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Sovereign Stress, Banking Stress, and the Monetary Transmission Mechanism in the Euro Area*

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Abstract

In this paper, we investigate to what extent sovereign stress and banking stress have contributed to the increase in the level and in the heterogeneity of non-financial firms' refinancing costs in the Euro area during the European debt crisis and how they did affect the monetary transmission mechanism. We identify the increasing effect of government bond yield spreads (sovereign stress) and the share of non-performing loans (banking stress) on firms' financing costs using an instrumental-variable approach. Moreover, we estimate both sources of stress to have significantly impaired the monetary transmission mechanism during the European debt crisis.

Keywords: banking stress, firms' financing conditions, government bond yields, interest rate channel, monetary policy transmission, sovereign stress

JEL Classification: E43, E44, E52

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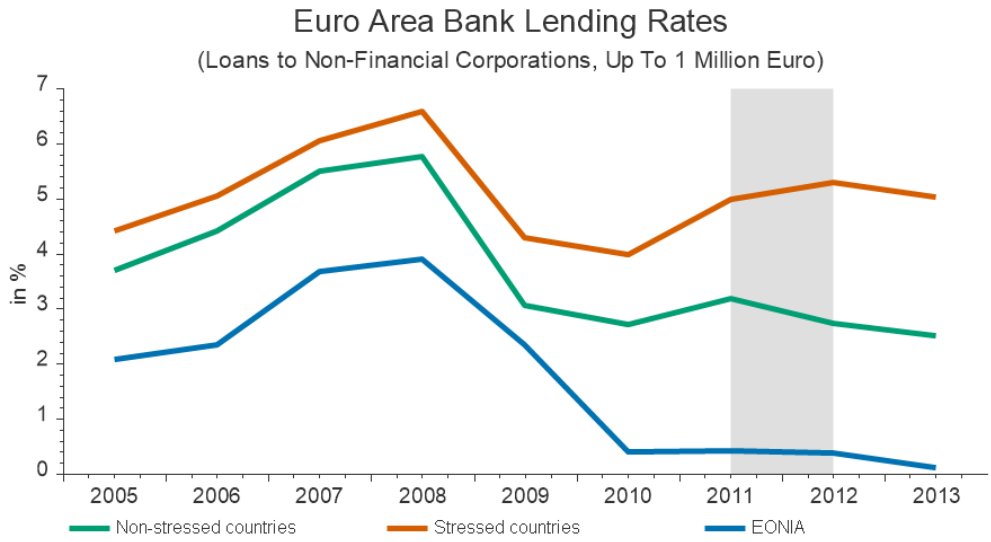
1 Introduction

During the European sovereign debt crisis firms‘ financing costs have been disconnected from the key monetary policy interest rate in the Euro area. While bank lending rates of non-financial corporations are usually closely related to short-term money market interest rates, the spread between these two rates has considerably increased not only in the course of the worldwide financial crisis in 2008 (from below 2 percentage points to about 3.5 percentage points) but also in 2011 (to about 4 percentage points) when some Euro area countries have experienced sovereign debt crises. Furthermore, the heterogeneity of bank lending rates in various Euro area countries has increased. The difference between maximum and minimum country-specific spreads between short-term bank lending rates of non-financial corporations and the overnight money market rate has been equal to about 1 percentage point before 2008 and up to about 4 percentage points in 2012.

In this paper, we investigate to what extent sovereign stress and banking stress have contributed to this increase in the level and in the heterogeneity of non-financial firms' refinancing costs in the Euro area and how they did affect the monetary transmission mechanism. We use a large firm-level data set (Amadeus) in order to address two major challenges: Firstly, firms financing costs are not only driven by macroeconomic conditions like sovereign stress or banking stress but also by firm-specific characteristics. If the average riskiness of firms varies across Euro area countries this also affects the relation between monetary policy rates and bank lending rates. By using balance sheet data for non-financial corporations we control for firm-specific characteristics. Secondly, in order to support our causal interpretation of the results, we use an instrumental-variable approach. In addition, we control for aggregate variables which are related to the aggregate interest rate level in the economy.

Figure 1 depicts aggregate bank lending rates for stressed and non-stressed Euro area countries together with the overnight money market rate (Eonia). „Stressed“ countries in our sample are Ireland, Italy, Spain and Portugal, „non-stressed“ countries Austria,

Figure 1: Bank lending rates stressed vs. non-stressed countries



Notes: Bank lending rates are the country-level rates one loans to non-financial corporations, new business, up to one year, up to one million euro. Sources: European Central Bank and Datastream.

Finland, France and Germany.[1] The dynamics of the rates in the two country groups are the same in the first half of the sample. However, the rates diverge in 2012, rising in the stressed and falling in the non-stressed countries.

How can we explain the change in the relation between monetary policy rate and bank lending rates? A couple of recent papers show that sovereign stress in terms of elevated government bond yields may affect financing costs of non-financial corporations. Gertler and McCallum (2007), for example, introduce government bonds as collateral in an otherwise standard New-Keynesian macroeconomic model. Since sovereign stress reduces the price of government bonds their value as collateral is also reduced. As a consequence, lending costs of non-financial corporations increase in response to sovereign stress. Other papers like Gertler and Karadi (2011) stress the healthiness of banks as financial intermediaries. Decreasing government bond prices reduce net worth and, therefore, capital of banks. This makes refinancing more expensive for banks themselves and is also transmitted to non-financial firms' financing costs. Bocola (2016) adds a precautionary motive for banks to the Gertler-Karadi framework and shows that sovereign stress may affect financing costs of non-financial firms through two channels: a risk channel and

[1] See section 3.3 for details on this classification.

a liquidity channel. In this framework, the financing costs of non-financial firms depend both on their own productivity and riskiness and on the financial situation of the banks. In addition to sovereign stress, models of the Gertler-Karadi and Bocola type imply more generally that financing costs of non-financial firms depend on the financial situation of banks. Sovereign stress is not the only factor that may negatively affect net wealth of banks. An increase in the share of non-performing loans, for example, does also reduce net worth of banks due to the adjustment of the value of outstanding loans in banks' balance sheets. Therefore, both sovereign stress as indicated by elevated government bond yields and banking stress as indicated by the share of non-performing loans may affect the spread between bank lending rates of non-financial corporations and the monetary policy rate. Since government bond yields and the share of non-performing loans have become more heterogeneous in the Euro area since the European debt crisis, these factors may also explain the disconnection and the heterogeneity of firms' refinancing costs. This also implies a non-linearity in the effect of changes in the monetary policy rate on firms' financing costs: elevated stress levels may impair the monetary transmission channel from policy rates to bank lending rates.

We show (1) that corporate financing costs in stressed countries and in non-stressed countries in the Euro area significantly moved in different directions during the years 2011 and 2012, even after controlling for firm-specific characteristics, while they moved in the same direction before the sovereign debt crisis; that (2) sovereign stress and banking stress significantly increased corporate financing costs and thus help explaining the observed disconnection between stressed and non-stressed countries; and (3) that both macroeconomic stress factors impaired the monetary transmission mechanism. While our three main results are in line with theoretical considerations and thus come at no surprise qualitatively, we are – to the best of our knowledge – the first to quantify the exact effects on corporate financing costs and the monetary transmission mechanism.

The remainder of the paper is organized as follows. Section 2 motivates the importance of sovereign stress and banking stress for the analysis of firms' financing conditions. Section 3 introduces the micro-level data used throughout the analysis and describes our measure

of firms' financing costs. Sections 4 and 5 then highlight the importance of sovereign stress and banking stress for firms' financing costs and the monetary transmission mechanism and describe our instrumental variable approach for the two sources of macroeconomic stress. Estimation and results are presented and discussed in section 6. Finally, section 7 concludes.

2 Theoretical channels of stress pass-through

Our approach of examining the effects of sovereign stress and banking stress on firms' financing costs is motivated by the two channels proposed in Bocola (2016). He analyzes and estimates the pass-through of sovereign stress on firm borrowing rates through the balance sheets of financial intermediaries. His framework is built on the quantitative DSGE model with financial intermediation of Gertler and Karadi (2011), in which an agency problem between households and the financial intermediaries introduces a financial accelerator mechanism propagating shocks to the financial intermediaries. Below we briefly sketch the main aspects of this mechanism and explain the extension introduced by Bocola (2016) as well as the resulting channels of influence of sovereign stress and banking stress on firms' financing costs.

In the framework of Gertler and Karadi, financial intermediaries receive funds from households and lend to firms who use the credit to finance their investments. However, there exists an agency problem between the households and the financial intermediaries, because the bankers operating the financial intermediaries can divert a fraction of the deposits received by the households. Consequently, the latter require the former to fulfill an incentive constraint, according to which the gains of this infidelity cannot be larger than the implied costs (households can force unfaithful bankers into bankruptcy). As a consequence, the maximum amount of deposits a banker is entrusted with – and thus her ability to finance firm credit – is tied to her equity serving as collateral. It is in this vein that the agency problem introduces an endogenous constraint on the intermediaries' ability to lend to the real economy.

A shock to the quality of intermediaries' assets reducing their value therefore weakens intermediaries' balance sheet and decreases equity. Due to the leverage ratio constraint financial intermediaries will then demand less firm assets, i.e. credit to finance new investment. This in turn reduces firm investment and the price of firm assets held by banks, further weakening the intermediaries' balance sheets. As a consequence, the effect of the initial shock to the quality of intermediaries' assets is amplified and can trigger an economic recession.

Bocola (2016) extends the Gertler-Karadi framework by introducing government bonds held by the intermediaries. The balance sheet of a financial intermediary can thus be represented as in table 1.

Table 1: Balance sheet of a financial intermediary

Assets	**Liabilities**
Government bonds (B)	Deposits (D)
Loans to firms (L)	Equity (E)

In the model, an increased probability of sovereign default and thus higher government bond yields affect borrowing costs of firms via two channels. First, there is a direct effect through the balance sheets of the financial intermediaries: Rising yields reduce the price of government bonds held by the intermediaries, weakening their balance sheets (B). As a consequence, banks' net worth declines which in turn reduces their ability to obtain funding. The resulting increase in funding costs is passed down to the real economy in form of higher borrowing costs for firms. Second, if the probability of a sovereign default increases, banks anticipate potential losses on their bond holdings and thus tighter funding conditions in the future. In addition, holding firm assets in itself becomes more riskier for banks. Once the default occurs, all then constrained intermediaries will sell their firm assets, drastically reducing their value. This so called risk channel generates „a precautionary motive for banks to deleverage and to reduce their holdings of firms' claims." (Bocola (2016), p. 3).

Besides the direct effects of both sources of macroeconomic stress, we can also derive an indirect effect on firms' financing conditions because the monetary transmission mech-

anism depends on both sovereign and banking stress: In the model of Bocola (2016) sovereign stress affects the asset side of banks' balance sheet, because rising yields and and thus declining prices of government bonds decrease banks' net worth, reducing their ability to obtain funding, resulting in an increase in borrowing costs for firms. In the monetary transmission mechanism from the central bank to firms, the pass-through of interest rates crucially hinges on the behaviour of the financial intermediaries, i.e. banks. Accordingly, both sovereign stress and central bank interest rate decisions affect banks' funding costs and therefore the interest rates they demand for lending to firms. In this sense, the outlined effect of sovereign stress constitutes a premium for banks for a given interest rate decision by the central bank. Consider a scenario in which the central bank reduces interest rates. This reduction will, through the banks and with a temporal delay, be transmitted to firms' borrowing costs, so the banks decrease lending rates. If during this process, however, sovereign stress is high, then the mechanism described above will take effect and induce the banks to increase their lending rates. As result, the pass-through of central bank interest rate decisions will be diminished. Since this diminishing effect will be higher for higher levels of sovereign stress it follows that the level of sovereign stress affects the monetary transmission mechanism.

Similarly, we derive the interaction effect between the monetary transmission mechanism and banking stress. The risk channel in the model of Bocola (2016) suggests that banks deleverage and reduce credit to firms because they are perceived as riskier. Accordingly, banks will demand a premium on credit to firms. In addition, higher risk may induce banks to increase their liquidity buffer in preparation for possible future negative shocks. Consider again the scenario in which the central bank reduces interest rates. If banking stress is high, the resulting increase in lending rates will counteract the expansionary monetary policy. As before with sovereign stress, the degree of counteracting effect will be higher for higher levels of banking stress. Therefore, the level of banking stress affects the monetary transmission mechanism.

In conclusion, sovereign stress can reduce the banks' resources to finance firms and banks may be more reluctant to lend due to a precautionary motive. Thus, and in addition to

sovereign stress, also banking stress is an important determinant in explaining changes in firms' financing conditions. Therefore, the model implies that the level of both sources of stress impacts the monetary policy transmission, as they directly influence optimal behaviour of financial intermediaries when lending to firms.

Related literature has examined specific aspects of the sovereign-banking-firm-nexus. Acharya et al. (2004) develop a model with interdependency between stress in the banking sector and sovereign risk. Gennaioli et al. (2014) in turn examine the effects of government defaults on the banking sector and private credit. Similarly, Correa et al. (2014) analyze the impact of sovereign credit rating downgrades on bank stock returns. And Brutti and Sauré (2015) show that cross-country bank exposures to sovereign debt of Euro area countries propagate sovereign risk. Focusing on sovereign risk and firm credit, Corsetti et al. (2013) argue that the costs of financial intermediation depend on sovereign risk and that higher government risk premiums therefore also increase the wedge between the risk-free rate and private borrowing costs. Moreover, Sandleris (2014) finds that sovereign defaults can reduce foreign and domestic credit to the private sector.

3 Data

3.1 Firm-level data

We use firm-level data from the Amadeus data set provided by Bureau van Dijk. It contains annual balance sheet data of a large number of firms in different countries, sectors and with different legal forms. Examples of recent use of this data set include de Almeida (2015), who uses Amadeus data to examine the relationship between the financing conditions of firms in several Euro area peripheral countries and sectoral inflation, and Egger et al. (2015), who look at the relation between firm-level productivity or quality of products and domestic sales and exports in France. Deeper insights into the structure of the Amadeus data set and specifically the concern of representativeness can be found in Kalemli-Ozcan et al. (2015).

Our sample comprises non-financial corporations[2] from the following eight member countries of the Euro area: Austria, Finland, France, Germany, Ireland, Italy, Portugal, and Spain[3], covering the time from 2004 to 2013. A firm is allocated to the country in which the firm is domiciled, according to the classification provided by Bureau van Dijk. We account for outliers in the data by applying the following two-step procedure: First, we compute and drop the bottom and top 2% percentiles of all micro variables employed. In addition, we then eliminate those remaining observations containing implausible ratios of balance sheet positions by imposing that fixed assets, long-term borrowed funds and short-term borrowed funds as a ratio of total balance sum, respectively, must be non-negative and can not exceed 1. For the case of the own funds to balance sum ratio the upper limit applies as well, whereas the non-negativity constraint is not enforced because own funds as measured in a balance sheet can in fact be negative. This combination of trimming the data and removing observations with implausible values ensures outliers are removed and broadly follows the procedure described in Kalemli-Ozcan et al. (2015).

From this balance sheet data we utilize seven variables which are relevant for determining the financing conditions of the respective firm (see Altmann (2000); Altmann et al. (2014) and the references therein). Table 7 in the appendix lists the variables used in the analysis and the exact definitions. While this parsimonious specification may not fully cover the financial situation of a firm in every single detail, we are confident to capture the most important financial aspects. To explain the change in firms' financing conditions the micro variables enter the regressions in differences. To better capture the effect of monetary policy on the firm-level, we additionally include interaction terms between the levels of the seven micro variables and the change in the money market rate (Eonia). The variables described above are available for every country in our sample, thus allowing us to consistently estimate our specification across countries. Summary statistics of the variables are provided in table 8 in the appendix. Overall our balanced panel data set comprises 2.301.610 observations for 230.161 firms. Of the firms in our data set are 40.41% small

[2]We exclude financial corporations, that is firms with NACE sector classification from 6400 to 6700.

[3]Due to insufficient numbers of observations, we exclude Belgium, Greece, Luxembourg and the Netherlands from the sample.

(turnover up to 1 Million Euro), 55.32% medium sized (turnover more than 1 Million Euro and up to 50 Million Euro) and 4.27% large (turnover more than 50 Million Euro). All non-financial sectors except agriculture and mining are represented.

3.2 Measuring financing conditions at the firm level

We measure financing conditions at the firm level by interest payments divided by the average of liabilities in the current and previous period and call this variable financing conditions indicator or simply financing costs R_{ijt} for firm i in country j at time t. The average of two consecutive end-of-year values is taken as proxy for the average amount of debt during the year. It should be noticed that this indicator does not represent marginal borrowing costs but rather average borrowing costs in a specific period. Therefore, changes in bank lending rates on new business are only slowly reflected in our financing costs measure.

Using the financing conditions indicator variable described above, we construct average financing costs for each country by aggregating the firm-level specific financing costs according to

$$\overline{R}_{jt} = \frac{1}{N_{jt}} \sum_{i=1}^{N_{jt}} R_{ijt}, \qquad j = 1, \ldots, J \tag{1}$$

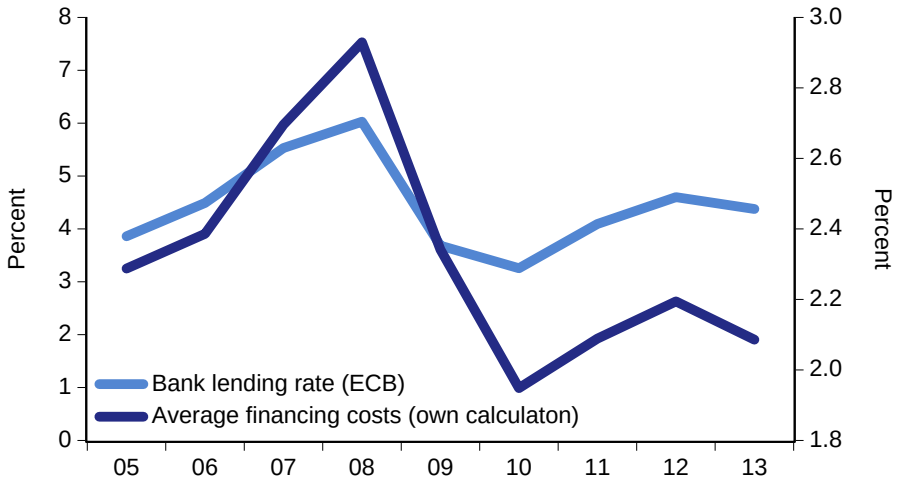
and

$$\overline{R}_{t} = \frac{1}{\sum_{j=1}^{J} N_{jt}} \sum_{j=1}^{J} \sum_{i=1}^{N_{jt}} R_{ijt}, \tag{2}$$

for the Euro area as a whole, where $J = 8$ is the number of countries, N_{jt} the number of firm observations for country j in period t, and R_{ijt} is the financing condition indicator for firm i in country j in period t.

To assess the reasonableness of the generated indicator, figure 2 depicts aggregate bank lending rates for non-financial corporations for the Euro area together with the average

Figure 2: Financing conditions indicator and aggregate bank lending rate



Notes: Bank lending rate denotes the short-term bank lending rate as published by the ECB (left scale) and the financing conditions indicator constructed from our individual firm data (right scale). Sources: European Central Bank and Bureau van Dijk

value of the financing conditions indicator for each year in the Euro area as a whole.

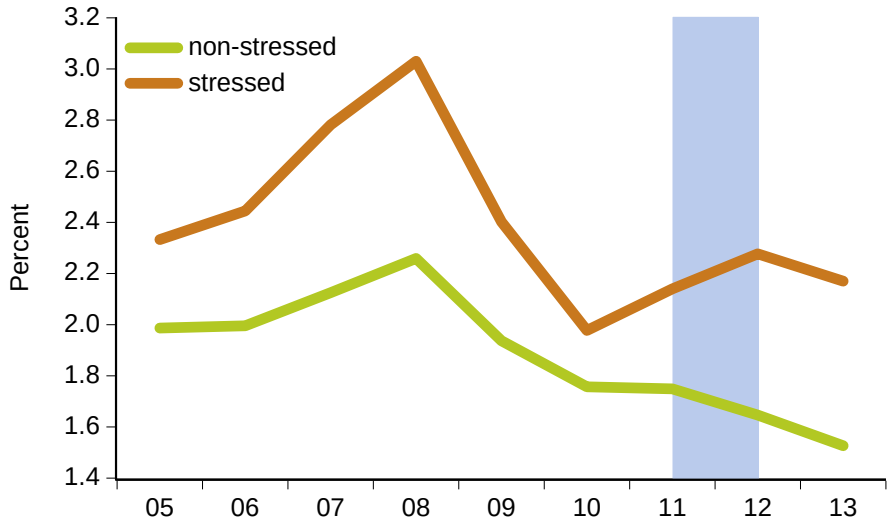
As can be seen, there are differences in the levels, but the dynamics of both time series are very similar.[4] Comparable results also hold if we examine the individual countries separately. Therefore, the aggregated micro-level data and aggregate bank lending rates capture the same underlying dynamics. Financing costs for firms started rising in 2005 and reached a peak in 2008 before decreasing in 2009 and 2010. Afterwards, rates rose again in the wake of the European debt crisis. In conclusion, our constructed financing conditions indicators is a valid proxy for the dynamics of micro-level financing costs.

3.3 Firm-level financing conditions in stressed and non-stressed countries

The classification of countries into the two subgroups „stressed“ and „non-stressed“ is based on the respective country's government bond yield: Those countries with yields above the Euro area average are labeled „stressed“ (Ireland, Italy, Spain and Portugal),

[4]One potential reason for the difference in levels is the fact that liabilities on the firm level contain provisions which are not directly associated with interest payments. Positive provisions therefore lead to an understatement of firms' financing conditions according to our measure.

Figure 3: Firms' financing costs in stressed vs. non-stressed countries



Notes: Interest payments in relation to total liabilities. Sources: Bureau van Dijk and own calculations.

whereas those with lower yields are labeled „non-stressed" (Austria, Finland, France and Germany).[5] Applying this classification to our measure of firms' financing costs constructed above we find in figure 3 the same diverging development for the two subgroups in 2012 considering micro data as we observed before with aggregate bank lending rates (figure 1) in section 1: Rates rose in the stressed and fell in the non-stressed countries. In addition, this difference in development can already be observed in 2011. That is, based on our firm-level data, stressed and non-stressed countries exhibited diverging financing costs in the two years 2011 and 2012.

While insightful, the graphical analysis of aggregate measures can not answer the question whether the differences in observed outcomes are based on country-specific variables or on differences between the examined country groups with respect to the underlying micro-level data. If these were heterogeneous across countries, we would also expect financing costs to be different. To assess potential differences across countries, table 2 provides summary statistics of the (aggregated) micro variables used for each country.

Although the differences are small for many variables, they are substantial for some, especially with respect to borrowed funds, both long- and short-term, own funds rentability

[5]This corresponds to the classification in Corsetti et al. (2013)(although they consider some additional countries which are not contained in our sample) and to the sample of countries with a sovereign debt crisis in Knedlik and von Schweinitz (2012).

Table 2: Descriptive statistics of micro-level variables per country

Variable	Statistic	AT	DE	ES	FI	FR	IE	IT	PT	Total
	mean	10.2	8.8	6.0	12.5	9.5	6.2	4.9	6.7	5.9
cashflow	sd	8.4	7.3	7.3	10.1	8.1	7.8	6.2	7.2	7.0
	median	9.3	7.4	5.0	11.4	8.5	5.4	3.7	5.6	4.7
	mean	40.7	44.4	42.7	51.0	31.3	46.1	31.1	33.3	35.5
fassets	sd	28.3	29.0	28.1	27.4	24.8	31.7	27.4	24.1	27.9
	median	35.9	41.1	39.6	53.4	24.2	44.4	23.0	29.3	29.2
	mean	13.8	35.4	21.3	28.5	11.5	17.7	20.4	17.3	19.9
ltbfunds	sd	11.8	22.1	20.8	20.4	14.1	20.5	18.5	19.0	19.3
	median	10.5	31.8	15.3	24.8	6.4	9.8	15.2	11.5	14.2
	mean	50.9	28.0	40.1	33.9	50.0	34.0	53.7	47.4	48.0
stbfunds	sd	22.1	22.5	23.4	18.5	19.9	22.9	24.0	22.1	24.2
	median	53.5	23.8	38.4	31.6	49.9	28.8	55.6	46.8	48.2
	mean	1.7	2.8	2.6	2.7	1.8	2.2	2.3	3.0	2.4
refinancing costs	sd	1.4	1.9	1.7	1.6	1.4	1.7	1.6	1.9	1.7
	median	1.4	2.6	2.3	2.5	1.5	1.8	2.0	2.7	2.1
	mean	14.8	11.9	5.9	12.9	14.6	6.6	4.8	5.5	6.4
ofrentability	sd	31.0	24.3	25.1	31.6	26.5	22.4	29.6	23.8	27.8
	median	11.9	8.1	5.0	12.7	12.6	6.3	4.0	4.8	5.3
	mean	35.1	36.6	38.6	37.5	38.5	48.4	25.9	35.4	32.1
ofratio	sd	20.1	19.9	23.0	21.0	18.8	23.9	20.2	18.8	22.0
	median	31.7	34.2	35.9	36.4	37.3	48.4	20.8	32.9	28.3
	mean	5.2	4.0	2.1	5.3	5.3	3.2	1.5	2.1	2.2
roi	sd	7.7	6.2	6.4	8.4	7.3	7.6	5.3	5.7	6.1
	median	4.0	2.7	1.5	4.3	4.5	2.6	0.6	1.4	1.2

Notes: All statistics in percent, i.e shares (see table 7) are multiplied by a factor of 100.

and the return on investment. The latter two are pronouncedly lower in the group of stressed countries (Spain, Ireland, Italy and Portugal). Using micro data we are able to control for these differences on the firm-level. To assess the divergence in aggregate financing costs more analytically, we estimate the following panel specification:

$$\Delta R_{ijt} = \sum_{t=2006}^{2013} \beta_t year_t + \sum_{t=2006}^{2013} \delta_t year_t * stressed_j + \sum_{k=1}^{K} \gamma_k \Delta z_{ikt} + \sum_{l=1}^{L} \zeta_l \Delta w_{jt} + \varepsilon_{ijt}, \quad (3)$$

where $year_t$ denotes a set of year dummies and $year_t * stressed$ a set of interaction terms between these year dummies and the indicator variable $stressed$ which is 1 for stressed countries (Ireland, Italy, Spain and Portugal) and zero otherwise (Austria, Finland, France, Germany). In addition, we include the set of aforementioned $K = 7$ firm-specific control variables z_{ikt} and a set of $L = 2$ country-specific macro control variables w_{jt} to be explained below. The model is specified in first differences in order to account for unobserved firm-specific heterogeneity. The sample is 2006 to 2013 and we use a balanced

Table 3: Different evolution of financing costs across countries – balanced panel

Dependent variable is the difference of financing costs

Variable	**(1)**	**(2)**
year2008	0.134***	0.0848***
	(0.00510)	(0.00578)
stressed*2008	0.115***	0.0769***
	(0.00570)	(0.00593)
year2009	–0.322***	–0.262***
	(0.00591)	(0.00800)
stressed*2009	–0.306***	–0.304***
	(0.00648)	(0.00684)
year2010	–0.180***	–0.300***
	(0.00467)	(0.00605)
stressed*2010	–0.245***	–0.226***
	(0.00516)	(0.00532)
year2011	–0.00787	–0.132***
	(0.00403)	(0.00561)
stressed*2011	0.171***	0.251***
	(0.00445)	(0.00529)
year2012	–0.102***	–0.162***
	(0.00398)	(0.00484)
stressed*2012	0.239***	0.313***
	(0.00444)	(0.00629)
year2013	–0.120***	–0.183***
	(0.00382)	(0.00475)
stressed*2013	0.0133**	0.0859***
	(0.00432)	(0.00532)
micro controls	no	yes
macro controls	no	yes
N	1.380.966	1.327.969
R^2	0.099	0.110
adj. R^2	0.099	0.110

Notes: Dependent variable is the difference of the financing conditions indicator. The set of firm-specific variables (micro controls) is described in the text. Marginal effects reported in all columns with cluster-robust standard errors at the firm level in parentheses. Statistical significance at the 5, 1, 0,1 percent levels denoted by *, **, ***, respectively.

panel to deal with potential problems regarding the entry and exit of firms. The results are shown in table 3.

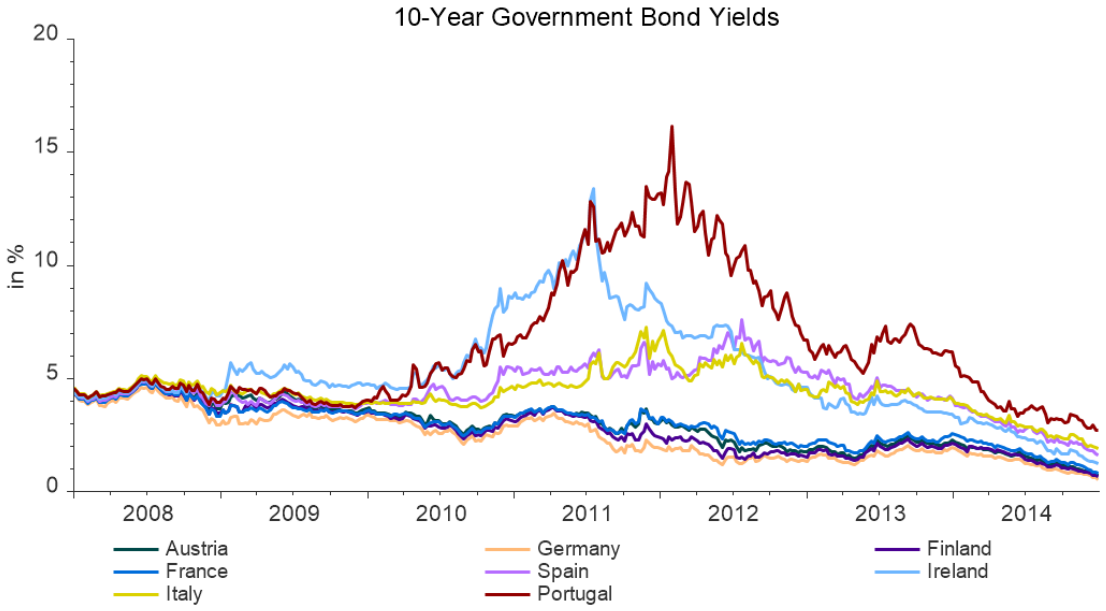
Column(1) contains the baseline specification using only year dummies and the interaction terms between year dummies and $stressed$, thus quantifying the results observed in figure 3. Reported marginal effects correspond to percentage point changes in firms' financing conditions. Until 2010 the sign of the change in refinancing costs was the same for both stressed and non-stressed countries. This, however, changed in the years

2011 and 2012, where the change in refinancing costs has been negative for non-stressed countries ($\beta_{2011} = -0.008$ and $\beta_{2012} = -0.102$), but positive for stressed countries ($\beta_{2011} + \delta_{2011} = 0.163$ and $\beta_{2012} + \delta_{2012} = 0.137$); the differences are significant at the 0.1% level. In 2013, financing costs have decreased in both country groups, although the reduction was smaller in stressed countries ($\beta_{2013} < 0, \beta_{2013} + \delta_{2013} < 0, \delta_{2013} > 0$).

As mentioned above, simply looking at the aggregate refinancing costs in the two country groups neglects potential country- and firm-specific heterogeneities across and within countries, respectively. To account for these differences, we add our previously described set of micro variables and dummies controlling for firm size to the baseline specification. Furthermore, we include the growth rate of gross domestic product and the change in the respective country's unemployment rate to account for real economic activity in the respective countries. The results are depicted in column (2).

As can be seen, the results of the baseline specification remain qualitatively unchanged: Until 2010 the sign of the change in refinancing costs was the same for both stressed and non-stressed countries, while the change in refinancing costs was negative in non-stressed countries, but positive for stressed countries in the years 2011 and 2012. The added control variables exhibit the expected signs – firms face higher financing costs if GDP growth in their respective country is lower and if the unemployment rate in the firms' home country increases. In addition, we find that small and medium firms have higher financing costs, as can be seen in the complete estimation results in table 9 in the appendix. However, controlling for micro- and macroeconomic determinants yields quantitatively quite different results, compared to the specification without control variables. For example, financing costs decreased stronger in the non-stressed countries in 2011 and 2012 with the controls. This suggests that the included variables are relevant for the estimation and therefore accounting for heterogeneities across and within countries is important to explain the observed aggregate differences.

Figure 4: Government bond yields



Source: Refinitiv Datastream.

4 Sovereign stress

4.1 Sovereign stress in 2011 and 2012

Starting in late 2009 with the onset of the European debt crisis, several Euro area countries experienced years of highly increased sovereign stress, commonly defined as episodes with high risk premiums on sovereign bond yields. Figure 4 depicts the yields of ten-year government bonds. Especially during the years 2011 and 2012 the risk premiums of the stressed countries have been markedly elevated. Importantly, before the financial crisis the yields have been almost identical for all countries.

In the first half of the sample until 2009, government bond yields evolved in a parallel manner with only a minimal average premium for the later stressed countries. This, however, changed completely in the second half of the sample. Starting in 2010, the yields for stressed and non-stressed countries diverge substantially. Because of a decline in the yields for the stressed countries, the difference then diminished again from 2013 onwards.

This sovereign stress in turn negatively affected the financial system, especially the behav-

ior of banks (Panetta et al., 2011). The resulting impairment of the monetary transmission mechanism was the ground on which the European Central Bank (ECB) decided to intervene in the public and private debt securities markets.

4.2 Government bond yields and firms' refinancing costs

From the perspective of a bank, government bonds are alternative assets for loans to private households and non-financial corporations. Therefore, the return of government bonds and loans to private households and firms should be connected, especially if the bulk of banks' lending to non-financial corporations is directed to domestic firms as is the case for the countries in our sample. According to the expectation hypothesis of the term structure, government bond yields should reflect expected changes in the money market rate such that bank lending rates and government bond yields of similar maturities should exhibit similar dynamics over time. In addition, banks hold government bonds as assets in their balance sheets and thus are directly affected by changes in the prices of these assets. This is a key mechanism in the model of Bocola (2016) described in the theoretical considerations in section 2.[6]

4.3 Instrumenting government bond yields

Both sovereign stress – and therefore government bond yields – and non-financial corporations' financing costs may be exposed to the same country-specific shocks. This leads to a simultaneity bias in a pure OLS estimate of the effect of changes in government bond yields on firms' financial conditions. We exploit the high-frequency availability of government bond yields and construct exogenous variation for government bond yields by explaining the daily variation in a specific country's government bond yield by changes in government bond yields of other countries. Furthermore, we use the spread of government bond yields against the Euro area average in order to eliminate the common Euro area wide component of government bond yields.

[6]For further details on the relationship between bank lending rates for firms and government bond yields see Elton et al. (2001) and Chatelain and Tiomo (2001); Chatelain et al. (2003).

We run the following OLS regression for each of the eight countries in our sample, respectively:

$$G_{jt} = \beta_{0,j} + \sum_{k \neq j} \beta_k G_{kt} + \varepsilon_{jt}, \tag{4}$$

where $G_{j,t}$ refers to daily 10-year government bond yield spreads versus the Euro area average. The set of explanatory variables on the right-hand side consists of the other countries in the group of stressed and non-stressed countries, respectively. For France, for example, the explanatory variables are 10-year government bond spreads for Germany, Austria and Finland, and for Italy the right-hand-side variables are 10-year government bond spreads for Ireland, Portugal and Spain. The regression results are shown in Table 4.

For Germany, the yield spread has a zero mean and a rather low standard deviation; other countries' yield spreads do not contribute to the explanation of its variation. Therefore, the actual and the fitted value of Germany's government bond yield are essentially zero. For all other countries the regression fit is very good with high values for R^2 and F-statistic. The yearly averages of daily fitted values of these regressions, denoted by $\widehat{G}_{jt}$, are used for the identification of the effect of government bond yield changes on firms' refinancing costs in section 6.

5 Banking stress

5.1 Banking stress and non-performing loans in 2011 and 2012

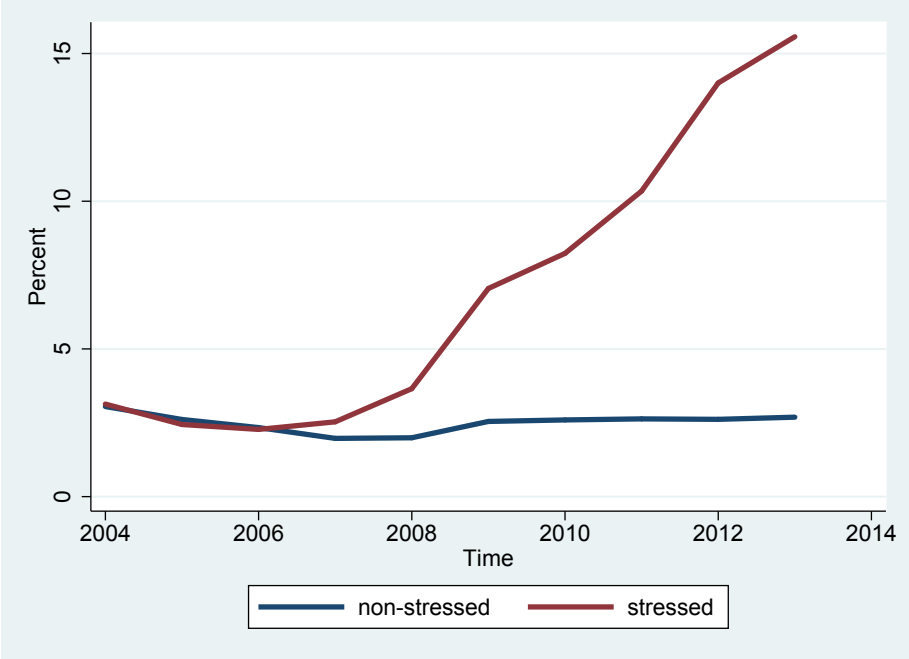
Sovereign stress may not be the sole macroeconomic determinant of firms' financing costs. A potential shortcoming of government bond yield spreads in the European debt crisis is that although they are an important determinant of banking stress, they may not fully capture the distortions in the financial sector. As suggested in the model of Bocola (2016), stress on the financial side is one aspect, however, one also needs to take into account banking stress through the asset side of banks' balance sheets, when real economic fundamentals in stressed countries deteriorate. One variable to measure this dimension is

Table 4: Daily Government Bond Yield Regressions

	Dependent variable: Government Bond Spread			
	AT	DE	FI	FR
	(1)	(2)	(3)	(4)
DE	−0.887		0.101	−0.047
	(1.512)		(1.249)	(2.673)
AT		−0.0001	0.680***	1.277***
		(0.0003)	(0.009)	(0.024)
FI	0.996***	0.00002		−0.624***
	(0.013)	(0.0003)		(0.040)
FR	0.409***	−0.00000	−0.136***	
	(0.008)	(0.0001)	(0.009)	
Constant	0.019***	0.00002	−0.004**	0.021***
	(0.002)	(0.00003)	(0.002)	(0.004)
Observations	2,609	2,609	2,609	2,609
R^2	0.932	0.002	0.869	0.807
Residual S.E.	0.086	0.001	0.071	0.152
F Statistic	11,852.700***	1.435	5,774.105***	3,620.820***

	Dependent variable:			
	ES	IE	IT	PT
	(5)	(6)	(7)	(8)
IT	1.132***	−1.641***		2.047***
	(0.015)	(0.072)		(0.051)
IE	0.110***		−0.101***	0.561***
	(0.006)		(0.004)	(0.012)
ES		0.946***	0.600***	−0.423***
		(0.055)	(0.008)	(0.047)
PT	−0.073***	0.833***	0.186***	
	(0.008)	(0.017)	(0.005)	
Constant	−0.201***	0.640***	0.235***	−0.591***
	(0.010)	(0.029)	(0.006)	(0.024)
Observations	2,609	2,609	2,609	2,609
R^2	0.951	0.815	0.966	0.940
Residual S.E. (df = 2605)	0.341	1.002	0.248	0.822
F Statistic	16,982.190***	3,831.258***	24,912.330***	13,631.570***
Note:				*p<0.1; **p<0.05; ***p<0.01

Figure 5: Non-performing loans in stressed and non-stressed countries



Notes: Non-performing loans are defined as bank non-performing loans to total gross loans in percent. Source: World Development Indicators (World Bank).

the share of non-performing loans of banks.[7] If the aggregate share of defaults on corporate loans increases in a country, the banks in the respective country may be forced to demand a premium when granting new loans.[8] In addition, Noth and Tonzer (2017) compare commonly used measures of bank risk in the literature and show that the share of non-performing assets (with loans being one component of this measure) performs best in explaining failures of banks one year ahead.

Figure 5 depicts the share of non-performing loans to the private sector for stressed and non-stressed countries over time. Initially the share is small and almost identical for both country groups with an only marginally higher share in the stressed countries. Moreover, it declines further until 2007. With the Great Recession non-performing loans rise in both country groups until 2009, when the paths for the two country groups diverge: While the share of non-performing loans decreases somewhat in the non-stressed countries in

[7] Due to data unavailability we estimate the share of non-performing loans for Finland in 2013 with a univariate autoregressive process.

[8] See Corsetti et al. (2013) and Zoli (2013) for further considerations on the effects of non-performing loans.

2010 and increases only slightly thereafter, the respective share in the stressed countries continues to rise strongly. As a consequence, in 2013 the share of non-performing loans is roughly four times larger in the stressed countries than in the non-stressed group.

Moreover, non-performing loans are a reasonable measure in the context of our analysis for one important reason. The variable is a real-economic, micro-based measure and as such subject to at most indirect influence of the central bank, unlike the yields on sovereign bonds which as described above are an explicit target of the ECB's unconventional monetary policy actions. Accordingly, this allows analyzing the effects of monetary policy given the real-economic stress in the banking sector.

5.2 Instrumenting non-performing loans

A potential concern when using the share of non-performing loans is that it is aggregated from micro-level data and thus contains individual firms in the respective country, thereby violating the strict exogeneity assumption we have to presume in order to infer the causal effect of the macroeconomic variables on firm-level financing conditions. This assumption requires idiosyncratic shocks to individual firms to be uncorrelated with country-specific variables. Since the non-performing loans are computed as the country average over all loan defaults, the effect of one single firm should be inconsequential. However, to ensure that the strict exogeneity assumption holds, we instrument our measure of banking stress as follows. Because our data on non-performing loans are on a yearly frequency, we can not apply the same high-frequency approach as with the government bond yields. Instead, we use firms' balance-sheet data to predict financial distress. To this end, we generate a measure of non-performing loans that is uncorrelated with idiosyncratic shocks to individual firms by regressing non-performing loans in period t on its own past value as well as the past value of the interest rate coverage ratio, i.e. the share of interest rate payments over profits. A higher risk of defaulting on loans is highly correlated with increases in loan costs (interest rate payments) at the firm-level, as a higher probability of default is compensated by a borrowing premium charged by banks and thus higher interest rates for the respective firm. At the same time, higher interest rates in

itself may further exacerbate the financial situation of a firm and increase the probability of default. Accordingly, the collective interest rate coverage ratios at the firm-level in a country should be a valid predictor of that country's measure of non-performing loans. To control for additional microeconomic influences we also include the set of firm-level control variables from our main specification. After computing the interest rate coverage ratio at the firm-level, we compute the aggregate ratio as the average over all firms in the respective country and year and estimate the following auxiliary regression separately for the sub-groups of stressed and non-stressed countries:

$$npl_{jt} = \beta_0 + \beta_1 npl_{jt-1} + \beta_2 icr_{jt-1} + \sum_{k=1}^{K} \gamma_k z_{jkt-1} + \alpha_j + \varepsilon_{jt}, \tag{5}$$

where $icr_{j,t-1}$ denotes the aggregate interest-coverage ratio in country j in period $t-1$ and $z_{j,k,t}$ the set of K aggregate firm-level control variables. Based on the results of the regressions in 5 (Table 10), we compute our instrument for non-performing loans as the fitted values $\widehat{npl}_{j,t}$ for each country in our sample. Comparing the fitted to the original values we see that the correlation between the two is higher than 0.89 for every country. Our created instrument therefore is both relevant as well as exogenous to idiosyncratic shocks to individual firms in period t.

6 Estimation and Results

6.1 Estimation framework

In order to explore the impact of government bond yields and non-performing loans on firm-specific financing conditions, we estimate the following panel regression model:

$$\begin{aligned} \Delta R_{ijt} &= \delta \Delta im_t + \beta \Delta \widehat{G}_{jt} + \eta \Delta \widehat{npl}_{jt} + \sum_{k=1}^{K} \gamma_k \Delta z_{ikt} \\ &+ \sum_{k=1}^{K} \phi_k (z_{ikt} * \Delta im_t) + \sum_{l=1}^{L} \zeta_l \Delta w_{jt} + \alpha_j + \varepsilon_{ijt}, \end{aligned} \tag{6}$$

where Δim_t denotes the change in the money market rate, $\Delta \widehat{G}_{jt}$ the change in the fitted government bond spread for country j in period t and $\Delta \widehat{npl}_{jt}$ the change in fitted non-performing loans in country j in period t. In addition, z_{ikt} denotes the set of K firm-specific control variables, $z_{ikt} * \Delta im_t$ the interactions between these micro variables and the change in the money market rate, w_{jt} a set of L country-specific macro control variables and α_j a set of country fixed effects.

In the theory outlined in section 2 we derived that the transmission of central bank interest rate changes and thus δ should depend on both sovereign and banking stress. Accordingly, and assuming a linear relationship, we plug

$$\delta = \alpha_0 + \lambda \widehat{G}_{jt} + \tau \widehat{npl}_{jt} \tag{7}$$

into 6:

$$\begin{aligned} \Delta R_{ijt} &= \theta \Delta im_t + \beta \Delta \widehat{G}_{jt} + \eta \Delta \widehat{npl}_{jt} + \lambda (\Delta im_t * \widehat{G}_{jt}) + \tau (\Delta im_t * \widehat{npl}_{jt}) \\ &+ \sum_{k=1}^{K} \gamma_k \Delta z_{ikt} + \sum_{k=1}^{K} \phi_k (z_{ikt} * \Delta im_t) + \sum_{l=1}^{L} \zeta_l \Delta w_{jt} + \alpha_j + \varepsilon_{ijt}, \end{aligned} \tag{8}$$

where $\theta = \lambda \alpha_0$ and $\Delta im_t \widehat{G}_{jt}$ and $\Delta im_t * \widehat{npl}_{jt}$ the interaction effects between the change

in the money market rate and the level of government bond yield spreads and the level of non-performing loans, respectively. The model is specified in first differences in order to account for unobserved firm-specific heterogeneity and estimated as a pooled cross-section.

The sample is 2005 to 2013 and we again use a balanced panel to deal with potential problems regarding the entry and exit of firms. Standard errors are clustered on the firm level.[9]

6.2 Main results

The results of the estimations are shown in table 5.[10]

Column (1) presents a naive specification with neither sovereign nor banking stress, but with macro controls, country fixed effects, the full set of firm variables and the full set of interaction terms between the firm variables and the change in the money market rate. The change in the money market rate is estimated to have a positive effect on firms' financing conditions. The coefficient is highly significant and economically substantial. The marginal effect of the change in the money market rate (taking into account the interaction terms with the set of micro variables) is estimated to be 0.33. Accordingly, the results imply that on average one third of a change in the money market rate is passed on to firms.

The remaining columns then introduce our measures of macroeconomic stress. Columns (2)-(4) contain as a reference the results of estimating our specifications by OLS, in which

[9] Since we observe firm-level data in different countries, different firms in the same country and year may be correlated due to a shared macroeconomic background. Accordingly, there could be cross-sectional dependence for which standard errors need to be adjusted. The natural solution to this potential problem is to additionally cluster the standard errors on the time dimension (two-way clustering). However, Petersen (2009) shows that if the number of clusters in one dimension is very small (in his example 10 years and 10k firms), the estimated standard errors are basically the same whether the researcher clusters just on the larger dimension (the firm level in our case) or on both. We only have 9 clusters in the time dimension (10 years and regression specification in first differences) and more than 200k firms, so the result in Petersen (2009) applies to our case. We were even unable to compute the two-way clustered standard errors, as Stata could not carry out the command. As a result, we cluster our standard errors on the firm level. The critical assumption in this is that there is no correlation between firms of the same country for different years. We argue that this is highly plausible, since we are dealing with annual data in first differences in our estimations.

[10] We provide the full estimation results including the micro variables in Table 11 in the appendix.

Table 5: Results of panel estimation – balanced panel

Dependent variable is the difference of financing costs

Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
	OLS				IV		
Δim	0.668***	0.665***	0.657***	0.707***	0.666***	0.734***	0.788***
	(0.246)	(0.246)	(0.246)	(0.248)	(0.246)	(0.244)	(0.246)
$\Delta\widetilde{G}$		0.0228***	0.0253***	0.0307***	0.0677***	0.0718***	0.0969***
		(0.0007)	(0.0007)	(0.0009)	(0.0009)	(0.0010)	(0.0011)
Δnpl			0.0346***	0.0209***		0.0247***	0.0731***
			(0.0011)	(0.0013)		(0.0011)	(0.0014)
$\widetilde{G} * \Delta im$				–0.0051***			–0.0843***
				(0.0016)			(0.0012)
$npl * \Delta im$				–0.0110***			–0.0153***
				(0.0004)			(0.0004)
cons	–0.0815***	–0.0812***	–0.0882***	–0.0791***	–0.0857***	0.136***	0.184***
	(0.0066)	(0.0066)	(0.0067)	(0.0067)	(0.0066)	(0.0044)	(0.0045)
micro controls	yes	yes	yes	yes	yes	yes	yes
micro inter. terms	yes	yes	yes	yes	yes	yes	yes
macro controls	yes	yes	yes	yes	yes	yes	yes
country FE	yes	yes	yes	yes	yes	yes	yes
N	2.000.041	2.000.041	2.000.032	2.000.032	2.000.041	1.776.532	1.776.532
R^2	0.056	0.057	0.057	0.058	0.058	0.078	0.081
adj. R^2	0.056	0.057	0.057	0.058	0.058	0.078	0.081

Notes: Dependent variable is the difference of the financing conditions indicator R_ijt. The set of firm-specific variables (micro controls) is described in the text. Standard errors are cluster-robust at the firm level (in parentheses). Statistical significance at the 5, 1, 0.1 percent levels denoted by *, **, ***, respectively.

the government bond yield spread and the share of non-performing loans are used as regressors themselves. Columns (5)-(7) then present our main results when instrumenting the two variables as described in sections 4 and 5

Focusing on our main specifications using an instrumental variable approach, we first incorporate sovereign stress into the analysis in column (5). While the estimate for the money market rate is basically unchanged, the coefficient on the bond yield spread $\Delta\widehat{G}$ is highly significant and has the expected sign – a rise in sovereign stress increases the financing conditions of firms in the respective country, while controlling for the firm-specific and macroeconomic variables described above.

As suggested by the model of Bocola (2016) in section 2 and the considerations in section 5, sovereign stress may not only have a direct effect on firms' financing conditions but in

addition an indirect effect through the balance sheets of banks, conjecturing an important role for banking stress in the monetary transmission mechanism and firms' financing conditions. We take stress in the banking sector into account by adding our instrument for the share of non-performing loans to the specification. As can be seen in column (6) of table 5, the change in the share of non-performing loans is estimated to significantly increase firms' financing costs. The remaining coefficients are qualitatively unchanged compared to the previous results.

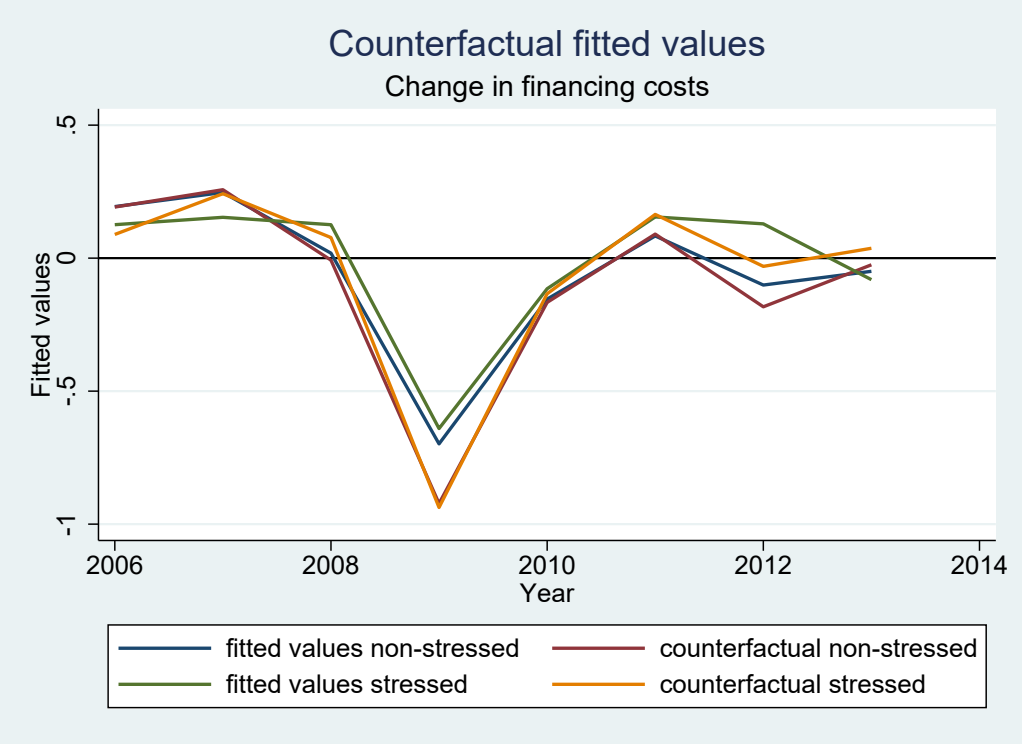
In the last column we introduce interaction terms for the change in the money market rate with the levels of both the spread and non-performing loans, respectively, to shed light on the question whether the level of existing stress – for both sovereigns and in the banking sector – impairs the monetary transmission mechanism in the Euro area. Our results support this hypothesis, as the coefficients of both interaction terms are estimated to be significantly negative. Accordingly, the level of both sovereign and banking stress reduce the effect of a change in the money market rate on firms' financing conditions, impairing the monetary transmission mechanism.

Based on the specification in the last column we are able to compute counterfactual fitted values of the change in financing costs for a hypothetical scenario in which both the instrument for the government bond yield and the instrument for the non-performing loans equal their respective averages such that the deviations from the averages are zero and there is no effect of these variables. This corresponds to removing the contributions of these variables from the fitted values, thereby quantifying the effect of the two sources of macroeconomic stress.

Figure 6 displays the fitted yearly changes as well as the counterfactual fitted changes without the contribution of sovereign and banking stress for the subgroups of stressed and non-stressed countries, respectively.

While both the fitted values and the counterfactual fitted values evolve in parallel for both subgroups in most years, we see a distinct breakdown of this relationship in 2012 for the stressed countries. The fitted values for this subgroup (green line) indicate that financing costs increased in 2012 (0.129), while they decreased in the non-stressed countries (-

Figure 6: Counterfactual fitted values



Notes: Computations are based on specification 7 in table 5

0.098). However, the counterfactual fitted values reveal that this division is caused by sovereign and banking stress in the stressed countries. Without the stress variables (yellow line) the change in financing costs would have been negative for the stressed countries as well (-0.031).

Comparing the IV results with their OLS counterparts in columns (2)-(4), we see that the OLS approach underestimates the coefficients of several key variables. Especially the effect of sovereign stress can not be correctly recovered by OLS, as the estimates of the effect of the change in the variable are only about a third of the values of the IV estimates and the estimated interaction coefficient is is even smaller. A similar relation holds for the change in the money market rate; its coefficients are larger in the IV approach. The change in non-performing loans does not exhibit this clear pattern, as the respective coefficient in the specification without interaction effects (column (3)) is larger than its IV counterpart. However, even for this variable the size of the estimated coefficients varies substantially between OLS and IV estimates.

Table 6: Results of panel estimation complete – unbalanced panel

Dependent variable is the difference of financing costs

Variable	**1**	**2**	**3**	**4**	**5**	**6**	**7**
	OLS				IV		
Δim	0.225**	0.222**	0.225**	0.233**	0.224**	0.224**	0.266***
	(0.0980)	(0.0980)	(0.0978)	(0.0977)	(0.0979)	(0.0980)	(0.0979)
$\Delta\widetilde{G}$		0.0079***	0.0083***	0.0030***	0.0504***	0.0689***	0.0944***
		(0.0004)	(0.0004)	(0.0005)	(0.0005)	(0.0006)	(0.0007)
Δnpl			0.0254***	0.0215***		0.0520***	0.0902***
			(0.0008)	(0.0009)		(0.0008)	(0.0009)
$\widetilde{G} * \Delta im$				0.0135***			–0.0586***
				(0.0008)			(0.0007)
$npl * \Delta im$				–0.0006***			–0.0064***
				(0.0002)			(0.0002)
cons	–0.0250***	–0.0256***	–0.0322***	–0.0301***	–0.0315***	0.0591***	0.0895***
	(0.0026)	(0.0026)	(0.0026)	(0.0027)	(0.0026)	(0.0025)	(0.0025)
micro controls	yes	yes	yes	yes	yes	yes	yes
micro interaction terms	yes	yes	yes	yes	yes	yes	yes
macro controls	yes	yes	yes	yes	yes	yes	yes
country FE	yes	yes	yes	yes	yes	yes	yes
N	7.803.355	7.803.355	7.803.322	7.802.689	7.803.355	7.209.152	7.207.777
R^2	0.038	0.038	0.038	0.038	0.039	0.043	0.044
adj. R^2	0.038	0.038	0.038	0.038	0.039	0.043	0.044

Notes: Dependent variable is the difference of the financing conditions indicator. The set of firm-specific variables (micro controls) is described in the text. Standard errors are cluster-robust at the firm level (in parentheses). Statistical significance at the 5, 1, 0,1 percent levels denoted by *, **, ***, respectively. Country abbreviations „at“, „es“, „fi“, „fr“, „ir“, „it“, „pt“ denote Austria, Spain, Finland, France, Ireland, Italy and Portugal. Germany is the reference country.

6.3 Robustness analysis

The analysis so far has been performed using the balanced panel of firm-level data. We focus on the balanced panel to prevend potential biases stemming from entry and exit of firms to affect the empirical analysis. However, to explore the effects of these firm dynamics and to assess the robustness of our results in the presence of firm entry and exit, we re-estimate the specifications in table 5 with the unbalanced panel. The results for the main variables of interest are depicted in table 6.[11]

As before, column (1) presents a naive specification without sovereign and banking stress,

[11] Full results can be found in table 12 in the appendix.

but with macro controls, country fixed effects, the full set of firm variables and the full set of interaction terms between the firm variables and the change in the money market rate. Columns (2)-(4) contain the results of the OLS estimation and columns (5)-(7) the ones from the IV estimations in which we instrument the measures of sovereign and banking stress, respectively.

While the results are qualitatively unchanged, the effect of the money market rate is estimated to be substantially smaller than with the balanced panel, with the coefficients now ranging from 0.22 to 0.27 (balanced panel: 0.66 to 0.79) across specifications. Again computing the marginal effect of a change in the money market rate for the specification in column (1), we find the pass-through of monetary policy to firms' financing conditions to be 0.26 in the unbalanced panel, while this value was estimated to be 0.33 in the balanced panel. The explanation for this difference is that the firms in the unbalanced panel which drop out over the sample are the ones which have a higher probability of facing financial difficulties. These firms react especially sensitively to changes in financing conditions, especially if interest rates rise. Since this increase in financing conditions will cause constrained firms to become insolvent, they drop out of the sample and the estimated effects of monetary policy is smaller. In contrast, the balanced panel by construction only contains firms that remain in the sample and thus react to changes in their financing conditions. Accordingly, the estimated pass-through is higher in the balanced panel.

Similarly, most coefficients are estimated to be (in absolute terms) smaller in the unbalanced panel compared to the balanced one. However, since the qualitative results are unchanged, the unbalanced panel confirms the findings in our main analysis.

7 Conclusions

In this paper, we analyze to what extent financing conditions of non-financial corporations in the Euro area depend on country-specific factors, in particular the respective country's government bond yield spread (sovereign stress) and the share of non-performing loans

(banking stress), and how they affect the monetary transmission mechanism. Our main results are that both the government bond yield spread and the share of non-performing loans significantly increase firms' financing costs. This cannot be explained by firm-specific characteristics like leverage or profitability but does also hold true when controlling for firm characteristics. Moreover, both sources of stress have a significantly negative effect on the monetary transmission mechanism. The higher the stress levels the smaller is the reaction of firms' financing conditions to changes in the monetary policy rate. The impairing effect is particularly pronounced for the share of non-performing loans and the associated banking stress.

This result is important for the effectiveness of monetary policy. Asset purchase programs that target at lowering government bond yields may only have a limited impact on firms' financing conditions if banking stress is the main reason for high financing costs. For monetary policy to be fully effective – be it conventional interest rate policy or unconventional asset purchase programs – it is necessary to reduce the level of banking stress in all member countries of the Euro area.

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Appendix

A Data

A.1 Micro-level data

Table 7: Firm-level variables used

Variable	Description	Definition
cashflow	cash flow	cash flow/balance sum
fassets	fixed assets	fassets/balance sum
ltbfunds	long-term borrowed funds	ltbfunds/balance sum
stbfunds	short-term borrowed funds	stbfunds/balance sum
ofrentability	own funds rentability	profit/own funds*100
ofratio	own funds ratio	own funds/balance sum*100
roi	return on investment	profit/balance sum*100

Notes: Variables are taken from the „Amadeus“ data set of Bureau van Dijk.

Table 8: Descriptive statistics of micro-level variables

Variable	mean	min	max	sd	p25	median	p75
cashflow	5.9	-71.2	50	7.0	2.0	4.7	8.9
fassets	35.5	0	99.4	27.9	11.3	29.2	55.3
ltbfunds	19.9	0	100	19.3	4.7	14.2	29.6
stbfunds	48.0	0	100	24.2	29.1	48.2	67.0
refinancing costs	2.4	0.0	11.6	1.7	1.1	2.1	3.3
ofrentability	6.4	-259.3	250	27.8	0.2	5.3	15.3
ofratio	32.1	-94.9	100	22.0	14.3	28.3	46.6
roi	2.2	-101.3	44.8	6.1	0.1	1.2	4.1

Notes: All statistics in percent, i.e shares (see table 7) are multiplied by a factor of 100. p25 and p75 denote the 25% and 75% percentile, respectively.

A.2 Macro-level data

Money market rate: The money market rate is the Euro Overnight Index Average (EONIA) published by the ECB.

Bank lending rate: Loans to non-financial corporates rate, new business, up to one year, up to one million euro, ECB MFI Statistics (downloaded via ThomsonReuters Datastream, code: [JJ]IRUU1B, where [JJ] denotes the country code).

Government bond yields: Datastream Government Bond Yield, 10 Years, Euro (downloaded via ThomsonReuters Datastream, code: BM[JJ]10Y(RY), where [JJ] denotes the country code).

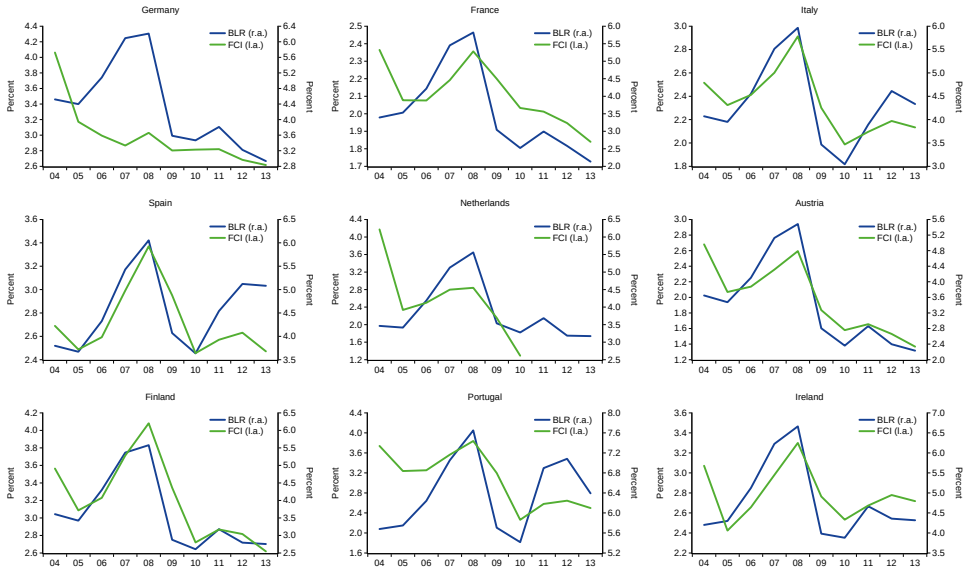
Non-performing loans: Bank non-performing loans to total gross loans in percent from World Development Indicators, published by the World Bank.

Gross domestic product: Yearly growth rate of real gross domestic output, chain linked volumes, published by Eurostat.

Unemployment rate: Unemployment rate, annual average, published by Eurostat.

B Additional graphs and tables

Figure 7: Financing conditions indicator and aggregate bank lending rate



Notes: Bank lending rate denotes the short-term bank lending rate as published by the ECB (left scale) and the financing conditions indicator constructed from our individual firm data (right scale).

Table 9: Results of year dummy regressions complete – balanced panel

Dependent variable is the difference of financing costs

Variable	1	2
year2008	0.134***	0.0848***
	(0.00510)	(0.00578)
year2009	–0.322***	–0.262***
	(0.00591)	(0.00800)
year2010	–0.180***	–0.300***
	(0.00467)	(0.00605)
year2011	–0.00787	–0.132***
	(0.00403)	(0.00561)
year2012	–0.102***	–0.162***
	(0.00398)	(0.00484)
year2013	–0.120***	–0.183***
	(0.00382)	(0.00475)
stressed*2008	0.115***	0.0769***
	(0.00570)	(0.00593)
stressed*2009	–0.306***	–0.304***
	(0.00648)	(0.00684)
stressed*2010	–0.245***	–0.226***
	(0.00516)	(0.00532)
stressed*2011	0.171***	0.251***
	(0.00445)	(0.00529)
stressed*2012	0.239***	0.313***
	(0.00444)	(0.00629)
stressed*2013	0.0133**	0.0859***
	(0.00432)	(0.00532)
small		0.0163***
		(0.00316)
medium		0.0537***
		(0.00303)
Δur		0.0234***
		(0.000699)
gdp growth		0.0402***
		(0.00129)
$\Delta cashflow/bs$		1.429***
		(0.0645)
$\Delta fassets/bs$		0.480***
		(0.0158)
$\Delta ltbfunds/bs$		–0.459
		(0.271)
$\Delta stbfunds/bs$		–1.033***
		(0.271)
$\Delta ofrentability$		–0.000336***
		(0.0000363)
$\Delta ofratio$		–0.00900***
		(0.00271)
Δroi		–0.0175***
		(0.000667)
N	1.380.966	1.327.969
R^2	0.099	0.110
adj. R^2	0.099	0.110

Notes: Dependent variable is the difference of the financing conditions indicator. The set of firm-specific variables (micro controls) is described in the text. Standard errors are cluster-robust at the firm level (in parentheses). Statistical significance at the 5, 1, 0.1 percent levels denoted by *, **, ***, respectively.

Table 10: Results of auxiliary regression non-performing loans

Dependent variable is non-performing loans

Variable	**non-stressed**	**stressed**
npl_{t-1}	0.224	0.833***
	0.14	0.0879
icr_{t-1}	0.0255*	–0.253***
	0.0129	0.0462
$refi_{t-1}$	0.247*	1.667**
	0.129	0.671
$cashflow/bs_{t-1}$	68.20*	–181.2
	38.53	144.2
$fassets/bs_{t-1}$	–23.09*	54.4
	12.19	38.47
$ltbfunds/bs_{t-1}$	–91.02**	529
	32.32	317.6
$stbfunds/bs_{t-1}$	–100.6***	504.3
	32.75	316.5
$ofrentability_{t-1}$	–0.104*	0.972**
	0.0588	0.416
$ofratio_{t-1}$	–0.867**	5.700*
	0.337	3.185
roi_{t-1}	–0.481	–0.617
	0.46	1.711
cons	101.1***	–554.0*
	33.12	318.7
country FE	yes	yes
N	36	35
R^2	0.98	0.979
adj. R^2	0.969	0.966
F (p-value)		

Notes: Dependent variable is non-performing loans. Marginal effects reported in all columns with standard errors in parentheses. Statistical significance at the 5, 1, 0,1 percent levels denoted by *, **, ***, respectively.

Table 11: Results of panel estimation complete – balanced panel

Dependent variable is the difference of financing costs

Variable	1	2	3	4	5	6	7
	OLS				IV		
Δim	0.668***	0.665***	0.657***	0.707***	0.666***	0.734***	0.788***
	(0.246)	(0.246)	(0.246)	(0.248)	(0.246)	(0.244)	(0.246)
small	0.105***	0.105***	0.105***	0.105***	0.105***	–0.0088***	–0.0091***
	(0.0033)	(0.0033)	(0.0033)	(0.0033)	(0.0033)	(0.0027)	(0.0027)
medium	0.0436***	0.0432***	0.0433***	0.0427***	0.0426***	0.0200***	0.0191***
	(0.0032)	(0.0032)	(0.0032)	(0.0032)	(0.0032)	(0.0026)	(0.0026)
Δur	0.0671***	0.0653***	0.0646***	0.0791***	0.0562***	0.0436***	0.0633***
	(0.0009)	(0.0009)	(0.0009)	(0.0013)	(0.0009)	(0.0009)	(0.0013)
gdpg	–0.0452***	–0.0462***	–0.0351***	–0.0323***	–0.0472***	–0.0360***	–0.0378***
	(0.0006)	(0.0006)	(0.0007)	(0.0007)	(0.0006)	(0.0006)	(0.0006)
$\Delta cashflow/bs$	2.173***	2.178***	2.159***	2.146***	2.170***	1.829***	1.813***
	(0.0608)	(0.0608)	(0.0608)	(0.0608)	(0.0608)	(0.0574)	(0.0575)
$\Delta fassets/bs$	0.621***	0.621***	0.625***	0.626***	0.622***	0.589***	0.586***
	(0.0142)	(0.0142)	(0.0142)	(0.0142)	(0.0142)	(0.0137)	(0.0137)
$\Delta ltbfunds/bs$	–0.665***	–0.666***	–0.659***	–0.672***	–0.667***	–0.602***	–0.552***
	(0.186)	(0.186)	(0.186)	(0.187)	(0.186)	(0.186)	(0.187)
$\Delta stbfunds/bs$	–1.293***	–1.295***	–1.289***	–1.300***	–1.296***	–1.216***	–1.161***
	(0.186)	(0.186)	(0.186)	(0.187)	(0.186)	(0.186)	(0.187)
$\Delta ofrentability$	–0.0003***	–0.0003***	–0.0003***	–0.0003***	–0.0003***	–0.0004***	–0.0004***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$\Delta ofratio$	–0.0110***	–0.0111***	–0.0109***	–0.0111***	–0.0111***	–0.0096***	–0.0092***
	(0.0019)	(0.0019)	(0.0019)	(0.0019)	(0.0019)	(0.0019)	(0.0019)
Δroi	–0.0246***	–0.0245***	–0.0243***	–0.0242***	–0.0243***	–0.0218***	–0.0217***
	(0.0006)	(0.0006)	(0.0006)	(0.0006)	(0.0006)	(0.0006)	(0.0006)
d^{AT}	0.0469**	0.0437**	0.0336	0.0258	0.0497**	–0.0695***	–0.113***
	(0.0210)	(0.0210)	(0.0210)	(0.0211)	(0.0210)	(0.0145)	(0.0145)
d^{ES}	–0.0567***	–0.0583***	–0.0893***	–0.118***	–0.0548***	–0.168***	–0.264***
	(0.0070)	(0.0070)	(0.0070)	(0.0072)	(0.0070)	(0.0048)	(0.0053)
d^{FI}	–0.0450***	–0.0498***	–0.0545***	–0.0572***	–0.0414***	–0.118***	–0.150***
	(0.0088)	(0.0089)	(0.0088)	(0.0090)	(0.0088)	(0.0056)	(0.0056)
d^{FR}	0.0089	0.0096	0.0047	–0.0057	0.0146**	–0.121***	–0.182***
	(0.0067)	(0.0067)	(0.0067)	(0.0068)	(0.0067)	(0.0043)	(0.0045)
d^{IR}	0.0937***	0.0918***	–0.0290**	–0.0541***	0.0839***	–0.176***	–0.362***
	(0.0123)	(0.0123)	(0.0126)	(0.0126)	(0.0122)	(0.0114)	(0.0119)
d^{IT}	–0.0301***	–0.0339***	–0.0599***	–0.0787***	–0.0402***	–0.161***	–0.223***
	(0.0067)	(0.0067)	(0.0067)	(0.0068)	(0.0067)	(0.0043)	(0.0045)
d^{PT}	–0.174***	–0.182***	–0.205***	–0.223***	–0.199***	–0.243***	–0.376***
	(0.0078)	(0.0079)	(0.0079)	(0.0079)	(0.0079)	(0.0054)	(0.0058)
$cashflow/bs * \Delta im$	–0.328***	–0.320***	–0.338***	–0.412***	–0.316***	–0.315***	–0.400***
	(0.0221)	(0.0221)	(0.0220)	(0.0222)	(0.0220)	(0.0220)	(0.0220)
$fassets/bs * \Delta im$	0.148***	0.149***	0.147***	0.144***	0.147***	0.141***	0.137***
	(0.0034)	(0.0033)	(0.0034)	(0.0034)	(0.0034)	(0.0034)	(0.0034)
$ltbfunds/bs * \Delta im$	–0.250	–0.248	–0.239	–0.208	–0.253	–0.347	–0.294
	(0.246)	(0.246)	(0.246)	(0.248)	(0.246)	(0.244)	(0.246)
$stbfunds/bs * \Delta im$	–0.385	–0.383	–0.367	–0.334	–0.384	–0.476*	–0.416*
	(0.246)	(0.246)	(0.246)	(0.248)	(0.246)	(0.244)	(0.246)
$ofrentability * \Delta im$	0.0001*	0.0001**	0.0001**	0.0001*	0.0001*	0.0000	0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$ofratio * \Delta im$	–0.0045*	–0.0045*	–0.0045*	–0.0043*	–0.0045*	–0.0054**	–0.0050**
	(0.0025)	(0.0025)	(0.0025)	(0.0025)	(0.0025)	(0.0024)	(0.0025)
$roi * \Delta im$	0.0027***	0.0027***	0.0029***	0.0031***	0.0027***	0.0026***	0.0029***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
$\Delta \widetilde{G}$		0.0228***	0.0253***	0.0307***	0.0677***	0.0718***	0.0969***
		(0.0007)	(0.0007)	(0.0009)	(0.0009)	(0.0010)	(0.0011)
Δnpl			0.0346***	0.0209***		0.0247***	0.0731***
			(0.0011)	(0.0013)		(0.0011)	(0.0014)
$\widetilde{G} * \Delta im$				–0.0051***			–0.0843***
				(0.0016)			(0.0012)
$npl * \Delta im$				–0.0110***			–0.0153***
				(0.0004)			(0.0004)
cons	–0.0815***	–0.0812***	–0.0882***	–0.0791***	–0.0857***	0.136***	0.184***
	(0.0066)	(0.0066)	(0.0067)	(0.0067)	(0.0066)	(0.0044)	(0.0045)
N	2.000.041	2.000.041	2.000.032	2.000.032	2.000.041	1.776.532	1.776.532
R^2	0.056	0.057	0.057	0.058	0.058	0.078	0.081
adj. R^2	0.056	0.057	0.057	0.058	0.058	0.078	0.081

Notes: Dependent variable is the difference of the financing conditions indicator. The set of firm-specific variables (micro controls) is described in the text. Standard errors are cluster-robust at the firm level (in parentheses). Statistical significance at the 5, 1, 0,1 percent levels denoted by *, **, ***, respectively. Country abbreviations „at“, „es“, „fi“, „fr“, „ir“, „it“, „pt“ denote Austria, Spain, Finland, France, Ireland, Italy and Portugal. Germany is the reference country.

Table 12: Results of panel estimation complete – unbalanced panel

Dependent variable is the difference of financing costs

Variable	1	2	3	4	5	6	7
	OLS				IV		
Δim	0.225**	0.222**	0.225**	0.233**	0.224**	0.224**	0.266***
	(0.0980)	(0.0980)	(0.0978)	(0.0977)	(0.0979)	(0.0980)	(0.0979)
small	0.211***	0.211***	0.210***	0.211***	0.211***	0.162***	0.162***
	(0.0023)	(0.0023)	(0.0023)	(0.0023)	(0.0023)	(0.0022)	(0.0022)
medium	0.0227***	0.0227***	0.0230***	0.0234***	0.0230***	0.0423***	0.0412***
	(0.002)	(0.0023)	(0.0023)	(0.0023)	(0.0023)	(0.0022)	(0.0022)
Δur	0.0201***	0.0197***	0.0185***	0.0212***	0.0132***	0.0172***	0.0165***
	(0.0006)	(0.0006)	(0.0006)	(0.0007)	(0.0006)	(0.0006)	(0.0008)
gdpg	–0.0432***	–0.0430***	–0.0358***	–0.0376***	–0.0428***	–0.0429***	–0.0478***
	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)
$\Delta cashflow/bs$	2.750***	2.751***	2.744***	2.745***	2.751***	2.678***	2.670***
	(0.0295)	(0.0295)	(0.0295)	(0.0295)	(0.0295)	(0.0300)	(0.0300)
$\Delta fassets/bs$	0.634***	0.634***	0.635***	0.635***	0.635***	0.631***	0.630***
	(0.0075)	(0.0075)	(0.0075)	(0.0075)	(0.0075)	(0.0076)	(0.0076)
$\Delta ltbfunds/bs$	–0.135	–0.135	–0.129	–0.131	–0.136	–0.126	–0.100
	(0.0917)	(0.0917)	(0.0917)	(0.0917)	(0.0917)	(0.0928)	(0.0928)
$\Delta stbfunds/bs$	–0.716***	–0.716***	–0.710***	–0.712***	–0.715***	–0.692***	–0.669***
	(0.0917)	(0.0917)	(0.0917)	(0.0917)	(0.0917)	(0.0928)	(0.0928)
$\Delta ofrentability$	–0.0001***	–0.0001***	–0.0001***	–0.0001***	–0.0001***	–0.0001***	–0.0001***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$\Delta ofratio$	–0.0082***	–0.0082***	–0.0082***	–0.0082***	–0.0082***	–0.0079***	–0.0077***
	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0009)
Δroi	–0.0284***	–0.0284***	–0.0283***	–0.0283***	–0.0283***	–0.0277***	–0.0277***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
d^{AT}	–0.0045	–0.0074	–0.0104*	0.0033	–0.0025	–0.0861***	–0.105***
	(0.0056)	(0.0056)	(0.0056)	(0.0057)	(0.0056)	(0.0055)	(0.0055)
d^{ES}	–0.0041	–0.0048	–0.0233***	–0.0214***	–0.00361	–0.0550***	–0.0939***
	(0.0030)	(0.0030)	(0.0030)	(0.0031)	(0.0030)	(0.0029)	(0.0031)
d^{FI}	–0.137***	–0.140***	–0.138***	–0.124***	–0.133***	–0.180***	–0.197***
	(0.0036)	(0.0036)	(0.0036)	(0.0037)	(0.0036)	(0.0034)	(0.0034)
d^{FR}	–0.0241***	–0.0238***	–0.0257***	–0.0265***	–0.0194***	–0.0826***	–0.117***
	(0.0027)	(0.0027)	(0.0027)	(0.0027)	(0.00270)	(0.0025)	(0.0026)
d^{IR}	0.0956***	0.0936***	0.00760	0.0217**	0.0871***	–0.101***	–0.212***
	(0.0080)	(0.0081)	(0.0084)	(0.0084)	(0.0081)	(0.0084)	(0.0087)
d^{IT}	0.0037	0.0028	–0.0170***	–0.0133***	–0.00270	–0.0363***	–0.0701***
	(0.0027)	(0.0027)	(0.0028)	(0.0028)	(0.0027)	(0.0025)	(0.0026)
d^{PT}	–0.0295***	–0.0330***	–0.0519***	–0.0458***	–0.0547***	–0.101***	–0.195***
	(0.0033)	(0.0033)	(0.0033)	(0.0033)	(0.0033)	(0.0032)	(0.0034)
$cashflow/bs * \Delta im$	–0.406***	–0.404***	–0.424***	–0.426***	–0.393***	–0.424***	–0.456***
	(0.0124)	(0.0124)	(0.0124)	(0.0124)	(0.0124)	(0.0124)	(0.0124)
$fassets/bs * \Delta im$	0.132***	0.132***	0.130***	0.131***	0.130***	0.132***	0.129***
	(0.0019)	(0.0019)	(0.0019)	(0.0019)	(0.0019)	(0.0019)	(0.0019)
$ltbfunds/bs * \Delta im$	0.146	0.147	0.142	0.134	0.140	0.146	0.164*
	(0.0980)	(0.0980)	(0.0978)	(0.0976)	(0.0979)	(0.0980)	(0.0979)
$stbfunds/bs * \Delta im$	–0.0062	–0.0046	–0.0044	–0.0124	–0.0074	–0.0056	0.0190
	(0.0980)	(0.0980)	(0.0979)	(0.0977)	(0.0979)	(0.0980)	(0.0979)
$ofrentability * \Delta im$	–0.0001***	–0.0001***	–0.0001***	–0.0001***	–0.0001***	–0.0001***	–0.0002***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$ofratio * \Delta im$	–0.0009	–0.0009	–0.0010	–0.0010	–0.0009	–0.0009	–0.0007
	(0.0010)	(0.0010)	(0.0010)	(0.0010)	(0.0010)	(0.0010)	(0.0010)
$roi * \Delta im$	0.0038***	0.0038***	0.0040***	0.0040***	0.0038***	0.0041***	0.0042***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
$\Delta \widetilde{G}$		0.0079***	0.0083***	0.0030***	0.0504***	0.0689***	0.0944***
		(0.0004)	(0.0004)	(0.0005)	(0.0005)	(0.0006)	(0.0007)
Δnpl			0.0254***	0.0215***		0.0520***	0.0902***
			(0.0008)	(0.0009)		(0.0008)	(0.0009)
$\widetilde{G} * \Delta im$				0.0135***			–0.0586***
				(0.0008)			(0.0007)
$npl * \Delta im$				–0.0006***			–0.0064***
				(0.0002)			(0.0002)
cons	–0.0250***	–0.0256***	–0.0322***	–0.0301***	–0.0315***	0.0591***	0.0895***
	(0.0026)	(0.0026)	(0.0026)	(0.0027)	(0.0026)	(0.0025)	(0.0025)
N	7.803.355	7.803.355	7.803.322	7.802.689	7.803.355	7.209.152	7.207.777
R^2	0.038	0.038	0.038	0.038	0.039	0.043	0.044
adj. R^2	0.038	0.038	0.038	0.038	0.039	0.043	0.044

Notes: Dependent variable is the difference of the financing conditions indicator. The set of firm-specific variables (micro controls) is described in the text. Standard errors are cluster-robust at the firm level (in parentheses). Statistical significance at the 5, 1, 0,1 percent levels denoted by *, **, ***, respectively. Country abbreviations „at“, „es“, „fi“, „fr“, „ir“, „it“, „pt“ denote Austria, Spain, Finland, France, Ireland, Italy and Portugal. Germany is the reference country.

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