Universidade do Minho
Escola de Economia e Gestão

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STATEMENT OF INTEGRITY

I hereby declare having conducted this academic work with integrity. I confirm that I have not used plagiarism or any form of undue use of information or falsification of results along the process leading to its elaboration.

I further declare that I have fully acknowledged the Code of Ethical Conduct of the University of Minho.

ABSTRACT

We will study the credit supply effects of the unexpected regulation in capital ratios (LTD ratio) imposed by the Troika under the Economic Adjustment Program for Portugal, using an exhaustive Portuguese loan-level data for SMEs. The introduction of LTDs ratios regulations may force banks to reduce their exposure to credit markets and in order to adequate its balance sheet, banks can reduce lending for firms causing funding problems to companies. In order to evaluate the impact of this regulation, we will have to construct a variable to measure the degree of exposure of firms' to more or less affected banks. Therefore, we will have to control for several firm-level balance sheet variables and sales to account for market demand.

Using data from Central Balance Sheet provided by Banco de Portugal, an extensive dataset containing balance sheet variables for a representative number of firms operating in Portugal, we conclude that in fact the LTD ratio policy had an impact in firms' investment during the period of analysis.

Keywords: Credit crunch; loan to deposit ratios; regulations; access to credit; crisis; liquidity shock.

Summary

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1. Introduction

The aim of this thesis is to explore the indirect link between the unexpected shock on the banking sector, namely the regulation concerning the Loan to deposit (LTD) ratios required by the Troika under the Economic Adjustment Program for Portugal, and firms' investment. In a nutshell, how shocks that have a relative impact in financial intermediaries can overflow to real effects, particularly in terms of companies' investment capacity?

The purpose of this research is relevant as Portugal had emerged from the world economic crisis in 2008 and during the period the crisis of the European Union's sovereign debt was ongoing, some of the impositions by the regulatory authority could negatively influence the country's recovery. The structure at the business level in Portugal is mainly composed of micro, small and medium-sized firms, 0,3% of the total number of firms in Portugal are large and approximately 99,7% are micro-enterprises (according to 2015 data). Any impact is important in economic terms as since SME's contributed to approximately 55% of total turnover and 75% of employment in Portugal. SME's are very dependent on banks' credit. Data from Acharya et al (2014) indicate that there was a 45% drop in new credits during 2008 to 2013. Therefore, changes in credit supply conditions might have a significant impact in the economy.

We investigate the impact in the economy of regulatory changes on loan-to-deposit ratios by exploring a rich database (Central Balance Sheet) that contains general data of the firms (year of foundation, type of company, sector, etc.), economic-financial data that contains variables extracted from the balance sheets of the firms (assets, equity, liabilities, etc.) and employment data. This panel represents the universe of non-financial companies operating in Portugal, consisting of a relatively large sample, indicating that the present study does not suffer from data underrepresentation problems. Based on this, given the unavailability of access to bank level data, data from LTD ratios were collected manually from 2010 to 2015 from 18 Portuguese banking institutions, as well as from the 5 main banks in the country, representing approximately 80% of the credit made available during the period. Using that information, Banco de Portugal Microdata Research Laboratory (*BPLim*) constructed a variable indicating the level of exposure of firms (in terms of credit) to banks which were more or less affected by the policy of decreasing LTD ratios. In this way, we matched the CB database with the dataset created by *BPLim* with the aforementioned variable using an anonymized indicator of a firm.

Given the banking relationship that a firm has, regardless of the number of banks, we built a credit-weighted exposure variable that takes into account the LTD ratio in which bank b was in year y and thus determined the degrees of exposure in which firms i meet.

As this level of exposure is a continuous variable, it makes economic sense to check it in levels, that is, given a certain level of exposure to more or less affected banks, what is the reflection on the investment capacity of a firm i?

For this, we divide the exposure variable into deciles, and formulate the following hypothesis:

Given a firm's greater exposure in terms of credit and potential credit to banks hard hit by the regulation of LTD ratios, it is expected that that firm will not be able to raise loans and consequently decrease its investment capacity.

In order to verify this hypothesis, we estimate an econometric model with fixed effects for firm (partialling out any time invariant differences between firms) and fixed effects for years (taking into account aggregate effects that can influence the outcome, such as sovereign debt crisis of the euro zone and two capital exercises proposed by the EBA), we also use financial variables in order to control and finally, the created exposure variable to link the adjustment of the ratios and variation in the firms' investments.

We present evidence to corroborate our main hypothesis: a higher level exposure of firms to banks affected by the policy is associated with a negative investment variation; we found that our main variable is significant in all exposure deciles, the magnitude of the investment variation for SMEs is decreasing and varies from -1.5 pp (second decile) to -5.7 pp (last decile), when we tested the robustness of our results, we found that the variation in investment for large companies (with revenues greater than 50 M Euros) has no relation to the level of exposure of these companies to more or less affected banks.

This thesis is structured as follows. In section 2, describes the context of Portugal in the sovereign debt crisis in Europe and the role of Loan to deposit ratio regulation. In section 3, we present the main objectives of this thesis. In section 4, we discuss the literature about credit crunch events and liquidity. In section 5, we describe the construction of the dataset and present the descriptive statistics. In section 6, we describe the methodology used in this thesis. Section 7, present and discuss the results. Section 8, concludes.

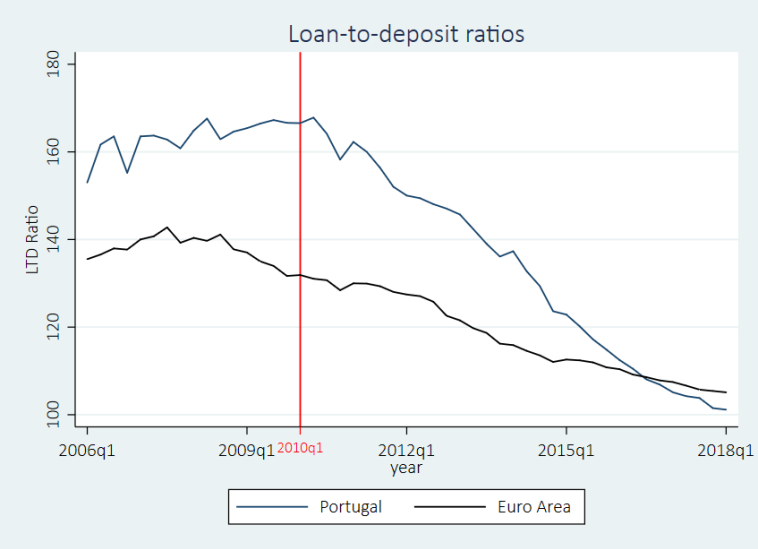
2. Loan to deposit ratios in the context of the Portuguese sovereign debt crisis

The after effects of the world financial crisis in 2008 and the European sovereign debt crisis that the world has witnessed are clearly related to the activity of regulators in order to set new capital requirements and try to enhance the structure and robustness of finance sector. Consequently, an active debate in academia about the trade-offs related to higher capital and liquidity has arisen.

Specifically, on the European sovereign crisis and its effects in Portugal is a clear object of study, given that the country faced a severe economic crisis during the period from 2008 to 2012.

Portuguese banks, as opposed to many other European banks, managed the first part of the crisis pretty well mainly because of their lack of exposure to toxic assets such as subprimes (European Commission, 2011). However, the Portuguese banking system had some major weaknesses that made it vulnerable later on in the crisis. First of all, it had a very weak liquidity position, being too dependent on wholesale and interbank borrowing with an average loan-to-deposit ratio of 160% until mid-2010 (European Commission, 2011), much higher than the European Union average as we can see in Figure 1. Furthermore, the proportion of real estate and mortgage loans, as a percentage of total credit outstanding, was high and Portuguese families were extremely indebted, making loans to that sector very vulnerable.

Figure 1 – LTD ratios for Portuguese financial sector and Euro Area



Note: Source Eurostat – RAI (Risk Assessment Indicators database).

In 2010, total outstanding residential loans amounted to 66.2% of the Portuguese GDP (European Commission, 2011). The other major weakness lies in their increasing exposure to sovereign risk, 4.1% of the total assets in January 2011 (Banco de Portugal, 2011). Therefore, financial markets had poor expectations on the sustainability of public finances which led to a strong increase in risk premium on sovereign debt. This had negative repercussions on the Portuguese banking system's access and funding costs in the international wholesale debt markets (Banco de Portugal 2010). In this context, Portuguese banks were, therefore, facing restrictions on access to interbank money market financing, which led to a worsening in their liquidity situation (Banco de Portugal, 2010).

In April 2011, the Portuguese government, saw a significant decline in its credit rating to below investment grade, (Standard & Poor's downgraded the country to BBB-), making it impossible for banks to fully rediscount Portuguese sovereign debt at the European Central Bank. In April the Portuguese

government requested financial assistance from Troika (European Commission, European Central Bank and IMF) and in May both parts finalized the negotiations and signed a Memorandum of Understanding launching the Economic Adjustment Program (European Commission,2011). The program covered the period from 2011 to 2014 consisted of a joint-financial package of up to 78 billion euros (provided by EFSM, EFSF and IMF) for potential fiscal financing needs and support to the banking system.

Table 1 – Chronology of Events

Date	Event
dec/09	EU council addresses recommendations to Portugal in accordance with Article 126(7) with a view to bringing an end to the situation of an excessive government deficit by 2013.
nov/09	Parliament passes austerity budget aimed at bringing down high public debt levels. The budgetary target for 2011 is set at 4.6 percent of GDP.
mar/11	The Portuguese government addresses to EC and ECB a note in which it engages to undertake substantial fiscal and structural measures. Stability Programme spelling out the measures included in the note sent to the Commission and ECB fails to be approved in Parliament. S&P downgrade Portugal's credit rating to BBB-.
apr/11	Portugal request financial assistance from EFSM/EFSF and IMF Technical mission of Troika starts discussions with Portuguese authorities.
may/11	The Programme is agreed at technical level between Troika mission and Portuguese authorities. Signature of the Memorandum of Understanding / The Programme is agreed by the IMF board. Council adopts implementing Decision of granting union financial assistance amounting to EUR 78 billion.

Note: Adapted from Europe Commission (2011)

One of the programme's objectives was the stabilization of the financial sector (European Commission, 2011). In order to achieve this goal, the banking sector was asked to work on the four following pillars (Banco de Portugal, 2012): reinforcing the solvency of the banking system, promoting a gradual an orderly deleveraging of the banking system and ensuring the stable funding of the banking system, reinforcing the supervision of the banking system and strengthening the regulatory framework.

This research will focus specifically on topic 46 of the document presented by the technical commission of Troika named "Occasional Paper 79 – Economic adjustment for Portugal", that exposed the commission

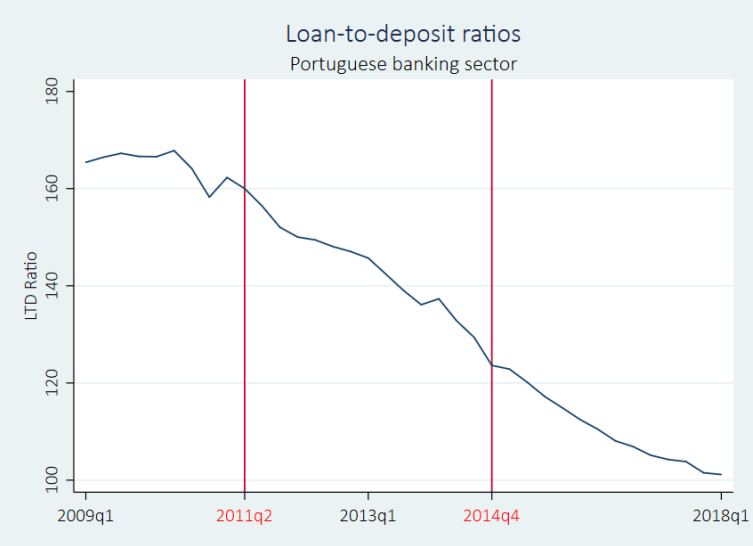
guidelines to maintain the stability of financial sector while supporting a balanced and orderly deleveraging of banks (Europe Commission, 2011). The technical commission restate that the deleveraging of banks must be done "in an orderly fashion within the Eurosystem framework, be consistent with the Economic Adjustment Programme and follow clear, institution-specific target loan-to-deposit ratios" (Europe Commission, 2011). The Bank of Portugal acted as supervisory entity, conducting four-monthly reviews in conjunction with ECB, IMF and European Commission in order to evaluate the feasibility of individual banks' medium-term funding plans and their implications for leverage ratios for the sector and for the economy.

3. Objectives

This paper focus on a specific capital requirement, the Loan-to-deposit ratio (LTD). According to Kashyap et al. (2002) deposit-taking and lending by banks are closely related, where both of variables reveal the liquidity transformation function of banks, thus it's important to deal with loans and deposits jointly, as is done with LTD ratio. The LTD ratio measures the coverage of loans with stable funds, usually deposits of households, non-financial firms and government. When loans exceed deposits, we face a funding problem in which banks move to wholesale funding, basically demanding the bank to continually roll over bill and bond issues and to renew borrowing from other financial institutions, in general depending on both domestic and foreign investors.

As we can see in Figure 1, since 2009 the average LTD ratio for Portuguese banks was about 165, which means that for every 100 euros deposited, banks had 165 euros in loans. The Economic Adjustment Programme, approved in May/2011 with the total duration until 2014, and since then the LTD ratio dropped to 120 in last quarter of 2014, almost a 40 percentage points of variation during the period.

Figure 2 –Loan-to-deposit ratios of Portuguese banks



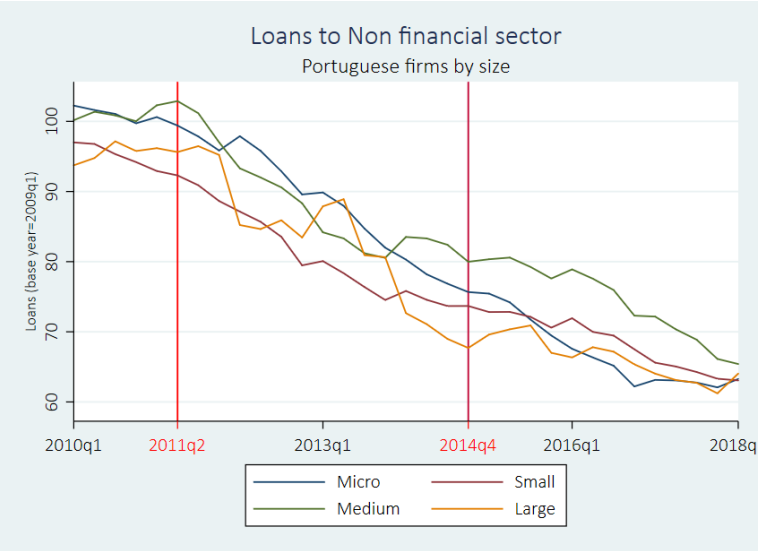
Note: Source Eurostat – RAI (Risk Assessment Indicators database) / the red marks indicate the begin and the final date of the Economic Adjustment Program.

LTD's regulation has the role of a macroprudential policy instrument to contain systemic risk in periods of economic expansion and it is reasonable to link this type of regulation to a possible shortage of credit in the economy – see, for example, Kashyap et al. (2002).

Said that, this project aims to verify if the regulation required by the Troika under the Economic Adjustment Program caused a shortage in credit for Portuguese SMEs, going further, we want to check how the banks manage their lending due to a negative liquidity shock, how does it affects the financial "health" of the companies, more specifically, its investment variation.

Hence, one problem of identification in the research is to disentangle the fall in demand for credit by SMEs (exhibited in Figure 2), due to the crisis in the euro zone with the liquidity shock and to link its effects on a firms' investments.

Figure 3 – Loans to non-financial sector – by firm size



Note: Source BPStat – Monetary and financial statistics - the red marks indicate the begin and the final date of the Economic Adjustment Program.

A contribution to the literature is the identification of a causal link between a negative liquidity shock (drop of LTD ratios) to a credit supply for SMEs firms in Portugal, using an extensive dataset linking bank balance sheets, loans, firm balance sheets provided by Banco de Portugal. We will be able to verify the impact of public policy and regulations regarding the financial sector and how this shock flows into the non-financial sector thought loans to Portuguese SMEs during the Economic Adjustment Program.

4. Literature Review

4.1 Loan-to-Deposit Ratios

According to Van den End (2016), deposit-taking and loaning by banks are closely related and the two concepts reflect the liquidity function of banks. The Loan-to-Deposit ratio is the main liquidity indicator that measures this relationship between loans and deposits. When loans exceeds deposits, banks' face a funding problem and they have to access financial markets, which may be more expensive and unstable (Van den End, 2016).

The macroprudential dimension identifies the link among funding imbalances at the bank level and system wide liquidity risk, in other words, if a considerable share of banks operates with a funding gap, negative shocks to market funding can stress the whole banking sector, affecting credit supply and economic growth. Some papers investigate the link between liquidity ratios and stress in economy, using

LTD ratios and other variables, for example, Le Leslé (2012) as a measure of liquidity problems at the banking sector.

As indicated by Goodhart et al. (2013) no single regulatory measure is enough to address the several sources of systemic risk. Their model in particular suggests that capital itself is insufficient to suppress the problems that arise during a crisis. This emphasize the importance of funding measures based on the LTD ratio to alleviate systemic liquidity risk, and reveals that the ratio could be used by the macroprudential authority to address long and short term liquidity risks.

According to Kashyap et al.(2002) the ratio will fluctuate on a trend reflecting short-term financial cycles, it tends to rise in years of economic boom, given that there is market funding to finance the credit expansion, furthermore, the ratio usually levels of in turbulent economic circumstances when wholesale funding is replaced for retail savings and consequently credit growth decline.

4.2 Capital Ratios Regulations

The multiple potential adjustment dimensions and scarcity of historical episodes to evaluate the response of banks to a tightening of liquidity regulation has created a wide range of views about the impact of liquidity regulation.

Bernanke and Lown (1991) analyse the impact of bank capital on lending during the recession in 1990-1991 and find that a 1 percentage point increase in the capital to asset ratio had a positive impact of 2.6 p.p in the growth rates of loans. On the other hand, a study carried out by Hancock and Wilcox (1993) analyses bank credit flows in 1990 and concludes that each US$1 that banks fell short of regulatory capital reduce bank credit by US$3, they also estimated the effect of a shortfall in bank capital relative to a specific target (the hypothesis was that banks have an internal target) and the results were for every US$1 additional in capital reduce loan growth by US$1.5. Those papers used cross sectional or panel data analysis that uses regional variation in bank health and economic conditions to set a relationship between capital requirements and bank lending.

Some papers followed a dynamic strategy (such as VAR) placing bank capital and economic variables. In this vein, Berrospide and Edge (2010) in an analysis for the US, uses Bank Holding Companies data, for the period 1992-2009, to verify the impact of banking capital on lending. Those authors find an impact of 0.7 to 1.2 p.p in loan growth for a 1 percentage point increase in capital ratio and claim that their results are less concerning than the others because when banks lend to big holding companies they are more concerned with the operational risk than the capital ratios.

Other papers look into banks bailouts in specific countries, Gianetti and Simonov (2013) analyze the banking crisis in Japan and the efforts by the government to recapitalize banks and reach required capital ratios. They conclude that large capital infusions made by government increased credit supply and make allocation more effective.

Albertazzi and Marchetti (2010) looked into lending in Italy after Lehmann Brother's crash, they find that facing capital constraints, banks direct loans to less riskier companies (flight to quality) and the incapacity of borrowers to change their lending channel (banks), from less capitalized to stronger banks.

Khwaja and Mian (2008) develop a new methodology to overcome the identification problem of disentangling the dynamics of demand and credit supply from the effect of a specific policy or event and consequently the effects on real economy. The strategy is based on within firm differences-in-differences comparing loans from distinct banks to the same firm, thus firm fixed effects absorb the whole firm specific change in credit demand therefore the difference estimated in loan changes within the same firm can be seemingly attributed to differences in bank liquidity shocks. The authors used a natural experience, the nuclear tests made in Pakistan in 1998 that forced banks to block dollars withdrawals in order to secure the government against problems in balance of payments and concluded that a 1% decline in bank liquidity leads to 0,6% decline in bank's loan to a specific firm. The authors also looked into its differences in firm's size, the coefficients for 1% drop in a bank's liquidity leads to a reduction in lending for small firms of 0,87% and of 0,3% for large firms.

Gropp et al. (2019), following Khwaja and Mian (2008), focus their analysis on a specific event: the increase in capital requirements for selected banks in the Euro area by the European Banking Authority in 2011. The authors build a panel linking syndicated loans, banks and non-financial firms' balance sheets and perform their analysis for bank-level, loan-level and firm-level, exploiting the existence of multiple bank-firm relationships. Gropp et al. (2019) cluster industries in order to isolate specific effects, finding that banks affected by the event reduce their credit supply of syndicated loans by 27 percentage points compared to banks in the control group and for firm-level. They also conclude that firms that obtain credit from affected banks exhibited 4 percentage points less asset growth, 5 percentage point less sales and 6 percentage points less investment growth.

Finally, Iyer et al. (2014), using the same approach as Khwaja and Mian (2008), using firm multiple banking relationships in order to control for demand effects, analysed the specific case that occurred in Portugal during the crisis in 2007, the unexpected freeze on European interbank market, causing a negative liquidity shock due to lack of funding for banks. The authors used a differences-in-differences approach comparing lending before and after the crisis among banks with different liquidity shocks or different

interbank borrowing ratios, they found that the dependence of interbank funds reduces credit supply for firms and a 10% increase in interbank borrowing of the lending bank results in a 3,7% reduction in credit availability for firms, they also found that the credit supply reduction is higher for smaller and younger Portuguese firms.

5. Data Sources and Summary Statistics

We analyze the impact of the regulation imposed by Troika under the Economic Adjustment Program, during 2010 to 2015. In order to verify the causal link between the liquidity shock and credit market, we have to overcome the identification problem that is the effects of economic crisis in Europe and consequently in Portugal during the period, the crisis may cause a reduction in loans, so is difficult to see the specific effects of the adjustment program (drop in LTD ratios) itself.

We have access to the records on all granted loans, which are recorded by the Bank of Portugal, which is the regulator and supervisor of the banking system in Portugal. For these purposes, we employ the information in the credit register (Central Credit Register, CRC in Portuguese) which contains confidential and very detailed information at the loan level on all commercial and industrial (C&I) loans granted to all non-financial publicly limited and limited liability companies by all banks operating in Portugal in order to calculate the degree of exposure of firms to more or less affected banks and the Central Balance Sheet Harmonized Panel Data (CBHP) that provides economic and financial information on Portuguese non-financial companies.

According to the CBHP manual, the dataset is constructed based on Central Balance database which contains economic and financial data for companies in Portugal annually since 2006 onwards, and is based on information reported through "Informação Empresarial Simplificada" (IES), the harmonized panel which we will use for this research, contains only variables that are consistent over time because they were not affected since the changing of accounting systems (in 2010, the replacement of POC to SNC).

Some delimitations were defined for the scope of the this research, for example, we exclude from the CB database, all large companies (with revenues greater than 50 mm Euros per year, and employs more than 250 people), so we will follow the European Commission Recommendation 2003/361/CE and selected only SMEs firms, by definition: SMEs are defined taking into account the number of permanent employees, turnover and / or total annual balance sheet. Thus, a micro enterprise is one that "*employs less than 10 people and whose annual turnover or annual balance sheet does not exceed 2 million euros*"; as a small company one that "*employs less than 50 people and whose annual turnover or annual balance sheet does not exceed 10 million euros*" and as a medium company one that "*employs less than 250*

people and whose annual turnover does not exceed 50 million euros or whose total annual balance does not exceed 43 million euros ", as we can see in Table 1 above,

Table 2 – SMEs Definition

	Micro	Small	Medium
N° of workers	<10	<50	<250
Turnover	≤2M€	≤10M€	≤50M€
Annual Balance Sheet	≤2M€	≤10M€	≤43M€

Notes: Turnover and Annual Balance Sheet are measured in Million Euros.

We choose to not include Large firms, due to the facility of these companies to seek liquidity through other mechanisms in the financial market, such as, issuance of debt securities, IPO's and public traded companies, which are able to raise capital to finance their operations through the sale of shares, both types of companies do not need exclusively credit offered by banks to raise capital, thus they could bias the obtained results. Moreover, according to CB database, in 2015 SMEs accounts for approximately, 99,7% [1]of all non-financial firms in Portugal, (89,1% were Micro companies and 10,6% were Small & Medium firms), and in terms of total turnover, SMEs accounts for 58,5% of total turnover (specifically, Micro companies : 15,8% and Small & Medium firms : 42,7%).

Table 2 presents the descriptive statistics for the variables used in the regression model. Our dataset consists of more than two million observations; the average firm in our sample is thirteen years old with a median of ten years. The mean leverage ratio is 35% with a median of 5%, our average firm is well collaterized (tangibility) with a ratio of 22%.

[1] Authors' own calculation using the Harmonized Central Balance Sheet database.

Table 3 – Descriptive Statistics

Variable	Mean	Median	SD
Firm Age	13.45	10.00	12.20
ln (Total Assets)	11.44	11.50	2.09
Leverage	0.35	0.05	0.86
ln (Tangibility)	0.22	0.08	0.28
ln (Networth)	10.78	10.80	2.01
ln (Sales)	11.23	11.46	2.34
Export (% of exporting firms)	11%		

Notes: Variables are measure in Euros, Firm Age is measured in Years
Number of observations: 2.433.912

In order to check whether a Bank was affected or not by the policy (adjustment program), it is necessary to collect data of their LTD ratios, for reasons of confidentiality and unavailability, it was necessary to carry out a manual collection of LTD ratios in the documents "Balance Sheets & Reports" of banks operating in Portugal through their respective websites. The expression used by banks to calculate LTD ratios is the same as per BdP instruction 23/2011, in order to have comparable data between banks, eliminating any concerns regarding the calculation of the ratio that could generate discrepant results in the analysis.

Thus, according to expression below, the ratios are calculated using the following variables:

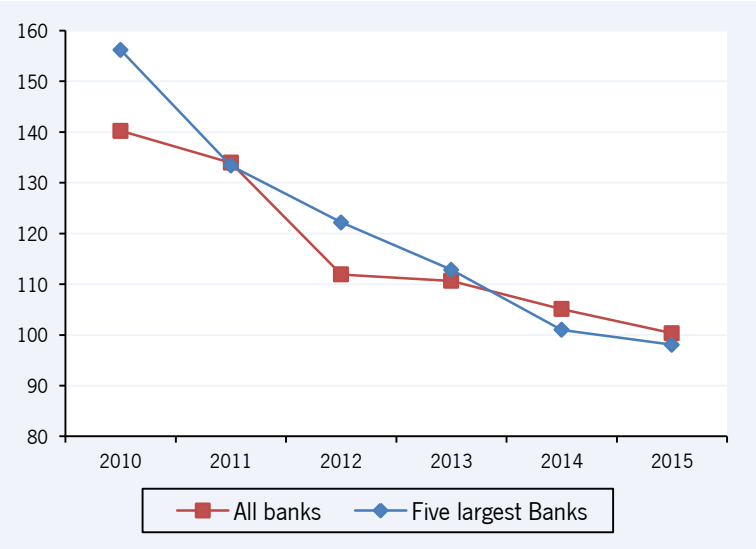
$$\frac{Total\ Credit - \left(\frac{Provisions}{Accumulated\ impairment\ for\ credit}\right)}{Client\ deposit}$$

So, we have the following set up: 18 financial institutions[2] that represents about 80% of all credit granted in Portugal (according to the *BPLim*), with different levels of adjustment of LTD ratios, it was not possible to find all ratios for all banks due to the fact that some institutions did not provide the indicator in their balance sheets, as well as the above accounts to calculate the indicator.

Therefore, in the pre-adjustment period (2010) we have an average ratio of 140, and in subsequent years, until 2014 (deadline for banks to adjust their ratios), there was a negative adjustment of 25 percentage points of LTD ratios for the observed banks, according to Figure 5.

[2] The financial institutions are: BPI SA, Santander Totta SA, Banco Comercial Português SA, Caixa Geral de Depósitos SA, Haitong Bank SA (former Espirito Santo Investment Bank), Finantia SA, Banco de Investimento Global SA, Bison Bank (Former BANIF Banco de Investment), Banco Português de Gestão SA, BEST SA, Caixa Económica Montepio Geral SA, Banco BIC Português SA, Novo Banco dos Açores SA, Banco Atlântico Europa SA, Caixa Central de Crédito Agrícola Mútuo CRL, BANIF SA. For analysis purposes, Banco Espírito Santo was considered too, liquidated in 2013 and transformed into NOVO Banco SA, thus, the ratios from 2010 to 2013 correspond to Banco Espírito Santo and from 2014 correspond to NOVO Banco SA.

Figure 4 – LTD Ratios for Collected Banks in the sample



Notes: Own computations. Based on the manual collection on "Balance Sheets & Reports" of 18 banks operating in Portugal (red curve), the blue curve have the Loan-to-Deposit ratios of the fifth largest banks in Portugal, according to BdP : Caixa Geral de Depósitos, BPI, Santander Totta, BCP, Banco Espirito Santo (until the bankruptcy in 2013) and Novo Banco (for 2014 and 2015 values).

6. Variables, Methodology and Econometric Approach

6.1 Variables

From the collection of LTD ratios of the 18 financial institutions mentioned above, the *BPLim* (Microdata Laboratory of Banco de Portugal) team identified from each firm's unique randomized code (TINA), the available credit[3] by the financial institution b to firm i in year t, in order to build an index that measures the exposure degree of firms (through loans) to banks with their respective levels of LTD ratios.

Denotes in the expression (2) $Exposure_{i,t}$, exposure degree of firm i in a year t (December values), $Credit_{i,b,t}$, amount of credit (in Euros), available for firm i by bank b, at year t, divided by $Credit_{it}$, which corresponds to the total volume of credit made available to firm i in year t, multiplied by $Loan-to-Deposit_{b,t}$, which corresponds to Bank LTDs ratio b in the year t.

$$Exposure_{i,t} = \sum_{b=1}^{n} \frac{Credit_{i,b,t}}{Credit_{i,t}} x\ Loan-to-Deposit_{b,t} \quad (1)$$

We have the following situation of the Degrees of exposure of firms during the analysis period, according to Table 3:

[3] To calculate this variable, BPLim team used a variable that is the sum of regular and potential credit, representing the total available credit that a firm can access.

Table 4 – Degrees of Exposure

Degrees of Exposure	Min	Max
1	0	52.63
2	52.63	73.06
3	73.06	85.00
4	85.00	97.85
5	97.85	107.69
6	107.69	113.00
7	113.00	118.99
8	118.99	127.10
9	127.1	144.00
10	144.00	379.00

Notes: Own computations.The degrees of exposure are the deciles of the variable $Exposure_{i,t}$

As the above variable captures the degree of exposure of firms to banks (more or less affected by the policy of increasing LTD ratios) it is not coherent to analyze it as a set, as we would not be able to capture the different levels of exposure and how they influence investment. Thus, it is interesting to check the variable as an exposure decision, in order to group firms by their levels of exposure and check whether, given a higher or lower level, what effect this has on the investment of the firms.

It is expected that given the exposure levels of the firms, the reflection of the decrease in investment will be increasing, that is, firms that make up the last deciles, will be more affected in the investment variation than firms that make up the first deciles.

We also include some control variables (see table 2 for a detailed description of the variables).

Tangibility is used as a proxy for collateral, since it corresponds to a firm's capital structure. The theory suggests that companies with more tangible assets in their capital structure are more likely to raise credit, given that these types of assets are easily valued by the market and can be used as collateral (Campello and Giambona, 2013).

We will use a firm's financial leverage as a risk measure, given the level of leverage a bank may be more apt or not to give credit to that company, so we will use leverage as a risk measure, the variable was calculated using Debt scaled by Equity and Liabilities.

Networth is a variable to gauge a company's health and it provides a snapshot of the firms' current financial position, since lenders (banks) scrutinize a business's net worth to determine if it is financially healthy. If total liabilities exceed total assets, a creditor may not be too confident in a company's ability to

repay its loans and can affect their investments as well, thus, we take the logarithm of Total Assets minus Total Liabilities to calculate Networth.

We will use a the logarithm of firm's total assets to control for the size of the firms, according to Gropp et al (2019) and firm's age as a measure of a lender's perception of risk and bank relationship, as long as long-term relationship with banks can facilitate access to credit for older firms.

We will use the logarithm of Sales in order to control for demand effects and dummy variable for exporting firms.

All control variables were winsorized before the log transformation at the 1% level following Gropp et al (2019).

We are interested to verify the indirect link between firms' exposure (in terms of global credit) to banks that had to adequate its levels of LTD ratios and how this exposure affects firms' investments. So, we have constructed a variable to proxy investment using the variation of fixed tangible assets, denoted in expression (2).

$$\Delta Investment_{it} = \frac{(Fixed\ Tangible\ Assets_t - Fixed\ Tangible\ Assets_{t-1}) + Depreciations}{Fixed\ Tangible\ Assets_t} \quad (2)$$

6.2 Methodology and Empirical Model

In order to achieve the relationship that we are seeking, this research will follow Gropp et al. (2019) and will use a Fixed Effects model for panel data, since it is the most used method in corporate finance.

A regression model with panel data, with n observations in T periods and K variables, can be represented as follows:

$$y_{it} = x_{it}\beta + \varepsilon_{it}, \;\; i = 1,2,\dots,n; t = 1,2,\dots,T \quad (3)$$

Where y_{it} is the dependent variable, x_{it} is a $1\ K$ vector containing the explanatory variables, β is a vector of parameters to be estimated and ε_{it} it the errors. The sub-indices i and t denote the observational unit and the period of each variable, respectively. Thus, in a database with balanced panel data, the total number of observations corresponds to $n \cdot T$.

If the model follows all the classical regression hypotheses, one can estimate it by Ordinary Least Squares (OLS), obtaining the desired estimates. The main ones refer to the error, which is assumed to be homoscedastic and not correlated in time and space.

The problem of heteroscedasticity, if detected, makes it necessary to use the method of Generalized Least Squares (GLS). According to Verbeek (2008), if the Ordinary Least Squares (OLS) estimator were used, not taking into account the non-homoscedasticity of the disorders, the estimates would still be uneven

and consistent, but would not be more efficient. Thus, the significance tests of the estimates would be biased if OLS was used. The same argument is valid in the presence of autocorrelation of errors.

Another problem that may arise in panel data, and that would make the use of OLS impossible, is endogeneity. This occurs when the correlation between some explanatory variable x_j and the error is different from zero, that is: $Cov(x_j, \varepsilon_{it}) \neq 0$.

Wooldridge (2016) highlights the three main sources of endogeneity: omission of model variables (unobserved heterogeneity), measurement errors of the variables and simultaneity between the variables.

The most frequent problem with panel data is the issue of unobserved heterogeneity. In this case, there would be factors that determine the dependent variable but are not being considered in the equation within the set of explanatory variables because they are not directly observable or measurable. Taking into account the unobserved heterogeneity, the model above can be rewritten as follows:

$$y_{it} = x_{it}\beta + c_i + \varepsilon_{it}, \;\; i = 1,2, \dots, n; t = 1,2, \dots, T \qquad (4)$$

Where c_i represents the unobserved heterogeneity in each observational unit constant over time.

According to Wooldridge (2016), if c_i is correlated with any variable in x_{it} and we try to apply OLS in this case, the estimates will be not only biased but also inconsistent.

The same consequences occur in the model in the case where the classical hypothesis that there is no correlation between some explanatory variable x_j and the error $Cov(x_j, \varepsilon_{it}) = 0$ is not valid. Thus, in this case, we can only use OLS if we have justification to assume that $Cov(c_i, x_j) = 0$. If that hypothesis is valid we can consider a new compound term, $v_{it} \equiv c_i + \varepsilon_{it}$ and estimate the model by OLS, since we would have $Cov(V_{it}, x_j) = 0$.

In the case where $Cov(c_i, x_j) = 0$ in order to estimate this equation consistently, the most usual approach in the context of longitudinal data is Fixed Effects. In this estimation method, even allowing $Cov(c_i, x_j) = 0$ the idea is to eliminate the unobserved effect c_i, based on the following assumption $E(\varepsilon | x_i, c_i) = 0$, where $x_i \equiv (x_{i1}, x_{i2}, \dots x_{iT})$ known as a strict exogeneity condition. The transformation of fixed effects (or transformation within) is achieved in two steps. Taking the mean of equation (4) in time we obtain:

$$\overline{y}_i = \overline{x_i}\beta + c_i + \varepsilon_i \qquad (5)$$

and subtracting (5) from (4) for each t, we get the transformed equation of fixed effects,

$$\mathrm{y_{it}} - \overline{\mathrm{y_i}} = (\mathrm{x_{it}} - \overline{\mathrm{x_i}})\beta + \varepsilon_{\mathrm{it}} - \varepsilon_{\mathrm{i}} \qquad (4)$$

or

$$\ddot{y}_{it} = \ddot{x}_{it}\beta + \ddot{\varepsilon}_{it}, \;\; i = 1,2, \dots, n; t = 1,2, \dots, T \qquad (6)$$

thus removing the unobserved heterogeneity c_i.

The Fixed Effects estimator is obtained by applying OLS in equation (6) and under the assumption of strict exogeneity, this estimator is consistent. This estimator is also known as an estimator within, by using the time variation within each observational unit.

In our model we include firm fixed effects to capture unobserved time-invariant firm heterogeneity and year fixed effects, to capture any time related effects that are not included in the model, for example, the two regulatory interventions introduced by EBA in 2011, the EBA stress test requiring 5% of core tier 1 ratio in June, in this specific event, any Portuguese bank was affected and the 2011 EBA capital exercise subsequently raised the required core tier 1 ratio to 9%, affecting some Portuguese banks[4] . The estimated 115 billion euro capital shortfall due to the EBA capital exercise was however well above the 2.5 billion euro capital shortfall due to the 2011 EBA stress test (Acharya, Engle, and DianePierret, 2014).

Hence, in our empirical analysis, we control for a rich set of firm characteristics to remove any potential confounding factors and avoid an omitted-variable bias and capture other determinants of the firms', corporate policies, loan demand and supply. These controls are, leverage, net worth, sales, age of the firm, total assets and tangibility.

Finally we clustered standard errors at firm level, accounting for heteroskedasticity across firms in our model's unexplained variation, or since the amount of variation in the outcome (investments) is correlated with the explanatory variables, so we can take this correlation into account.

Said that, we have the following expression:

$$\Delta Investment_{it} = \beta \cdot Exposure_{i,t} + \gamma \cdot X_{it} + \eta_t + n_i + \varepsilon_{it} \qquad (7)$$

Where, $\Delta Investment_{it}$, our main outcome is the percentage variation in a firms' i investments (proxied by the capital expenditures of the firm) in a year t. The variable $Exposure_{i,t}$ measure the level of exposure of a firm i to bank b, in terms of global credit (sum of regular credit and potential credit, representing the total available credit that a firm can access), since it's not a categorical variable but continuous (varies from 0 to 379), we split $Exposure_{i,t}$ in deciles to verify the relationship between a firm level of exposure to a more or less affected bank by the Adjustment in LTD ratios and a firms' capacity to invest, we expect that, lower levels of $Exposure_{i,t}$, reflects in a higher variation of investment, since those firms' were indirectly less affected by the policy.

In vector X we control for several firm-specific characteristics and market demand. We first introduce age of the firm ($Firm\ age$), Total assets ($\ln Total\ Assets$) to control for size. In addition, we include a set

[4] Four Portuguese banks were affected during EBA Capital Exercise in 2011 : Banco BPI SA, Banco Comercial Português SA, Caixa Geral de Depósitos and Espirito Santo Financial Group SA

of balance sheet variables to capture a firms' financial situation,$Leverage$, as a perception of risk, Tangibility ($\ln Tangibility$) as a proxy for collateral and net worth ($\ln networth$) as a financial health indicator. Finally we include the logarithmized variation of Sales ($\ln sales$) to control market demand.

Besides that, Following Gropp et al (2019), η_t is a set of Year fixed effects and n_i is firm fixed effects to control for macroeconomics events and firms'-specific changes, respectively.

7. Results

In this section, we examine how the degree of exposure to more or less affected bank can influence a firms' investment, we first estimate the equation (7) for SME's companies, since our hypothesis is: Smaller firms that rely only in banks credit and doesn't have access to more sophisticated financial instruments or markets were affected, since the banks had to adjust their levels of LTD ratios following the Troika recommendation during 2011 to 2014 causing a credit shortfall. We find that there was a substantial reduction on banks' LTD ratio of 25 percentage points and the results of our analysis shows that the impact of this policy was transmitted to SMEs companies.

We estimate three specifications based in our baseline model of firms' variation in investments as in Equation (7). Table 4 shows the specifications estimated, in column (3), the most strong specification, we control for firm characteristics and balance sheet variables (total assets, age of the firm, leverage, net worth, exporting firm, tangibility) and for market demand (sales) following Gropp et al (2019), we stress our specification with firm and year fixed effects to account for both firm and year heterogeneity, respectively.

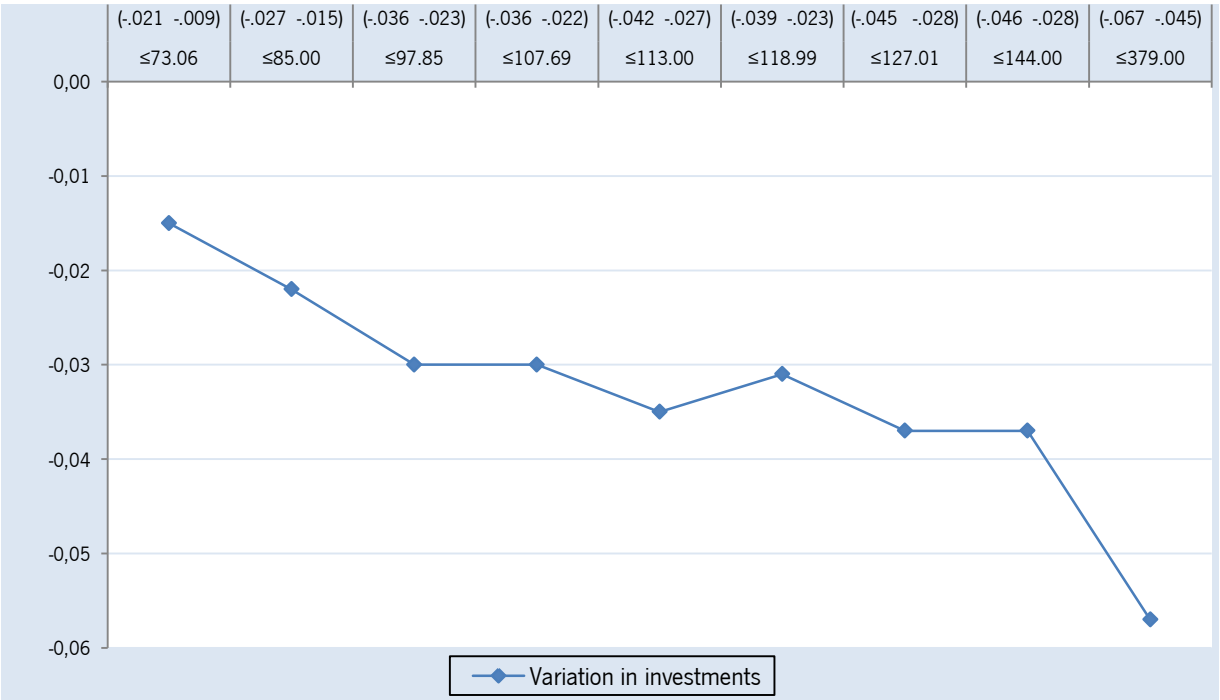
Table 5 – Regression Analysis

Main Variable	Model 1	Model 2	Model 3
Exposure (by deciles)			
[52.63 , 73.06]	-0.027***	-0.023***	-0.015***
(73.06 , 85.00]	-0.032***	-0.033***	-0.022***
(85.00 , 97.85]	-0.038***	-0.043***	-0.030***
(97.85 , 107.69]	-0.039***	-0.042***	-0.030***
(107.69 , 113.00]	-0.029***	-0.042***	-0.035***
(113.00 , 118.99]	-0.033***	-0.042***	-0.031***
(118.99 , 127.01]	-0.016***	-0.040***	-0.037***
(127.01 , 144.00]	-0.022***	-0.040***	-0.037***
(144.00 , 379.00]	-0.008***	-0.051***	-0.057***
Controls			
ln (Assets)		-0.006***	0.119***
Firm age		-0.004***	-0.007**
Leverage		-0.048***	-0.028***
ln (Networth)		0.003***	0.002*
ln (Tangibility)		-0.196***	0.709***
Export		0.041***	-0.000
ln (Sales)		0.037***	0.021***
Firm FE	NO	NO	YES
Year FE	NO	YES	YES
r2	0.001	0.063	0.046
N	803.380	345.304	345.304
F-test for H0 : 2nd decile = 10th decile (p-value)			0.014
Joint test of significance (p-value)			0.000

Notes: Own computations. The dependent variable is investments in Euros. The sample use data from 2010 to 2015 (the whole period of the LTDs ratios Policy) for SME's.Our main variable of interest (exposure) is in deciles in order to measure how this intensity influence firms' outcomes. In column 1 we don't control for any balance sheet variables nor Year and Firm FE, in column 2 we include firm controls and Year FE, in column 3 we add firm controls, Year and Firm FE. We perform two tests, one to check if the coefficients of the 2nd and 10th decile are equal and a joint test, to verify if all year dummies are equal to zero. Standard errors are adjusted for heterokesdacity and clustered at firm level. Significance levels *10%, **5%, ***1%.

As expected when we split our main variable of interest (Exposure) in deciles we clearly verify that the affected-bank effect is present at all deciles and its relationship with firms' investment variation are significant at one percent statistical significance level. The magnitude of investment variation for SMEs is crescent and ranges from -1.5 pp (second decile) to -5.7 pp (last decile) showed in Figure 6.

Figure 5: Investment variation by deciles of Exposure



Notes: Own computations. Created using the coefficients in column (3) of Table 4; The values in parenthesis represent the 95% conf. interval for each deciile.

So, firms that had a commercial relationship (in terms of credit exposure) with less affected banks (or banks that had a lower LTD's ratios) faced a variation in their investments of -1.5 pp comparing to firms that had a relationship with more affected banks, faced a variation in their investments of -5.7 pp (tenth decile), supporting our main hypothesis: the level of exposure to more affected banks influence the firms' investment, since they face a reduction in credit because of the exogenous shock to the bank supply. Put differently, firms borrowing from banks exposed to LTD ratios reduction policy are more likely to reduce its investments.

These results above are coherent to the literature of credit crunch events and its effects on financial outcomes of firms, for example, in Cingano et al. (2016), using Italian credit register data, observed the 2007 liquidity drought in interbank markets as a consequence of variation in credit supply by banks and consequently affects firms' investment, they found strong effects for young and small firms, they provided evidence that firms that borrowed from banks with a higher level of exposure to the interbank market faced a higher negative variation in investments, given a 10% increase of exposure induces a fall of approximately 10% in the investment rate of a firm. In another paper, Bottero et al. (2020) looking for banks that were more or less exposed to Greek bailout, find that firms that were more exposed to those banks (in terms of

credit) cut investments more than less exposed firms, for a percentage point increase in lender's exposure, firms reduce its investments by 0,3 percent, they have also find that the results are driven by small firms.

Next, we focus on the firm-specific control variables. The coefficients of Total assets, leverage and tangibility are all significant at one percent statistical significant level and precise. Larger firms (in terms of assets) are less likely to reduce investment, consistent with Bentolila et al (2018) and Gropp et al (2019). We also document that firm tangibility or its capacity to use collateral to secure credit is relevant for its investments, a 10% variation in a firms' tangibility leads to a 0.07 pp variation in investments, and that leverage is negatively associated with firms' investment, suggesting that firms with higher levels of debt (riskier firms) face negative investment variations. We have also find that larger firms (in terms of assets) tends to have a higher variation in investments, specifically, a 10% variation in total assets is associated with a 0.01 pp increase of investments. Our results are in line with others that verify the impact of balance sheet position in corporate outcomes, for example, in Gropp et al (2019) and Dwenger et al (2020).

Another significant finding of our analysis is the coefficients' differences between column (2) and (3). In specification (3), we have the more robust model that we included firm and year fixed effects, in specification (2) we did not control for firm fixed effects, as we can observe in Table 4. The deciles of Exposure are higher in (2) than (3) and does not vary, we cannot observe any trend as we change to a higher degree of exposure.

The coefficient signs of our control variables are not coherent to the literature as well, according to (2), a larger firm (in terms of total assets) face a decreasing of investment, a firm with more collateral capacity leads to a decrease of investments and the dummy exports variable is also significant at one percentage level of significance in column (2) and not in column (3).

We can only explain this variation with firm fixed effects that we included in specification (3), apparently, it seems that there are a relevant number of unobservable time-invariant factors of the firms, that are important and influence the results in model (3).

To show the robustness of our results, we run the equation using less restrictive specifications. In Table 3, column (2) we exclude firm fixed effects and the coefficients for all deciles of the variable Exposure are statistical significant at one percent significance level, the magnitude is crescent in every decile and higher than the model in column (3), for example, it ranges from -2.3 pp (second decile) to -5.1 pp (last decile).

In column (1) we exclude all firm controls, year and firm fixed effects from the original model described in Equation (7), all our coefficients remain significant at one percent significance level, but the magnitude didn't show any trend, it's irrelevant in economic terms.

We perform one test to verify if the coefficient values of the second and the tenth decile are equal and we reject this hypothesis and we can conclude that the coefficient of the 10th decile is lower than the 2nd decile and is statistically different. A joint test of significance as well and we can justify that the use of Fixed effects is adequate in our model.

Finally, as demonstrated above, results remain different and statistical significance regarding specifications (3) and (2). Thus, the magnitude of the effects is significant across all specifications but the magnitude is different.

7.1 Additional robustness checks

In this section we will provide additional robustness checks in order to verify if our results are robust and hold for different specifications. For this, we estimate the equation (7) excluding the SMEs companies from the sample and restricting the sample for large firms (with revenues greater than 50 million EUR).

As expected it's reasonable to argue that larger firms have access to other financial instruments or sources of credit and don't rely exclusively in commercial banks to have access to credit, they can shift more easily from a financier to another and again we confirm our expectations that, there's no statistical significance of level of Exposure for large firms and its investment, none of the deciles has significance, even controlling for firms' balance sheet characteristics, year and firm fixed effects, as we can see in Table 5 below:

Table 6 – Regression Analysis for Large Firms

Main Variable	
Exposure (decile)	
[53.95 , 75.79]	-0.011
(75.79 , 87.07]	0.001
(87.07 , 96.63]	0.019
(96.63 , 104.70]	0.005
(104.70 , 111.67]	0.006
(111.67 , 117.83]	0.025
(117.83 , 126.39]	-0.002
(126.39 , 141.00]	0.006
(141.00 , 265.86]	0.033
Controls	YES
Firm FE	YES
Year FE	YES
r2	0.039
N	3.219

Notes: Own computations. The dependent variable is investments. The sample use data from 2010 to 2015 (the whole period of the LTDs ratios Policy) for Large companies.Our main variable of interest (exposure) is in deciles in order to measure how this intensity influence firms' outcomes. We stress our model with firm and year fixed effects. Standard errors are adjusted for heterokesdacity and clustered at firm level. Significance levels *10%, **5%, ***1%.

8. Conclusion

In this thesis, our main objective was to evaluate the impact of the LTDs regulation policy imposed by the Troika within the scope of Economic Adjustment Program for Portugal and to establish a relationship between this liquidity shock and the firms' investment capacity. We achieve identification by accounting for the level of exposure of firms to more or less affected banks (who supplies credit for firms'). We proceed by breaking this exposure variable in deciles and comparing the magnitude effect of less and more affected firms.

Having access to a very complete database, with detailed information about all non-financial firms operating in Portugal, allowed us to control for firm characteristics that are traditionally used in corporate finance analysis.

We have find statistical significance in the degree of exposure to firms (SMEs) attached to the less and more affected bank, the magnitude of the effects in investment is also crescent, in other words, given the first deciles of exposure, the variation in investment is lower (but negative) than in the above deciles, in our preferred specification, it varies from -1.5 pp (second decile) to -5.7 pp (tenth decile).

We have also estimated a robustness check to verify the same effect for large firms, and as expected we didn't find any statistical relationship, arguing that for large firms, they could swap regular loans from commercial banks to other financial solutions and/or rely more in internal finance simply because they're larger or have access to external financial market or in a case of a multinational company, intracompany loaning (from parent company to subsidiaries).

Our results in this thesis have important policy implications. The regulators should take into consideration the composition of firm-bank relationship when imposing a regulation, the process of fast deleverage of large banks (in terms of LTD ratios) are correlated with a negative impact on firms investments, the reduction of banking concentration should be at policy maker agenda, with more options, firms could swap for banks without liquidity problems.

9. Appendix A:

TABLE 7 – Variables Description

Variable	
$Exposure\ i,t$	$\sum_{b=1}^{n} \frac{Credit_{i,b,t}}{Credit_{i,t}}\ x\ Loan - to - Deposit_{b,t}$
Control Variables (Winsorized at 1% level)	
$\ln(Tangibility)$	$\ln\left(\frac{Fixed\ Tangible\ Assets}{Total\ Assets}\right)$
$Leverage$	$\frac{Debt}{Equity\ and\ Liabilities}$
$\ln(Networth)$	$\ln(Total\ Assets) - \ln(Total\ Liabilities)$
$\ln(Sales)$	$\ln(Sales_t) - \ln(Sales_{t-1})$
$\ln(Total\ Assets)$	$\ln(Total\ Assets)$
$Firm\ Age$	$Year_t - Year\ of\ foundation + 1$
$Export$	*Export=1 ; Dont't export =0*
Explanatory Variable	
$Investment$	$\frac{(Fixed\ Tangible\ Assets_t - Fixed\ Tangible\ Assets_{t-1}) + Depreciations}{Fixed\ Tangible\ Assets_t}$

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