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The relation between capital ratios and banks' financial performance.

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Abstract

This dissertation seeks to answer a question on which there is a vast literature but not much consensus: the relation between the capital ratios and banks' financial performance. This questions is revisited resorting to a two-steps analysis, by firstly estimating the linear correlation on all the performance and capital parameters as dependent and independent variables respectively, followed by a multiple regression analysis, employing only a set of the variables analysed in the correlation analysis. This analysis led to the conclusion that capital ratios hold a negative relationship with banks' financial performance. Moreover, this dissertation has also found that when employing net income over assets or return on assets the results are consistent, independently on which variable is adopted as dependent variable. On the contrary, the conclusions are quite different when analysing the Total Capital to risk-weighted assets ratio or the Total Capital to total assets ratio.

A presente dissertação, visa responder a uma questão para a qual existe uma vasta literatura mas pouco consenso: A relação entre os requisitos de capital e a performance dos bancos. Esta questão é respondida com recurso a uma análise bifásica, através de uma primeira análise de correlação linear às variáveis de performance e capital como variáveis dependentes e independentes respetivamente, e a segunda análise, através de regressões, visou apenas parte das variáveis analisadas na correlação.
As análises realizadas permitiram concluir que os requisitos de capital se relacionam negativamente com a performance dos bancos. Adicionalmente, a presente dissertação permitiu também concluir que independentemente da variável utilizada para caracterizar a performance, seja o Resultado Liquido sobre o Total de ativos ou o RoA, os resultados são consistentes. Pelo contrário, o mesmo não se observou ao nível do denominador do capital, isto é, verificou-se que as conclusões são distintas adotando o RWA ou o Total de Ativos como denominador do Capital.

JEL Classification: C1; C33; G2
Key words: Basel III, Capital Requirements, Banking, Europe banking, Bank Profitability, Finance
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1. List of Acronyms

(SCP) structure–conduct–performance

(RWA) Risk- Weighted Assets

(ROA) Return on Assets

(ROE) Return on Equity

(TA) Total Assets

(NI) Net Income

(BIS) Bank for International Settlements

(MENA) Middle East and North Africa

(U.S.) United States

(GDP) Gross Domestic Product

(GIIPS) Greece, Ireland, Italy, Portugal and Spain

2. Introduction

By definition, firms (and banks) are profit-maximizing agents. Their ability to generate profits can however be conditioned by several factors. Regulation may be one of those factors, especially in the banking sector. Banks are subject to capital requirements, anchored on the frameworks set up by the Basel Committee. These started as a regulatory response to improve banking industry regulation and risk management. Minimum capital requirements are one of Basel's key principles, though banks and investors interpret them differently.

This dissertation intends to answer a controversial question on which there is a lot literature but little consensus: is there a relationship between capital requirements and banks' financial performance and if so, is it positive or negative? This question may only be answered by analysing data representing each definition for a specific time and place. This study will focus on the Net Income (NI), Return on Assets (ROA) and Return on Equity (ROE) in representation of the bank's financial performance, and the Tier1 Capital, Tier2 Capital and Total Capital representing capital ratios. These variables will be analysed for a large set of European banks for the 10-year period comprehended between 2011 and 2020.

The results suggest that there is indeed a relationship between capital ratios and banks' financial performance. This relation is negative, even though it can depend on the ratio employed (if applying the risk-weighted assets (RWA) or Total Assets (TA) as the denominator of the Total Capital amounts). However, and taking into consideration the information associated to each parameter, TA and RWA, it was considered that the RWA would bring more information to the analysis than the TA. Furthermore, this dissertation has also found that employing the NI to TA or the ROA the results are consistent, independently on which variable is adopted as dependent variable. On the opposite, conclusions are also quite different when analysing capital ratios as the Total Capital to RWA ratio or the Total Capital to TA ratio, given that the first suggests a negative relation while the latter a positive one.

The dissertation is structured in five chapters. The first one is the current one, the introduction. It is followed by the Literature Review, where it is summarized the existing literature on the relations between risk, capital and profitability. The third chapter is about the Methodology, discussing the existing literature on the key variables to consider in the study, so as the way to treat them. This chapter is also useful to perform a data description and the data quality analysis in order to ensure the greatest data integrity. The fourth chapter consists on the analysis of the correlations and regressions

and their results. The fifth and final chapter is the conclusion, where the main takeovers on the relation in study are described, as well as future ideas to take into consideration on future studies on the topic.

3. Literature Review

3.1. A Framework Capital Requirements and Basel guidelines

Framed in the Basel regulations, capital requirements started as a regulatory response to improve banking industry supervision and risk management. The Basel regulation has upgraded and increased substantially its importance after the Financial Crisis of 2008 by enhancing the requirements for financial stability, transparency and disclosure (CFI - Basel III - Overview, History, Key Principles, Impact s.d.). The minimum capital requirements represent one of Basel's key principles, and banks and investors have interpreted this differently during time. As this dissertation intends to evaluate the relationship between banks' capital and performance, it is also important to frame capital on its various relationships, consequently taking into consideration what other relations capital requirements may hold.

Lending operations tend to represent an important source of earnings for the commercial banking system, therefore it is important to understand whether and how lending and profitability are related. Through a deep analysis, a relation is indeed confirmed (Bridges, et al. 2014), even though a modest one (Berrospide e Edge 2010),(Karmakar e Mok 2015). More importantly, it was acknowledged a relationship between better capitalized banks and lending (Gambacorta e Mistrulli 2004). According to this foundation, the higher the levels of capital, the lower will be the impact of regulation on bank's lending. Considering lending is affected by the level of capital banks hold, then profitability should also be impacted, as the lending operations are among the main operations that a traditional bank performs.

3.2. Relationship between capital and profitability

Capital and profitability are two variables with great importance, affecting the performance of each other. According to several studies, shown through different perspectives, capital and profitability hold a positive relationship, meaning that the higher the levels of capital, the higher the bank's profitability, and vice-versa. In a 168 bank sample in 17 MENA countries, (Bitar, Saad and Benlemlih 2016) have concluded that banks with higher capital ratios are the more efficient and profitable ones, particularly for 'too-big-to-fail' banks and the ones domiciled in well-governed countries.
An Asian banking system driven study also documented a positive relation between capital and profitability (Lee e Hsieh 2013)**.** Identically, (Berger 1995) states a positive relation between capital

and earnings, but an additional conclusion was taken with relevance to this study - the fact that forced increases of capital levels do not necessarily follow the positive relation. According to (Berger 1995), when facing forced increases of capital levels, banks are forced to leave their optimal capital levels and consequently there is a negative impact on profitability. However, (Bandta, et al. 2018) found evidence that voluntary increases in capital have a positive impact on the RoA once banks have the opportunity to adjust the levels of capital to their strategies. Furthermore, an increase in the capital requirements was found to be harmful in bank performance and stability and contribute to a higher banking-system fragility in some Asian countries (Barth, Caprio, Jr. e Levine 2006) and (Barth, Caprio Jr. e Levine 2008).

On the other hand, there are also authors claiming a negative relation between capital and profitability. (Goddard, et al. 2010) discusses the opportunity cost of holding higher levels of capital as the lessening of the shareholders returns. (Berger 1995) also evidences a negative relation, but when banks face forced increases of capital levels.

A transversal idea is hence that the positive or negative relation depends on the bank's freedom to hold more or less capital (Mehran e Thakor 2011)**.** Nevertheless, in light with the stricter capital requirements with which banks must comply with, and also a well-defined computation methodology, the optimal level of capital may not be a decision for some institutions. Thus, it is important to study whether facing the stricter capital requirements implemented following the global financial crisis, capital and profitability can be described as a positive or negative relation for the European region over the last 10 years.

3.3. Relationship between capital and risk

The relationship between capital and risk cannot be kept apart. As a primary assumption, the greater the risk, the higher the generated profit (Merton 1973) (Ghysel, Santa-Clar e Valkano 2005). While the literature shows no significant impact of the capital requirements on bank risk (Demirgüç-Kunt and Detragiache, Basel Core Principles and bank soundness: Does compliance matter? 2011), for many researches, this is not a consensual topic as conclusions differ on a positive or negative relationship between capital and risk as exposed in the following sources:

- A negative relationship was established between capital and risk (Aggarwal e Jacques 1998). According to this study, an increase in the capital levels and a decrease in the portfolio risk

were observed. However, these conclusions correspond to the impact of a new U.S. regulation (PCA) in 1992/1993.

- An empirical evidence is found on a positive relationship between capital levels and risk (Altunba, et al. 2007). This study however implies that inefficient European banks appear to hold higher capital levels and take less risk, depending on several factors of which the type on ownership. This is an interesting conclusion once it is taken for the European banks - the same geographic spectrum to be studied here.
- Other positive relation between capital and risk is documented by (Shrieves e Dahl 1992). This study concludes that capital and risk are simultaneously related, for a 1984 to 1986 period and a minimum $100 million in assets threshold. This means that the increase of one impacts the other in the same way and banks in this study mitigate the effect of one by changing the other in the different direction.
- No relation between capital and risk (Rime 2001). This study, applied for Swiss banks during the 1989-1995 period, reflected a no relationship between capital and risk. Banks perceived higher capital availability less costly than a descending adjustment of the portfolio riskiness. Nonetheless, banks were observed to increase the levels of capital in response to the regulatory pressure facing the fear of a penalty.
- Negative relation between risk (Z-score) and capitalization (Tan e Floros 2013) for the Chinese commercial banking industry over the 2003-2009 period.

Thus, in light with the previous sources and conclusions for such distinct time periods and countries, there are quite mixed evidences on what relationship capital and risk hold between each other.

4. Methodology

4.1. Methodology

In order to assess the existence of a relation between the capital and financial profitability, it is essential to compare the bank's data representing the bank's capital adequacy and the profitability metrics chosen.
Regarding the capital ratios to be used, and taking into consideration the work of (Demirgüç-Kunt, Detragiache and Merrouche 2013) and (Demirgüç-Kunt and Anginer 2014) there will be mainly two options to take into consideration in this analysis; risk-weighted and not weighted.

The traditional capital adequacy ratio is computed by dividing the sum of Tier 1 Capital and Tier 2 Capital by the total RWA. This ratio must be, according to Basel III, at least 8% of the RWA. However, some sources suggest an alternative of computing the same ratio replacing the RWA by the TA (Arnold, et al. 2012) ; (Cathcart, El-Jahel e Jabbour 2015) ; (Dermine 2015). This was actually adopted in Basel III, which determines that banks need to comply both with risk-weighted capital requirements and unweighted ones (leverage ratio). Such alternatives will be taken into consideration when performing the correlation and regression analysis.

To ensure the profitability definition is properly attended, several parameters should be combined and compared in order to capture the perspective of each one.
Net Income is the latest element of the income statement, and as such, represents the most liquid value of this analysis. This value provides the opportunity to understand the real capability of the bank to generate profits or losses during each financial period (as defined in the Capital Indicators chapter). The use of these parameters also follows the work performed by (Bitar, Saad and Benlemlih 2016) taking into consideration (Demirgüç-Kunt, Detragiache and Merrouche 2013) and (Demirgüç-Kunt and Anginer 2014) where net income to total assets is employed as a measure of bank profitability.

Other ratios could also be used to infer the bank's performance and evolution on that matter, such as the Return on Assets (ROA) providing the bank's ability to profit from each unit of asset owned or the Return on Equity (ROE). The ROA and ROE indicate the level of efficiency of the bank's assets and equity respectively on profit creation, something the Net Income is not able to capture. The ROA and ROE are also more comparable indicators, as they take into account the real efficiency of the

banks in regard to the assets or equity employed, thus excluding other factors like the dimension of the market that will affect the Net Income.
The variables stated previously are the result of well-defined formulas or definitions, described as follows:

4.1.1. Capital Indicators

- Risk-Weighted Assets (RWA): Corresponds to the market risk and operational risk capital requirements' multiplied by 12.5, plus the risk-weighted assets for credit. (BIS - Bank for International Settlements s.d.)
- Tier 1 Capital: Corresponds to the capital amount resulting from the sum of equity and retained earnings (disclosed reserves). This amount must ascend to at least 6% of the total RWA of the institution. (BIS - Bank for International Settlements s.d.)
- Tier 2 Capital: Corresponds to supplementary capital. Tier 2 includes the undisclosed reserves, revaluation reserves, General provisions/general loan-loss reserves, Hybrid debt capital instruments and Subordinated term debt. Tier 2 does not hold a minimum percentage, but it cannot be higher that 100% of the Tier 1 Capital. (BIS - Bank for International Settlements s.d.)
- Capital Adequacy: Constitutes the sum of the Tier 1 Capital and Tier 2 Capital and as previously stated must ascend to at least 8% of the total RWA of the institution. (BIS - Bank for International Settlements s.d.)
- Leverage Ratio: The Leverage ratio is defined by the way it is computed, a percentage resulting from the division between the capital measure by the exposure measure (total assets). (BIS - Bank for International Settlements, 2017)

4.1.2. Profitability Indicators

- Net Income Basic: Corresponds to the latest element of the Income Statement of an enterprise. This value results from the deduction of all costs and expenses, depreciations, amortizations and taxes. (Corporate Financial Institute (CFI) s.d.)
- Total Assets: Corresponds to the sum of the bank's book value. (Corporate Finance Institute (CFI) s.d.)

- Return on Assets: Is the return measured in terms of profit generated by the assets employed, according to the Datastream database used and as expressed by the following mathematical formula:

$$ROA = \frac{\begin{array}{c} Net\ Income\ -\ Bottom\ Line\ + \\ ((Interest\ Expense\ on\ Debt - Interest\ Capitalized)\ *\ (1 - Tax\ Rate))) \end{array}}{\begin{array}{c} Average\ of\ Last\ Year's\ (Total\ Assets\ -\ Customer\ Liabilities\ on\ Acceptances) \\ and\ Current\ Year's\ (Total\ Assets\ -\ Customer\ Liabilities\ on\ Acceptances) \end{array}} \quad (1)$$

- Return on Equity: Corresponds to the return generated from the equity invested in the company/bank's assets. (Damodaran s.d.) This ratio results from the following formula:

$$ROE = \frac{Net\ Income}{Shareholder's\ Equity} \quad (2)$$

4.2. Data description

The data used on this analysis was retrieved from Refinitiv Eikon Datastream, using a 147 banks' sample on a yearly (end of year) base from the European market for a 10-year time, from 2011 to 2020. The data considered in this study will consequently be a panel dataset as it represents the same variables on a yearly basis (Gujarati 2011). I have opted for including information to identify the banks (name), a numeric code for each bank, and the year to trace the data timeline and set the time series. In addition, to describe the bank's capital and financial information, quantitative information has been also retrieved, and that information will be the source for the analysis to perform. The data was retrieved in the local currency of each institution once it was not possible to retrieve all the information in euro keeping the necessary data integrity. However, to mitigate such limitation, several ratios were computed, dividing the different profitability and capital parameters by a common denominator, the TA. The TA as common denominator follows the suggestions provided in the literature summarized in the methodology section and so presented itself as the strongest option. By computing these ratios, all parameters are presented and analysed in the form of a ratio, becoming that way comparable.

In order to characterize the bank's capital, the following variables were extracted:

- Capital Adequacy ratio tier1
- Risk Weighted Assets (RWA)
- Tier 2 Capital
- Total Assets

In order to characterize the bank's profitability, the following variables were extracted:

- Net Income – Basic
- Return on Assets (ROA)
- Return on Equity – Total (%)

Through the previous variables extracted, it was possible to generate further information useful for the analysis, and to bypass the data limitations encountered, namely:

- Net Income/TA (providing the amount of net income per total assets of the bank)
- RWA/TA (providing the amount of the bank's RWA per Total Assets)
- Tier2/RWA (getting the Tier2 ratio)
- Tier2/TA (getting the units of Tier 1 for each unit of assets of each bank)
- Tier 1 Capital (by multiplying the Capital Adequacy ratio Tier1 with the Risk Weighted Assets, reaching a nominal amount)
- Capital Adequacy (by summing the previously computed Tier 1 capital with the already extracted Tier 2 Capital)
- Tier1/TA (getting the units of Tier 1 for each unit of assets of each bank)
- Capital/TA (getting the units of the computed capital adequacy for each unit of assets of each bank)
- Calculated Total Ratio (by dividing the previously computed Capital Adequacy by the originally extracted Risk Weighted Assets).

To the initial sample, several conditions were applied to ensure the greatest data quality, of which:

- Not Available (NA) information was replaced by null cells;
- The CAPITAL ADEQUACY RATIO-TIER 1 should be between 0% and 50% in order to exclude the major outliers.

The previous conditions applied have resulted on a final data sample of 133 banks. To this final sample, further data quality checks were performed to ensure the statistical accuracy. A summary statistics analysis was performed and the output table shall be analysed next for the main parameters that will be used in this dissertation.

The fields name and year are the qualitative ones; these provide the information regarding the banks identification and the year to which each data corresponds to. They are the main axes that contextualize the evolution of the quantitative information retrieved.

Variable	Obs	Mean	Std. Dev.	Min	Max	Median
Tier1 ratio	1 175	0,15	0,40	0,42	0,48	0,15
Net Income to TA	1 175	0,01	0,01	-0,12	0,05	0,01
ROA	1 037	0,93	0,44	-0,89	0,66	0,83
ROE	1 161	0,52	0,47	-0,14	0,98	0,08
RWA to TA	1 175	0,32	0,24	0,00	1,18	0,32
Tier2 ratio	1 112	0,20	0,90	-0,09	10,53	0,03
Tier2 to TA	1 175	0,01	0,01	-0,06	0,08	0,01
Tier1 to TA	1 175	0,05	0,04	0,00	0,24	0,05
Capital to TA	1 175	0,06	0,04	0,00	0,29	0,06
Capital ratio	1 112	0,35	0,90	0,01	10,67	0,18

Table 1 - Summary statistics for the parameters considered.

The Tier 1 ratio represents the ratio between the Tier 1 Capital and the RWA. The information on this parameter is among the most complete after the data quality filters, with 1175 observations.
The mean of 15.2% shows that banks have Tier 1 Capital ratios significantly above the 6% minimum required for this ratio, and also more than the Tier 1 and Tier 2 capital ratios combined (8%).

The minimum Tier 1 Capital ratio of 4.2% is linked to the Greek Bank Alpha Bank in the year of 2011. This ratio is quite normal, considering the specific context of the sovereign debt crisis Europe went through, and in which Greece was a leading figure (Lane 2012), and especially considering the minimum 6% Tier1 requirement was only implemented since January 1st 2013.
The second minimum Tier 1 ratio of 4.93% corresponds to the ATTICA BANK SA in 2020, a year marked by the Covid19 pandemic[1] which led the central governments and central banks to ease the requirements and enable banks to not reach the usual minimum ratios. However, it is important to refer the 3% Tier 2 Capital Ratio of the ATTICA BANK SA in 2020 completed the 8% minimum required for the Total Capital Ratio to be reported by banks. Finally, the standard deviation shows some fluctuation on the reported value as it varies around 4 percentage points, or 26% of the medium Tier 1 Capital ratio.

[1] The Covid-19 pandemic was a pandemic virus originated in China and spread across the globe. (Ciotti, et al. 2020) This pandemic influenced the global markets with the rising fears of a global shutdown and led to great uncertainty and many changes on the daily routines of the developed countries. The pandemic had special impact in the beginning of 2020 on the global economy as it did shut down most of the global economic activities, having had a real impact on several sectors, of which the banking sector.

The Risk Weighted Assets (RWA) parameter is not filled for all the observations retrieved, with 63 missing observations. This parameter represents the bank's assets properly weighted according to the regulation applicable. As so, it must be at all circumstances a positive value, which can indeed be confirmed. Because this value depends directly on the total assets of the banks, and also on the quality of the assets in balance, this is a value with a great fluctuation between institutions and even between reporting periods for the same institution, reason why the standard deviation of the RWA is so high.

The Tier2 over RWA is the computation of the Tier 2 Capital Ratio, which corresponds to the division of the Tier 2 Capital by the Total RWA. This ratio should be at least the enough to the sum of Tier 1 and Tier 2 be a minimum of 8%. Hence, the Tier2 Ratio must be greater or equal to zero and not greater than the Tier 1 Capital. There are however two negative observations matching the BANK OF CYPRUS in the years of 2011 and 2012. Even though these observations are considered outliers, they are not material and therefore will be kept. Also important to notice that, despite the negative Tier 2 Capital Ratio, the Capital Adequacy ratio reached the regulatory minimum 8% because of the offsetting Tier 1 Capital ratio.

The Tier2 over TA, is the result of the division of the Tier 2 Capital by the Total Assets. This ratio provides an alternative vision of the Tier 2 from the official one using the RWA as denominator. As the previous one, this ratio also presents a negative minimum value, which despite being an outlier will be kept as not considered material. The mean and median are equal representing a good data consistency.

5. Findings

5.1. Correlation Analysis

On a first stage, a quite elementary and linear observation is implemented into the two main variables: the Net Income to Total Assets and the Capital Adequacy to Total Assets, both in the form of calculated average.

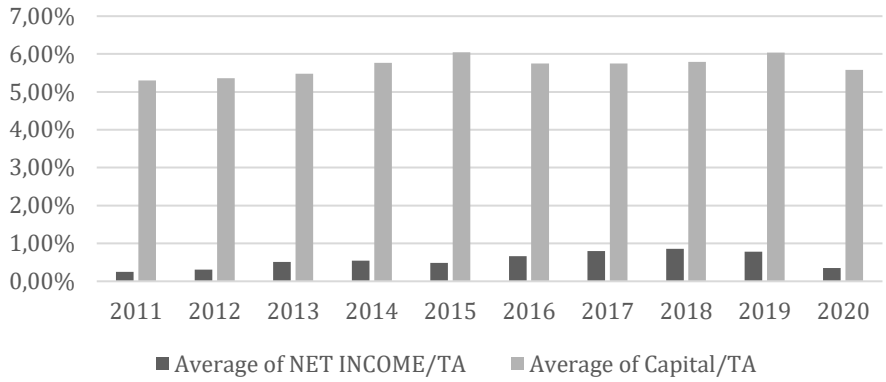

Figure 1 - Evolution of Average Net Income to TA and Average Capital to TA.

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
ANI	0	1	1	1	-1	1	1	1	-1	-1
ATC	0	1	1	1	1	-1	1	1	1	-1
Trend	0	2	2	2	0	0	2	2	0	-2

Table 2 - Sign table for the variables evolution trend[2].

Based on the figure 1 and using also a system of positive/negative/null values on table 2, it is possible to conclude the two parameters do follow the same trend for most of the years, 6 out of 9 years. (2011 is not considered, as there is no information that enables to conclude on the evolution regarding previous years). Yet, this analysis does not provide more than a circumstantial conclusion. That is why this study will focus its data analysis on a two-step approach, starting with a linear correlation analysis and then stepping into a more robust regression analysis.

By performing these analyses, it will be possible to address the main question on whether there is or not a relationship between banks' capital and financial performance, and conclude on the type of relation between the parameters chosen to characterize both the capital ratios and the financial performance indicators.

[2] The table presents the trend of the Average Net Income (ANI) and the Average Total Capital (ATC) over the 10 years period in analysis. The "1" represents a positive evolution, growth, and the "-1" represents a negative evolution. When the sum of the two variables' trend for a given year sums "2" that means both trends are aligned. If on the contrary the sum of the two variables' trend sums null, then they are not aligned and do not follow the same trend in the given year.

This dissertation will also focus on understanding how different metrics of financial profitability can differ on the conclusions.

Starting from a linear correlation analysis between all the extracted parameters, we reach some conclusions, namely that the Net Income over TA is quite correlated with both ROA and ROE. Similarly, RWA over TA is quite correlated with both Tier 1 to TA and Capital to TA. Performance indicators are highly correlated between each other and the same does happen to the capital indicators, and that is not a surprise as they are all representing the same. Note that for the correlation analysis it is considered a high correlation the one equal or higher than 0.5.

	TIER 1 RATIO	NI / TA	ROA	ROE	RWA / TA	Tier2 / RWA	Tier2 / TA	Tier1 / TA	Capital / TA	Capital Ratio
TIER 1 RATIO	1									
NI / TA	0,1821	1								
ROA	0,1411	0,9356	1							
ROE	0,1482	0,7173	0,6482	1						
RWA / TA	-0,3201	-0,1942	-0,1753	-0,1934	1					
Tier2 / RWA	-0,0142	0,0768	0,0663	0,0332	-0,2756	1				
Tier2 / TA	-0,3060	0,0920	0,1768	0,0346	0,1773	0,2131	1			
Tier1 / TA	0,0206	-0,0868	-0,0886	-0,1281	0,9076	-0,2731	0,0729	1		
Capital / TA	-0,0658	-0,0560	-0,0342	-0,1108	0,9029	-0,1975	0,3467	0,9607	1	
Capital Ratio	0,0289	0,0846	0,0723	0,0396	-0,2893	0,9991	0,1999	-0,2721	-0,2003	1

Table 3 - Correlation matrix.

In contrast, no high correlations were found between performance and capital indicators. Nonetheless, the conclusions may differ a lot depending on the parameter observed, and whether the parameter is a ratio with the Total Assets or the RWA as denominator of the fraction.

	Tier 1 ratio	Tier 2 ratio	Capital Ratio
NI/TA	0,1821	0,0768	0,0846
ROA	0,1411	0,0663	0,0723
ROE	0,1482	0,0332	0,0396

Table 4 - Data from the correlation matrix using RWA as denominator

The table 4 provides the specific comparison between the profitability parameters considered and the capital parameters in the form of their ratios. The Tier 1, Tier 2 and Capital Adequacy ratios result from the use of the RWA as denominator. The correlations on the table 2, despite not very expressive coefficients, are in their majority very consistent, with the exception of the Tier 1 Ratio with the Total assets. These values suggest a positive relation, meaning that when the capital ratios increase, so do the profitability ratios.

	RWA / TA	Tier 1 / TA	Tier 2 / TA	Capital / TA
NI/TA	-0,1942	-0,0868	0,0920	-0,0560
TA	-0,3307	-0,3305	0,0651	-0,2927
ROA	-0,1753	-0,0886	0,1768	-0,3420
ROE	-0,1934	-0,1281	0,0346	-0,1108

Table 5 - Data from the correlation matrix using TA as denominator

Following (Demirgüç-Kunt, Detragiache and Merrouche 2013) and (Demirgüç-Kunt and Anginer 2014) suggestion, a similar exercise is going to be performed, but now replacing the RWA by the Total Assets as the ratio denominator.

In fact, this analysis is completely contradictory to the previous one and mainly suggests a negative relation, but not for all the parameters.
The Tier 1 to TA presents a negative relation with all profitability parameters, yet the same is not true for the Tier 2 to TA. Nevertheless, despite both Tier 1 and Tier 2 being part of the capital adequacy computation, they are two distinct parts of the equation representing different asset elements and different strategies.
Despite the different relations observed on Tier 1 to TA and Tier 2 to TA, the fact is that the capital adequacy follows the Tier 1 to TA trend, and the same happens for the RWA to TA ratio.

Indeed, when an institution holds higher levels of capital, it will be more prepared to face the risks assumed on their balance sheet, thus the risk assumed is lower. By the (Merton 1973) theory, the lower the risk assumed, the lower will be the return and vice versa. Consequently, the higher the capital adequacy of an institution, the lower the risk assumed by the institution and thus the lower will be the return/profitability. On the other hand, the lower the capital adequacy levels, the more leveraged the institution will be in regard to the assets' risk, thus the higher will be the risk and the higher will be the profitability. Surely, this rationale depends on several factors of which the institution ownership, country and level of capital optimization, however these are factors that will not be possible to incorporate in this analysis and as so will not be considered.

Additionally, it is important to highlight the consistency on the results of the relations across the different profitability parameters. If the Tier 1 and Tier 2 are contradictory, the same does not happen in profitability and all parameters present coherent results.

5.2. Multiple Regression Analysis

Following the previous conclusions, it is important to perform a few regressions in order to expunge unwanted effects in comparison to the correlation analysis. The regressions should help to consolidate the conclusions, or contrarily raise further questions.

On the correlation analysis, it was performed linear correlations, however to the regressions analysis a different model will be adopted. The regressions will be performed considering that this analysis is based on the same panel of banking institutions for a series of years, thus, the movement meant to be captured should be evaluated yearly instead of an isolated time. Therefore, in order to address such matter a panel analysis will be adopted.
Furthermore, and given that the sample is large enough, the regressions are going to consider fixed effects, accounting for unobserved heterogeneity. Also, in order to avoid heteroscedasticity, and despite it affects mainly cross-sectional data (Gujarati 2011), the robust error type was also selected.

To assess the statistical significance of a determined variable, several indicators may be taken into consideration among the ones in the regressions' outputs.

1. The statistical significance can be inferred using the P-value. This test "gives the marginal significance level where one would be indifferent between rejecting and not rejecting the null hypothesis." (Brooks 2008, 74). Given that the confidence interval is usually of 95%, the p-value must be lower than 5% for the independent variables to be statistical significant.
2. The F-test should also be taken into account, providing the overall significance on an interval in which the critical value must fit in, in order to be considered statistical significant and representative of the population, similarly to the t-test.
3. The R Square described by (Gujarati 2011) as "an overall measure of goodness of fit of the estimated regression line", is also an indicator to look at, as it expresses the percentage of the variation able to be explained by all the regressors considered.

Both the t and F tests depend on the assumption that the error term is normally distributed, a necessary requirement for small samples, but not so much for large samples (Gujarati 2011). Given that the sample used is considered large, these tests can and should be used for the statistical significance analysis.

Taking into consideration the assumption of the classical linear regression model, which declares "that there is no exact linear relationship among the regressors" (Gujarati 2011), in order to avoid

collinearity, the regressions performed follow the previous correlation matrix, ensuring only low correlated variables are included in the same regression analysis.

The panel data analysis addresses the values for each variable i for time t. This model can be represented by the following equation:

$$Y_{it} = \alpha_0 + \alpha_i + \beta x_{it} \quad + u_{it} \tag{3}$$

Where

- u: The error term
- β: Parameters
- Y: Dependent Variable
- x: Independent Variable
- α_0: constant
- α_i: bank fixed effect

5.2.1. The profitability ratios

The Net Income, as stated previously is the ultimate indicator of an institution balance sheet, and as so, the best thermometer of the financial performance – the information meant to be measured in this study. This variable will provide a glance at how the performance relates to the capital ratios in general and to each ratio. In line with the Net Income, also the ROA and ROE represent good variables to estimate this relationship, even though providing different accounting perspective and consequently possibly varying the conclusions. These are going to be the dependent variables.

The independent variable on the other hand will be the Total Capital Ratio (Total Capital to RWA).

The regressions are expressed as follows:

- $Net\ Income\ to\ TA_{it} = \alpha_0 + \alpha_i + \beta\ Total\ Capital\ Ratio_{it} \quad + u_{it}$ (4)
- $ROA_{it} = \alpha_0 + \alpha_i + \beta\ Total\ Capital\ Ratio_{it} \quad + u_{it}$ (5)
- $ROE_{it} = \alpha_0 + \alpha_i + \beta\ Total\ Capital\ Ratio_{it} \quad + u_{it}$ (6)

R-Sq:	
within =	0,0110
between =	0,0149
overall =	0,0054

F(1,127) =	7,83
Prob > F =	0,0059

NET INCOME / TA	Coef.	Std. Err.	t	P > |t|	[95% Coef. Interval]	
Capital Ratio	-0,0031004	0,0011078	-2,80	0,006	-0,0052925	-0,009082
_cons	0,0073184	0,0003904	18,75	0,000	0,0065459	0,0080909

Table 6 - Regression on Net Income to TA with Total Capital Ratio

The first regression, between Net Income to TA and Total Capital ratio results on the following expression:

- $Net\ Income\ to\ TA_{it} = 0.0073184 \quad + \alpha_i - 0.0031004\ Total\ Capital\ Ratio_{it} \quad + u_{it}$ (7)

The variables are statistically significant since the p-value is lower than 5% (significance level), so there is a non-zero correlation between these parameters. Through the R-Square, it is possible to conclude that the Capital Ratio explains an overall 0.54% of the movements of the Net Income to TA, which corresponds to a normal percentage for the statistical test in question, even if somewhat low.

This regression indicates a negative relationship between the Net Income and the Capital Ratio.

R-Sq:	
within =	0,0257
between =	0,0156
overall =	0,0049

F(1,124) =	35,84
Prob > F =	0,0000

ROA	Coef.	Std. Err.	t	P > |t|	[95% Coef. Interval]	
Capital Ratio	-0,5330645	0,0890419	-5,99	0,000	-0,7093034	-0,3568256
_cons	1,155075	0,0301308	38,34	0,000	1,095438	1,214712

Table 7 - Regression on ROA with Total Capital Ratio

The second regression, between the ROA and Total Capital ratio provides the following expression:

- $ROA_{it} = 1.155075 \quad + \alpha_i - 0.5330645\ Total\ Capital\ Ratio_{it} \quad + u_{it}$ (8)

The variables are statistically significant since the p-value is equal to zero, so there is a non-zero correlation between these parameters. This relationship is hereby concluded as negative in line to the previous relation analyzed.

R-Sq:	
within =	0,0008
between =	0,0077
overall =	0,0021

F(1,127) =	1,89
Prob > F =	0,1714

ROE	Coef.	Std. Err.	t	P > |t|	[95% Coef. Interval]	
Capital Ratio	-1,636666	1,189906	-1,38	0,171	-3,991276	0,7179432
_cons	7,549136	0,4217112	17,90	0,000	6,714646	8,383627

Table 8 - Regression on ROE with Total Capital Ratio

At last, the third regression between the ROE and Total Capital ratio provides the following expression:

- $ROE_{it} = 7.549136 \quad + \alpha_i - 1.636666\, Total\ Capital\ Ratio_{it} \quad + u_{it}$ (9)

Contrarily to the previous regressions, the ROE is not statistically significant since the p-value is greater than 5% (significance level). Even if considering a lower confidence level of 90%, the p-value of 17.1% exceeds the 10% significance level and so it is not possible to conclude on a non-zero correlation between these parameters.

All these regressions do provide the same answer, the performance indicators respond negatively to a given unit change on the capital ratios, that is, when capital ratios increase, the bank's performance tend to decrease and vice-versa.

Furthermore, these regressions allow concluding that both Net Income and ROA represent good and significant parameters to represent the financial performance of a bank, showing a good consistency on the results when compared with the same independent variable.

5.2.2. The Capital Ratios

Having had the confirmation that both NI to TA and ROA present consistent results when regressed with total capital ratio, will now be exclusively analysed the NI to TA by regressing it with the different capital ratios available.

The regressions performed are as follows:

- $Net\ Income\ to\ TA_{it} = \alpha_0 + \alpha_i + \beta\ Total\ Capital\ Ratio_{it} + u_{it}$ (10)
- $Net\ Income\ to\ TA_{it} = \alpha_0 + \alpha_i + \beta\ Tier\ 1\ Capital\ Ratio_{it} + u_{it}$ (11)
- $Net\ Income\ to\ TA_{it} = \alpha_0 + \alpha_i + \beta\ Tier\ 2\ Capital\ Ratio_{it} + u_{it}$ (12)
- $Net\ Income\ to\ TA_{it} = \alpha_0 + \alpha_i + \beta\ Tier\ 1\ Capital\ Ratio_{it} + \beta\ Tier\ 2\ Capital\ Ratio_{it} + u_{it}$ (13)

R-Sq:	
within =	0,0110
between =	0,0149
overall =	0,0054

F(3,127) =	7,83
Prob > F =	0,0059

NET INCOME / TA	Coef.	Std. Err.	t	P > |t|	[95% Coef. Interval]	
Capital Ratio	-0,0031004	0,0011078	-2,80	0,006	-0,0052925	-0,009082
_cons	0,0073184	0,0003904	18,75	0,000	0,0065459	0,0080909

Table 9 - Regression on Net Income to TA with Total Capital Ratio

The first regression, between Net Income to TA and Total Capital ratio has already been analyzed previously and results on the following expression:

- $Net\ Income\ to\ TA_{it} = 0.0073184 + \alpha_i - 0.0031004\ Total\ Capital\ Ratio_{it} + u_{it}$ (14)

It represents as stated a negative relationship between capital and performance.

R-Sq:	
within =	0,0197
between =	0,0389
overall =	0,0324

F(1,132) =	8,01
Prob > F =	0,0054

NET INCOME / TA	Coef.	Std. Err.	t	P > |t|	[95% Coef. Interval]	
Tier 1 Capital Ratio	0,0004207	0,0001487	2,83	0,005	0,0001266	0,0007148
_cons	-0,0007346	0,0022616	-0,32	0,746	0,0052083	0,0037391

Table 10 - Regression on Net Income to TA with Tier 1 Capital Ratio

The second regression, between the Net Income to TA and Tier 1 Capital ratio provides the following expression:

- $Net\ Income\ to\ TA_{it} = -0.0007346 \quad + \alpha_i + 0.0004207\ Tier\ 1\ Capital\ Ratio_{it} \quad + u_{it}$ (15)

The variables are statistically significant since the p-value of 0.5% is lower than the 5% significance level for the 95% confidence level considered.

This regression, contrarily to the previous ones, evidences a positive relation between the Net Income to TA as dependent variable and the Tier 1 capital ratio as independent variable, thus of a positive relation between capital and performance when extrapolating.

R-Sq:	
within =	0,0147
between =	0,0118
overall =	0,0041

F(2,124) =	9,31
Prob > F =	0,0028

NET INCOME / TA	**Coef.**	**Std. Err.**	**t**	**P > |t|**	**[95% Coef. Interval]**	
Tier 2 Capital Ratio	-0,0036149	0,001184	-3,05	0,003	-0,0059598	-0,00127
_cons	0,0069484	0,0002369	29,33	0,000	0,0064797	0,0074172

Table 11 - Regression on Net Income to TA with Tier 2 Capital Ratio

The third regression, between the Net Income to TA and Tier 2 Capital ratio provides the following expression:

- $Net\ Income\ to\ TA_{it} = 0.0069484 \quad + \alpha_i - 0.0036149\ Tier\ 2\ Capital\ Ratio_{it} \quad + u_{it}$ (16)

The Tier 2 Capital ratio is a statistically significant variable since the p-value is lower than 5% (0.28% in fact) and the t-value of -3.05 is not framed in the non-statistically significant interval between -1.96 and 1.96 for a 95% significance level. Hence, it is possible to state there is a non-zero correlation between these parameters.

The Tier 2 Capital ratio is able to explain an overall 0.41% of the changes on the Net Income to TA. Likewise Total Capital ratios, the Tier 2 capital ratio also evidences a negative relation with the Net Income to TA.

R-Sq:	
within =	0,0375
between =	0,0014
overall =	0,0012

F(2,127) =	11,94
Prob > F =	0,0000

NET INCOME / TA	Coef.	Std. Err.	t	P > |t|	[95% Coef. Interval]	
Tier 1 Capital Ratio	0,0004247	0,0001197	3,55	0,001	0,0001878	0,0006615
Tier 2 Capital Ratio	-0,0036872	0,0010998	-3,35	0,001	-0,0058635	-0,001511
_cons	0,0004869	0,0018389	0,26	0,792	-0,0031519	0,0041257

Table 12 - Regression on Net Income to TA with Tier 1 Capital Ratio and Tier 2 Capital Ratio

The forth and final regression, between the Net Income to TA and Tier 1 Capital ratio and Tier 2 Capital ratio intends to aggregate in one, the two capital ratios that sumed result on the total capital ratio. This regression will provide a vision on the relationship between these ratios and performance when combining the two ratios, and it results on the following expression:

- $$Net\ Income\ to\ TA_{it} = 0.0004869 \quad + \alpha_i + 0.0004247\ Tier\ 1\ Capital\ Ratio_{it} \quad -0.0036872\ Tier\ 2\ Capital\ Ratio_{it} + u_{it} \qquad (17)$$

The two variables are statistically significant as both have a p-value inferior to 5%. Also both variables' t-value are not framed in the non-statistically significant interval of -1.96 and 1.96 for the confidence interval considered. Interestingly, the two variables combined are only able to explain an overall 0.12% of the model, a lower percentage of the one presented by each of the two independently. Likewise observing the two variables independently, when combining them the conclusions remain, the Tier 1 Capital ratio indicates a positive relation while the Tier 2 Capital ratio indicates a negative one. However, and at the end of day, considering the most embracing ratio, the Total Capital ratio, the conclusion is that the Capital ratios hold a negative relation with the bank's performance indicators. These are in fact consistent conclusions to the ones obtained from the correlation matrix.

Additionally, and taking into consideration the work of (Demirgüç-Kunt, Detragiache and Merrouche 2013) and (Demirgüç-Kunt and Anginer 2014), the same analysis should be performed to the total Capital but now considering the TA as the denominator of the ratio instead of the RWA, that is, considering the Leverage Ratio.

The regressions performed are as follows:

- $Net\ Income\ to\ TA_{it} = \alpha_0 + \alpha_i + \beta\ Leverage\ Ratio_{it} \quad + u_{it}$ (18)
- $ROA_{it} = \alpha_0 + \alpha_i + \beta\ Leverage\ Ratio_{it} \quad + u_{it}$ (19)

R-Sq:	
within =	0,0069
between =	0,0108
overall =	0,0032

F(1,132) =	3,92
Prob > F =	0,0497

NET INCOME / TA	Coef.	Std. Err.	t	P > |t|	[95% Coef. Interval]	
Leverage Ratio	0,043984	0,0222019	1,98	0,050	0,0000665	0,0879016
_cons	0,0031573	0,0012662	2,49	0,014	0,0006527	0,005662

Table 13 - Regression on Net Income to TA with Leverage Ratio

R-Sq:	
within =	0,0022
between =	0,0050
overall =	0,0008

F(1,129) =	0,59
Prob > F =	0,4451

ROA	Coef.	Std. Err.	t	P > |t|	[95% Coef. Interval]	
Leverage Ratio	2,328093	3,039781	0,77	0,445	-3,686189	8,342375
_cons	0,7971143	0,1697058	4,70	0,000	0,4613471	1,132881

Table 14 - Regression on ROA with Leverage Ratio

The regressions result on the following expression:

- $Net\ Income\ to\ TA_{it} = 0.0031573 \quad + \alpha_i + 0.043984\ Leverage\ Ratio_{it} \quad + u_{it}$ (20)
- $ROA_{it} = 0.7971143 \quad + \alpha_i + 2.328093\ Leverage\ Ratio_{it} \quad + u_{it}$ (21)

Firstly, it is important to note that for the second regression, the ROA is not statistically significant as the p-value exceeds in much the 5% significance level. The first regression on the other hand with a p-value slightly inferior to 5%, is still considered statistically significant, especially if considering a 90% confidence level.

The Total Capital to TA ratio, also known as the Leverage Ratio, evidences a positive relation to the net income to TA indicating a positive relation between capital and performance.

The different results on the regressions depending on the denominator used are evident, and indeed the TA and the RWA provide different results because they do represent different concepts. The Total Assets represent the assets of the bank, despite their risk or characteristics. The RWA on the other hand take into consideration the counterparty, type of product, etc. and consequently represents according to the regulation applicable, a measure of the risk associated to the assets in balance. This could represent a limitation for the analysis, or on the opposite, a way of better considering the risk assumed per asset in balance in relation to the total capital assumed by each bank.

6. Conclusions

The present dissertation aims to answer an academic and policy-relevant question, is there a relation between capital ratios and banks' financial performance? For answering this question, this study began by observing what similar studies have concluded on this matter. In a matter of fact, this is not a consensual topic, as the literature is vast but so are the conclusions. Some essentials are considered a common ground. Risk and return are positively related and thus so is risk and profitability. However, when introducing capital in the equation all becomes more subjective. Capital is according to some sources positively related to risk, as others state the inverse. Also some sources claim a negative relation between capital and profitability, as others state the opposite, and some have even concluded the inexistence of a relation.

The aim of this dissertation is to examine if, for European banks in the last 10-year period there is a relation and in what direction. For such, data was extracted from Refinitiv Eikon Datastream including capital and profitability variables, namely RWA, Tier1 Capital, Tier2 Capital and Net Income, ROA and ROE respectively.

After all, is there a relation between capital ratios and profitability? If focusing on the linear correlation analysis, the conclusion would be consistent. There is a negative relation between the chosen profitability ratios and all capital ratios with TA as denominator but one, the Tier2 Capital to TA. This latest ratio contrarily to the remaining has evidenced a positive relation, which is not unusual considering Tier2 Capital ratio hold a secondary hierarchy on the Total Capital, given that some banks do not even report any amount is this ratio. Still, the correlation analysis would be short to properly conclude on this matter, and so on a two-step analysis, and recurring to the correlation matrix, were prepared regressions with Net Income as dependent variable and a set of capital ratios as the independent variables. Firstly, the regressions required a proper understanding on the database, to conclude on the kind of regression to perform. Considering the panel data combined with a large data, it was considered as the most suitable option a panel data analysis with fixed effects. This analysis would enable to adapt the regression to the information described for a time period, and not as simply an isolated act.

On the one hand, and focusing on the regression between NI to TA and the Total Capital ratios, the regressions have provided conclusions with a great level of certainty as the level of significance was quite inferior to 1%. However, the obtained conclusions were mixed. While the Capital ratio holds a negative relation, the capital to TA, also known as Leverage Ratio holds a positive one, which was quite the opposite of the correlation conclusions. The conclusion divides hence on whether to consider

the TA or the RWA as the capital ratio. According to the literature revised in this dissertation, the best denominator for the ratio to consider should be the TA. However, the fact is that the RWA is the denominator officially adopted for the main reports. Therefore, considering the Capital ratio – with the RWA as denominator – it is possible to capture an additional way of measuring the risk of the bank's assets in addition to the level of capital assumed by the bank. Hence, this dissertation concludes on a negative relation between the capital ratios and the bank's financial performance.

Despite not the core of the dissertation, one additional conclusion could be drawn by both the correlation and regressions analysis, and that is the consistency on the results among the profitability ratios. Some literature has evidenced not enough consistency on the conclusions when using ROA and ROE instead of the Net Income, yet in this study, ROA has evidenced similar consistency and coherence on the conclusions as by adopting the Net Income to Total Assets.

This dissertation value creation is related to the fact that despite the literature on the topic, not much of it relates to a large spectrum of European banks as this one includes, and also provides further studies on the best modelling to adopt when approaching this analysis.

As for suggestion to future studies on this relation, it would be interesting to include economic variables that would allow to analyse the evolution and response of this relation to and over the economic cycles. One other topic that would be important to contextualize would be the relevance of the sovereign debt on the bank's capital requirements relation to performance.
The 2008 financial crisis in Europe, presented a new problem: high deficit to GDP ratios (Lane 2012), leading to a great disparity on the annual spread on ten-year sovereign bond yields between Germany, for example, and the GIIPS (Lane 2012), leaving these last countries in the rope of further lending. The studies on this topic are insufficient, however a relation was found on the banks' lending recovery depending on the level of exposure to the GIIPS (Popov e Horen 2013). Furthermore, banks were also observed to reduce lending in countries with sovereign's financial problems. Thus, this could be an important point of view to explore and incorporate.

In fact, this topic will never cease to require further analysis and explanations as the changes are constant and so is the need for banks to adapt to new products, technologies, and the constant need to deliver strong and rock-solid results.

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