} \tag{13}$$

Solving the maximization problem leads to the following well known relation between the investment rate and marginal Q.

$$\frac{I_{it}}{K_{it}} = \gamma_i + \frac{\alpha}{2} E\big[q_{it} | \Omega_{it}\big] + \zeta_{it} \tag{14}$$

where marginal q is the present discounted value of expected future marginal profits.

$$E\big[q_{it}|\Omega_{it}\big] = \sum_{s=0}^{\infty}(\beta(1-\delta))^s E\big[\pi_{it+s}|\Omega_{it}\big] \tag{15}$$

with

$$\pi_{it+s} = \frac{\partial \Pi(K_{it+s}, \theta_{it+s})}{\partial K_{it+s}} - \frac{\partial C(I_{it+s}, K_{it+s}, \zeta_{it+s})}{\partial K_{it+s}} \tag{16}$$

The central idea in Gilchrist and Himmelberg is to replace marginal Q, $E\big[q_{it}|\Omega_{it}\big]$, by a proxy derived from an estimated VAR in firm fundamentals, which include the profit rate as one of the variables.

Let x_{it} be a vector of observable firm fundamentals that follows a stationary stochastic process,

$$x_{it} = Ax_{it-1} + f_i + d_t + u_{it} \tag{17}$$

with f_i a segment fixed effect, d_t an aggregate shock (common to all segments), and innovation term u_{it}.

If the profit function is assumed to be homogenous of degree one, marginal profit is equal to the observed ratio of realized profit to capital, π_{it}. Include π_{it} as the first element of x_{it}. Then $\pi_{it} = c'x_{it}$, with c equal to the vector with 1 as the first element and zero elsewhere. The projection of q_{it} on x_{it}, f_i and d_t is given by,

$$P\big[q_{it}|x_{it}, f_{i,d_t}\big] = \big[c'(I - \beta(1-\delta)A)^{-1}\big]x_{it} + \Gamma_1 f_i + \Gamma_2 d_t \tag{18}$$

Replacing marginal Q by this projection leads to our final empirical specification of investment

$$\frac{I_{it}}{K_{it}} = \frac{1}{\alpha}\big[c'(I - \beta(1-\delta)A)^{-1}\big]x_{it} + \eta_t + u_i + \epsilon_{i,t} \tag{19}$$

with $[c'(I-\beta(1-\delta)A)^{-1}]x_{it}$ being called fundamental Q.

Fundamental Q is obtained as follow. We estimate the VAR in equation (17) using the following variables: the profit rate (gross operating profit after taxes), the sales capital ratio and bank debt leverage. We include fixed effects and country-time dummmies in the estimation and estimate the VAR using GMM. This gives us an estimate of A. We then set β equal to 0.96 , and δ equal to 0.20.

A.8 Further robustness result tables

TABLE A.3

Tightening, bank debt leverage and investment

error correction model controlling for total leverage

bank-dependence defined as dummy variable

	Dependent variable is IK_{it}		
	(1)	(2)	(3)
Variable	OLS	WITHIN	DIFF-GMM
IK_{it-1}	0.38***	−0.06*	0.12*
	(0.03)	(0.04)	(0.06)
$\triangle y_{it-j}$	0.03	0.04	0.25**
	(0.02)	(0.02)	(0.11)
$(y-k)_{it-1}$	1.04**	10.61***	17.43***
	(0.50)	(1.97)	(6.49)
CK_{it-j}	0.05***	0.04	−0.00
	(0.01)	(0.02)	(0.07)
BD_i	2.21***		
	(0.78)		
T_{lt-1}	11.14***	8.30*	6.16
	(4.16)	(4.34)	(9.37)
$T_{lt-1} * BD_i$	−4.15**	−2.89	−10.19**
	(1.82)	(1.98)	(4.77)
$total\ leverage_{it-1}$	0.11***	0.05	−0.01
	(0.04)	(0.05)	(0.11)
T_{lt-1}*$total\ leverage_{it-1}$	−0.17**	−0.09	0.02
	(0.08)	(0.09)	(0.21)
N. of Observations	1882	1882	1492
N. of Cross-section	349	349	335
N. of Instruments			107
m2 (p-value)			0.90
H-test (p-value)			0.13

Notes: Sample period is 2004-2009. All regressions contain country-time dummies

Standard errors are heteroscedasticity consistent. Column 3: Two step GMM estimates.

Instrument set column (3) IK_{it-j}, $\triangle y_{it-j}$, CK_{it-j}, T_{lt-j}, $bank\ debt\ leverage_{it_0}$,

$total\ debt\ leverage_{it}$ j=2,3,4 t=2000

m2 is second order serial correlation tests, asymptotically N(0,1).

H-test is Hansen test of overidentifying restrictions.

*** Significant at 1% level, ** at 5% level,* at 10% level

TABLE A.4

Tightening, bank debt leverage and investment

fundamental Q model controlling for total leverage

bank-dependence defined as dummy variable

	Dependent variable is IK_{it}		
	(1)	(2)	(3)
Variable	OLS	WITHIN	DIFF-GMM
Q_{it}	0.06^{***}	0.04^{**}	0.06
	(0.01)	(0.02)	(0.04)
BD_i	3.48^{***}		
	(0.98)		
T_{lt-1}	16.33^{***}	10.01^{**}	6.80
	(4.68)	(4.45)	(9.26)
$T_{lt-1} * BD_i$	-5.95^{***}	-3.92	-12.85^{***}
	(1.96)	(2.09)	(3.77)
$total\ leverage_{it-1}$	0.14^{***}	-0.01	0.08
	(0.04)	(0.06)	(0.10)
T_{lt-1}*$total\ leverage_{it-1}$	-0.29^{***}	-0.13	0.02
	(0.11)	(0.10)	(0.22)
N. of Observations	1942	1942	1560
N. of Cross-section	350	350	340
N. of Instruments			92
m2 (p-value)			0.19
H-test (p-value)			0.41

Notes: Sample period is 2004-2009. All regressions contain country-time dummies

Bootstrapped standard errors. Columns 3: Two step GMM estimates.

Instrument set column (4) T_{lt-j}, π_{it-j}, $(y-k)_{it-j}$, $bank\ debt\ leverage_{it_0}$, $total\ debt\ leverage_{it}$ j=2,3,4 $t_0 = 2000$

m2 is second order serial correlation tests, asymptotically N(0,1).

H-test is Hansen test of overidentifying restrictions.

*** Significant at 1% level, ** at 5% level,* at 10% level

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