LISBON SCHOOL OF ECONOMICS & MANAGEMENT
UNIVERSIDADE DE LISBOA

MASTER

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MASTER'S FINAL WORK

DISSERTATION

DETERMINANTS OF BANK CAPITAL RATIOS IN EUROPEAN UNION BANKS

VANESSA MIGUEL TOSCANO

OCTOBER - 2019

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SUPERVISOR:

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ABSTRACT

We analysed European Union banks' Common Equity Tier 1 (CET1) ratio determinants after Sovereign Debt Crisis. We resorted to information from the *Bankscope* database. We exported information of 137 banks from the 27 countries belonging to the EU, from 2011 to 2018. We performed a regression analysis, running several models to identify the significant variables and their impact on the CET1 ratio. To attest the results' robustness, we replicate the analysis *winsorizing* the dependent variable and the variable that represents Return on Equity. We verified that size, risk exposure, leverage and liquidity are factors that affect CET1 ratio and banks solvency. Additionally, we observed that the European Central Banks' (ECB) asset purchase program seems to increase banks' capacity to absorb potential losses, which justifies this kind of measures by the regulator.

JEL Classification: G01; G20; G21

Keywords: CET1 ratio; CET1 ratio determinants; Basel III; Capital requirements; Regression analysis

RESUMO

Neste trabalho, analisamos os determinantes do rácio *Common Equity Tier* 1 (CET1) dos bancos da União Europeia após a Crise das Dívidas Soberanas. Utilizámos informação da base de dados do *Bankscope.* Exportámos informação de 137 bancos dos 27 paises da UE no período de 2011 a 2018. Baseámos o nosso estudo numa análise de regressão, sendo que analisámos vários modelos de forma a analisar od determinantes e qual o seu impacto no rácio CET1. Para atestar a robustez dos resultados, replicámos a análise aplicando um processo *winsor* à variável dependente e à variável que representa o Return on Equity. Verificámos que o tamanho, a exposição ao risco, a alavancagem e a liquidez são fatores que afetam o rácio CET1 e consequentemente a solvabilidade do banco. Adicionalmente, observámos que o programa de compra de ativos por parte do Banco Central Europeu (BCE) aparenta aumentar a capacidade dos bancos para absorver as suas potencias perdas, pelo o que se justifica este tipo de ações por parte do regulador.

Classificação JEL: G01; G20; G21

Palavras-chave: Rácio CET1; Determinantes do rácio CET1; Basileia III; Requisitos de capital; Análise de regressão

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LIST OF ABBREVIATIONS

CET1- Common Equity Tier 1

EU- European Union

ECB- European Central Bank

EBF- European Banking Federation

MREL- Minimum Requirement for own funds and Eligible Liabilities

M&A- Merger and Acquisitions

GDP- Gross Domestic Product

EBA- European Banking Authority

RWA- Risk-Weighted Assets

ROA- Return on Assets

ROE- Return on Equity

GLS- Generalized Least Squares

OLS- Ordinary Least Squares

GLM- Generalized Linear Model

CRD IV- Capital Requirements Directives

1. INTRODUCTION

The recent financial crisis affected the entire financial system. Regulatory measures were implemented as a response to the deficiencies detected. Given that certain European countries were facing weak economies, the financial crisis worsened their situation. Highly indebted countries in Europe affected the banking sector, leading to the European sovereign debt crisis. Bank capital ratios can detect banks' incapability to absorb losses (BCBS, 2016).

Common Equity Tier 1 Ratio, hereafter CET1 ratio, is an example of a bank capital ratio. It indicates banks' capacity to absorb losses, which makes important to address its determinants. Identifying the factors that influence this capital ratio will allow us to use this information. According to the Basel III regulatory framework, this ratio should meet a minimum of 4,5% (Basle Committee on Banking Supervision, 2017).

Currently, European banks have 13.8%, on average, as reported by EBF[1]. Still, due to the difficulties faced, the Single Resolution Board requires the establishment of Minimum Requirement for own funds and Eligible Liabilities (MREL) (KPMG International, 2019). This requirement represents one of the key tools to enhance banks' resolvability. Banks should have on their balance sheet enough capacity to absorb losses. Thereby, banks are obliged to maintain minimum own funds and eligible liabilities to be used as a buffer to absorb losses in case of a bank failure and resolution. MREL requirement includes the loss absorption amount and the recapitalization amount of the bank. Thus, according to the banks' risk exposure, it should maintain a certain amount to forearm itself in case of resolution. In this case, MREL ensures that the costs of a banks' failure will be borne by its investors, avoiding the need for bailouts.

Nowadays European banks are facing problems due to their low profitability, mainly justified by ECB's low interest rates. The economic slowdown in Europe promotes the maintenance of ECB records low interest rates. Therefore, banks'

[1] See https://www.ebf.eu/facts-and-figures/banking-sector-performance/

profitability is affected, which makes them change their business models. European banks are motivated to resort to Merger and Acquisitions (M&A), to diversify their business overcoming low profitability. M&A avoids bankruptcy of the acquired bank preventing its impact on the financial system.

According to literature, capital requirements are a determinant of the banks' capital structure (Mishkin, 2000). Capital requirements work as a cushion to absorb unexpected losses. In case these losses exceed the buffer it could lead to bank failures (Berger *et al.*, 1995). Bank failures are contagious, so bank capital should be a regulated item (Berger *et al.*, 1995). Banks with weak capital buffer and weak capital structure are more vulnerable to spillovers (Bruyckere *et al.*, 2013). Vulnerable banks are more likely to default, making investors demand higher rates which in turn contributes to increasing default (Lane, 2012).

Banks' capital adequacy level has a significant effect in contagion, which justifies Basel III implementation (Bruyckere *et al.*, 2013). This regulatory framework strengthened bank capital requirements by increasing liquidity and decreasing leverage (Batista & Karmakar, 2017). Basel III calls for a minimum leverage ratio requirement (Gambacorta & Karmakar, 2016). This ratio was set as 3% acting as a complement to risk-weighted capital requirement[2] (Batista & Karmakar, 2017). Banks' CET1 ratio indicates its capacity to absorb potential losses, while leverage ratio represents the maximum loss that can be absorbed by banks' equity (Gambacorta & Karmakar, 2016).

The study aims to examine the impact of several variables on the level of banks' CET1 ratio. Our research question is:

What were the determinants of CET1 ratio in European Union banks after the Sovereign Debt Crisis?

In order to address this question, we gathered annual data related to European Union banks from 2011 to 2018, and we analysed the impact of the independent variables in the CET1 ratio.

[2] CET1 ratio minimum requirement is a risk-weighted capital requirement

We found that larger banks, riskier banks and higher leverage banks have lower CET1 ratio. Moreover, we observed that banks with higher liquidity ratios present higher CET1 ratios, making them more solvents. And, the Quantitative Easing, the measure held by ECB to purchase financial assets appears to increase the banks' capacity to absorb potential losses.

This paper is structured as follows. Chapter 2 embodies the literature review on the European Sovereign Debt Crisis and the CET1 ratio. Focusing on the main causes and consequences of the crisis, and findings related to past studies on capital ratios. Chapter 3 describes the data and methodology used to perform the analysis. Chapter 4 presents the results of the research. Finally, Chapter 5 summarizes the main conclusions achieved, the limitations of this research and discusses further studies.

2. LITERATURE REVIEW

This section is organized by subsections. In subsection 2.1 we will start by making a historical framework of what triggered the European debt crisis. Then subsection 2.2 describes its causes and consequences. In subsection 2.3, we refer to crisis effects, such as contagion, spillover effects and the interdependence between banks and sovereigns. In subsection 2.4, we will describe some measures taken to mitigate the effect of the crisis. Subsection 2.5 refers to Basel III regulatory framework and its importance. Subsection 2.6 references past studies related to determinants of capital ratios. And finally, subsection 2.6.1 highlights the main findings from the literature regarding capital ratios studies.

2.1. EUROPEAN DEBT CRISIS

In 2007 the financial crisis in the United States of America affected the financial system around the world. The speculation around the house price masked some problems that were not detected in the financial system. When prices stopped growing the risk became clear. Subprime mortgage loans deteriorated the quality of the market (Demyanyk & Van Hemert, 2011).

Following the 2007 financial crisis, regulators became concerned about the risk that banks were facing. Several changes were made in regulation in order to limit the risk exposure and avoid the need for a possible bail-out (CGFS, 2018). Basel III was developed to address the deficiencies in financial regulation detected with the financial crisis. This regulatory framework is composed by three key principles: capital requirements, leverage ratio and liquidity requirements. With Basel III, banks are required to maintain a minimum CET1 ratio of 4,5% (Basle Committee on Banking Supervision, 2017).

However, such changes in regulation were not enough to foresee the sovereign debt crisis. Since the end of 2009, beginning of 2010, eurozone member states faced a severe Sovereign Debt Crisis. Although it was originated in Greece, it spread to several other European countries (Missio & Watzka, 2011). Greece's debt levels became unsustainable, they couldn't repay it, and asked for help (Bruyckere *et al.*, 2013). In May 2010, the European countries agreed to provide Greece bilateral loans for an amount of 80 billion euros, to be repaid until June 2013 (Nikiforos *et al.*, 2015). The International Monetary Fund also financed Greece for a total amount of 30 billion euros (Mink & Haan, 2013). The fear of contagion was the major motivation to provide financial support to Greece (Constâncio, 2012). Greece's default worried investors. Investors became worried about the likelihood of EU bailout countries like Italy, Spain and Portugal, from a Greek default (Mink & Haan, 2013; Gupta, 2015).

Rating agencies downgraded several European countries due to their high debt levels and high government deficits, creating a loss of confidence (Missio & Watzka, 2011). This could lead to speculation, and if investors stop investing in bonds issued by other governments, then those governments could not be able to repay their creditors, worsening the problem. Therefore, it was created a 700bn euro firewall to protect other euro members from a full-blown Greek default (Gupta, 2015).

Before the crisis, Ireland, Greece and Spain showed signs of real convergence, their cumulative growth differentials increased from 20 to 45% compared to Germany, in 2007. This convergence was based on borrowed money and

accompanied by high inflation rates (Knot & Society, 2012). Correlation between countries can be observed by studying contagion. Missio & Watzka (2011) found that Portuguese, Spanish, Italian and Belgian yield spreads increase along with their Greek counterparts.

This period was then characterised by an environment of accelerating debt levels and high government deficits. Several banks suffered capital losses and member states had to bail out the affected banks.

2.2. CAUSES AND CONSEQUENCES

The financial crisis triggered several factors leading to the European Sovereign Debt Crisis. The main causes of the crisis were: member states highly indebted (Gupta, 2015); high structural deficits (Bruyckere *et al.*, 2013); and the Great Recession (Gupta, 2015).

The main consequences of the Eurozone crisis were: expensive bailouts which increase the likelihood of sovereign default (Acharya *et al.*, 2014); sovereign's and banks' downgrade by rating agencies (Alsakka & Gwilym, 2013); increase in unemployment (Lane, 2012); credit crunch (Acharya *et al.*, 2018); and contagion (Mink & de Haan, 2013; Allegret *et al.*, 2017).

Although there are common reasons for the peripheral countries to face this crisis, that are mentioned above, there are additional causes behind this that varied from country to country. For example, in Ireland, sovereign debt arised from the property bubble burst (Kelly, 2009), causing problems to Irish banks, which were downgraded to junk status (Corbet, 2014). In Spain, the increase in private debt emerging from the property bubble was shifted to sovereign debt, due to government measures and the bailouts that banks received (Dehesa, 2012). In Portugal, the recessions of 2002-2003 and 2008-2009 difficult Portuguese ability to repay their public debt (Lourtie, 2011).

Borrowing practices were stimulated by unusually lower interest rates and easy credit conditions (Fagan & Gaspar, 2007). The banks' investment in sovereign debt turned them sensitive to their default. Therefore, when some countries started to default on parts of their debt, banks highly exposed to the sovereign risk faced a

huge problem. Bruyckere *et al.* (2013) concluded that bank default risk related to country default risk increases with the banks' increasing of debt of that country on its balance sheet. They also concluded that this effect is stronger when country default risk rises. These conclusions confirmed the increased link and interdependence between banks and countries which is consistent with other studies (Beirne & Fratzscher, 2013; Acharya *et al.*, 2018). After the Greek crisis, highly indebted economies started to worry investors (Gupta, 2015). Bond investors demand higher rates of return when they expect that a government is likely to default on its part of the debt (Cochrane, 2011). The combined effect of increasing interest rates and the downgrade of sovereign bonds made Portugal, Ireland, Italy, Greece and Spain (PIIGS) unable to finance themselves (Waller *et al.*, 2012). PIIGS were then obliged to request for monetary help (Cline, 2012). On the other hand, bailouts triggered sovereign credit risk, and weakened the financial sector (Acharya *et al.*, 2014).

Analysing the evolution of public debt, before the crisis we can observe low spreads on sovereign debt, which indicates that markets weren't expecting default risk (Lane, 2012). In 2007-2008 US risky asset prices decrease affected European banks which invested in such assets, speeding European stock markets collapse (Ali, 2012). European banks used US asset-backed securities as a source of dollar finance, making them highly exposed to its losses (Acharya & Schnabl, 2010).

The global financial crisis was a confirmation for the interdependence within the financial system. With the 2007 financial crisis, the combined effect of domestic recessions, banking sector distress and decline in investors' risk appetite, fuelled the conditions for a sovereign debt crisis (Lane, 2012). One of the causes of this crisis was the fact that there were no sanctions for countries that violated the debt-to-GDP ratios, defined by Maastricht Criteria. Bruyckere *et al.* (2013) concluded that countries with higher public debt to GDP ratios in the crisis were more sensitive to domestic financial sector stress.

2.3. CRISIS EFFECTS

There are several studies supporting the interdependence between banks and sovereign risks; and contagion from a sovereign debt crisis to banks.

There is some evidence for the contagion of crisis. De Bruyckere *et al.* (2013) found that banks with weak capital buffer and a weak funding structure are more vulnerable to spillovers. They also found that at the country level the debt ratio is the most important driver of contagion. In their research, they found empirical evidence for both contagion, and an excessive correlation between banks and sovereign, as it was referred above. Their work supports the implementation of Basel III since they found that banks' capital adequacy level has a significant effect on contagion. The correlation between countries can be reduced by increasing the Tier 1 ratio. And the degree of contagion of banks and sovereign decreases with lower debt ratios (Debt-to-GDP ratio). Caruana & Avdjiev (2012) also found a correlation between banks and sovereigns.

Recapitalization of troubled banks using public funds can mitigate a banking crisis, but this action can be problematic if public debt and sovereign risk reach an excessive level (Acharya & Schnabl, 2010). Thus, the Sovereign Debt Crisis strengthened the relationship between bank and country risk.

High exposure of sovereign debt makes a country more vulnerable to rises in the interest rate it pays on its debt (Corsetti & Dedola, 2011). Vulnerability increases the probability of default, which makes investors demanding higher yields, making default even more likely (Lane, 2012).

2.4. MEASURES TAKEN

In order to mitigate the crisis effects the following measures were taken: provided bailout funds, austerity measures, reducing short-term interest rates and EBA stress tests (Cline, 2012).

Bailout funds were used to recapitalize banks. Some member states bailed out troubled banks, without a common resolution regime. These rescue operations increased the national debt and caused a deterioration of public finances (IMF Staff

and Note, 2009). Literature refers to the need and importance of having a sound fiscal and banking union (see Black *et al.* (2016), and Bruyckere *et al.* (2013)). The monetary union of the Euro area was not accompanied by a sound banking or fiscal union, financial regulation and fiscal policy remain at national responsibility. Lane (2012) argued for the fragility of a monetary union related to the absence of a banking union and other buffer mechanisms at a European level. The currency union brought advantages but also some problems. National governments were able to borrow in a common currency, which triggers some free-rider problems if there are strong incentives to bail out a country that borrows excessively (Beetsma & Uhlig, 1999). With the common currency, the euro, countries couldn't raise interest rates or print less currency, to decrease inflation (Lane, 2012; Waller *et al.*, 2012). Therefore, they couldn't avoid recession, leading tax revenues to fall and unemployment to increase (Knot, 2012; Allegret *et al.*, 2017; Cochrane, 2011).

Concerns increased as the crisis was developing, and measures were taken to mitigate its effects. ECB injected capital in troubled member states banks (De Bruyckere *et al.*, 2013). Some states were rescued by sovereign bailout programs, represented by Troika, which is constituted by the International Monetary Fund, European Commission and ECB (Lourtie, 2011). At the end of 2009, the Greek government announced that their budget deficit was larger than it was reported, leading to two bailouts under Troika supervision. Portugal and Ireland also received rescue packages supervised by Troika (De Bruyckere *et al.*, 2013). Raising taxes and lowering expenses, were measures taken by some governments that caused a social unrest environment (Cline, 2012). Eurozone countries had to reduce their spending, which could slow countries' economic growth, as with Greece (Mink and de Haan, 2013). Austerity measures slowed the Greek economy: unemployment increased, consumer spending was cut back, and the capital needed for lending was reduced (Waller *et al.*, 2012). The austerity measures were not well accepted by politicians, as seen by the intention to leave the EU by Greece. ECB intervened reducing short-term interest rates, providing extensive liquidity and entering into currency swap arrangements to facilitate access to dollar liquidity (Constâncio, 2012).

As a consequence of this crisis, a new form of financing appeared, Eurobond (Knot, 2012). In December 2010, Luxembourg's prime minister and Italy's finance minister proposed the issuance of Eurobonds (Juncker and Tremonti, 2010). They believed that the issuance of such an instrument would restore the debt of the member states (Curzio, 2011; Lourtie, 2011). The European Stability Mechanism (ESM) was established to provide immediate financial assistance programmes for the member states in financial difficulty (Knot, 2012). The ESM was funded with 700 billion euros, aiming to restore financial stability in the EU (Curzio, 2011).

The European Banking Authority (EBA) is one of the primary regulators of the EU banking industry, that aims to maintain financial stability in the banking sector (EBA, 2016). EBA also took measures to identify potential problems behind the crisis causes. It conducted sovereign stress testing exercise and required banks to rebuild capital plans (De Bruyckere *et al.*, 2013). The increased volatility in debt markets and the contagion in the euro area were important factors of the crisis period (Acharya *et al.*, 2014a). EBA annual transparency and stress tests allowed greater transparency in the European financial system and identified weaknesses in banks' capital structures (Berger & Bouwman, 2016). Transparency tests address information on banks' capital, risk-weighted assets (RWA), market and credit risk (Basel Commitee on Banking Supervision, 2011). Stress tests examine whether the bank would stay solvent in the event of a crisis (European Central Bank, 2010).

2.5. BASEL III

Basel III is an international regulatory framework, developed by the Basel Committee (Batista & Karmakar, 2017). It is composed by a set of measures arising from the deficiencies in financial regulation revealed by the 2007 financial crisis (Batista & Karmakar, 2017). The banking sector entered the financial crisis with too much leverage and inadequate liquidity buffers (Bcbs, 2015). Basel III was implemented in order to tackle banks' capital ratios risk sensitivity (Batista & Karmakar, 2017). This framework creates capital buffers, stipulates more Common Equity, introduces Leverage ratio, Liquidity coverage and Net Stable Funding Ratio (Batista and Karmakar, 2017). It strengthened bank capital requirements, increasing liquidity and decreasing leverage. After several revisions and adjustments, the

Basel Committee achieved the most recent version in September 2012[3]. That document embodies the core principles for effective banking supervision. It has the 29 principles, covering supervision powers, the need for early intervention and timely supervision actions, supervisory expectations of banks, and compliance with supervisory standards (BSB, 2012). Basel III demands a minimum leverage ratio requirement for banks of 3% (Batista & Karmakar, 2017). Osterberg and Thomson (1989); and Berger *et al.* (1995) emphasize the importance of legal capital requirements.

Some literature supported the deficiencies of having just this capital requirement. The major flaw of Basel II was that risk weights applied to the various asset categories failed to fully reflect the underlying risk in banks' portfolios (Batista & Karmakar, 2017). Vallascas & Hagendorff (2013) concluded that the calibration of regulatory capital requirements to portfolio risk is very weak. Basel II only marginally increased the risk sensitivity of capital requirements and introduced an asymmetric treatment of low and high-risk portfolios (Vallascas & Hagendorff, 2013). Basel III calls for a minimum leverage ratio requirement (Gambacorta & Karmakar, 2016). This ratio is defined as banks' Tier 1 capital over an exposure measure independent of risk assessment, which is the main improvement compared with the existing risk-weighted capital requirement (Ingves, 2014). The leverage ratio was set at 3%, and act as a complement and a backstop to risk-weighted capital requirement (Batista & Karmakar, 2017)..

The risk-weighted capital requirement indicates the capacity to absorb potential losses, and the leverage ratio represents the maximum loss that can be absorbed by equity (Gambacorta & Karmakar, 2016). The leverage ratio complements the risk-weighted capital requirement, but the opposite is also true, in fact they both complement themselves (Batista & Karmakar, 2017). During a boom phase, credit risk is low, so banks are motivated to expand the size of their balance sheets, reducing risk weights (Batista & Karmakar, 2017). The extension of credit can be excessive when the assessment of credit weights is overoptimistic, in a period with low interest rates (Gambacorta & Karmakar, 2016). Then, when credit risk

[3] See https://www.bis.org/bcbs/history.htm

materialises, bank capital act as a buffer to absorb the losses incurred (Batista & Karmakar, 2017). The leverage ratio counterbalances the impacts of falling risk weights, it is stricter constraint during booms, prevent the excessive increase in the size of banks' balance sheets and, therefore, the excessive risk-taking (Batista & Karmakar, 2017).

2.6. CAPITAL RATIOS

Our objective in this paper is to study the impacts of the European Sovereign Debt Crisis in banks' CET1 ratio. There is some literature regarding the effect of the European sovereign debt crisis on bank stocks. Bank's stocks decreased with the event of the crisis. Allegret, *et al.* (2017) concluded that rising sovereign risk of the three countries most affected by the crisis, decreased eurozone banks' stock returns. That finding is consistent with the remaining literature concerning contagion and transmission of sovereign risks to banks (Allegret *et al.*, 2017; Acharya *et al.*, 2018).

Previous literature also evaluates the effects on banks' capital ratios. Regulations that demand capital buffers to mitigate the adverse effect of the crisis seem to affect bank behaviour (Ediz, *et al.*, 2011).

There are studies relating to capital decisions and covering capital requirements. Berger *et al* (1995) conclude that there are two contrary forces that determine the banks' capital structure. Market capital requirement causes banks to hold capital against unexpected losses, increasing its capital buffers. On the other hand, the regulatory safety net is likely to lower bank capital. Mishkin (2000) refers that legal capital requirements are a determinant of the banks' capital structure. Bank managers have incentives to hold less capital than what is required due to the high costs of holding capital. Banks hold additional capital because they are required to do so by regulatory authorities. Berger, *et al.* (1995) refer to this as "market" capital requirement. This capital works as a cushion to absorb unexpected losses, if these losses exceed the buffer it could lead to bank failures. As referred, bank failures are considered contagious, so bank capital should be a regulated item. Barth *et al.* (2011) proved that the Basel Committee's regulation influence in banks' capital

level is much higher than required formally. Berger *et al.* (2008) argue that financial institutions manage and adjust their capital ratios and level to their own targets, set quite above the minimum regulatory.

2.6.1. CAPITAL RATIOS: MAIN FINDINGS

One can find some studies regarding the determinants of capital ratios, a measure that reflects a banks' stability. Ahmad, *et al.* (2008) studied the determinants of bank capital ratios of Malaysian banks. They found that banks' risk-taking is higher with increasing capital ratios, which is consistent with existent literature (See: Shrieves & Dahl, 1992). Shrieves & Dahl (1992) defend that a banks' reduction in debt-to-asset ratio, as a response to a higher capital requirement, will allow that bank to achieve its desired total risk, increasing its asset risk. According to Ahmad, *et al.* (2008) there is no significant correlation between bank managers' capital decisions and profitability, which is not consistent with prior researches (see Berger, *et al.* (1995) and Saunders & Wilson (2001)). This inconsistency might be justified because this study was carried out for a developing country. Although, Klepczarek (2015) also concludes that profitability (measured by ROA) is negatively related to capital level.

Brink & Arping (2009) find a negative correlation between size, asset structure (defined as RWA to total assets) and capital structure (defined as total liabilities to total assets) of a bank. Ahmad *et al.* (2008) and Klepczarek (2015) also support the finding that banks' size is negatively correlated with capital adequacy. Gropp & Heider (2008) confirm the negative correlation between banks' size and Tier 1 capital.

Since we also want to study CET1 ratio impacts, we took into consideration some variables used in past researches. The data used and the methodology followed are described in detail over the next section.

3. DATA AND METHODOLOGY

Our objective is to address the factors that influence the CET1 ratio in banks within the European Union. Our research question is:

What were the determinants of CET1 ratio in European Union banks after the Sovereign Debt Crisis?

This section describes the work that was done in this thesis. It focuses on the data and methodology used to answer our research question. It is structured as follows. Section 3.1 describes the sample used and the criteria applied to select it. Section 3.2 presents. Section 3.3 details the independent variables. Section 3.4 presents the model followed in this research. Subsection 3.4.1 refers to preliminary statistics, such as the descriptive statistics and the correlation matrix of the variables used. And section 3.5 presents the robustness analysis.

3.1 SAMPLE

We collected annual data for all our variables from *Bureau Van Dijk BankScope* database from 2011 to 2018. Our analysis is based on a selected sample of 137 banks within the EU, belonging to 27 countries.

This sample was obtained taking into consideration firm size and location. We filtered the search results from the database, considering the banks' natural logarithm of assets amount (bank size). From that screening, we selected the biggest 5 from each European Union country, when applied. Note that for some countries it was not possible to get 5 banks.

In our sample, we have 426 observations of the dependent variable.

3.2 DEPENDENT VARIABLE

Our goal is to address the determinants of the CET1 ratio, i.e the factors that affect CET1 ratio. Therefore, we consider it as the dependent variable in our model.

CET1 ratio refers to the coefficient between Common Equity Tier 1 Capital and the amount of RWAs[4]. It is widely used as a measurement of a banks' core equity capital. It measures a banks' capacity to withstand financial stress and remain solvent.

$$CET1\ Ratio = \frac{Common\ Equity\ Tier\ 1\ Capital}{Risk\ Weighted\ Assets}$$

The Capital Requirements Directive (2013/36/EU) and the Capital Requirements Regulation (575/2013) reflect Basel III rules on banks' capital requirements. Directive 2013/36/EU and Regulation (575/2013) are the transposition of the CRD IV package. CRD IV was introduced in 2013 as a result of several revisions of the original banking directive adopted by the European Commission. In 2008 it was made the first revision (CRD II) and in 2009 the original banking directive was revised once more (CRD III). The financial crisis period was marked by banks' vulnerability. Banks faced insufficient liquidity and insufficient quality and quantity of capital reserves. Aiming to overcome this issue CRD IV sets stronger prudential requirements for banks, requiring for sufficient liquidity and capital reserves. In order to keep track of this requirement, in the EU, the ECB establishes targets for the CET1 ratio. CET1 capital in the event of a crisis is the first deducted from this tier, so it is important to ensure that this ratio is above the required.

EBA performs annual stress tests using the CET1 ratio, to ascertain how much capital banks would have left in an adverse scenario. If banks do not respect the regulatory minimum, regulators might overtake them or shut them down.

We wanted to ensure residuals normality because the models used assumes it. To address if residuals are normally distributed, we perform a Shapiro-Wilk test. This test intends to check normality, its null hypothesis is that the population is normally distributed. Thus, if the p-value is less than the alpha level (1%, 5% or 10%), the null hypothesis is rejected, and therefore we don't have statistical evidence to confirm normality.

[4] Regulatory indicator used to define the minimum amount of capital that must be held by banks to reduce their risk of insolvency

Performing this test, we came out with a p-value of 0,078% (See Figure 2 in Appendix), so the null hypothesis is rejected. Nonetheless, Figure 1 in Appendix, shows that the Standardized normal probability plot fits the diagonal line. Additionally, in Figure 4, the kernel density graph shows the similarity with a normal distribution. Therefore, this means that residuals distribution is close to normal.

3.3 INDEPENDENT VARIABLES

Aiming to determine the factors that influenced the CET1 ratio, we used independent variables already used in previous literature. In our research, we focus on the strength of influence of the following variables: Total equity to total liabilities ratio, banks' size, Risk-Weighted Assets ratio, Return on Assets, Return on Equity, Ratio of Liquid Assets to Deposits, and a dummy variable.

EQTL represents the ratio of total equity to total liabilities which expresses bank leverage. Leverage measures how much capital comes using debt (borrowed funds). Low leverage leads to a high ratio of total equity to total liabilities. In contrast, high leverage leads to a lower total equity to total liabilities ratio. It is expected that when our dependent variable increases total equity to liabilities ratio also increases. High leverage banks would face difficulties raising new equity, and therefore, would hold less equity than low-leverage banks (Ahmad *et al.*, 2008). Thus, high leverage (low total equity to liabilities ratio) would probably reflect a lower CET1 ratio. In conclusion, we expect a positive relationship between this independent variable and the dependent variable of our model.

Size, measuring the banks' size, is expressed by the natural logarithm of the banks' asset. Klepczarek (2015) found that larger banks feel safer despite lower capital buffers, so they tend to have lower CET1 ratios. This is in line with the "Too big to fail" doctrine. Rime (2001) also finds a negative relationship between size and capital, large banks tend to increase their ratio of capital over RWAs less than others. According to previous literature, bank size is negatively related to capital (Ahmad *et al.*, 2008; Jacques & Nigro, 1997; Gropp & Heider, 2008; Brink & Arping, 2009; Bateni *et al.*, 2014; Asarkaya & Ozcan, 2007). However, Das &

Ghosh (2004) found that bank size doesn't have a significant impact on the ratio of capital over RWAs. Therefore, we expect that bank size is negatively related to CET1 ratio.

RWA_TA represents the Risk-weighted assets ratio. It is calculated as RWAs over Total assets, this ratio is used as a proxy of risk indicator. We expect a negative relation between RWAs to total Assets and CET1 ratio. An increase in RWAs leads to a higher RWA over Total assets ratio and to a lower CET1 ratio, as this is calculated as CET1 capital over RWA. Literature also confirms that this explanatory variable negatively affects the CET1 ratio (See: Klepczarek, 2015; Brink & Arping, 2009; Das & Ghosh, 2004; Asarkaya & Ozcan, 2007). Nonetheless this is not consensual, Jacques & Nigro (1997) found that changes in RWAs to total assets have a positive relation with changes in capital ratios. Which also makes sense, taking into consideration the interpretation of such ratio. Banks with higher RWA to total assets have more risky assets, which require higher capital buffers.

ROA expresses Return on Assets, which is a measure of profitability. This ratio is calculated as Net Income over Total assets. This variable tends to have a positive impact on capital. Rime (2001) found that *ROA* has a significant and positive impact on capital, concluding that profitable banks improve their capitalization through retained earnings. This statement is consistent with other studies (See: Das & Ghosh, 2004; and Bateni, *et al.,* 2014). However, others found that *ROA* has no impact on capital since it is not statistically significant (Klepczarek, 2015).

ROE represents Return on Equity, which is a measure of financial performance. This variable is commonly used as an alternative cost of capital, and it is calculated as Net Income over Equity. In previous literature, *ROE* shows a negative impact on capital (Bateni *et al.*, 2014; and Asarkaya & Ozcan, 2007). Adversely, Brink & Arping (2009) found that *ROE* in a country perspective has a significant positive impact in Germany, and in a year by year perspective has a positive impact in 2005. Others found that *ROE* has no significant impact on banks' capital ratios (Klepczarek, 2015).

LiquidAss_Dep represents the liquidity available to the total of short-term deposits of the bank. This variable is expressed by the natural logarithm of the

coefficient between Liquid Assets and Deposits. We expect that an increase in bank liquidity positively impacts banks' capital ratios since investors would require higher rates of return on bank shares (Angbazo, 1997). Ahmad *et al.* (2008) found that the ratio of total liquid assets to total deposits has a positive impact on banks' capital. Therefore, we expect that this variable has a positive correlation with the dependent variable.

We included a dummy variable ECB to capture the quantitative easing effect on CET1 ratio. It is unity for observations after 2014 and zero otherwise.

3.4 REGRESSION MODEL

According to previous literature, firstly we define a panel data, and then, we carried out a regression analysis. We perform some tests to our independent variables in order to detect problems such as: multicollinearity, heteroskedastic and omitted variables.

We formulate a regression model in accordance with past studies related to capital ratios. Our model expresses the CET1 ratio as function of a set of bank-specific variables, as well as external variables. Thus, the generic regression model is written as follows:

$$\boldsymbol{CET\,1}_{i,t} = \boldsymbol{\beta_0} + \boldsymbol{\beta_1 EQTL}_{i,t} + \boldsymbol{\beta_2 Size}_{i,t} + \boldsymbol{\beta_3 RWAs}_{i,t} + \boldsymbol{\beta_4 ROA}_{i,t} + \boldsymbol{\beta_5 ROE}_{i,t} + \boldsymbol{\beta_6 LiqAssetstoDep}_{i,t} + \boldsymbol{\beta_7 ECB}_{i,t} + \boldsymbol{\varepsilon}_{i,t}$$

where $\boldsymbol{CET\,1}_{i,t}$, CET1 ratio of bank i at time t; $\boldsymbol{EQTL}_{I,t}$, Total equity to total liabilities ratio of bank I at time t; $\boldsymbol{Size}_{i,t}$, represents the natural logarithm of total assets of bank i at time t; $\boldsymbol{RWAs}_{i,t}$, ratio of total risk-weighted assets total assets of bank i at time t; $\boldsymbol{ROA}_{i,t}$, return of assets of bank i at time t; $\boldsymbol{ROE}_{i,t}$, return of equity of bank i at time t; $\boldsymbol{LiqAssetstoDep}_{i,t}$, ratio of liquid assets over deposits of bank i at time t; $\boldsymbol{ECB}_{i,t}$, a dummy variable: equals one for the period after 2014 and zero otherwise, in order to investigate the quantitative easing[5] effect; and $\boldsymbol{\varepsilon}_{i,t}$ is the error term.

[5] It consists to an unconventional monetary policy, where the ECB buy and sell securities from the banking system, influencing the level of reserves that banks hold in the system, leading to increases in their balance sheets (Joyce *et al.*, 2012).

In our study we used five different models: Driscoll-Kraay regression, GLS regression, OLS regression, GLM and Arellano-Bond. We used a Driscoll-Kraay regression in order to correct heteroskedasticity problems. In this regression, the error structure is assumed to be heteroskedastic and possibly correlated between the panels (Driscoll & Kraay, 1998). This regression can be used in both balanced and unbalanced panels and can handle missing values.

GLS is more efficient than OLS under heteroscedasticity or autocorrelation (Meliciani & Peracchi, 2006). This was the motivation for us to use GLS since our data have heteroscedasticity. Nonetheless, we also used OLS to see the results in our data. OLS relies on several assumptions: linearity, random sampling observations, conditional mean equal to zero, no multicollinearity, homoscedasticity, no autocorrelation and normality of errors (Williams *et al*, 2013). Our data has heteroskedasticity, and residuals are not normally distributed so this could not be a reliable model to run, justifying the usage of GLS.

GLM is a generalization of ordinary linear regression that allows for dependent variables to have error distribution models other than normal.

The Arellano-Bond estimator is a generalized method of moments estimator used in dynamic panel data models (Roodman, 2006). This estimator assumes that the dependent variable has a lag effect (Roodman, 2006). What happens in the independent variable only affects the dependent in the period after.

3.4.1 PRELIMINARY STATISTICS

After selecting our sample and variables, we treated the chosen variables for our model. In annex, Table VI presents the descriptive statistics, that summarizes the features of our data collection. We can check that our sample has 426 observations of the dependent variable, and that CET1 ratio mean is 19,09%.

The maximum observed for CET1 ratio refers to KOMMUNINVEST I SVERIGE AB in 2017. This company is a Swedish local government funding agency. This observation (212 percent) is justified by the fact that this company's scheme helps municipal governments to raise capital through the issuance of bonds. On the other hand, the minimum observed value for CET1 ratio is reported by

PANCRETAN COOPERATIVE BANK in 2013. This company is a Greek regional cooperative bank, providing retail banking products and services to local privates, self-employed professionals and SMEs.

Regarding the minimum observed value for s*ize* variable reflects INBANK AS's reported size of 2015. The maximum reflects CREDIT AGRICOLE's reported size of 2011. INBANK AS was founded in 2015, which can explain the fact that it presents the minimum size of our sample. CREDIT AGRICOLE is one of the biggest banks in Europe, and in 2011 closed several agreements, e.g. the Carispezia acquisition.

Concerning the *RWA_TA* variable, the minimum value is the percentual reported amount by WELLS FARGO BANK INTERNATIONAL in 2017. The maximum reflects the amount reported by AEGEAN BALTIC BANK, a Greek credit institution, in 2016. The higher the Risk-weighted assets, the higher it will be the minimum amount of capital that must be held in order to reduce the risk of insolvency (Basel Commitee on Banking Supervision, 2011).

The minimum of the variable *EQTL* reflects CZECH NATIONAL Banks' bank leverage reported in 2017. The maximum refers to the EUROPEAN STABILITY MECHANISM's amount in 2014. EUROPEAN STABILITY MECHANISM is an international organisation that provides financial assistance to eurozone members whenever they are in financial difficulty. As referred in the previous section, low leveraged banks result in a higher ratio of *EQTL*, and high leveraged ones would have a lower *EQTL* ratio.

For *ROA*, the minimum value belongs to the 2013 NOVA KREDITNA BANKA MARIBOR D.D. reported amount. The maximum amount reflects the return on assets of INBANK AS in 2017.

The *ROE*'s minimum and the maximum observed value belong to ARBEJDSMARKEDETS TILLAEGSPENSION in 2018 and 2013, respectively. This is an investor of pension funds in Denmark.

And lastly, the minimum observed for the ratio of the natural logarithm of Liquid assets over short-term deposits refers to the observation of GE CAPITAL

EUROPEAN FUNDING in 2018. This is an Irish company formed with the purpose of issuing debt securities to repay existing credit facilities, refinance indebtedness, and for acquisition purposes. Liquid assets to deposits maximum observed value belongs to WELLS FARGO BANK INTERNATIONAL (Ireland) in 2011.

In annex, Table VII displays the correlation matrix of the variables used in our regression analysis.

Following the previous section, where we put forward our beliefs with respect to the correlation between the dependent and the independent variables, Table VII shows the real correlation between them.

As we can see, the size variable exhibits a negative relationship with the dependent variable. This is in accordance with previous literature (See: Klepczarek, 2015; Ahmad *et al.*, 2008; Bateni *et al.*, 2014).

RWA_TA also has a negative correlation with the dependent variable, meaning that an increase in RWAs variable will reflect a decrease in CET1 ratio. This responds to our expectations and is also in line with previous literature (Rime, 2001; Bateni *et al.*, 2014).

EQTL variable presents a positive correlation with CET1 ratio, pursuant to what we expected taking into consideration previous studies on capital ratios (Ahmad *et al.*, 2008).

It is observed that *ROA* has a positive correlation with the dependent variable. Although the impact of *ROA* in the CET1 ratio is not consensual in the literature, our results are in line with Bateni *et al.* (2014).

ROE in our regression seems to be negatively correlated with CET1 ratio. Past studies also confirm that *ROE* shows a negative impact on capital (Asarkaya & Ozcan, 2007; Bateni *et al.*, 2014).

The ratio between Liquid Assets and Deposits presents a positive relationship with CET1 ratio. Which means that when the ratio of Liquid Assets to Deposits increases, CET1 ratio tends to increase. That is aligned with our expectations presented in the previous section (Ahmad *et al.*, 2008).

Regarding our dummy variable ECB, it has a positive impact on CET1 ratio. This means that quantitative easing[6] implementation increased CET1 ratio. A decrease of commercial banks' assets, and therefore, of the denominator of CET1 ratio, which makes the overall ratio to increase (all else being equal).

3.5 ROBUSTNESS ANALYSIS

Performing a robustness analysis allows us to check if the results obtained stay the same given a change in inputs. Therefore, we replicate the model observing for the following effects: country, year, firm, random and fixed. Additionally, we correct *ROE* and CET1 ratio, submitting them to a winsor process.

Winsorizing will allow us to limit extreme values in our data in order to reduce the effect of possible spurious outliers (Rousseeuw & Leroy, 1987). Our data is not normally distributed, and as we know distribution can be heavily influenced by outliers (Mehmetoglu & Jakobsen, 2017). So, applying this transformation we can reduce the possibility of our data to be influenced by outliers. We only applied it to *ROE* and CET1 ratio because these variables had more extreme values. Winsorized estimators are usually more robust than the standard ones. Applying winsorization, our residuals seems to approximate more to a normal distribution, as you can see in kernel density graph (Figure 4 and 5).

Table I exhibits the descriptive statistics taking into consideration the corrections in *ROE* and CET1 ratio.

[6] ECB's measure of buying assets from commercial banks, as part of its monetary policy measures, supporting economic growth

Table I - Descriptive statistics (Robustness check)

Variable	Observations	Mean	Std deviation	Min	Max
CET1 Ratio_w	429	.184711	.1272641	.055	.8026
Size	863	23.80273	2.216189	17.56087	28.26205
RWA_TA	516	.4502035	.2364921	.0007195	1.083926
EQTL	863	.1472523	.8029398	-.0541251	14.21628
ROA	871	.0027281	.013841	-.1352	.0711
ROE_w	865	.0656516	.2613421	-1.1493	1.3367
LiquidAss_Dep	866	-1.045432	1.590327	-9.21034	12.02304
ECB	1,096	.625	.4843439	0	1

In Table I the variables signalized with "_w" are the ones that were submitted to winsorization.

The correlation between the dependent and independent variables is close to our model with the standard variables (Table VIII).

In addition to winsorization, we also performed different regressions. The objective is to reinforce the conclusions obtained, because findings based on a single method may distort the results. Thus, the application of several methods to address our research question will strengthen the results.

4. RESULTS

This chapter exhibit and discuss the results. Section 4.1 displays the results arising from our determinants' estimation of the CET1 ratio. Section 4.2 presents the robustness analysis results.

4.1 DETERMINANTS OF CET1 RATIO

What were the determinants of CET1 ratio in European Union banks after the Sovereign Debt Crisis?

In order to answer our research question, we assess the determinants of the CET1 ratio and present the results in Table II.

As we can observe, with an exception for Model 4 and 7, *size* presents a significant and negative impact in CET1 ratio. Large banks appear to have a lower CET1 ratio. For the two regressions in Model 4 and 7, *size* does not impact the CET1 ratio and has a positive coefficient, which is the opposite of what we expected. Larger banks tend to increase their capital ratios more than other banks (Rime, 2001).

In all Models, the *RWA_TA* is negatively related to CET1 ratio. This was already verified in previous literature (See, for example: Klepczarek, 2015; Brink & Arping, 2009). The correlation between risk and capital is often negative due to the difference in risk perception. The assets that a regulator classifies as a high level of risk are not considered as risky by managers (Wong *et al*, 2008). Thus, since our Models shows that *RWA_TA* negatively affects the CET1 ratio, it confirms the difference in risk perception within regulatory authorities and managers.

The results are consistent in all Models regarding *EQTL*. This variable presents a positive correlation with the CET1 ratio. As seen in previous literature, low leverage banks would have a higher CET1 ratio (Ahmad *et al*, 2008).

ROA and *ROE* don't have a significant impact on CET1 ratio. Nonetheless, their coefficients sign are in line with previous literature and with our expectations (See Klepczarek, 2015; Bateni *et al*, 2014).

In relation to the ratio of Liquid assets over deposits, we observe in Models 4, 6, 7 and 10 that it has a significant and positive correlation with the CET1 ratio. As we expected, banks with more liquidity appear to have a higher CET1 ratio (Ahmad *et al*, 2008).

The Quantitative Easing effect, that we express by ECB, appears to have a positive and statistical significance in all models except in Model 10. Model 10 represents an Arellano–Bond linear dynamic panel-data estimation, where it is considered the lag effect of the dependent variable. In other words, what happens in the independent variable only impacts the dependent one period after. Therefore, the Quantitative Easing effect of, for example, 2010 do not influence 2011's CET1 ratio.

Table II - Determinants of CET1 Ratio

VARIABLES	(1) Driscoll-Kraay regression	(2) Driscoll-Kraay regression	(3) Driscoll-Kraay regression	(4) Driscoll-Kraay regression	(5) Driscoll-Kraay regression	(6) GLS Regression	(7) OLS regression	(8) OLS regression	(9) GLM regression	(10) Arellano-Bond regression
size	-0.0184***	-0.0184***	-0.0140***	0.0414	-0.0184***	-0.0110***	0.0414	-0.0123**	-0.0184***	-0.1144***
	(0.0045)	(0.0045)	(0.0012)	(0.0252)	(0.0045)	(0.0012)	(0.0884)	(0.0049)	(0.0039)	(0.0375)
RWA_TA	-0.5785***	-0.5763***	-0.5635***	-0.3927**	-0.5785***	-0.3879***	-0.3927***	-0.5259***	-0.5785***	-0.7590***
	(0.0923)	(0.0961)	(0.0985)	(0.1447)	(0.0923)	(0.0182)	(0.1206)	(0.1199)	(0.0691)	(0.2069)
EQTL	1.0042***	0.9923***	0.9495***	1.2030***	1.0042***	0.9096***	1.2030**	0.9171***	1.0042***	1.1371**
	(0.0825)	(0.0815)	(0.0778)	(0.1835)	(0.0825)	(0.0637)	(0.5780)	(0.2111)	(0.1385)	(0.5152)
ROA	0.7430	0.6128	2.6459	5.4229	0.7430	0.1344	5.4229	3.9231	0.7430	0.4259
	(0.8865)	(0.8800)	(2.5964)	(3.1052)	(0.8865)	(0.4695)	(4.9586)	(3.4366)	(1.0399)	(0.8904)
ROE	-0.1527	-0.1494	-0.2782	-0.4761	-0.1527	-0.0404	-0.4761	-0.3781	-0.1527	-0.0027
	(0.1273)	(0.1310)	(0.2441)	(0.2677)	(0.1273)	(0.0453)	(0.4409)	(0.3176)	(0.0945)	(0.0663)
LiquidAss_Dep	0.0257	0.0248	0.0369	0.0383*	0.0257	0.0097***	0.0383*	0.0192	0.0257	0.0166**
	(0.0171)	(0.0169)	(0.0212)	(0.0165)	(0.0171)	(0.0021)	(0.0216)	(0.0244)	(0.0160)	(0.0065)
ECB	0.0356***		0.0455**	0.0404**	0.0356***	0.0183***	0.0404*		0.0356***	0.0339
	(0.0097)		(0.0151)	(0.0165)	(0.0097)	(0.0056)	(0.0213)		(0.0110)	(0.0224)
CET1_Ratio = L,										0.4097***
										(0.0578)
Constant	0.8012***	0.8080***	0.6819***	-0.8130	0.8012***	0.5204***	-0.7114	0.6250***	0.8012***	3.0690***
	(0.1642)	(0.1704)	(0.0563)	(0.6222)	(0.1642)	(0.0364)	(2.1458)	(0.1624)	(0.1319)	(0.9385)
Year Effects	No	Yes	No	No	Yes	No	No	Yes	No	No
Country Effects	No	No	Yes	No	Yes	No	No	No	No	No
Firm Effects	No	No	No	Yes	Yes	No	No	No	No	No
Wald Test	-	-	-	-	-	-	FE	-	-	-
Observations	390	390	390	390	390	390	390	390	390	246
R-squared	0.3583	0.3647	0.4175	0.6831	0.3583		0.1988			
Number of groups	77	77	77	77	77	77	77	77		
Number of id										68

Note: This table presents the results of the determinants of CET1 Ratio. Model 1 refers to a regression with Driscoll-Kraay standard errors. Model 2 is a regression with Driscoll-Kraay standard errors with year effects, while Model 3 is with country effects, Model 4 with firm effects, and Model 5 with year, country and firm effects. Model 6 is based on a GLS regression. Model 7 and 8 are OLS regressions with fixed effects and year effects, respectively. Model 9 is a generalised linear model. Model 10 is an Arellano–Bond linear dynamic panel-data estimation. Robust standard errors in parentheses. OLS= ordinary least squares; GLM= generalized linear model; GLS= generalized least squares

4.2 ROBUSTNESS ANALYSIS RESULTS

Table III exposes the results obtained replicating the models used and applying a winsorized process to CET1 ratio and *ROE*. We decide to do this transformation in these two variables given their discrepancy of minimum and maximum values. Despite these values were justified by the nature business of the entities that have such values, they are far from what is normal in our sample. Thus, we applied the winsorized process to these variables, in order to limit extreme values (Rousseeuw & Leroy, 1987). The robustness analysis strengthens the results that we came with. Results achieved with such transformations are similar to the results presented previously.

Size has a significant and negative correlation with CET1 ratio in all Models, except for Model 4 and 7, just like it had without winsorizing *ROE* and CET1 ratio. The difference is that with this transformation, in model 4 and 7 the coefficient is negative.

The results in *RWA_TA, EQTL* and *ROA* are consistent since they are the same with and without winsorizing. *RWA_TA* is significant and influences negatively the CET1 ratio. *EQTL* also remains significant and positively impacts the CET1 ratio. While *ROA* still has a positive coefficient but doesn't impact the CET1 ratio.

ROE, which was submitted to winsorization, is now significant in Models 6 and 9. Meaning that in Models 6 and 9 *ROE* does have a significant and negative impact in CET1 ratio. Regarding the rest of the Models, the results are consistent with the ones reported before.

Regarding the ratio between Liquid assets and deposits, the results are similar. In this hypothesis, it is significant and has a positive impact on the dependent variable in Model 3, in addition to Models 4, 5, 6, 7 and 10. Thus, it appears that now, *LiquidAss_Dep* has a positive and significant relationship with the CET1 ratio taking into consideration country effects.

Table III - Determinants of CET1 Ratio (Winsorized)

VARIABLES	(1) Driscoll-Kraay regression	(2) Driscoll-Kraay regression	(3) Driscoll-Kray regression	(4) Driscoll-Kraay regression	(5) Driscoll-Kraay regression	(6) GLS regression	(7) OLS regression	(8) OLS regression	(9) GLM regression	(10) Arellano-Bond regression
Size	-0.0149***	-0.0149***	-0.0186***	-0.0079	-0.0172	-0.0109***	-0.0079	-0.0096*	-0.0149***	-0.0886***
	(0.0021)	(0.0021)	(0.0024)	(0.0138)	(0.0174)	(0.0009)	(0.0480)	(0.0050)	(0.0025)	(0.0315)
RWA_TA	-0.5340***	-0.5330***	-0.5106***	-0.4101***	-0.3905***	-0.4092***	-0.4101***	-0.4264***	-0.5340***	-0.6105***
	(0.0689)	(0.0713)	(0.0734)	(0.1030)	(0.0990)	(0.0148)	(0.1014)	(0.0831)	(0.0551)	(0.1156)
EQTL	1.0327***	1.0254***	0.9385***	0.9370***	0.8185***	0.9364***	0.9370**	0.8526***	1.0327***	0.8342***
	(0.0594)	(0.0605)	(0.0724)	(0.1032)	(0.1019)	(0.0526)	(0.3735)	(0.2624)	(0.1327)	(0.2188)
ROA	0.6166	0.5821	1.2972	1.7317	1.7004	0.2749	1.7317	1.7528	0.6166	0.1982
	(0.7550)	(0.7454)	(1.7146)	(1.1137)	(1.0973)	(0.3638)	(1.6966)	(1.5708)	(0.7680)	(0.4922)
ROE_w	-0.1311	-0.1327	-0.1650	-0.1709	-0.1713	-0.0613*	-0.1709	-0.1814	-0.1311*	-0.0078
	(0.1058)	(0.1081)	(0.1757)	(0.0977)	(0.0992)	(0.0369)	(0.1768)	(0.1638)	(0.0770)	(0.0524)
LiquidAss_Dep	0.0094	0.0090	0.0159*	0.0230**	0.0185*	0.0041***	0.0230**	0.0101	0.0094	0.0163***
	(0.0067)	(0.0065)	(0.0082)	(0.0079)	(0.0081)	(0.0014)	(0.0114)	(0.0118)	(0.0081)	(0.0063)
ECB	0.0279***		0.0315***	0.0281**	0.0188***	0.0156***	0.0281**		0.0279***	0.0240**
	(0.0063)		(0.0078)	(0.0101)	(0.0037)	(0.0041)	(0.0123)		(0.0080)	(0.0110)
CET1_Ratio_w = L,										0.3501**
										(0.1455)
Constant	0.6743***	0.6798***	0.7489***	0.4181	0.6924	0.5211***	0.4786	0.5087***	0.6743***	2.4304***
	(0.0771)	(0.0808)	(0.0876)	(0.3387)	(0.4769)	(0.0280)	(1.1726)	(0.1401)	(0.0777)	(0.7881)
Year Effects	No	Yes	No	No	Yes	No	No	Yes	No	No
Country Effects	No	No	Yes	No	Yes	No	No	No	No	No
Firm Effects	No	No	No	Yes	Yes	No	No	No	No	No
Wald Test	-	-	-	-	-	-	FE	-	-	-
Observations	390	390	390	390	390	390	390	390	390	246
R-squared	0.5025	0.5070	0.5651	0.8690	0.8726		0.3579			
Number of groups	77	77	77	77	77	77	77	77		
Number of id										68

Note: This table presents the results of the determinants of CET1 Ratio. Model 1 refers to a regression with Driscoll-Kraay standard errors. Model 2 is a regression with Driscoll-Kraay standard errors with year effects, while Model 3 is with country effects, Model 4 with firm effects, and Model 5 with year, country and firm effects. Model 6 is based on a GLS regression. Model 7 and 8 are OLS regressions with fixed effects and year effects, respectively. Model 9 is a generalised linear model. Model 10 is an Arellano–Bond linear dynamic panel-data estimation. Robust standard errors in parentheses. OLS= ordinary least squares; GLM= generalized linear model; GLS= generalized least squares

In Table III we observe that ECB is positive and statistically significant in every Model. With the winsorization process, the effect caused by the Quantitative Easing in period 0 will affect the CET1 ratio in period 1.

The robust analysis results confirm the results and strengthen the conclusions reached.

5. CONCLUSION

This work aims to identify the determinants of the CET1 ratio of European banks between 2011 and 2018. Our results are mainly aligned with existing literature.

We found that larger banks have lower CET1 ratio. This is in line with the "Too big to fail" doctrine. Larger banks feel safer, so they don't feel the need to have capital buffers (Klepczarek, 2015).

Riskier banks have a lower CET1 ratio (Das & Ghosh, 2004; Asarkaya & Ozcan, 2007). This can be justified by looking at the formulas of both ratios. The ratio to measure risk is calculated as RWAs over Total Assets, and the CET1 ratio is calculated as CET1 capital over RWA. Increasing the RWAs, and consequently the banks' risk, we are simultaneously decreasing the CET1 ratio. In our study, we verified that variable *RWA_TA* negatively correlates with the CET1 ratio.

We have evidence to conclude that banks with a lower ratio of total equity to liabilities have a lower CET1 ratio. High leverage banks would hold less equity since they face difficulties in raising equity, so their CET1 ratio would be lower (Ahmad *et al.*, 2008).

We also found that banks with more liquidity are more solvents. Liquidity has a positive impact on banks' capital ratios (Angbazo, 1997; Ahmad *et al.*, 2008). Higher liquid banks have an easier ability to transfer hard assets into cash, so they have more ease to money assess. In case of a crisis they would be in advance.

Additionally, the measure held by ECB to purchase financial assets appears to increase the banks' capacity to absorb potential losses, since it has a positive impact in CET1 ratio.

The present paper contributes to the already existing literature. Nonetheless, further research on this topic needs to be undertaken, given the subject's importance.

Our study limitation regards mainly the data used. Due to unavailable data we could not use a larger period, which would be much more interesting. We had constraints in the period used and the data available by bank. With a larger period, we could address better the Sovereign Debt Crisis effects. Results would have been more robust if we had the same data available for all the banks in our sample. We did not have the same number of observations by banks. If we had used only quoted banks in our study, we might not have such problems, but by doing that selection, we would be biased our sample. Choosing only quoted banks would result in a sample composed only by banks with the greatest importance in the financial system.

Future researchers should use larger samples to robust their results, in order to overcome the problem of unavailable data. It would also be interesting to use a wider timeframe. This will only be possible when there is a database with extensive financial information about all banks, and not only about the quoted ones.

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ANNEX

Table IV - Literature Review Summary Table of Empirical Papers

Author (year)	Country/Region	Period	Methodology	Dep. Variable	Ind. Variables	Main Conclusions
Ahmad et al (2008)	Malaysia	1995-2002	Assess determinants of bank capital ratios (OLS, FGLS)	CAR- Capital adequacy ratio	NPL to Total loans; Risk index; Size; Net interest margin; Total equity to total liabilities; Total liquid asset to total deposit; Dummy equals 1 for low capitalized banks; Dummy equals 1 for period 1999-2002; Dummy equals 1 for year 1996	Strong positive relationship between regulatory capital and bank management's risk-taking behaviour. Regulators' risk-based capital standards didn't impact regulatory capital adjustment by low-capitalized banks. Bank capital decisions are not driven by bank profitability.
Klepczarek (2015)	22 European countries	2013	Examines the determinants of CET1 ratio (OLS)	CET1 ratio	Size; ROA (profitability); ROE; Competitive pressure (average country CAR 1 ratio); Share of deposits in non-equity liabilities; RWA/Total Assets; Loans/Total Assets; Average country inflation rate	Bank size and the risk indicators have impact on banks' capital adequacy. There is a strong effect of competitive pressure, and a negative correlation between CET1 ratio and the share of deposits in non-equity liabilities.
Gropp et al (2008)	USA and 15 EU members	1991-2004	Addresses the capital structure of banks from the perspective of empirical capital structure	Tier 1 capital ratio	Market-to-book ratio; Profitability; Size; Collateral; Ln(Asset volatility); Dummy for dividend payers	Banks appear to have stable capital structures at levels that are specific to each individual bank. Capital requirements are second-order importance for banks' capital structures.

Vallascas et al (2013)	41 worldwide countries	2000-2010	Evaluates risk sensitivity of minimum capital requirements (GMM)	RWATA- Regulatory risk assessment	Asset volatility; Size; ROA; Buffer (Regulatory capital ratio minus minimum required capital ratio (%)); Deposits[7]; Loans; Non-interest income; Basel II (Dummy equals 1 if Basel II is adopted); IRB (Dummy equals 1 if bank has adopted internal ratings-based approach); Standardized (Dummy variable equals 1 if bank adopted the standardized approach); Shadow banking (Total value of securitized assets over total GDP (%)); Capital regulation (index); Regulatory strength (index); GDP growth	RWAs are ill calibrated to a market measure of bank portfolio risk. This low-risk sensitivity of capital requirements allows banks to build up capital buffers by underreporting their portfolio risk and undermines banks' ability to withstand adverse shocks. Risk sensitivity of capital requirements is higher for banks that have adopted Basel II.
Bondt & Prast (1999)	Germany, France, Italy, Netherlands, UK and UK	1990-1997	Assessing empirically the determinants of changes in risk-weighted bank capital ratios in a cross-country perspective	Tier 1 ratio Total capital adequacy ratio (RACR- risk-adjusted capital ratios)	Cost of capital- Net Income/Average Equity*100; Loan ratio- Loans/Total Assets*100; OBS ratio: On balance sheet items/Total assets*100; Asset growth; Bank sentiment: Bank share index minus Total market index (%); Trend; Dummy capitalisation: 1 if RACR < median, 0 otherwise	Bank-specific characteristics and the degree of undercapitalization are relevant for bank capital ratios. Capital regulation seems to be effective in influencing bank capital ratios.

[7] Vallascas et al (2013) defined the variable Deposits as the ratio of customer deposits over total liabilities, and it is a variable with a significant and positive impact on RWAs to total assets ratio

Saunders & Wilson (2001)	Worldwide countries	1893-1992	Test business-cycle sensitivity of the relationship between charter value and capital structure decisions (Pooled time series cross sectional)	Log (1-MCAP[8])- log leverage	Equity return index; Short-term bill return series; Long-term bond return series; Cash reserves to Total assets; Loans to Total assets; Size; National bank indicator; Trust company indicator; Bank holding company indicator; Charter value measure; Interaction variable (charter value measure*equity return index)	During economic expansions, bank charter values increase, reflecting growth opportunities. There is a positive relationship between charter value and capital ratios during expansions. The charter value and bank leverage relationship are sensitive to market conditions.
Rime (2001)	Switzerland	1989-1995	Assess whether and how Swiss banks react to constraints placed by the regulator on their capital (Pooled cross-sectional data)	Change in capital ratios Change in risk levels	Size; ROA; Regulatory pressure; Current loan losses; REG (Dummy equals one if banks' capital ratio is within 1 s.d. of the minimum capital requirement); Capital to Total assets; Capital to RWA; RWA to Total assets	Swiss banks close to the minimum regulatory capital requirements tend to increase their ratio of capital to RWAs, which indicated that regulatory pressure induces banks to increase their capital. Regulatory pressure has no impact on banks' risk-taking.
Brink & Arping (2009)	G10[9] and Switzerland	2002-2008	Assesses the link between Tier 1 ratio on bank and macroeconomic factors (OLS)	Tier 1 capital ratio	Interest coverage ratio; ROE; Net interest margin; Size; Total Liabilities to Total Assets (capital structure); RWA to Total Assets (asset structure)	For almost each country and year a banks' size, asset and capital structure are negatively related to its Tier 1 capital ratio.

[8] MCAP stands for banks' Market Capital Ratio
[9] G10 is composed by USA, UK, Italy, France, Germany, Japan, Canada, Netherlands, Belgium and Sweden

Jacques & Nigro (1997)	USA	1990-1991	Examines the risk-based capital impact on bank capital (3SLS- three-stage least squares)	Change in capital ratios Change in risk levels	Size; BHC (Dummy equals to one for banks belonging to a multibank holding company); LEVD (Dummy equals to one for banks with less than 5% leverage ratio); Cap [10]period before; Change in RWAs to Total assets; Income to Total assets; Regulatory pressure variables (RPL and RPG); Intercept; Size; BHC (Dummy equals to one for banks belonging to a multibank holding company); LEVD (Dummy equals to one for banks with less than 5% leverage ratio); RWAs to Total Assets period before; Change in Cap; Regulatory pressure variables (RPL and RPG);	Risk-based capital standards were effective in increasing capital ratios and reducing portfolio risk in commercial banks.
Bateni et al (2014)	Iran	2006-2012	Assess capital adequacy determinants (Panel Data regression)	Capital adequacy ratio	Size; Total loans to Total assets; ROE; Total deposits to Total assets; Total deposits to Total assets; RWAs to Total Assets; ROA; Total Equity to Total Assets	Capital adequacy ratios is adversely affected by banks' size. RWAs to Total assets and Total deposits to Total assets have no impact in capital adequacy ratios.
Asarkaya et al (2007)	Turkey	2002-2006	Analyses the determinants of capital structure in Turkish banking sector (GMM)	Capital adequacy ratio	RWAs to Total assets; ROE; Share of deposits in non-equity liabilities; GDP (quarterly); Average capital adequacy ratio of the sector; Size	Portfolio risk, economic growth, average capital level of the sector and return on equity are positively correlated with capital adequacy ratio. Share of deposits are negatively correlated with capital adequacy ratio.

[10] Defined as the ratio of total capital (Tier 1 + Tier 2) to Total RWAs

Ediz et al (1998)	UK	1989-1995	Impact of bank capital requirements on its capital ratio decisions (Multivariate regression)	Tier 1 capital ratio Tier 2 capital ratio	Change in trigger dummy (equals 1 if the bank has experienced an upward adjustment in its trigger ratio in the previous 3 quarters); Fee income to Net interest income; Net interest income to Total RWAs; Deposits to Total RWAs; RAR trigger less than 1 s.d (equals 1 if RAR is less than one bank-specific standard deviation above the banks' trigger); Off-balance sheet assets to Total RWAs; Profit and loss to Total RWAs; Total provisions; 100 percent weighted assets to Total RWAs; Lagged dependent variable	Capital requirements seem to affect bank behaviour over and above the influence of the banks' own internally generated capital targets. Capital requirements appear to be an attractive regulatory instrument, since they reinforce the stability of the banking system.
Ghosh & Das (2004)	27 banks in India	1996-2001	Investigates the link between changes in risk and capital (SUR[11] and 2SLS)	Change in capital ratios Change in risk levels	Intercept; Size; REG (Dummy equals one if banks' capital is at least equal to the regulatory minimum); Cap[12] period before; Cap*REG; Change in Non-performing assets; Change RWA to Total assets; ROA Intercept; Size; REG (Dummy equals one for banks with total capital ratios below 8%); Risk period before; Change Cap; Change in Non-performing assets;	Large banks increased their ratio of capital to RWAs less than other banks. Regulatory pressure has negative and significant impact on the ratio of capital to RWAs. Risk exposure and capital levels are related, most of banks mitigate the effects of increases in capital by decreasing asset risk posture.

[11] SUR stands for Seemingly Unrelated Regression
[12] Ghosh & Das (2004) defines Cap as Capital to Total RWAs

Table V - Literature Review Summary Table of Independent Variables

Independent Variables	Studies	Conclusions regarding this variable
Size	Ahmad et al (2008)	Negative relationship between size and capital, so large banks face less pressure to raise capital. However, under FGLS bank size is not a determinant of bank capital.
	Vallascas et al (2013)	Size doesn't have a significant impact on the ratio of RWA to Total Assets.
	Klepczarek (2015)	Bank size and CET1 ratio are negatively correlated. Larger banks feel safer despite their lower capital buffers (Too big to fail doctrine).
	Saunders & Wilson (2001)	Bank size is positively related to leverage.
	Rime (2001)	Size has a negative and significant impact on capital (defined as Capital to total assets and capital to RWAs), large banks increase their ratio of capital to RWA less than others. This variable has a positive impact on the ratio of RWA to total assets.
	Jacques & Nigro (1997)	Bank size is inversely related to changes in Tier 1 plus Tier 2 capital to RWAs ratio, and has a positive impact in RWAs to total assets ratio.
	Gropp et al (2008)	Size has a significant and negative impact on regulatory tier 1 capital ratio, smaller banks have more Tier 1 capital.
	Brink & Arping (2009)	In a country by country perspective, size has a negative relation with Tier 1, with exception for Germany. In a year by year perspective, size has a negative relation with the dependent variable except for 2008.
	Ghosh & Das (2004)	Size has no significant impact on the ratio of capital to RWAs, but it has a significant and positive impact on RWAs to total assets ratio.
	Bateni et al (2014)	Size is negatively related with capital adequacy ratio.
	Asarkaya et al (2007)	Size has a significant negative relationship with capital adequacy ratio.
Total Equity to Total Liabilities	Ahmad et al (2008)	Positive relationship between bank leverage and the risk-weighted capital adequacy ratio.
Liquid Assets/Deposits	Ahmad et al (2008)	The ratio of total liquid asset assets to total deposits has a positive impact on bank capital.

RWA to Total assets	Klepczarek (2015)	RWAs to total assets ratio negatively affects CET1 ratio, confirming the difference in the risk perception within the regulatory authorities and the managers.
	Rime (2001)	The changes of this variable have a significant and positive relationship with the changes in capital to total assets ratio, and a non-significant relationship with RWAs to total assets ratio.
	Jacques & Nigro (1997)	With Risk-based capital ratio constraints, both lagged RWAs to total assets ratio and changes in RWAs to total assets ratio are significant to changes in Tier 1 plus Tier 2 capital to RWAs ratio and changes in RWAs to total assets ratio, respectively. The lagged RWAs to total assets ratio has a negative relation with changes in RWAs to total assets ratio. Changes in RWAs to total assets have a positive relation with changes in Tier 1 plus Tier 2 capital to RWAs ratio.
	Brink & Arping (2009)	In a country perspective RWA to total assets negatively impact Tier 1 ratio, with exception for Sweden. In a year perspective it always has a negative impact.
	Ghosh & Das (2004)	The change in RWA to Total assets, using the SUR estimates, has a significant negative impact in capital to RWAs, although, using 2SLS estimates it is not statistically significant.
	Bateni et al (2014)	The ratio of RWAs to total assets do not have any impact on capital adequacy ratio.
	Asarkaya et al (2007)	RWAs to total assets is negatively and significantly correlated with capital adequacy ratio.
ROA	Vallascas et al (2013)	ROA is statistically significant and has a positive relationship with the ratio of RWA to Total Assets. Profitable banks have less incentives to engage in capital arbitrage by reporting lower RWA to Total Assets ratios.
	Klepczarek (2015)	ROA is not statistically significant.
	Rime (2001)	ROA has a significant and positive impact on capital (defined as Capital to total assets and capital to RWAs). Profitable banks improve their capitalization through retained earnings.
	Ghosh & Das (2004)	ROA has a significant and positive impact on capital to total RWAs ratio.
	Bateni et al (2014)	ROA has a significant and positive relationship with capital adequacy ratios.
ROE	Klepczarek (2015)	ROE is not statistically significant and shows a very low positive sign coefficient.
	Brink & Arping (2009)	In a country perspective, ROE has a significant positive impact on Tier 1 ratio only in Germany. Regarding a year by year analysis, ROE has a significant positive impact only in 2005. The higher the ROE, the more value a bank creates.
	Bateni et al (2014)	ROE has a significant and negative impact in banks' capital adequacy ratio.
	Asarkaya et al (2007)	ROE has a significant and negative impact when instruments started with lag 3.

Table VI - Descriptive statistics

Variable	Observations	Mean	Std deviation	Min	Max
CET1 Ratio	429	.1909084	.176169	.0283	2.124
Size	863	23.80273	2.216189	17.56087	28.26205
RWAs	516	.4502035	.2364921	.0007195	1.083926
EQTL	863	.1472523	.8029398	-.0541251	14.21628
ROA	871	.0027281	.013841	-.1352	.0711
ROE	865	2.762275	77.98345	-56.1166	2292
Liquid Assets to Deposits	866	-1.045432	1.590327	-9.21034	12.02304
ECB	1,096	.625	.4843439	0	1

Figure 1- Standardized normal probability plot

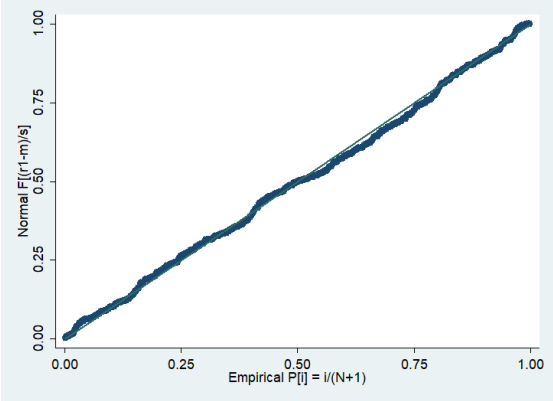

Table VII - Correlation matrix

	CET1 ratio	size	RWAs	EQTL	ROA	ROE	LiquidAsse	ECB
CET1 ratio	1							
size	-0.0217	1						
RWAs	-0.3864*	-0.5515*	1					
EQTL	0.0467	0.0804*	0.6183*	1				
ROA	0.0909*	-0.0016	-0.0776*	-0.0014	1			
ROE	0.1329*	0.023	-0.2661*	-0.0065	0.0305	1		
LiquidAsse	0.2914*	0.1839*	-0.2583*	0.0597*	0.0866*	0.0793*	1	
ECB	0.1660*	0.0003	-0.0204	0.0158	0.1349*	-0.053	-0.0051	1

Table VIII - Correlation matrix (Robustness check)

	CET1 ratio_w	size	RWAs	EQTL	ROA	ROE_w	LiquidAsse	ECB
CET1 ratio_w	1							
size	-0.042	1						
RWAs	-0.4424*	-0.5515*	1					
EQTL	0.1101*	0.0804*	0.6183*	1				
ROA	0.1217*	-0.0016	-0.0776*	-0.0014	1			
ROE_w	0.1744*	0.1327*	-0.2786*	-0.0309	0.5334*	1		
LiquidAsse	0.2304*	0.1839*	-0.2583*	0.0597*	0.0866*	0.1432*	1	
ECB	0.2015*	0.0003	-0.0204	0.0158	0.1349*	0.1196*	-0.0051	1

Figure 2- Shapiro-Wilk test output

Shapiro-Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
r1	**514**	**0.98921**	**3.720**	**3.162**	**0.00078**

Figure 3- Kernel density graph

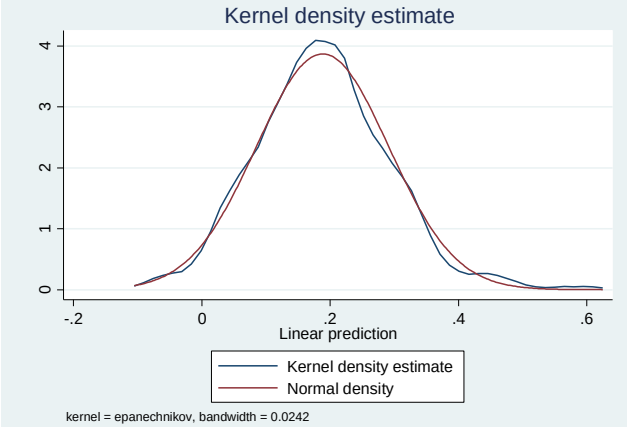

Figure 4- Standardized normal probability plot (Robustness check)

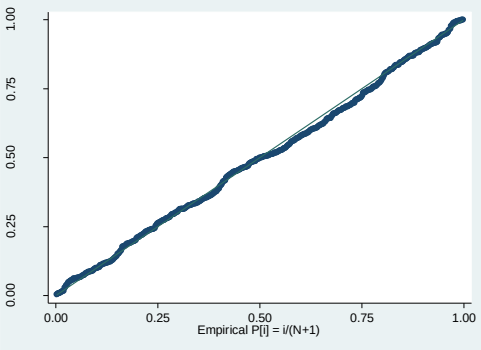

Figure 5- Kernel density graph (Robustness check)

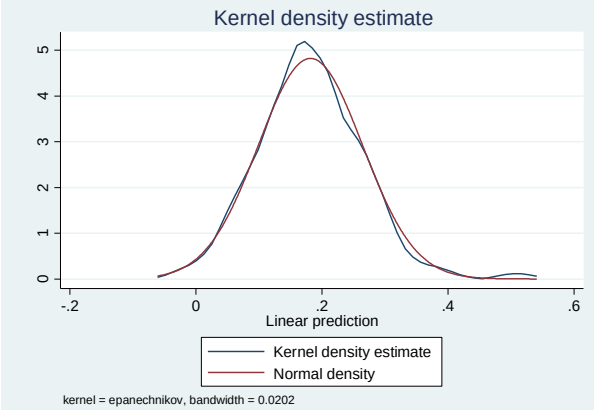

Figure 6- Residuals histogram (Robustness check)

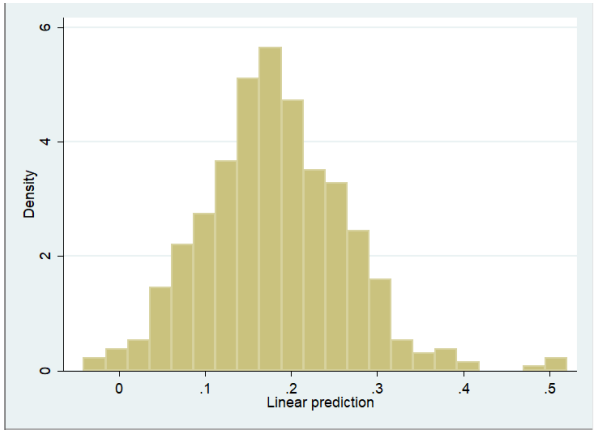

Figure 7- Dependent variable's Histogram

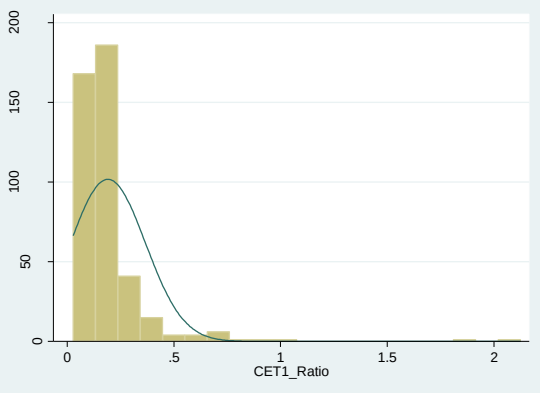

Figure 8- Residuals histogram