A Comparative Analysis of Capital, Risk, Efficiency, Profitability, Diversification and Integration of the Eurozone and the United States Banking Institutions in the aftermath of the Global Financial Crisis.

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June, 2021

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Acknowledgements

Initially, I would like to thank my supervisor Assistant Professor Simeon Papadopoulos for his support, motivation, patience and encouragement. His valuable guidance and thoughtful comments were essential for the successful completion of this dissertation.

I am also grateful to the members of my Advisory Committee, Professor Athanasios Noulas and Associate Professor Georgios Michalopoulos for their helpful suggestions. I would also like to express my gratitude to the other four members of my Committee Review, Professor Ioannis Papanastasiou, Professor Dimitrios Subeniotis, Assistant Professor Efstratios Livanis and Assistant Professor Petros Messis for agreeing to participate in my Committee Review and for their comments.

Finally, I would like to thank my husband, my parents, my three siblings and my dear friends Magda, Akrivi and Katerina. They were patient, supporting as well as understanding throughout all the years of my Ph.D. studies. I believe that without their support I wouldn't have been able to complete my thesis.

Abstract

This thesis provides a comparative analysis of the Eurozone and the United States banks in terms of capital, risk, efficiency, profitability, diversification and integration in the post-economic crisis period. Initially, we examine the development of efficiency and the progress of banking integration in the European Union by checking for convergence among banks of European and Eurozone countries as well as contrasting the results with those of banks in the United States. In the next stage of this analysis, we investigate the development and the interrelationships of bank risk, capital and efficiency of Eurozone and the United States after the global financial crisis. In the last stage of this analysis, we analyze the influence of bank diversification on capital, risk, profitability and efficiency. The findings also reveal how this influence differs depending on the type of diversification (asset, income and non-interest income diversification). Finally, we provide empirical evidence of how all the examined variables and interrelations vary per banking sector (commercial, cooperative and savings banks).

For the purposes of our survey, we employ a data sample consisting of aggregate balance sheets and income statement data from 2185 banks of the Eurozone and the United States, while the analyzed period spans from 2013 until 2018. Concerning the methodology, we employ the model of Data Envelopment Analysis developed by Charnes et al. (1978), the panel data model of Phillips, P. C., & Sul, D. (2007), the Three-Stage Least Squares (3SLS) model, developed by Zellner&Theil, (1962), the Adjusted Herfindahl Hirschman Indices (AHHI) and the two-step system generalized method of moments dynamic panel estimator (system-GMM) devised by Arellano and Bover (1995), developed further by Blundell and Bond (1998).

Our main findings show that the efficiency of the United States banking system is considerably higher than that of the Eurozone and the European Union. Moreover, there is no evidence of convergence across the reported banking groups, while our results indicate the presence of club convergence in all the examined groups. Furthermore, our findings convey that the United States banking system is closer to convergence than Eurozone and European Union banks.

Regarding capitalization, our results indicate that the capital ratio of United States banks is significantly higher than that of Eurozone banks regardless of the type of bank. Moreover, the capital ratios of the banks within the same sector present striking differences with each other. As for the risk ratio, we notice that the risk level of all banking groups and subgroups of our sample increases during the reported period reaching its peak during the year 2018.

Furthermore, the empirical evidence leads us to the conclusion that risk and capital are directly related irrespective of the causality order. Moreover, the findings suggest that an increase in efficiency levels may precede an increase in risk. Additionally, our results suggest that capital directly affects the efficiency of all the banks of our sample, with one exception, that of United States savings banks.

Our findings also indicate that income diversification has substantial benefits when compared to other types of diversification whereas non-interest income diversification has the most unfavorable results for the reported groups. Additionally, the impact of asset diversification is mixed for the dependent variables and it is contingent on whether a bank operates in the Eurozone or in the United States.

Finally, we may also conclude that the banking sector to which a bank belongs is a significant parameter affecting the levels of bank efficiency, the relationship of bank efficiency with capital and risk, the bank integration and the impact of bank diversification.

Publications and Conferences

Parts of this thesis were presented at the following conferences:

- *A Comparative Analysis of the Banking Integration in the European Union, the Eurozone and the United States,* presented at 10th Economic and Finance Conference, Rome, Italy, 10-13/09/2018, Dimitra Loukia Kolia, Simeon Papadopoulos.
- *A Comparative Analysis of the Banking Integration in the European Union*, presented at annual conference of the Swedish Network for European Studies in Economics and Business in Lund, Sweden, 13-14/11/2018, Dimitra Loukia Kolia, Simeon Papadopoulos.
- *The Development of the Levels of Bank Capital, Risk and Efficiency in the Eurozone and the U.S. After the Global Financial Crisis*, in Session 8 Accounting & Finance at the Twenty Seventh Annual Conference of the Multinational Finance Society between June 28 - 29, 2020, Dimitra Loukia Kolia, Simeon Papadopoulos.
- *A Comparative Analysis of the Relationship among Capital, Risk and Efficiency in the Eurozone and the U.S. Banking Institutions*, at the 11th International Research Meeting in Business and Management (IRMBAM-2020), (forthcoming) *postponed to July 2021*, Dimitra Loukia Kolia and Simeon Papadopoulos.

Moreover, the following papers have been published or are currently under review:

- Kolia, D. L., & Papadopoulos, S. (2020). *The Levels of Bank Capital, Risk and Efficiency in the Eurozone and the U.S. in the Aftermath of the Financial Crisis*, Quantitative Finance and Economics, 2020, 4(1): 66-90. doi: 10.3934/QFE.2020004 .
- Kolia, D. L., & Papadopoulos, S. (2020). *A Comparative Analysis of the Relationship among Capital, Risk and Efficiency in the Eurozone and the U.S. Banking Institutions,* Risk Governance and Control: Financial Markets & Institutions, 10(2), 8-20. http://doi.org/10.22495/rgcv10i2p1 .
- Kolia, D. L., & Papadopoulos, S. (under review). *A Comparative Analysis of the Integration in Banking Efficiency in the European Union, the Eurozone, and the United States*, *submitted to* the International Journal of Financial Services Management.

- Kolia, D. L., & Papadopoulos, S. (under review). *The Effect of Bank Diversification on the Capital, Risk, Efficiency and Profitability of the Eurozone and the United States Banks after the Global Financial Crisis*, *submitted to* the International Journal of Accounting and Finance.

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Introduction

The dire consequences of the recent financial crisis have revealed the weakness of a regulatory framework to ensure the financial stability of banking institutions. The existing regulations did not prevent banks from taking excessive **risks**, and thus highlighted the need for a further understanding of the bank risk determinants (Ding and Sickles, (2019)). Moreover, it has been suggested that **capital** requirements are not able to prevent bank failure alone as many banks that failed attained adequate capital before the crisis, hence further examination of capital is required (Bitar et al., (2018)). The recent financial turmoil has also revealed how fundamental a further investigation into the role of bank **efficiency** is regarding (i) bank stability, (ii) risk taking behaviour and (iii) banking **integration** (Mosko and Bozdo, (2016),Weill, (2009)).

Additionally, in the aftermath of the financial crisis, the concerns about the threats of bank **diversification** were raised and therefore its impact on financial fragility has been thoroughly reassessed (Ashraf et al., (2016)). As a result, the non-traditional banking activities are now being carefully monitored and new regulations are being implemented (for example, Basel III framework), aiming at more resilient banking institutions as well as banking systems. Thus, in the post-crisis period, banks of advanced economies have started, once again, to rely more on traditional banking practices and less on non-interest earning activities (Abuzayed et al., (2018)). These modifications have, however, significantly affected bank **profitability** and income structure (Maudos, (2017)).

Moreover, the global financial crisis showed how differently banking systems may behave after financial shocks. A typical example could be **the Eurozone and the U.S.** banking systems. Although the number of Eurozone banks' failures is lower than that of U.S. banking institutions, the speed of recovery of U.S. banking systems was remarkably greater (Ackermann, (2019)). This fact could be attributed to the different characteristics of both economies and banking institutions along with the different measures and policies implemented for recovery from the financial crisis (Lakhani et al., (2019)).

This thesis consists of four research areas investigating the aforementioned topics and comparing the results of the Eurozone and the United States Banking Institutions. More specifically, each chapter is an independent empirical research study examining one or more of the abovementioned issues, i.e. bank capital, risk, efficiency, profitability, diversification and integration by employing separate samples of Eurozone and United States banks in the post-crisis period. This study

also takes into consideration the type of bank (cooperative, commercial and savings banks) providing empirical evidence about how the examined relationships vary per type of bank.

More analytically, the employed data sample consists of aggregate balance sheet and income statement data from 2185 banks, 1584 Eurozone banks and 601 United States banks. We also investigate separately three subgroups of Eurozone banks (commercial, cooperative and savings banks which include 273, 838, 408 banks respectively) and three subgroups of United States banks namely 382 coomercial, 154 cooperative and 63 savings banks. For the purposes of the first chapter of our survey, we also incorporate in our sample 1768 European Union banks. The analyzed period spans from 2013 until 2018. This period is selected because the research in the banking field when employing post-crisis data is limited and the examination of the development of the relationships among capital, risk and efficiency after the financial crisis is even more limited.

Concerning the methodology, we estimate bank efficiency by applying the input-oriented C.C.R. model of Data Envelopment Analysis developed by Charnes et al. (1978). We also apply the panel data model of Phillips, P. C., &Sul, D. (2007), in order to investigate the process of banking integration by testing for convergence and for convergent clusters in banking efficiency. Additionally, we estimate bank capital by employing the ratio of the value of total equity to total assets and the Z-score is used as an indicator of bank risk. We also examine the relationship among capital, risk and efficiency of banking institutions by employing the Three-Stage Least Squares (3SLS) model, developed by Zellner&Theil, (1962). Finally, diversification measures are calculated by applying the Adjusted Herfindahl Hirschman Indices (AHHI) and the impact of bank diversification on capital, risk, efficiency and profitability is estimated by the two-step system generalized method of moments dynamic panel estimator (system-GMM) devised by Arellano and Bover(1995) and further developed by Blundell and Bond(1998).

The **first chapter**, entitled *"A Comparative Analysis of the Integration in Banking Efficiency in the European Union, the Eurozone, and the United States."***,**investigates the development of efficiency and the progress of banking integration in the European Union by checking for convergence among banks of European and Eurozone countries as well as contrasting the results with those of United States banks. In this chapter we try to determine (i) how the level of bank efficiency has developed in the post-crisis period (*RQ1,* Table 1) (ii) whether efficiency levels diverge for different banking sectors (commercial, cooperative and savings banks). *(RQ2*), (iii) if banking integration is achieved in the Eurozone, the European Union and/or the Unites States in the post-crisis period (*RQ3*), (iv) whether an advanced level of financial integration is associated with higher convergence of efficiency in

banking (*RQ4*), (v) how integration occurs in various ways in commercial, cooperative and savings banks (*RQ5*) and (vi) if banking integration varies among Eurozone, European Union and U.S. banks (*RQ6*). For the purposes of our survey, we employ the two-stage semi- parametric double bootstrap DEA method of Simar & Wilson (2007), which absorbs the effects of possible integration barriers in the measurement of efficiency. In the next stage of our analysis, we apply the panel data model of Phillips & Sul (2007), in order to investigate the process of banking integration by testing for convergence and for convergent clusters in banking efficiency.

The **second chapter** of this thesis, entitled "*The Levels of Bank Capital, Risk and Efficiency in the Eurozone and the United States in the Aftermath of the Financial Crisis.",* examines the development of the levels of capital, risk and efficiency of the Eurozone and the U.S. banking institutions after the financial crisis and tries to assess the following three research questions (also presented in Table 1): (i) how the levels of bank capital and risk have developed in the post-crisis period (*RQ7,* Table 1*),* (ii)how the levels of bank capital and risk vary between the Eurozone and the U.S. banks (*RQ8),* (iii) whether those levels diverge for different banking sectors (commercial, cooperative and savings banks). *(RQ9).*Concerning the methodology, we estimate bank efficiency by applying Data Envelopment Analysis and bank capital by employing the ratio of the value of total equity to total assets. The Z-score is also used as an indicator of bank risk.

The **third chapter***, entitled "A Comparative Analysis of the Relationship among Capital, Risk and Efficiency in the Eurozone and the United States Banking Institutions.",* studies the relationship among capital, risk and efficiency in Eurozone and U.S. banking institutions. We also assess the determinants of bank capital, risk and efficiency by providing evidence of how the interrelationship and the managerial behaviors vary per type of bank (commercial, cooperative and savings banks). In this chapter we address the following research questions: (i) what is the relationship between bank capital, risk and efficiency is in the post-crisis period (*RQ10,* Table 1), (ii) what is the effect of environmental variables, liquidity, lending specialization ratio as well as size on risk, capital and efficiency in relation to Eurozone and U.S. banks (*RQ11*), (iii) how the relationship among capital, risk and efficiency varies between Eurozone banks and U.S. banks, (*RQ12*), (iv) how the relationship among capital, risk and efficiency affects the different examined banking sectors (commercial, cooperative and savings banks) (*RQ13*). Concerning the methodology, we employ the input-oriented C.C.R. model of Data Envelopment Analysis developed by Charnes, 1978 to estimate efficiency. We also apply the Z-score to calculate bank risk and the ratio of the value of total equity to total assets as an indicator of bank capital. Moreover, the relationship among capital, risk and efficiency of banking institutions

is examined by employing the Three-Stage Least Squares (3SLS) model, developed by Zellner&Theil, 1962.

Finally, the **last chapter** of this thesis, entitled *"The effect of bank diversification on the capital, risk, efficiency and profitability of the Eurozone and the United States banks after the Global Financial Crisis."*,we examine (i)the influence of bank diversification on bank capital, risk, profitability and efficiency in a dynamic panel estimator (*RQ14-RQ17,* Table 1). We also examine (ii) how the influence differs depending on the type of diversification (asset, income, non-interest income diversification) (*RQ18*), and (iii) which banking type (commercial, cooperative and savings banks) is more benefited from diversification (*RQ19*). As regards the methodology, efficiency is estimated by employing Data Envelopment Analysis (D.E.A.), diversification measures are calculated by applying the Adjusted Herfindahl Hirschman Indices (AHHI) and the impact of bank diversification on capital, risk, efficiency and profitability is estimated by the two-step system generalized method of moments dynamic panel estimator (system-GMM).

Table 1: Research Questions

RQ1	How has the level of bank efficiency developed in the Eurozone, the European Union and the United States during the post-crisis period?
RQ2	How does the level of bank efficiency vary depending on the banking sectors to which a bank belongs?
RQ3	Has banking integration been achieved in the Eurozone, the European Union and/or the United States in the post-crisis period?
RQ4	Is an advanced level of financial integration associated with higher convergence of efficiency in banking?
RQ5	How does integration develop in different banking sectors (commercial, cooperative and savings banks)?
RQ6	How does banking integration vary among Eurozone, European Union and U.S. banks?
RQ7	How has the level of bank capital and risk developed in the post-crisis period?
RQ8	How do the levels of bank capital and risk vary between Eurozone and U.S. banks?
RQ9	Do the levels of capital, risk and efficiency diverge for different banking sectors (commercial, cooperative and savings banks)?
RQ10	What is the relationship between bank capital, risk and efficiency in the post-crisis period?
RQ11	What is the effect of (i) environmental variables, (ii) liquidity, (iii) lending specialization as well as (iv) size on the risk, capital and efficiency in relation to Eurozone and U.S. banks?
RQ12	How does the relationship among capital, risk and efficiency vary between Eurozone and U.S. banks?
RQ13	How does the relationship among capital, risk and efficiency differ

	depending on the banking sectors (commercial, cooperative and savings banks)?
RQ14	How does diversification affect the profitability of banking institutions in the Eurozone and the United States in the post-crisis period?
RQ15	How does diversification impact the capital of banking institutions in the Eurozone and the United States in the post-crisis period?
RQ16	How does diversification influence the risk of banking institutions in the Eurozone and the United States in the post-crisis period?
RQ17	How does diversification affect the efficiency of banking institutions of the Eurozone and the United States in the post-crisis period?
RQ18	How does this influence differ depending on the type of diversification (asset, income and non-interest income diversification)?
RQ19	How does the impact of diversification affect different banking sectors (commercial, cooperative and savings banks)?

Chapter 1:

A Comparative Analysis of the Integration in Banking Efficiency in the European Union, the Eurozone, and the United States.

Section 1.1: Introduction

Since its establishment, the European Union has progressively made a series of reforms in order to improve the integration of European financial markets.[1] The banking sector is one of the most important aspects not only of the financial markets, but also of the economy, as it is the main channel through which enterprises are financed. European integration is expected to contribute to a more efficient banking sector (European Central Bank, (2005)). Thus, the banking industry has experienced profound changes and reforms aiming at fostering integration of banking services across the E.U.[2] Nonetheless, European banking integration still confronts certain obstacles as European member-countries have different national characteristics and legal systems, which means that complete banking integration is not yet close to being achieved (Weill, (2009), Matousek et al., (2015), Kalemli-Ozcan et al., (2008), Stavárek et al., (2012)).

Therefore, in order to draw accurate conclusions, we must consider the possible barriers (environmental variables) that determine to what degree integration of European banks can be expected. For the purposes of our survey we examine country-specific and bank-specific barriers. Country-specific variables refer to the diversity of national market characteristics. This category forms the main conditions under which banks of each country operate, and how they affect their efficiency level. It is also important to note that they cannot be controlled by the managers of the banking institutions. On that basis, we analyze and compare the efficiency of European banks while controlling for the environmental variables that affect the outcome by employing the two stage semi-parametric bootstrap model developed by Simar and Wilson, (2007). Moreover, different types of banks do not follow the same efficiency pattern and therefore the bank-specific factors form barriers to

[1] The definition of an integrated financial market is: "The market for a given set of financial instruments and/or services is fully integrated if all potential market participants with the same relevant characteristics: 1. Face single set of rules when they decide to deal with those financial instruments and/or services 2. Have equal access to the above-mentioned set of

[2] The most decisive steps towards the economic and financial integration of European banking are:

- The European Commission's White Paper (1986)
- The Single European Act (1986)
- The Liberalization of capital flows (1988)
- The Second Banking Directive (1999)
- The establishment of Single Currency (1999)
- Financial Services Action Plan implemented (2005)

banking integration that should be considered (Pasiouras et al., (2009), Stavarek, (2005), Casu and Molyneux, (2003), Carbó Valverde et al., (2007) and Casu and Girardone, (2009)). In order to control for bank-specific barriers hampering European Integration, we examine seperatly three subgroups of banks (cooperative, commercial and savings banks) of our sample.

Concerning the integration of the European banking sector, Altunbas and Chakravarty, (1998) point out that "In the calculation for gains from European integration in the financial services, it is assumed that banks will become equally efficient between countries with the removal of cross-border restrictions.". Therefore, it is assumed that in a perfectly integrated European financial market, banks should be equally efficient regardless of their home-country. To reach this purpose, the convergence of efficiency across European banks is required. Thus, in our survey **we describe the progress of integration in the banking market by trying to determine whether convergence in banking efficiency between European countries exists.** We calculate European banking convergence by applying the methodology introduced by Phillips and Sul, (2007). This methodology permits us to determine whether our sample is convergent and the speed of convergence overtime. It also enables us to investigate the existence of possible sub-groups of countries which are already convergent.

The introduction of the common currency (the euro) represents one of the most important steps towards monetary integration and this analysis aims at testing the hypothesis that an advanced level of financial integration is associated with higher convergence of efficiency in banking. Hence, this thesis examines whether banking integration among the Eurozone countries has developed more than that of the total sum of European countries.

Additionally, we compare the evolution of efficiency and the progress of banking integration across Eurozone member countries with that of the United States. It is appropriate to compare U.S. banking with Eurozone banking because not only have the member countries of both Unions the same currency and Monetary Policy, but also each country maintains its different economic structure and legal system. Moreover, the permission of interstate banking in the U.S. is also recent, as until the 1990s, strict restrictions forbade the expansion of banking across different states (Johnson and Rice, (2007)). U.S. banking is considered to be more integrated than banking among Eurozone countries. Gropp and Kashyap, (2009) point out that: "the U.S. banking market appears significantly more integrated than the banking market in the E.U.".

For the above mentioned purposes we use a two-step approach:

Step 1: Estimation of the evolution of banking efficiency.

Step 2: Assessment of convergence in banking efficiency.

The rest of the study is organized as follows: Section 2 reviews the banking efficiency and convergence efficiency literature and Section 3 presents our research hypotheses. Section 4 presents the employed methodology. Section 5 describes the data and datasets used, Section 6 presents our empirical findings and section 7 summarizes our results and presents our conclusions.

Section 1.2: Literature Review

A great number of academic surveys address the issue of efficiency in European banking. The vast majority of those surveys is undertaken on a national level, while the number of cross-border studies is considerably lower. Regarding the cross-border investigations, the greatest part is focused on Western European countries and some of those studies compare the results with U.S. banks. Most of these studies focus on the comparison of banking efficiency between countries (Kösedağ et al., (2011), Kolia and Papadopoulos, (2020b)). In addition, recent surveys investigate how the European banking integration was affected by the global financial crisis of 2008.

There are only a few studies trying to control for the environmental factors which affect efficiency and none of the surveys tries to control for these factors in order to examine the convergence of bank efficiency. For instance, Casu and Molyneux, (2003) apply a non-parametric D.E.A approach and a Tobit regression approach for European Union banks, throughout the period 1993-1997 and proved that the differences in the efficiency of the sample are mainly attributed mainly to country-specific factors. Kolia and Papadopoulos, (2020a) investigate the relationship among capital, risk and efficiency in the Eurozone and the U.S. banking systems and take into consideration environmental variables. Furthermore, Dietsch and Lozano-Vivas, (2000) conduct a cross-country analysis of cost efficiency, between French and Spanish banks, in order to determine the effect of environmental factors on banking efficiency. They apply the distribution free approach (D.F.A.) and provide evidence that during the period 1988-1992 the difference between the two banking samples is limited when environmental variables are taken into account. Similarly, Carbó Valverde et al., (2007) compare the efficiency of 153 large European banks that operate in ten European Union countries during the period 1996-2002. Their results indicate that when environmental variables are controlled for, the efficiency scores of the reported banks are almost the same.

As regards the investigation of banking integration through convergence, some studies analyze the convergence of interest rates, productivity, capital flows, behavioral patterns and so on, as a measure of European integration (Fernández de Guevara et al., (2007), Rughoo and Sarantis, (2014), Gropp and Kashyap, (2009), Sander and Kleimeier, (2004), Centeno and Mello, (1999), Tziogkidis et al., (2020) and Badircea et al., (2016)).

Additionally, regarding the relation between efficiency and integration, in his paper Stavarek, (2005) compares the efficiency of three banking groups of European countries, which are separated according to the involvement of these countries in the integration process, by applying D.E.A analysis. The author's main conclusion is that banking efficiency is connected with economic development and European Union integration. There are only a handful of studies which assess directly the issue of the convergence efficiency throughout European banking as a measure of integration and the reported results are mixed.

On the one hand, some papers conclude that there is no evidence of convergence in European banking. For instance, Matousek et al., (2015) investigate efficiency and convergence of the Eurozone and the EU15 during the period 2005-2012. The methodology applied is the parametric distance function approach (NPLs) which calculates efficiency, and the Phillips and Sul technique is used in order to calculate convergence. The results of the paper support the view that there is a decrease in efficiency during the reported period and that there is no evidence of convergence in the sample. Furthermore, they find evidence of club formation with weak convergence. Similarly, Centeno and Mello, (1999) investigate the integration of the money market and the banking market of six European countries between 1985 and 1994, and they conclude that although the money market is integrated, banking is not.

Interestingly, many findings reported by other researchers indicate that there is convergence in European banking. For example, Casu and Girardone, (2009) investigate the convergence of cost efficiency of European banks from 1997 until 2003. The methodology used is DEA, σ and β convergence and data in the EU-15 area and the results suggest the existence of convergence in the sample. Nevertheless, there is no evidence for the improvement of efficiency levels. Moreover, Weill, (2009) surveys convergence of cost efficiency of 10 EU member countries from 1994 until 2005. He estimates cost efficiency of EU banks with the Stochastic Frontier Approach (S.F.A.) and analyses its evolution. Moreover, he uses β and σ convergence tests for panel data to show progress in convergence in cost efficiency between EU countries, followed by robustness checks. The main conclusions of this paper are the increase of efficiency through the reported period in all the EU countries and the existence of evidence of convergence in cost efficiency of these banks. As a result,

the paper provides evidence in favor of the improvement of European banking integration from 1994 until 2005.

Many papers conclude that although European banking is not yet integrated, evidence exists in favor of its development. For example, Kösedağ et al., (2011) conduct a cross-border analysis testing for convergence in European banking efficiency from 1990 until 2003. The methodology applied is data envelopment analysis (D.E.A.). The results indicate that efficiency of European banking has increased during the reported period and is more convergent than global banking, but even in this group convergence is at an infant stage. Moreover, Bos and Schmiedel, (2007) investigate the efficiency of 5000 European Union commercial banks through the period 1993-2004 in order to check for the existence of integration in the Single Market. The authors employ a meta-frontier approach in order to fairly compare the efficiency of the banks of different countries, and they find evidence in favor of improvement of the integration of European banking, although the efficiency scores vary across the sample. Furthermore, a test for the convergence of efficiency and the risk of Eurozone commercial, cooperative and savings banks over the period 1999-2012 is undertaken by Wild, 2016. The results show that although Eurozone banking is not yet integrated, there is convergence of efficiency when the ratio of equity to total assets is used as to control for risk.

Furthermore, Andrieș and Ursu, (2016) point out that the impact of financial crisis is a barrier for banking integration, explaining that an increase of convergence in banking efficiency was observed until 2008 and then, the convergence among bank efficiency worsen again.

This survey provides various contributions to the ongoing empirical literature. Firstly, our survey is unique in trying to check for convergence while controlling for country-specific and bank-specific factors that affect the efficiency of European and Eurozone banks. Secondly, although much of the literature focuses on the convergence of efficiency of European banking, none compares the convergence of efficiency of Eurozone, European and American banking. The majority of studies cover the banks of all European Union countries (Carbó Valverde, et al. (2007)) or EU-15 countries (Casu and Girardone, (2009), Matousek et al., (2015)) or other combinations of European countries (Centeno and Mello, (1999)). Thirdly, in our survey unlike any previous papers special consideration was given to the comparison of commercial, cooperative and savings banks, as subsets of our banking groups. Last but not least, we should mention that the recent research on European banking efficiency (2013-onwards) is very limited.

Concerning the different methodologies used for the studies, the following table (Table 2) shows that the majority of the related literature uses Data Envelopment Analysis (DEA) in order to calculate efficiency and β and σ convergence tests to

measure integration, while the use of the panel data model of Phillips, P. C., & Sul, D. is limited to only two surveys.

Table 2: Relevant Literature

Authors	Reported Period	Subject of research	Methodology to estimate efficiency	Methodology to estimate integration
Alexandrou, Koulakiotis, & Dasilas, (2011).	1990-2005	volatility spillovers for bank stock returns	-	Garch models
Altunbaş, & Chakravarty, (1998).	1988-1995	Inefficiency	mean, variance, skewness, gimi coefficient, Theil index	-
Badircea, Pirvu, & Florea, (2016)	2000-2004	banking assets flows through Europe		simple linear regression
Bos, & Schmiedel, (2007)	1993-2004	Efficiency	SFA	-
Carbó Valverde, Humphrey, & López del Paso,. (2007)	1996-2002	cost efficiency	Distribution Free Approach (DFA)	-
Casu & Girardone, (2009)	1997-2003	cost efficiency	DEA	β and σ convergence measures
Casu, & Molyneux, (2003)	1993-1997	Efficiency	DEA	tobit regression and bootstrapping
Centeno, & Mello, (1999)	1985-1994	interest rates and bank lending rates	-	the Augmented Dickey Fuller (ADF), the Phillip Perron (PP), and the Kwiatkowski et al. (KPSS) tests
Dietsch, & Lozano-Vivas, (2000)	1988-1992	cost efficiency	DFA	-
Fernández de Guevara, Maudos, & Pérez, (2007)	1993-2001	interest rates	-	σ convergence
Ilut, & Chirlesan, (2012)	2002-2010	Efficiency	DEA, VRS model	-
Kösedağ, Denizel, & Özdemir, (2011).	1990-2003	Efficiency	DEA	-
Mamatzakis, Staikouras, & Koutsomanoli-Filippaki, (2008)	1998-2003	cost and profit efficiency	SFA	β and σ convergence measures
Matousek, Rughoo, Sarantis, & George Assaf, (2015)	2005-2012	cost efficiency	parametric distance function approach (NPLs)	Phillips, P. C., & Sul, D methodology
Pastor, Pérez, & Quesada, (1997)	1992	Efficiency	DEA	-
Rughoo & Sarantis (2014)	2003-2011	deposit and lending rates	-	Phillips, P. C., & Sul, D methodology
Sander, &	2000-2002	interest rates	-	β and σ

Kleimeier, (2004)				convergence measures
Şargu, & Roman, (2012)	2003-2010	Efficiency	DEA	-
Stavarek, (2005)	2002-2003	Efficiency	Data envelopment analysis (DEA), CCR model and BCC model	-
Weill, (2009)	1994-2005	cost efficiency	Stochastic frontier approach (SFA)	β and σ convergence tests
Zhang & Matthews (2012)	1992-2007	cost efficiency	DEA	β and σ convergence measures

Section 1.3: Research Hypotheses

In this study we investigate the progress of integration in the European banking market by showing how convergence in banking efficiency has improved during the reported period. More specifically, we test the following four hypotheses:

H1: The European, Eurozone and United States banking systems are integrated.

We describe the progress of integration by showing whether convergence in banking efficiency exists, in each union separately. Initially, we employ the dynamic panel convergence methodology of Phillips and Sul, (2007)[3] in order to test for convergence. Then, in the case where we find no evidence of convergence in the unions, we apply the clustering algorithm of Phillips and Sul, (2007) and we examine if there are subgroups of banks which are convergent.

H2: The efficiency of Eurozone banks is more convergent than that of European Union banks.

This analysis aims at testing the hypothesis that an advanced level of financial integration is associated with higher convergence of efficiency in banking. The introduction of a common currency is considered as one of the most important steps towards monetary integration and, hence, this study examines whether banking integration among Eurozone countries has developed more than that of the total sum of European countries. For this purpose, we compare the speed of convergence

[3]The software used is the Stata Statistical Software, and the model which is introduced by Du. K., includes 5 commands in order to apply the above mentioned methodology.

of both groups and the results of the above mentioned convergence analysis of European and Eurozone banking.

H3: The integration of Eurozone banks of the same type is more developed than the integration of a general sample of banks.

In order to control for bank-specific barriers of European integration, we create three subgroups of Eurozone banking (commercial, cooperative and savings banks), and we repeat the above mentioned steps inquiring whether Eurozone banks operating in the same category are more integrated than the total sum of them.

H4: The samples of United States banks and its subgroups are more integrated than those of Eurozone banks.

In this stage, we compare the evolution of efficiency and the progress of banking integration across Eurozone member countries with that of the United States and of their subgroups (commercial, cooperative and savings banks).

Section 1.4: Research Methodology

1.4.1 Estimation of banking efficiency

1.4.1.1 Estimation of D.E.A results

While trying to draw accurate inferences about the impact of European Integration on banking efficiency, initially, we measure efficiency and make a comparison between the reported countries while controlling for environmental variables that affect the outcome.

The efficiency of a banking institution can be calculated as the radial distance of its efficiency to a frontier. In this research field, there is a vast and growing literature which is divided into two categories: non-parametric analysis, for instance Data Envelopment Analysis (D.E.A.), and parametric analysis, for example Stochastic Frontier Approach (S.F.A.).

In our study, we apply the well-established D.E.A. methodology, which was developed by Charnes et al., 1978 and measures efficiency by evaluating the ability of a Decision Making Unit (D.M.U.) to utilize multiple inputs in order to produce various outputs. Charnes et al., (1978) state that: “Our proposed measure of efficiency of any D.M.U. is obtained as the maximum of a ratio of weighted outputs

to weighted inputs subject to the condition that the similar ratios for every D.M.U. be less than or equal to unity." Moreover, D.E.A. does not provide absolute results, it generates relative results. To be more precise, the outcome is adjusted depending on the decision making units that are included in the sample. (Stavarek, (2004)).

The use of D.E.A. gives us the opportunity to compare banking systems of different sizes. This is of great importance for our survey because there is a great variety of sizes in the sample. Furthermore, another essential advantage of the use of D.E.A is that it can be applied even in small groups of financial institutions.

The C.C.R. model, applied in our survey, is developed by Charnes et al., (1978) and combines a number of inputs and outputs, in order to create a ratio of their weighted sums. Concerning its characteristics, it is an input-oriented model that is based on convex structure, constant returns to scale and radial distance. The choice of an input-oriented model is based on the fact that in periods during and following financial crises, firms focus on reducing expenses. Moreover, the management of a D.M.U controls more effectively the inputs than the outputs.

Furthermore, there are two techniques in modeling bank efficiency; the production approach and the intermediation approach. On the one hand, in the production approach financial institutions use physical assets, for instance labor and capital, in order to produce deposits and loans. On the other hand, in the intermediation approach they generate loans from deposits and physical assets. The appropriate variable categorization of inputs and outputs is of great importance as it can provide completely different results of relative efficiency. In our survey, as suggested by Berger and Humphrey, (1997), we adopt the intermediation approach which was developed by Sealey and Lindley, (1977). More specifically, Berger and Humphrey, (1997) examine a vast number of papers studying banking efficiency and they recommend the use of intermediation approach to measure bank efficiency.

For our analysis, we have selected three inputs (labor, capital, and deposits) and two outputs (loans and net interest income). More specifically, concerning inputs, 'labor' is defined as the total expenses of staff, 'capital' is defined as the book value of the fixed assets (property, plant and equipment) and the variable 'deposits' depicts the sum of time and demand deposits. Referring to outputs, 'loans' refers to the sum of net loans and advances to banks and net loans and advances to customers while 'net interest income' is the difference between interest incomes and interest expenses.

1.4.1.2 Estimation of two-stage semi-parametric double bootstrap DEA

Current DEA analysis incudes bootstrapping of efficiency results, in order to generate bias corrected efficiency scores, or take into consideration the effects of environmental variables on efficiency. For instance, Simar and Wilson, (2007), provide an alternative to the conventional D.E.A. approach by performing a two-stage semi-parametric bootstrap method which absorbs the effects of environmental variables in the measurement of efficiency. They apply a coherent Data-Generating Process (DGP). They use the single or double bootstrap procedures and test the statistical performance of their model by performing Monte Carlo experiments. This analysis overcomes the problem of a biased estimation (leaving out of the sample 0 or using log0 etc.) and of the serial correlation of DEA efficiency estimates. Their purpose was to estimate efficiency while controlling for external factors that affect the efficiency of the banks but cannot be influenced by their managers. These barriers explain to what extent integration can be accomplished and, therefore, must be seriously considered in the evaluation of the integration progress. In our survey, we apply the methodology of **Simar and Wilson, (2007),** more specifically the algorithm 2 of the two-stage semi-parametric double bootstrapping method[4].

In the first stage of our analysis, we employ D.E.A. to calculate the relative efficiency scores $\rho_{j.}$ Then, we apply the methodology of Simar and Wilson, (2007) to bootstrap D.E.A. results with a truncated bootstrap regression. For this purpose we use the maximum likehood method in order to regress the efficiency estimates $\hat{\rho}_j$ on a set of environmental variables z_j and Equation 1 is the model to be estimated.

$$\hat{\delta}_j = z_j\beta + \varepsilon_j \geq 1 \qquad (1)$$

Where:

$\hat{\rho}_j$: D.E.A. efficiency estimates

$\hat{\delta}_j$: we use only $\hat{\gamma}_j > 1$ in this step , $\hat{\delta}_j = 1/\hat{\rho}_j$

z_j : a vector of environmental variables for the jth bank

β: a vector of parametres associated with each factor to be estimated

ε_j : is a truncated random error $N(0, \hat{\sigma}_\varepsilon^2)$, truncated at $(1- z_j\hat{\beta})$

[4]We apply the methodology of **Simar and Wilson, (2007)** by using "rDEA" package version 4.47 in R software developed by Smith and Besstremyannaya, 2016.

The methodology can be summarized as follows:

Step 1: Use the methodology of maximum likehood method in order to estimate $\hat{\beta}$ of β and $\hat{\sigma}_\varepsilon$ of $\sigma_{\varepsilon,}$ in the truncated regression of $\hat{\delta}_j$ on z_j.

Step 2: Repeat the next 4 steps L_1 times to obtain a set of bootstrap estimates $Ɽ_j = \{\hat{\delta}_{jb}^{*}\}^{L}_{1,b=1}$:

Step 2.1: Estimate ε_j from the $N(0, \hat{\sigma}_\varepsilon^2)$ distribution with left-truncation at $(1-z_j\hat{\beta})$, for each i=1,….,m.

Step 2.2: Compute $\delta^*_j = z_j\beta + \varepsilon_j$, for each i=1,….,m.

Step 2.3: Set $x_j^* = x_j$, $y_j^* = y_i\hat{\delta}_j/\delta^*_j$ for all i=1,….n.

Step 2.4: Calculate $\hat{\delta}_j^* = \delta(x_j, y_j|\hat{\mathbb{P}}^*) \forall i=1,….,n$ (where $\hat{\mathbb{P}}^*$ is estimated by replacing (x,y) in D.E.A. analysis with (x_j^*, y_j^*)

Step 3: Calculate the bias-corrected estimator $\hat{\hat{\delta}}_j = \hat{\delta}_j - BIAS(\hat{\delta}_j)$ by using the D.E.A. estimates obtained in the previous step and the original estimate $\hat{\delta}_j$.

Step 4: Use the methodology of maximum likehood method in order to estimate the truncated regression of $\hat{\hat{\delta}}_j$ on z_j, yielding estimates $(\hat{\hat{\beta}}, \hat{\hat{\sigma}})$

Step 5: Repeat the next 3 steps L_2 times to obtain a set of bootstrap estimates $Ł = \{(\hat{\beta}^*, \hat{\sigma}_\varepsilon^*)_b\}^{L}_{2,\, b=1}$:

Step 5.1: Estimate ε_j from the $N(0, \hat{\hat{\sigma}})$ distribution with left-truncation at $(1-z_j\hat{\hat{\beta}})$, for each i=1,….,n

Step 5.2: Compute $\delta_j^{**} = z_j\hat{\hat{\beta}} + \varepsilon_j$, for each i=1,….,n.

Step 5.3: Use the methodology of maximum likehood method in order to estimate the truncated regression of δ_j^{**} on z_j yielding estimates $(\hat{\hat{\beta}}^*, \hat{\hat{\sigma}}^*)$.

Step 6: Construct the estimated confidence intervals by using the bootstrap results.

The variables L_1 and L_2 refer to the number of replications in the first and the second bootstrap respectively. According to Simar and Wilson, (2007) 100 replications are sufficient, while Hall, 1986 suggests the use of at least 1000 replications. In our survey, 100 replications are used in the first bootstrap while 2000 are used in the second one.

1.4.2 Assessment of convergence in banking efficiency

As banking is a multi-product business, it is quite complex to describe its integration. One way to describe the progress of integration in the European banking market is to show how convergence in banking efficiency for European countries has improved. For this purpose we rely on the dynamic panel method introduced by **Phillips and Sul, (2007)**[5]. This technique is a nonlinear factor model with a growth component and a time varying idiosyncratic component that allows for quite general heterogeneity across individuals and over time. The analysis consists of a long t-regression test of convergence which "represents the behavior of economies in transition, allowing for a wide range of possible time paths and individual heterogeneity….. a new method of clustering panels into club convergence groups is constructed." (Phillips and Sul, (2007)).

The applied model has significant advantages over the most commonly used methods, σ-convergence and β-convergence (Matousek et al., (2015)). More specifically, β and σ convergence do not provide information about the speed of the convergence process over the reported period, whereas the methodology of Phillips and Sul, (2007) permits the calculation of each country's relative transition parameters and compares it to the panel average, giving us evidences about the speed of convergence. Moreover, the employed methodology is capable of not only identifying if our sample is convergent, but also if the convergent sub-clusters exist in our sample.

To apply Phillips and Sul dynamic panel data method we need to perform three steps, while for the club convergence algorithm four more steps are necessary. More specifically:

[5]To apply Phillips and Sul, (2007) methodology, Stata statistical software is used and more specifically, the model introduced by Du, K.

Concerning the methodology, Phillips and Sul use the relative transition coefficients and propose a regression-based long t test. The hypotheses of convergence are as follows:

H_o: $\delta_i = \delta$ and a≥0

H_1: $\delta_i \neq \delta$ for all I and a<0

The three steps required for this methodology are the following:

Step 1: Calculation of the cross sectional variance H_1/H_t:

$H_t = \frac{1}{N} \sum_{i=1}^{N} (h_{it} - 1)^2$

Step 2: Perform OLS regression:

$\text{Log}(\frac{H_1}{H_T}) - 2\text{logL(t)} = \hat{a} + \hat{b} \log t + \hat{U}_t$

Where:

L(t)= log(t+1)

log t : the fitted coefficicnet of log t is $\hat{b}$ =2$\hat{a}$

$\hat{a}$: the estimate of a in H_0

t: the data for the regression starts at t=r*T, with some r>0

Step 3: Use $\hat{b}$ and a standard estimation error to perform a one-sided t test of null a ≥0. The standard estimation error is calculated using a heteroskedasticity and autocorrelation consistent (HAC) estimator. The t-statistic is normally distributed and the null hypothesis is rejected when t-statistic <-1.65.

1.4.3 Assessment of convergent clusters in banking efficiency

The rejection of the null hypothesis does not necessarily mean that there is no sub-group convergence within the panel. The club convergence algorithm developed by Phillips and Sul, (2007) provides the opportunity to determine whether convergent clusters in the reported sample exist. The four steps of the algorithm are listed below:

Step 1: The series (X_{it}) in the panel are ordered according to the last observation (X_{iT}).

Step 2: A core group which includes the first k highest panel members is created in order to form the subgroup G_k for some $N > k \geq 2$, and the convergence test statistic t(k) is estimated for each k. The size of the core group is selected by maximizing the t(k) under which min t(k) >-1.65.

Step 3: Once the core group is created, each remaining bank of the sample is added to the group and the log t test is repeated. A chosen critical value, c, is the criterion under which a bank is included in the current subgroup to form a new group. If the corresponding test statistic t is greater than c and if t>-1.65, the subgroup is created. If these pre-requisites are not fulfilled, the value of the variable c is increased and the model is repeated.

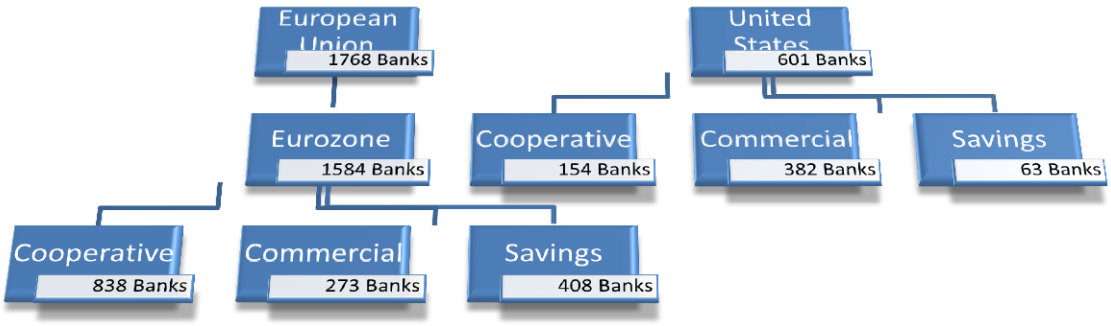
Step 4: The log t test is repeated for the rest of the banks, which have not been selected in the previous step, and if the null hypothesis is verified, a second club is created. In the case of rejection, the previous three steps are repeated for the remaining banks. In the case where no other groups can be created we can conclude that the remaining countries are not convergent in any sample.

Section 1.5: Data

Our data sample consists of aggregate balance sheet and income statement data from 2369 banks. The sample is divided into two parts; European and American banks. The types of banks used are commercial, cooperative, investment, savings, real estate and mortgage banks. The subgroups of banks that are separately investigated are commercial, cooperative and savings banks and they are chosen as they constitute the largest types of banking institutions in both economic unions (

Figure 1).

Figure 1: The data sample per banking sector



Regarding the group of European Union banks (Table 3), it includes the countries which have achieved the final stage of financial integration and are members of the European Economic Monetary Union[6] (Eurozone), as well as the countries which are not members of the Monetary Union[7]. This sample comprises of 1768 banks. The subgroup of European Union banks which is the Eurozone banks is separately investigated for the purposes of our survey and includes 1584 banks. Our sample also includes 601 United States banks.

Table 3: The Data Sample per country

Country	*Number of banks*

[6] Austria, Belgium, Cyprus, Germany, Estonia, Spain, France, Greece , Ireland, Italy, Lithuania, Luxembourg, Latvia, Malta, Netherlands, Portugal, Slovenia, Slovakia.
[7] Bulgaria, Czech Republic, Denmark, Finland, United Kingdom, Croatia, Hungary, Poland, Romania, Sweden

Austria	104
Belgium	12
Bulgaria	13
Croatia	21
Cyprus	9
Czech Republic	18
Denmark	18
Estonia	6
Finland	12
France	141
Germany	865
Greece	6
Hungary	13
Ireland	4
Italy	311
Latvia	9
Lithuania	5
Luxembourg	17
Malta	4
Netherlands	8
Poland	45
Portugal	16
Romania	16
Slovakia	9
Slovenia	7
Spain	38
Sweden	9
United Kingdom	32
European Union	1768
Eurozone	1584
United States	601

The reported period is 2013-2018 and was chosen for two reasons:

1. The studies on the European banking integration using recent data are limited and the comparison of integration of efficiency between European banks and American banks are even more limited for this period.

2. The article provides an analysis of the European banking system one decade after the implementation of the Financial Services Action Plan (FSAP), which is considered as the most important recent step towards integration, as it

removed the majority of legal obstacles towards the liberalization of the financial market and the integration of European banks[8].

Moreover, in this survey we describe the possible barriers of European banking integration which are not controlled by banks and are taken into account in the measurement of efficiency. These barriers explain to what degree integration can be achieved and are divided into four categories: country-specific, regulatory, bank-specific and institutional. More analytically,

- Considering banking regulation, all European countries implement the European Capital Requirement Directive (European Parliament (2013)) and the European Banking Directives (European Parliament (2002)). Hence, from this point of view, European banking forms a homogenous entity and banking regulation should not be considered as a barrier to banking integration.

- Furthermore, all countries of the EU share the same institutional framework, established by the Single Market Program (European Council (1987)) and Second Bank Directive (European Parliament (1989)). Therefore, we assume that institutional factors do not obstruct European banking integration.

- The third category (bank-specific factors) reflects the differences based on the type of banks (commercial, cooperative, savings banks and others). Each type of bank implements a different institutional framework, has different goals, provides different types of services and operations, and has different types of business risks. Thus, different types of banks do not follow the same efficiency pattern and do not form a homogenous group, forming barriers to banking integration. Hence, we also performed our analysis by using three subgroups of our sample that included only commercial, cooperative and savings banks and compared the results with the results of the general sample.

- Country-specific factors measure the main conditions under which banks of each country operate and the issue to be investigated is how these conditions affect their efficiency levels. Due to the diversity of national characteristics across different EU markets, we assume that country-specific factors constitute significant barriers of

[8] The purpose of this plan was threefold. It aimed at the creation of the single market for financial services and products, the creation of a single financial retail market and the implementation of common rules and supervision. According to the European Commission 98% of the measures of FSAP were implemented in 2005.

European banking integration. In our survey, we incorporate the following country-specific factors to the second stage truncated regression of the efficiency measurement; GDP real growth rate, inflation rate, budget balance, public debt, unemployment rate.

Table 4: Average Environmental Variables

	GDP real growth rate%	Inflation rate %	Public debt %	Unemployment %
Austria	1.451667	1.618	80.9	5.516667
Belgium	1.500667	1.436333	104.0167	7.666667
Bulgaria	2.7615	0.426333	24.51667	8.766667
Croatia	1.86	0.606667	80.58333	13.93333
Cyprus	1.6805	-0.349	103.1	13.25
Czech Republic	2.881667	1.208667	38.53333	4.55
Denmark	2.0875	0.576167	39.16667	6.25
Estonia	3.221	1.6955	9.783333	6.7
Finland	1.109	0.953667	60.61667	6.7
France	1.311	0.876167	96.38333	9.9
Germany	1.751	1.176167	70.48333	4.35
Greece	0.014667	-0.24117	178.0167	23.88333
Hungary	3.623	1.212	74.83333	6.283333
Ireland	9.192333	0.258667	84.33333	9.433333
Italy	0.466167	0.665333	134.4833	11.71667
Latvia	2.835167	1.088333	39.43333	9.716667
Lithuania	3.256167	1.269833	39.08333	8.8
Luxembourg	3.632333	1.102	21.96667	5.983333
Malta	7.420167	1.101333	56.86667	4.933333
Netherlands	1.836333	1.018333	61.88333	6.05
Poland	3.640167	1.036333	51.96667	6.966667
Portugal	1.636167	0.684	129.1833	11.73333
Romania	4.517	1.3155	36.95	5.95
Slovakia	2.897667	0.914667	52.13333	10.53333
Slovenia	2.704833	0.81	76.01667	8.083333
Spain	2.026667	0.679333	98.53333	20.8
Sweden	2.487	0.8885	41.86667	7.266667
United Kingdom	2.0275	1.757167	86	5.333333

According to Table 4, which reports the average environmental variables during the reported period, we notice that differences among the European countries are evident. In addition, Greece and Cyprus also have the two lowest inflation rates, these are less than -0.2%, while the inflation rates of the Estonia, United Kingdom as well are more than 1.5%. Furthermore, it is very interesting to note the huge differences of public debt level. More specifically, Estonia has the lowest public debt level, that is 9.78% and the highest levels are found in Greece (178.02%). Similarly, there are differences in the unemployment rate and the inflation rate amongst

European countries. Therefore, we may conclude that there is still a range of environmental variables in European Union countries, which highly affect banking efficiency, and should be taken into account.

Section 1.6: Empirical Results

1.6.1 Efficiency estimation

This section presents the results of the D.E.A. efficiency analysis, which have been calculated by using two models, as they are described in the second part of our survey. More specifically:

Model 1: We perform the estimation of D.E.A efficiency by using three inputs (labor, capital, and deposits) and two outputs (loans and net interest income).

Model 2: We estimate the bias corrected efficiency of the results of model 1 by considering the environmental variables and by applying the two-stage semi-parametric bootstrap method of Simar and Wilson, (2007).

Initially, we calculate D.E.A. efficiency scores of European banks (descriptive statistics of inputs and outputs are presented in Appendix). We also separately estimate the scores of each bank, set up in the Eurozone and in the United States. The descriptive statistics of the yearly DEA results for each model, spilt by the individual estimation periods, are presented in the following table (Table 5).

Table 5: Descriptive Statistics of DEA Efficiency Scores – General Sample

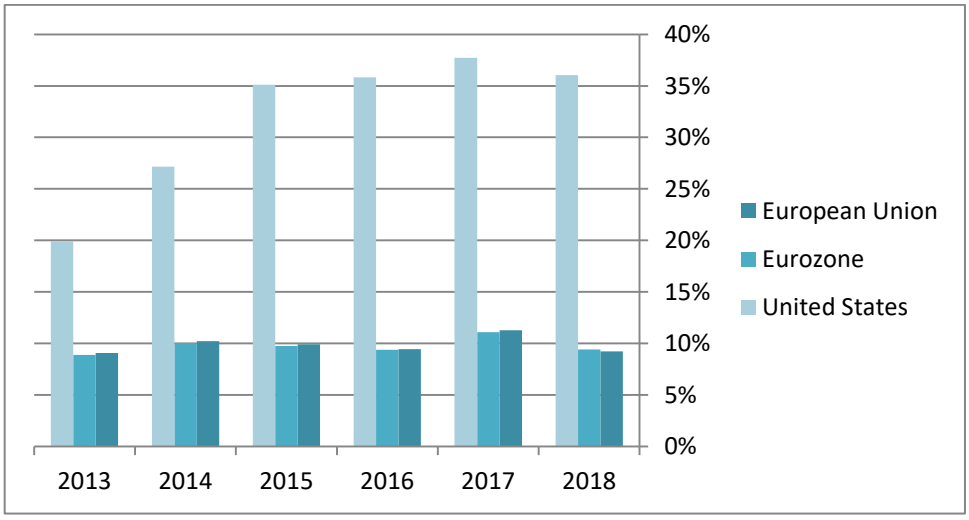
European Union		Mean	Median	St.dev	Min	Max
Model 1	2018	10.57%	8.62%	10.21%	0.00%	100.00%
	2017	12.77%	10.90%	9.83%	0.00%	100.00%
	2016	10.78%	8.98%	9.65%	0.06%	100.00%
	2015	11.27%	9.27%	9.78%	0.05%	100.00%
	2014	11.50%	9.60%	9.55%	0.09%	100.00%
	2013	10.05%	8.35%	8.87%	0.22%	100.00%
Model 2	2018	9.23%	7.94%	6.94%	0.00%	83.42%
	2017	11.29%	10.23%	7.15%	0.00%	85.90%
	2016	9.46%	8.43%	6.48%	0.04%	79.71%
	2015	9.92%	8.71%	6.72%	0.03%	81.27%
	2014	10.22%	9.02%	6.52%	0.06%	76.89%

	2013	9.08%	7.80%	11.82%	0.16%	432.20%
Eurozone		**Mean**	**Median**	**St.dev**	**Min**	**Max**
Model 1	2018	10.61%	8.66%	9.93%	0.01%	100.00%
	2017	13.18%	11.58%	9.59%	0.00%	100.00%
	2016	10.67%	8.98%	9.51%	0.08%	100.00%
	2015	11.11%	9.22%	9.66%	0.05%	100.00%
	2014	11.31%	9.56%	9.45%	0.09%	100.00%
	2013	9.94%	8.30%	8.96%	0.22%	100.00%
Model 2	2018	9.41%	8.00%	6.89%	0.00%	84.04%
	2017	11.09%	10.54%	10.52%	0.00%	80.93%
	2016	9.39%	8.43%	6.38%	0.05%	79.45%
	2015	9.75%	8.65%	6.52%	0.03%	80.96%
	2014	10.05%	8.98%	6.36%	0.06%	76.89%
	2013	8.89%	7.71%	9.28%	0.16%	283.61%
United States		**Mean**	**Median**	**St.dev**	**Min**	**Max**
Model 1	2018	36.04%	31.84%	15.58%	1.61%	100.00%
	2017	37.71%	34.07%	15.46%	0.00%	100.00%
	2016	35.83%	31.84%	15.71%	3.06%	100.00%
	2015	35.12%	32.21%	15.46%	3.28%	100.00%
	2014	27.16%	24.62%	14.06%	1.25%	100.00%
	2013	19.94%	17.04%	13.64%	0.84%	100.00%

Note: 1. The D.E.A. efficiency results of model 1 are generated using 'rDEA' package version 4.47 in R software developed by Smith and Besstremyannaya, 2016. 2. The dea efficiency results of model 2 are generated using the methodology of Simar and Wilson, (2007), more specifically the algorithm 2 of the two-stage semi-parametric double bootstrapping method. 3. The size of confidence interval for the bias-corrected DEA score is 0.05.

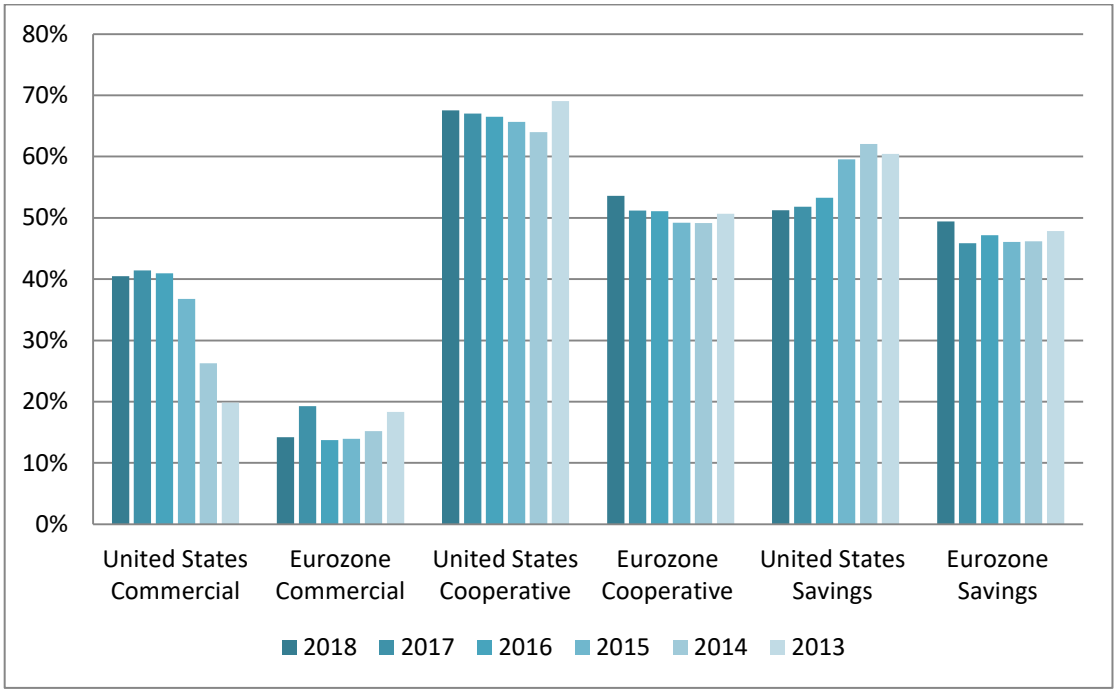
In Table 5, we can observe that the standard deviations of the European and Eurozone banking in model 1 are significantly higher than those of model 2, that is more than 30%. Considering the fact that model 2 is an expansion of model 1, which also controls for environmental variables that affect the efficiency of banking institutions, this outcome illustrates that in the reported groups the efficiency of banks is highly affected by environmental variables. Therefore, our results confirm the necessity for controlling exogenous factors in our study. Nevertheless, concerning the United States, we should mention that model 1 has been applied in order to calculate the DEA efficiency results as the environmental variables which are used in model 2 of our survey remain the same among U.S. banks. Figure 2 and Figure 3 illustrate the mean efficiency of Eurozone banking and United States banking and of their subgroups.

Figure 2: Median Efficiency 2013-2018



As regards the sample that includes all banks (commercial, cooperative, investment, savings, real estate and mortgage banks) our findings seem to suggest that the efficiency of the United States banking system is considerably higher, that is more than double, than that of Eurozone and the European Union banks (figure 2). Our findings are in line with those of Weigand, (2016) who compares the banking systems of the United States, the European Union and Japan. The author provides evidence that U.S. commercial banks outperform those of the other two unions during the period 2014-2015. It is also interesting to note that, throughout the reported period, the efficiency of United States banks increased about 80%, while that of Eurozone and European Union banks is quiet steady. This outcome could be explained as i. the recovery of the United States from the financial crisis of 2008 is faster than that of the European Union (Kollmann et al., (2016), Kollmann et al., (2017)), ii. the after-crisis regulatory framework implemented in the United States is more flexible than that of the Eurozone (Lakhani et al., (2019)) and iii. different interest rates policies are employed by the Federal Reserve Bank and the European Central Bank (McLannahan and Arnold, (2017)). Finally, we notice that the efficiency of the European Union banking group is slightly increased, when compared to Eurozone banks. One explanation could be that the Eurozone banks (Irish, Italian, Spanish and Greek banks) have the highest rates of non-performing loans in the European Union (Binham and Noonan, (2015)).

Figure 3: Median Efficiency of subgroups 2013-2018



In the next stage of our analysis, we calculate D.E.A. efficiency results separately for the banks that are cooperative, commercial and savings. In order to observe the differences among the analyzed groups, we depict the results in Figure 3. We notice that the efficiency of all Eurozone banking sectors is considerably lower than that of the United States. Moreover, the charts illustrate that the efficiency of cooperative banks is the highest reported in both the Eurozone and the United Stated and that the efficiency of commercial banks is the lowest reported. This outcome is in line with Spulbar et al., 2015 who conclude that cooperative and savings banks manage their costs more efficiently than commercial banks.

1.6.2 Convergence of efficiency

In this section we compare the evolution of efficiency and the progress of banking integration across Eurozone member countries with that of the United States and their subgroups (cooperative, commercial and savings banks).

Initially, we determine whether there is convergence of efficiency in European banking over the period 2013-2018 by describing the evolution of convergence, and contrasting the results of European banking with those of Eurozone countries. Moreover, we compare the development of the convergence in efficiency of European banks with that of the United States banks so as to assess which of the

unions is more integrated. Finally, we follow the same pattern in order to compare the convergence of the different types of Eurozone banks with those of the United States banks. In the following table (Table 3), we report the results of the test for convergence.

Table 6: Convergence of Efficiency

		Coeficient	t-statistics
European Union		-1.6748	-54.1004*
Eurozone		-1.6695	-50.6722*
	Commercial	-1.5136	-24.5433*
	Cooperative	-1.6896	-62.3616*
	Savings	-2.1759	-72.0216*
United States		-2.3548	-19.5428*
	Commercial	-2.1795	-10.0094*
	Cooperative	-1.5185	-102.129*
	Savings	-1.0879	-29.1054*

Notes: 1. Phillips and Sul, (2007) convergence methodology was applied by using the model introduced by Du, 2018 on Stata statistical software. 2. * indicates the rejection of the null hypothesis of convergence at the 5% significance level

When the t-statistics, obtained from the convergence test, are less than -1.65 the null hypothesis of convergence is rejected. Our results, as reported in table 3, show that the hypothesis of convergence is rejected. Moreover, the convergence test is applied to the subgroups of the United States and the Eurozone commercial, cooperative and savings banks, and the null hypothesis is also rejected. Therefore, based on our results, we can conclude that there is no evidence of convergence across the banking sectors of the European Union, the Eurozone and the United States. Among the several studies that investigate the integration of European banking by using efficiency as an indicator, many authors reach the same conclusion, for instance Centeno and Mello, (1999) and Matousek et al., (2015) and Goddard et al., (2007). Factors that can explain the absence of banking integration are the existence of differences in the legal and fiscal systems of each country as well as the existence of different economic conditions, language and culture (Goddard et al., (2007)). Our findings, however, seem to contradict those of Casu and Girardone,

(2009) and Weill, (2009) who indicate that there is convergence in European banking.

Nevertheless, we should mention that the t-statistics of the United States is higher than those of the Eurozone and the European Union, which has the lowest value. The larger the t-statistics are the closer to convergence the banking group is. Therefore, it is reasonable to conclude that banking integration among United States has not yet been achieved, but it is slightly more developed than that of European banks and Eurozone banks. This outcome could be explained as United States banks were rapidly recapitalized after the global financial crisis (Troubled Asset Relief Program, (2008)), whereas this did not happen in the Eurozone (Jenkins, 2015), thus Eurozone banks were differently affected by the global financial crisis depending, among other factors, on their different needs of bank capital.

Moreover, we find that the indicator of convergence of Eurozone banks is slightly higher than that of European Union banks. However, the difference is so slight that it cannot help us to draw valid conclusions and we cannot determine which banking system is closer to convergence. Hence, our results cannot confirm those of Alexandrou et al., (2011) and Andrieş and Căpraru, (2012) who conclude that the introduction of the common currency has contributed to the enhancement of European banking integration.

Furthermore, we may notice that commercial and savings banks in the United States are closer to convergence than those in Eurozone. However, as regards the cooperative banks the outcome is different. The t-statistic of cooperative banks of the Eurozone is higher than that of the United States cooperative banks. Furthermore, the commercial banking sector is closer to convergence than savings banks, and the least convergent banking group is that of the cooperative banks.

In addition, the convergence test provides information for the speed of convergence. More specifically, the higher the value of the coefficient is, the faster the rate of convergence. Table 3 illustrates that Eurozone banks have the highest speed as the variable coefficient is the highest among the banking groups examined. Moreover, the value of the coefficient of European Union banks is also higher than that of the rest of the banking groups and almost the same as that of Eurozone banks. Interestingly, the convergence progress of the Eurozone is faster than that of its three subgroups, while the speed of convergence of U.S. banks is lower than that of its subgroups, and the lowest recorded. Finally, we observe that United States savings and cooperative banks exhibit higher speed of convergence than Eurozone cooperative and savings banks.

The absence of convergence in the reported groups could be attributed to some divergent members of the sample. Thus, it is essential not to reject the existence of

convergence before we investigate whether there are clusters of banks in our sample for which convergence exists and whether there are divergent members of the sample (Matousek et al., (2015), Rughoo and Sarantis, (2012)). For this purpose, we apply the Phillips and Sul, (2007) clustering algorithm test, in order to investigate whether convergence between clusters of banks exists. The algorithm creates the clusters which are convergent and its results for European Union, Eurozone and United States banks are reported in Table 7.

Table 7: Convergent Clusters

European Union	**Club1**	**Club2**	**Club3**	**Club4**	**Club5**	**Club6**	**Club7**					
Coeficient	-0.243	-0.008	-0.197	0.064	-0.061	-0.176	0.179					
T-statistics	-0.287	-0.05	-1.571	0.535	-0.489	-1.438	4.249					
Number of banks	54	172	488	517	394	107	25					
% of total banks	3.07%	9.79%	27.77 %	29.43 %	22.42 %	6.09%	1.42%					
Eurozone	**Club1**	**Club2**	**Club3**	**Club4**	**Club5**	**Club6**	**Club7**	**Club8**	**Club9**	**Club10**		
Coeficient	-0.055	0.824	1.206	1.394	0.591	1.003	-0.044	6.229	0.937	1.515		
T-statistics	-0.184	8.778	10.322	10.824	6.78	10.835	-1.099	2.763	9.931	5.545		
Number of banks	156	128	266	280	404	217	94	2	23	5		
% of total banks	9.90%	8.13%	16.89 %	17.78 %	25.65 %	13.78 %	5.97%	0.13%	1.46%	0.32 %		
Eurozone Commercial	**Club1**	**Club2**	**Club3**	**Club4**								
Coeficient	-0.316	0.924	0.242	-0.135								
T-statistics	-1.117	7.062	2.836	-0.401								
Number of banks	176	34	44	17								
% of total banks	64.94 %	12.55 %	16.24 %	6.27%								
Eurozone Cooperative	**Club1**	**Club2**	**Club3**	**Club4**	**Club5**	**Club6**	**Club7**	**Club8**				
Coeficient	0.172	0.932	-0.179	-0.044	0.421	0.856	4.939	-2.444				
T-statistics	2.442	8.219	-1.338	-0.605	6.748	6.482	3.02	-79.2023				
Number of banks	99	73	236	290	114	15	2					
% of total banks	11.90 %	8.77%	28.37 %	34.86 %	13.70 %	1.80%	0.24%	0.36%				
Eurozone Savings	**Club1**	**Club2**	**Club3**	**Club4**	**Club5**	**Club6**	**Club7**	**Club8**				
Coeficient	1.016	0.03	-0.214	-0.081	0.101	0.052	0.014	0.476				
T-statistics	4.704	0.123	-1.616	-0.592	0.539	0.303	0.12	8.563				
Number of banks	8	24	90	134	79	28	34	11				
% of total banks	1.96%	5.88%	22.06 %	32.84 %	19.36 %	6.86%	8.33%	2.70%				
United States	**Club1**	**Club2**	**Club3**	**Club4**	**Club5**	**Club6**	**Club7**	**Club8**	**Club9**	**Club10**	**Club11**	**Club12**
Coeficient	-4.103	-0.228	-1.415	0.418	-0.055	-0.091	-0.093	1.095	-0.128	0.741	1.6	-2.485
T-statistics	-1.039	-0.256	-24.699	1.619	-0.416	-0.241	-1.118	4.256	-1.619	4.796	0.577	-404.408
Number of banks	6	3	3	3	19	62	121	153	165	44	4	4

% of total banks	1.02%	0.51%	0.51%	0.51%	3.24%	10.56 %	20.61 %	26.06%	28.11%	7.50 %	0.68 %	0.68%
United States Commercial	**Club1**	**Club2**	**Club3**	**Club4**	**Club5**	**Club6**	**Club7**	**Club8**				
Coeficient	-0.152	-1.415	-0.061	-0.153	-0.574	0.059	1.506	-2.9200				
T-statistics	-0.16	-24.699	-0.295	-1.235	-1.575	0.165	4.655	-689.512				
Number of banks	2	3	24	61	206	65	7	2				
% of total banks	0.54%	0.81%	6.49%	16.49 %	55.68 %	17.57 %	1.89%	0.54%				
United States Cooperative	**Club1**	**Club2**	**Club3**	**Club4**	**Club5**	**Club6**	**Club7**	**Club8**	**Club9**			
Coeficient	4.405	-1.415	-0.114	0.042	0.196	0.642	0.788	0.493	-2.62			
T-statistics	1.123	-24.699	-0.621	0.557	3.163	8.432	9.502	2.037	-155.574			
Number of banks	2	6	9	11	39	38	26	20	3			
% of total banks	1.30%	3.90%	5.84%	7.14%	25.32 %	24.68 %	16.88 %	12.99%	1.95%			
United States Savings	**Club1**	**Club2**	**Club3**	**Club4**	**Club5**	**Club6**	**Club7**	**Club8**	**Club9**	**Club10**		
Coeficient	-1.415	0.013	-0.025	0.046	0.178	2.37	0.59	0.255	1.574	-6.599		
T-statistics	-24.699	0.073	-0.808	0.367	2.857	14.198	10.651	2.7	5.065	-2.794		
Number of banks	3	5	13	7	12	4	5	5	4	3		
% of total banks	4.92%	8.20%	21.31 %	11.48 %	19.67 %	6.56%	8.20%	8.20%	6.56%	4.92 %		

Note: The results are generated using the methodology of Simar and Wilson, (2007), more specifically the clustering algorithm.

Our findings indicate the presence of club convergence in all the reported groups. More specifically, our results suggest that European banks may be divided into 6 different clusters which are convergent, while only 25 banks cannot be included in any cluster, comprising only 1.4% of the total number of banks. It is also worth mentioning that although the sample of European Union banks is divided into 6 convergent clusters, the vast majority of banks belong to 3 clusters amounting to 79.6% of the total sample of banks. In relation to Eurozone banks, the same pattern is repeated. We can compare our results with those of Matousek et al., 2015 investigating the efficiency and convergence of the Eurozone and EU15 from 2005-2012, and also applies the methodology of Phillips and Sul, (2007). The authors found no evidence of group convergence, and attributed the outcome to the impact of the financial crisis on European banking. However, our findings show the presence of club formation in European banking throughout the period 2013-2018. Therefore, our findings appear to support the view that banking integration has improved since 2012. This finding is in line with many papers which conclude that although European banking is not yet integrated, evidence exists in favor of its improvement, for example, Kösedağ et al.,(2011), Bos and Schmiedel, (2007), Wild, (2016).

As can be shown by the results reported in table 4, Eurozone banks may be separated into 10 clusters which are convergent and four of those clusters include the majority of banks in our sample (74.1% of the number of banks). Additionally,

the results show that there are 10 convergent clusters of U.S. banks, while among these clusters, three include 75.11% of the banks. Furthermore, as concerns the subgroups of banks, we observe that the same pattern is repeated. Our results seem to suggest that, with the exception of the U.S. savings banks, 4 convergent clusters include more than 80% of the sample of each group. Therefore, we reach the conclusion that, although none of the banking systems are convergent, our findings indicate the presence of club formation for all the banking groups and subgroups of our sample.

Section 1.7: Concluding Remarks

This chapter undertakes the task of examining the convergence of efficiency in the Eurozone, European and American banking markets which is of utmost importance as it sheds light on the process of banking integration. For this purpose, we have applied the methodologies of Simar and Wilson, (2007) and of Phillips and Sul, (2007) in order to calculate the efficiency and the convergence of efficiency for the above-mentioned banking markets, and the subgroups of cooperative, commercial and savings European and United States' banks during the period 2013-2018.

Regarding the evolution of banking efficiency, our findings show that the efficiency of the United States banking system is considerably higher, more than double, than that of the Eurozone and European Union banks. Moreover, throughout the reported period, the efficiency of United States banks increased about 80%, while that of the Eurozone and European Union banks is almost steady, fluctuating between 8%-11%. Finally, we notice that the efficiency of the European Union banking group is slightly increased, when compared to that of Eurozone banks.

Concerning the subgroups of banks (cooperative, commercial and savings banks), we observe the same pattern as the efficiency of all the Eurozone banking sectors is considerably lower than that of the United States. Our results also provide evidence that the efficiency of cooperative banks is the highest reported in both Eurozone and United Stated banking and that the efficiency of commercial banks is the lowest reported.

We also test for bank convergence in order to verify or reject the four hypotheses, related to integration, that were posed in our survey. The first hypothesis examines whether the European, Eurozone and United States banking systems are integrated. Our findings suggest that there is no evidence of convergence across these banking sectors, when considering all banks. Therefore, European, Eurozone as well as United

States banking systems are not yet integrated and thus, we reject the first hypothesis.

The second hypothesis aims at testing whether an advanced level of financial integration is associated with higher convergence of efficiency in banking. For this purpose, this chapter examines whether banking integration among Eurozone countries has developed more than that of European countries. We compare the results of the above mentioned convergence analysis of European and Eurozone banking and also the speed of convergence. We find that the indicator of convergence and the speed of convergence of Eurozone banks are slightly higher than that of European Union banks. However, the difference is so minimal that it cannot help us to draw any valid conclusions nor reject or confirm the second hypothesis.

Furthermore, our third hypothesis is associated with the control of bank-specific barriers hampering European integration, and examines whether the integration of commercial, cooperative and savings Eurozone and United States banks is greater than the integration of the total sample of banks. Our findings suggest that the integration of savings and cooperative banks is less developed than that of the total sample of banks, as the indicator of convergence and the speed of convergence of Eurozone banks are higher than those reported for the banking subgroups. However, both the commercial Eurozone and United States banks are closer to convergence than the total sample of banks. Thus, the third hypothesis can be confirmed only for the commercial banks of our sample.

Additionally, we tried to determine whether the samples of the United States banks and the subgroups of commercial, cooperative and savings banks are more integrated than those of the Eurozone banks. Our results indicate that the United States banks, apart from cooperative banks, are more integrated than the total sample of Eurozone banks throughout the reported period. Therefore, the forth hypothesis is confirmed.

Overall, our main findings convey that the efficiency of the United States banking system is considerably higher than that of the Eurozone and the European Union. Moreover, there is no evidence of convergence across the reported banking groups. However, our analysis shows that United States banks are closer to convergence than Eurozone and European Union banks, while the speed of convergence of the Eurozone and European Union banks is higher than that of the rest of the banking groups. Interestingly, our findings also indicate the presence of club convergence in all the reported groups and, with the exception of U.S. savings banks, four convergent clusters comprise more than 74% of the banks of each group. We also come to the conclusion that, although the U.S. banking system is closer to convergence than Eurozone and European Union banks, this outcome could possibly

change in the future as the Eurozone and the European Union's speed of convergence is higher.

Finally, our analysis could lead to further research into the evolution of efficiency and integration of Eurozone, European Union and United States banking systems, by employing a sample covering more years after the global financial crisis, as well as into whether the recent increase in banking efficiency and the improvement of the banking integration process will have an impact on economic growth.

Appendix A

Table 8: Descriptive statistics of D.E.A. inputs and outputs

	Inputs			Outputs	
	Fixed Assets	*Labour*	*Deposits*	*Loan*	*Net Interest Income*
European Union Banks					
2013	191746,6583	171761,0893	11101551,68	13210924,6	329847,7555
2014	170614,3912	156724,7574	10268977,71	11973031,92	306578,0783
2015	156620,2941	151657,2603	9846799,258	11182586,65	280220,8143
2016	148665,8183	148690,7978	9555429,558	10719872	259543,0197
2017	167130,8269	172575,4153	11174608,25	12482423,58	289602,7595
2018	159667,3573	169273,6994	10752938,18	11849524,79	272762,388
Eurozone Banks					
2013	167224,2808	157955,2876	9299395,324	11151406,86	285899,6826
2014	148479,1431	144337,6627	8479437,548	10008732,25	259963,666
2015	137147,8901	136681,1389	8235688,059	9377310,572	236274,0887
2016	133058,8655	140250,0215	8136852,985	9150417,294	221749,7222
2017	154560,9154	164931,0159	9676173,873	10812061,02	252655,6672
2018	146833,5121	163161,7772	9613748,597	10469386,61	240557,0497
Eurozone Commercial Banks					
2013	650056,103	618892,3343	34732075,91	41789062,59	1110332,26
2014	575101,1173	569840,2594	31860688,89	37653445,46	1020692,035
2015	532967,0952	549628,8535	31317284,77	35773952,87	939619,6117
2016	514470,183	588422,0637	30421997,87	34305217,37	883956,0947
2017	597343,1876	697707,569	36065610,82	40214810,62	1011089,392
2018	558762,9978	699362,4404	35641062,17	38543751,33	966515,4679
Eurozone Cooperative Banks					
2013	67335,62254	61643,95911	3681619,796	4502167,609	110938,7452
2014	59745,67015	56094,25596	3291761,001	4034320,573	97552,00908
2015	54523,52954	51063,07579	3164699,599	3690757,484	86230,46369
2016	53725,34072	46518,2244	3257736,457	3761835,417	80681,43587
2017	62609,32797	54499,27632	3892053,756	4421594,185	93000,47191
2018	61309,9221	52505,80713	3901901,06	4414049,847	86495,02006
Eurozone Savings Banks					
2013	62844,5725	59024,45223	4390508,364	4354686,63	111114,5243
2014	57115,23652	52742,40513	4053111,738	3913825,15	101290,8476
2015	52414,90485	47472,51288	3763136,91	3589957,963	89805,88174
2016	49919,8786	44841,0975	3709139,089	3565457,641	83353,04436

2017	58333,49475	52149,70537	4430899,664	4246778,63	89456,39508
2018	55989,80861	49362,0899	4453377,197	4241962,093	85576,11577
			United States Banks		
2013	254463,4815	159884,7162	15065778,41	10754246,99	547079,2593
2014	261007,7132	162850,7031	16191895,28	11627005,26	581874,651
2015	268906,5886	166511,0944	17042455,36	12668185,41	604737,8007
2016	280575,3658	169981,0703	18356793,19	13505498,3	659140,2385
2017	299710,7892	183320,3768	19292684,4	14342944,23	724691,1853
2018	314765,5478	192676,1998	20247287,94	15222520,26	800335,0337
			United States Commercial Banks		
2013	358259,7052	207733,9141	21633436,82	15171128,79	784653,5886
2014	366688,9351	210088,8592	23265658,28	16314506,79	833269,6823
2015	376636,5074	212913,6669	24380813,96	17724771,45	864228,933
2016	392213,5144	215324,2038	26409714,54	18797225,3	937453,978
2017	418527,5757	230093,8067	27563180,81	19863435,23	1028245,043
2018	437749,3382	240503,7892	28905146,47	21020993	1132317,539
			United States Cooperative Banks		
2013	42453,97392	53061,85888	1101181,449	2043298,781	82794,51949
2014	45659,78181	56516,08664	1223372,173	2318923,705	90756,34825
2015	50906,49316	61862,0066	1388843,399	2612928,436	99948,45977
2016	55549,82056	67946,24953	1558358,335	2935974,334	111364,979
2017	60895,90517	75646,02784	1721830,176	3285451,643	127261,6941
2018	66818,74072	84475,8805	1836685,818	3622171,716	144030,3605
			United States Savings Banks		
2013	87441,4127	113801,2063	5609976,413	4987018,81	214372,6508
2014	91726,7619	121920,254	6075283,635	5596604,857	234246,2698
2015	95813,60317	126757,7143	6739775	6224653	239535,3492
2016	101957,3016	130888,2857	7474089,206	6905819,683	283795,0159
2017	106819,0635	144438,2857	8457659,206	7627533,206	314985,3016
2018	117273,0794	145977,0794	9194659,619	8233947,508	363492

Chapter 2:

The Levels of Bank Capital, Risk and Efficiency in the Eurozone and the United States in the Aftermath of the Financial Crisis.

Section 2.1: Introduction

The dire consequences of the recent financial crisis have revealed the weakness of the regulatory framework to assure the financial stability of banking institutions. Multiple studies investigate the bank capital, risk and efficiency as well as the relationships between those variables (Bashir and Hassan, (2017); Nguyen and Nghiem, (2015); Williams, (2004); Anginer and Demirguc-Kunt (2014); Le, (2018); Williams, (2004)). However, the results of the existing literature are conflicting, stimulating further empirical research on this issue.

Additionally, the recent financial crisis showed how differently banking systems may behave after financial shocks (Ackermann, (2019)). This fact could be attributed to the different characteristics of both economies and banking institutions and to the different measures and policies implemented for the recovery from the financial crisis (Lakhani et al., (2019)). To the extent of our knowledge, there is no study comparing the levels of capital, risk and efficiency of Eurozone and U.S. banking systems by employing after crisis data. Therefore, in our survey we examine the development of the levels of capital, risk and efficiency develop in Eurozone and U.S. baking systems during the period 2013–2018.

For the purposes of our study, we use a sample that consists of 2185 banks commercial, cooperative, investment, savings, real estate and mortgage banks. It involves annual aggregate balance sheet and income statement data from the period 2013–2018. We investigate separately capital, risk and efficiency of both economic unions, Eurozone and the U.S. We also examine the three subgroups of Eurozone and those of U.S. banks depending on the banking sector (cooperative, commercial and savings banks).

As regards methodology, we evaluate the efficiency of the banking institutions of our sample by applying the input-oriented Charnes, Cooper and Rhodes (C.C.R.) model of Data Envelopment Analysis (D.E.A.) developed by Charnes et al. (1978). We measure bank capital by employing the ratio of the value of total equity to total assets and the Z-score as an indicator of bank risk.

Concerning the contributions of the survey, our study builds on the existing literature by thoroughly examining bank capital, risk and efficiency with a contemporaneous data set, as the research with data from the period 2013 and onwards is very limited and this includes the recovery period after the global financial crisis. Additionally, our study is the first to focus on the comparison of U.S. and Eurozone bank samples. The comparison is of utmost importance as the country unions have different characteristics and a different speed of recovery from the financial crisis. Moreover, to the extent of our knowledge our study is the first to separately investigate the capital, risk and efficiency results per bank type (commercial, cooperative and savings banks) by employing post-crisis data.

The chapter is organized as follows: Section 2 presents the literature review. Section 3 describes the research methodology employed. Section 4 presents the data sample and Section 5 the empirical results. Section 6 outlines the findings and describes the conclusions.

Section 2.2: Literature Review

After the introduction of the Basel Accord (1988), a multiple number of studies started to examine the relationship between bank capital and risk, by investigating the effect of bank capital adequacy regulations on bank risk. In contrast to the policy consensus, up until now, the literature yields contradicting results (Dahl and Shrieves, (1990); Rime, (2001); Repullo, (2002)). The number of those studies also increased significantly in the aftermath of the recent financial crisis where great concern for the stability of banking institutions arose.

According to several authors, a higher level of capital decreases the probability of default because of multiple reasons. More specifically, banks are able to withstand a decrease in their assets, withdrawals of deposits and money payments (Anginer and Demirguc-Kunt, (2014)). The banking institutions are also able to react to the requirement of more capital by increasing, even more, their portfolio risk (Fiordelisi et al, (2011b); Tan and Floros, (2013)). Moreover, the managers of poorly capitalized banks have moral hazard incentives to take on increased portfolio risks as those banks face more risks as a result of lower capital adequacy (Nguyen and Nghiem, (2015); Le, (2018)). The banks have benefited from the existence of deposit insurance schemes and take on further risks, the lesser the bank capital is, as they only risk the shareholders' capital and not the deposits (Kim and Santomero, (1988)). Lastly, banking institutions minimize the costs of having to rapidly issue bank equity (Peura and Keppo, (2006)).

Jacques and Nigro (1997) employ a three-stage least squares (3SLS) methodology to examine the interrelationship among bank capital, the risk-based capital standards and portfolio risk in commercial U.S. banks over the period 1990–1991. According to their results, the implementation of risk-based capital standards resulted in the increase of capital ratios and the reduction of portfolio risk. Similarly, Salas and Saurina (2003) suggest that a decrease of capital forgoes an increase in risk in Spanish banking institutions. In a more recent paper, Anginer and Demirguc-Kunt (2014) assess the empirical association between capital and risk by using multiple alternative measures of risk in more than 45 countries (1998–2012). Their findings indicate that an increase in capital precedes a decrease in risk. Ashraf et al. (2016) investigates the impact of risk-based capital requirements on bank risk-taking behavior in commercial banks of Pakistan during 2005–2012, by employing bias corrected least squares dummy variable (LSDVC) method and system GMM method to control for panel fixed effects, dynamic dependent variables, and endogenous independent variables. The results indicate that banks have reduced their portfolio risk as a result of increased capital requirements. Teixeira et al. (2019) suggest that there is a negative relationship among capital regulations and risk during systemic crisis years.

On the other hand, the managers of better capitalized banks tend to adopt cost-reducing practices as they have less moral hazard incentives (Tan and Floros, (2013); Fiordelisi et al., (2011b)). Haq and Heaney (2012) examine a sample of European banks during the period 1996–2010 and support the hypothesis that there is a U-shaped relationship between risk and capital. Teixeira et al. (2014) suggest that the relationship among risk and capital requirements depends on the location and the bank type. Last but not least, a number of studies conclude that there is no connection between bank capital and risk (Bitar et al., (2018); Cathcart et al., (2015)).

Furthermore, many studies investigate the relationship of capital and efficiency. The majority of the literature supports that there is a positive relationship between efficiency and capital (Bitar et al., (2018); Le, (2018); Kwan and Eisenbeis, (1997)). For instance, Sufian (2016) employ Data Envelopment Analysis to estimate the efficiency of Malaysian banks for the period 1999–2008. Moreover, Banker et al. (2010) examine Korean banking institutions during the period 1995–2005. Both studies suggest that efficiency is positively related to capital. However, according to other studies (for example Bashir and Hassan, (2017)) when capital increases, so do the agency costs and the free cash at the disposal of managers, and therefore efficiency decreases.

Multiple studies examining the relationship of efficiency and risk yield conflicting results. To be more precise, according to many authors efficiency and risk are adversely related (Tan and Floros, (2013), Williams, (2004), Le, (2018)). An

explanation could be that a decrease in efficiency could motivate the bank to boost its risks in order to offset the lost levels of efficiency (Nguyen and Nghiem, (2015)). Apart from credit and operational problems, poor managerial practices also can tarnish the banks reputation and cause market problems (Altunbas et al., (2007); Tan and Floros, (2013)).

However, multiple studies suggest that there is a positive relationship between risk and efficiency (Altunbas et al., (2007); Bashir and Hassan, (2017); Williams, (2004); Nguyen and Nghiem, (2015)). This could happen as banks that do not spend resources on risk monitoring and especially credit risk monitoring (monitoring of non-performing loans as well as other loans) appear to be more efficient in the short term. Yet, they take on higher risk in the medium and long term as this managerial behavior affects the quality of future loans.

Finally, apart from efficiency many studies investigate the development and the determinants of bank profitability, as an alternative measure of bank efficiency (Feng and Wang, (2018); Molyneux et al., (2019)). For example, Teixeira et al. (2019) investigates the effect of the dividend policy of banks, the institutional environment and banking regulation to the bank profitability of banks from Organisation for Economic Cooperation and Development (O.E.C.D.) countries, during the period 2004–2015.

Section 2.3: Research Methodology

Concerning the methodology, we employ a three-step approach. Initially, we employ the input-oriented C.C.R. model of D.E.A., developed by Charnes et al. (1978). In the next step, we apply the ratio of the value of total equity to total assets to calculate the bank capital. In the final step, we employ Z-score index in order to measure bank insolvency risk.

2.3.1. Estimation of banking efficiency

While trying to explore the associations among capital, risk and efficiency, initially, we calculate the efficiency of banking institutions. Banking efficiency can be estimated as the radial distance to an efficient frontier, and the related literature is divided into two classifications: non-parametric and parametric analysis. Mainly applied methodologies of each classification are Data Envelopment Analysis (D.E.A.) and Stochastic Frontier Approach (S.F.A.), respectively.

Following Tan and Floros (2013), Casu and Girardone (2009), Hou et al. (2014), Le (2018), and Zhang and Matthews (2012), we measure efficiency by employing D.E.A., developed by Charnes et al. (1978). A key advantage of this analysis and the main reason for its selection is that it can be used in order to compare banking institutions of different sizes. We should also mention that the provided results are relative and are adjusted accordingly to the D.M.U. included in the sample (Charnes et al., (1978), Stavarek, (2004)).

Our model employed is C.C.R. model (Charnes et al., (1978)), and the approach is the intermediation approach (Sealey and Lindley, (1977)). The model is vastly employed by the literature (Shah et al., (2019); Maity and Ganguly, (2019); Marjanović et al., (2018); Christopoulos et al., (2020)). As regards the characteristics of the model, it measures the ability of a Decision Making Unit (D.M.U.), j=1,….,n to utilize a number of inputs xi,j, i=1,….,m in order to produce multiple outputs xr,j, r=1,….,s by creating a ratio of their weighted sums. Our model is input-oriented and is based on constant returns to scale, radial distance and convex structure. The multiplier applied for the definition of the D.M.U.0 and the linear form is defined as follows:

max $Z_0 = \sum_r (u_r * y_{r0})$ (1)

subject to

$\sum_r (u_r * y_{rj}) - \sum_i (v_i * x_{ij}) = 0$, j=1,….,n, j≠0 (2)

$\sum_i (v_i\ x_{i0}) = 1,$ (3)

v_i , $u_r \geq \varepsilon \geq 0$

where:

v_i *= relative importance of input i*

u_r*= relative importance of output r*

ε = non-Archimedean value

The D.M.U.$_0$ is efficient if the associated objective Equation (1) is equal to 1, and this means that there is at least one optimal solution which yields, otherwise it is inefficient and the lower the efficiency score is, the less the efficiency of the D.M.U.

2.3.2. Estimation of bank capital and risk

Our empirical estimation also requires the calculation of capital and risk of the banking institutions in our sample. Bank capital is measured as the ratio of the value of total equity to total assets, which is mainly employed in the literature (Fiordelisi, (2011b); Tan and Floros, (2013); Zhang et al., (2013); Nguyen and Nghiem, (2015)).

We now turn our attention to discussing the risk of banking institutions. We witness that there is no consensus in the measurements employed for bank risk. Credit risk measurements are frequently used such as the ratio of non-performing loans (NPLs) to total loans[9], the ratio of loan loss provisions to total loans (Tan and Floros, (2013)) and the ratio of loan loss provisions to total assets (Bitar et al., (2018)). Market and liquidity risks are also employed in many studies (Zhang et al., (2013); Deelchand and Padgett, (2009)).

Nonetheless, the majority of recent research employs the insolvency risk, measured by using either Distance to Default (D-t-D) measure[10] or Z-score (Nguyen and Nghiem, (2015); Moyo, (2018), Barra and Zotti, (2018); Fiordelisi et al., (2011a), Ben Salah Mahdi and Boujelbene Abbes, (2018); Kabir and Worthington, (2017); Ghosh, (2014); Fiordelisi and Mare, (2014)).

We measure bank risk by the the Z-score. This index is widely used as an indicator of the probability of default and an indicator of bank soundness because it represents "the number of standard deviations by which returns have to diminish in order to deplete the equity of a bank" (Fiordelisi and Mare, (2014)). A higher Z-score implies higher bank solvency and lower probability of default, and is considered a direct measure of bank stability (Barra and Zotti, (2018)).

Furthermore, the Z-score has many benefits. Initially, it can be calculated for banks which are listed, as well as for the non-listed ones, while the D-t-D measures require data only from listed banks (Kabir and Worthington, (2017)). This is very important for the purposes of our survey as the sample includes both categories. It is also easy to calculate the Z-score since only accounting data are required. Lastly, the approach by which it associates capital, profits and risk is accepted by theoretical research (Barra and Zotti, (2018); Schaek and Cihak, (2008)).

Following Fiordelisi and Mare (2014) we apply the natural logarithm of Z-score, thus solving the problem of the existence of higher values in the distribution. Therefore,

[9]The ratio of NPLs to total loans is vastly employed in the literature. For instance: Fiordelisi et al. (2011b); Bashir and Hassan (2017); Kabir and Worthington (2017); Shim (2013).

[10] For example Saeed and Izzeldin (2016); Fiordelisi et al. (20011b); Kabir and Worthington (2017) employ D-t-D measure of insolvency risk.

insolvency risk (RISK) for each bank (i), time (t) and full sample period (T) is estimated as follows:

$$RISK_{i,t} = \ln(Z\text{-}score_{i,t}) = \ln((EQ_{i,t} + ROA_{i,t})/\sigma(ROA_{T,i})) \quad (4)$$

where:

EQ = equity to total assets

ROA = return on average assets

σ (ROA) = the standard deviation of ROA

Section 2.4: Data

Concerning the group of Eurozone banks, we analyze 1584 banks from countries participating in the European Economic Monetary Union; Austria, Belgium, Cyprus, Germany, Estonia, Spain, France, Greece, Ireland, Italy, Lithuania, Luxembourg, Latvia, Malta, the Netherlands, Portugal, Slovenia and Slovakia. Additionally, we investigate separately three subgroups of Eurozone banks: commercial, cooperative and savings banks which include 273, 838, 408 banks respectively. The United States bank group is separately examined and it comprises data from 601 banks with three subgroups: commercial, cooperative and savings banks consisting of 382, 154 and 63 banks. We adjust our data omitting banks with incomplete or missing annual financial data over the reported period. The number of banks in each country is presented in Table 9.

Table 9: The Data Sample per Country

Country	*Number of banks*	*Number of commercial banks*	*Number of cooperative banks*	*Number of savings banks*
Austria	104	20	56	18
Belgium	12	8	2	2
Cyprus	9	8	0	0
Estonia	6	5	0	0
Finland	12	7	2	2
France	141	68	56	13
Germany	866	20	464	345
Greece	6	5	1	0
Ireland	4	3	0	0

Italy	311	51	239	13
Latvia	9	9	0	0
Lithuania	5	5	0	0
Luxembourg	17	15	1	1
Malta	4	4	0	0
Netherlands	8	7	1	0
Portugal	16	11	2	2
Slovakia	9	7	0	2
Slovenia	7	5	1	1
Spain	38	15	13	9
Eurozone	1584	273	838	408
United States	601	382	154	63

The average prices of the inputs and outputs of the Eurozone and the United States groups as well as their subgroups, which are employed in the D.E.A. model of our study, are shown in Table 10.

According to the Table 10, it is interesting to note that both inputs and outputs of Eurozone banks, with the exception of deposits, slightly fall during the reported period, whereas the inputs and outputs of U.S. banks rise to some extent.

Moreover, we observe that the average figures of all the inputs and outputs are notably larger in the U.S. sample compared to the Eurozone one. This could be attributed to the fact that after the financial crisis, U.S. banks were considerably recapitalized, whereas Eurozone banks were not (Jenkins, (2015)).

Table 10: Descriptive statistics of inputs and outputs.

	Inputs			**Outputs**	
	Fixed Assets	Labour	Deposits	Loan	Net Interest Income
	Eurozone Banks				
2013	167224.28	157955.28	9299395.32	11151406.86	285899.68
2014	148479.14	144337.66	8479437.54	10008732.25	259963.66
2015	137147.89	136681.13	8235688.05	9377310.57	236274.08
2016	133058.86	140250.02	8136852.98	9150417.29	221749.72
2017	154560.91	164931.01	9676173.87	10812061.02	252655.66
2018	146833.51	163161.77	9613748.59	10469386.61	240557.049
	Eurozone Commercial Banks				
2013	650056.10	618892.33	34732075.91	41789062.59	1110332.26
2014	575101.11	569840.25	31860688.89	37653445.46	1020692.03
2015	532967.09	549628.85	31317284.77	35773952.87	939619.61
2016	514470.18	588422.06	30421997.87	34305217.37	883956.09
2017	597343.18	697707.56	36065610.82	40214810.62	1011089.39
2018	558762.99	699362.44	35641062.17	38543751.33	966515.46

	Eurozone Cooperative Banks				
2013	67335.62	61643.95	3681619.79	4502167.60	110938.74
2014	59745.67	56094.25	3291761.00	4034320.57	97552.01
2015	54523.52	51063.07	3164699.59	3690757.48	86230.46
2016	53725.34	46518.22	3257736.45	3761835.41	80681.43
2017	62609.32	54499.27	3892053.75	4421594.18	93000.47
2018	61309.92	52505.80	3901901.06	4414049.84	86495.02
	Eurozone Savings Banks				
2013	62844.57	59024.45	4390508.36	4354686.63	111114.52
2014	57115.23	52742.40	4053111.73	3913825.15	101290.84
2015	52414.90	47472.51	3763136.91	3589957.96	89805.88
2016	49919.87	44841.09	3709139.09	3565457.64	83353.04
2017	58333.49	52149.70	4430899.66	4246778.63	89456.39
2018	55989.80	49362.08	4453377.19	4241962.09	85576.12
	United States Banks				
2013	254463.48	159884.71	15065778.41	10754246.99	547079.25
2014	261007.71	162850.70	16191895.28	11627005.26	581874.65
2015	268906.58	166511.09	17042455.36	12668185.41	604737.80
2016	280575.36	169981.07	18356793.19	13505498.30	659140.23
2017	299710.79	183320.37	19292684.40	14342944.23	724691.18
2018	314765.54	192676.19	20247287.94	15222520.26	800335.03
	United States Commercial Banks				
2013	358259.70	207733.91	21633436.82	15171128.79	784653.59
2014	366688.93	210088.85	23265658.28	16314506.79	833269.68
2015	376636.50	212913.66	24380813.96	17724771.45	864228.93
2016	392213.51	215324.20	26409714.54	18797225.30	937453.98
2017	418527.57	230093.80	27563180.81	19863435.23	1028245.04
2018	437749.33	240503.78	28905146.47	21020993.00	1132317.54
	United States Cooperative Banks				
2013	42453.97	53061.85	1101181.44	2043298.78	82794.52
2014	45659.78	56516.09	1223372.17	2318923.70	90756.35
2015	50906.49	61862.01	1388843.39	2612928.43	99948.46
2016	55549.82	67946.25	1558358.33	2935974.33	111364.98
2017	60895.91	75646.02	1721830.17	3285451.64	127261.69
2018	66818.74	84475.88	1836685.81	3622171.71	144030.36
	United States Savings Banks				
2013	87441.41	113801.20	5609976.41	4987018.81	214372.65
2014	91726.76	121920.25	6075283.63	5596604.85	234246.26
2015	95813.60	126757.71	6739775.00	6224653.00	239535.34
2016	101957.30	130888.28	7474089.20	6905819.68	283795.01
2017	106819.06	144438.28	8457659.20	7627533.20	314985.30
2018	117273.07	145977.07	9194659.61	8233947.50	363492.00

Note: The variables are measured in thousands USD.

Furthermore, the descriptive statistics indicate that lending in the Eurozone has decreased during the reported period, while U.S. banks increased their lending ratios. This could be attributed to the fact that only Eurozone banks reduced their lending policy in order to lessen their risk levels after the financial crisis (Kok et al., (2016)).

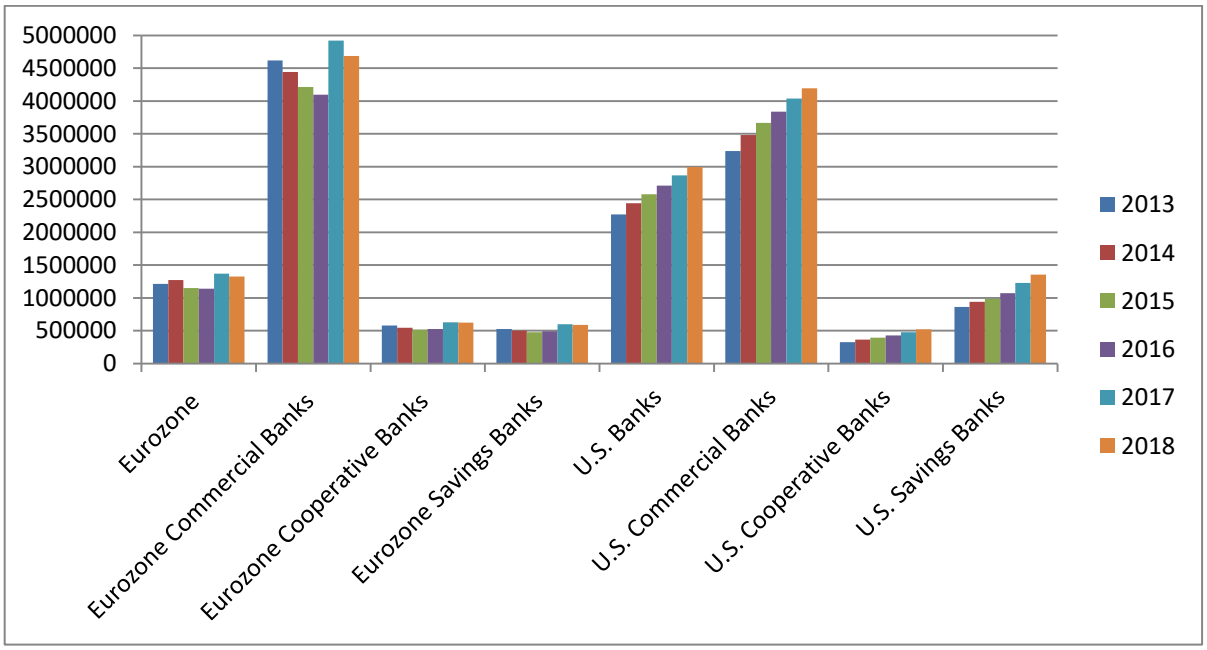
It is also interesting to note that the findings indicate that the ratio of net interest income to capital is considerably higher in U.S. banks than in Eurozone banks (Table 11). One explanation might be the different monetary policies employed by the Federal Reserve (interest rates positive or close to zero) and the European Central Bank (negative interest rates) which have a significant impact on net interest incomes.

Table 11: Net Interest Income/ Capital

Net Interest Income / Capital		
	Eurozone Banks	United States Banks
2013	1.71	2.15
2014	1.75	2.23
2015	1.72	2.25
2016	1.67	2.35
2017	1.63	2.42
2018	1.64	2.54
	Eurozone Commercial Banks	United States Commercial Banks
2013	1.71	2.19
2014	1.77	2.27
2015	1.76	2.29
2016	1.72	2.39
2017	1.69	2.46
2018	1.73	2.59
	Eurozone Cooperative Banks	United States Cooperative Banks
2013	1.65	1.95
2014	1.63	1.99
2015	1.58	1.96
2016	1.50	2.00
2017	1.49	2.09
2018	1.41	2.16
	Eurozone Savings Banks	United States Savings Banks
2013	1.77	2.45
2014	1.77	2.55
2015	1.71	2.50
2016	1.67	2.78
2017	1.53	2.95
2018	1.53	3.10

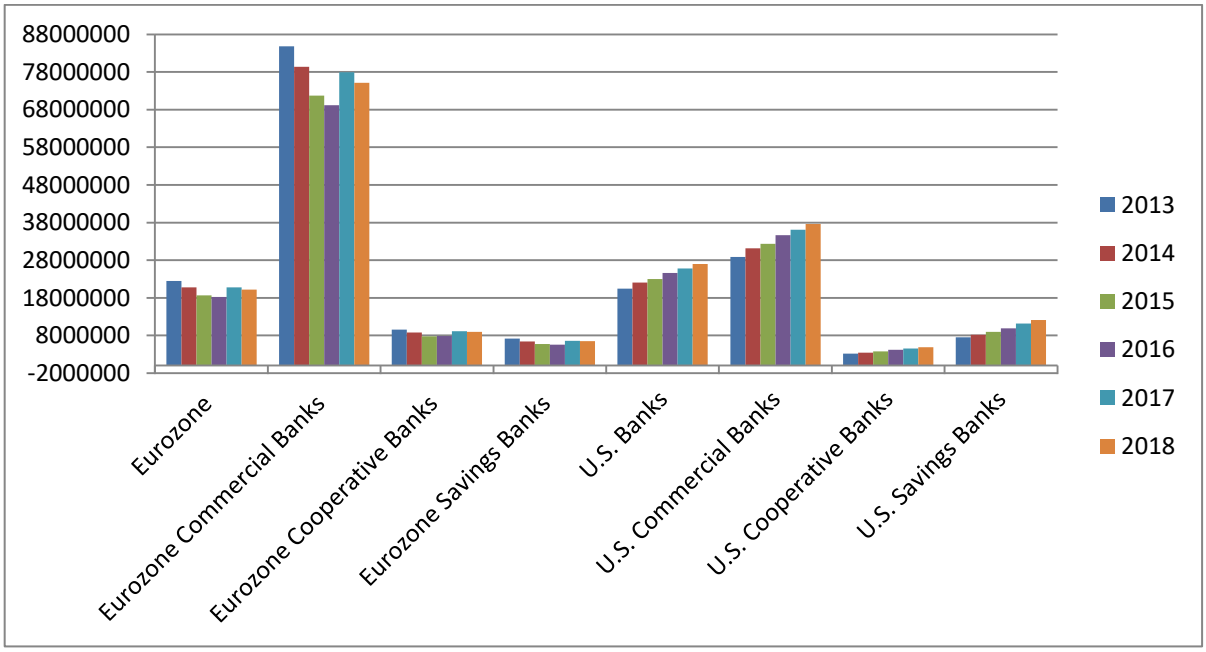
The average total equity of Eurozone banks and U.S. banks are illustrated in Figure 4. As we can observe, the U.S. banks of our sample have, with some exceptions, considerably more equity than Eurozone banks. Noteworthy, although the equity of Eurozone banks is quite stable during the reported period, the total equity of U.S. banks grows. We observe that, the total equity of Eurozone commercial banks is the highest reported, while the opposite happens with total equity of United States savings banks. The average total assets follow the same pattern and are presented in Figure 5. and the descriptive statistics of the total equity and total assets of our sample are presented in Table 12.

Figure 4: The average total equity of the Eurozone and the U.S. banks



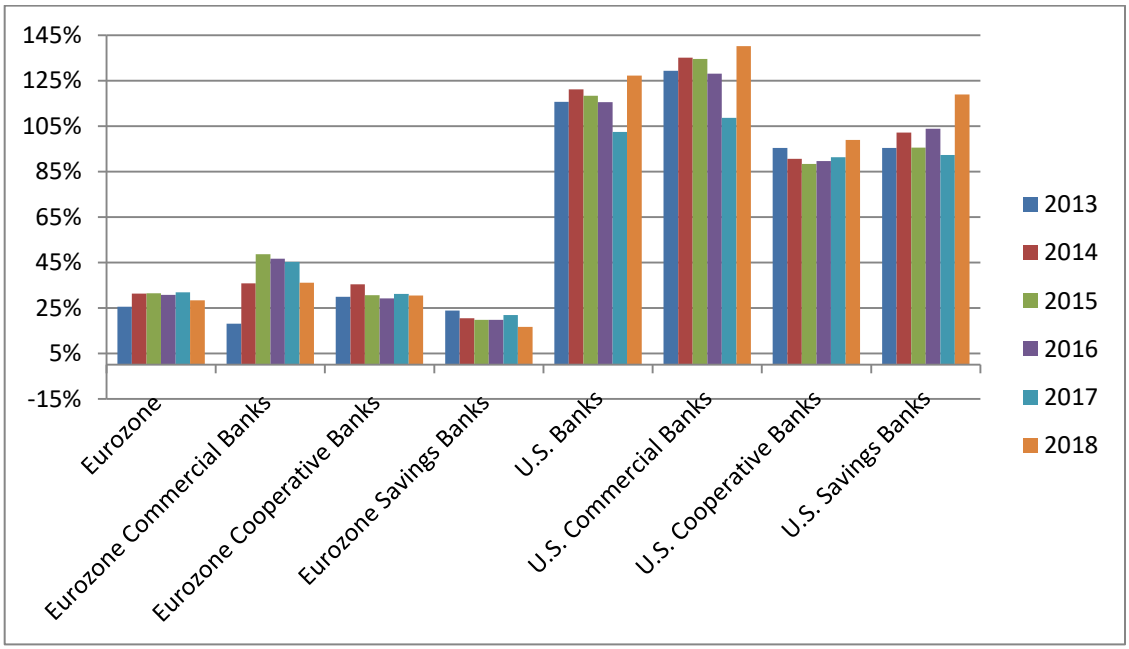
Note: the variables are measured in thousands USD.

Figure 5: The average total assets of the Eurozone and the U.S. banks



Note: the variables are measured in thousands USD.

Figure 6: Average of return on average assets (ROA).



A summary of the average of return on average assets (ROA) is depicted in the Figure 6 and the descriptive statistics in the Table 12. From the findings we observe that the R.O.A. estimates of Eurozone banks are significantly weaker than those of U.S. banks. Our results are consistent with those of the Federal Reserve Bank, (2019) which record that from 1990 until 2018 the R.O.A. ratio is about or above 1% in the

majority of years. Our results are also in line with the findings of Lakhani et al., (2019) who indicate that after the financial crisis the European R.O.A. ratio has weakened, whereas there is an increase in the U.S. ratio.

Table 12: Descriptive statistics of total equity, total assets & ROA.

	Eurozone Banks			U.S. Banks		
2013	Total Equity	Total Assets	ROA	Total Equity	Total Assets	ROA
Mean	1212618.21	22451465.17	25.58%	2270656.57	20464291.49	115.66%
Max	113747871.05	2496890827.00	557.00%	178733000.00	1945467000.00	5231.80%
Min	4469.18	21353.98	-1351.90%	11081.00	113718.00	-126.30%
Std	6660913.71	139635875.72	107.13%	13419347.24	129047209.20	224.09%
2014	Total Equity	Total Assets	ROA	Total Equity	Total Assets	ROA
Mean	1271032.70	20790140.83	31.30%	2443661.09	22066052.18	121.19%
Max	125436037.33	2522607232.98	743.60%	202370000.00	2074981000.00	5052.40%
Min	4460.08	26458.89	-684.20%	11742.00	134145.00	-300.70%
Std	6871572.05	132850620.14	67.13%	14459452.64	138206979.42	223.37%
2015	Total Equity	Total Assets	ROA	Total Equity	Total Assets	ROA
Mean	1150900.81	18670300.28	31.50%	2576810.20	23039618.37	118.38%
Max	108953823.58	2171077793.20	2009.70%	201513000.00	1914658000.00	7609.70%
Min	2612.88	23389.63	-909.60%	13714.00	161806.00	-229.90%
Std	6281449.29	118293745.78	85.16%	14763038.65	136684424.20	316.12%
2016	Total Equity	Total Assets	ROA	Total Equity	Total Assets	ROA
Mean	1141489.92	18230009.73	30.80%	2708489.38	24574909.68	115.56%
Max	110912355.68	2189321567.59	890.80%	206209000.00	2082803000.00	6190.70%
Min	4178.93	24712.31	-802.60%	54259.00	311294.00	-199.10%
Std	6208361.85	115214158.01	72.00%	15197185.98	144675434.55	256.03%
2017	Total Equity	Total Assets	ROA	Total Equity	Total Assets	ROA
Mean	1369775.05	20756383.70	31.93%	2867090.68	25826920.59	102.45%
Max	128575708.02	2341231851.98	2058.70%	211846000.00	2140778000.00	934.20%
Min	4888.72	28877.93	-435.00%	6891.00	8378.00	-172.90%
Std	7355018.15	128483314.39	78.84%	15564157.19	148759834.06	65.34%
2018	Total Equity	Total Assets	ROA	Total Equity	Total Assets	ROA
Mean	1323995.11	20154736.81	28.36%	2990989.99	26957366.62	127.24%
Max	122928406.94	2336758397.51	841.90%	214343000.00	2218960000.00	991.00%
Min	-2232.63	30245.19	-	76823.00	1279654.00	-19.40%

			1027.50%			
Std	7029009.61	124325055.21	68.99%	15716171.53	150804001.46	66.10%
	Eurozone Commercial Banks			U.S. Commercial Banks		
2013	Total Equity	Total Assets	ROA	Total Equity	Total Assets	ROA
Mean	4617018.83	84831716.47	18.06%	3239138.31	28834708.55	129.31%
Max	125436037.33	2496890827.00	557.00%	178733000.00	1945467000.00	5231.80%
Min	6845.85	21353.98	-1351.90%	11081.00	113718.00	-126.30%
Std	14811050.73	287643410.60	189.34%	16721430.86	160549850.05	277.74%
2014	Total Equity	Total Assets	ROA	Total Equity	Total Assets	ROA
Mean	4442946.16	79397280.53	35.83%	3482061.00	31119428.86	135.08%
Max	113747871.05	2522607232.98	743.60%	202370000.00	2074981000.00	5052.40%
Min	5977.02	26458.89	-684.20%	11742.00	134145.00	-300.70%
Std	14376278.20	276355790.39	130.20%	18021101.04	171993433.72	276.58%
2015	Total Equity	Total Assets	ROA	Total Equity	Total Assets	ROA
Mean	4210484.33	71702251.07	48.64%	3667500.90	32331945.35	134.47%
Max	108953823.58	2171077793.20	2009.70%	201513000.00	1914658000.00	7609.70%
Min	5001.49	23389.63	-909.60%	13714.00	161806.00	-229.90%
Std	13560366.11	248265240.50	182.16%	18391773.78	169941412.56	394.32%
2016	Total Equity	Total Assets	ROA	Total Equity	Total Assets	ROA
Mean	4097686.04	69195912.63	46.70%	3839087.51	34617209.90	128.10%
Max	110912355.68	2189321567.59	890.80%	206209000.00	2082803000.00	6190.70%
Min	5131.36	24712.31	-802.60%	54259.00	311294.00	-199.10%
Std	13359033.93	241329640.55	144.72%	18924113.30	180177562.90	318.89%
2017	Total Equity	Total Assets	ROA	Total Equity	Total Assets	ROA
Mean	4919459.29	77896048.10	45.22%	4037192.91	36118609.88	108.66%
Max	128575708.02	2341231851.98	2058.70%	211846000.00	2140778000.00	934.20%
Min	5916.14	28877.93	-435.00%	6891.00	8378.00	-172.90%
Std	15900520.49	267428764.76	161.36%	19368426.28	185114942.47	75.50%
2018	Total Equity	Total Assets	ROA	Total Equity	Total Assets	ROA
Mean	4687571.68	75150128.27	36.07%	4195142.62	37630498.26	140.12%
Max	122928406.94	2336758397.51	550.90%	214343000.00	2218960000.00	991.00%
Min	-2232.63	30245.19	-1027.50%	76823.00	1279654.00	-19.40%
Std	15136515.67	257683264.81	139.17%	19555199.90	187660254.46	73.64%
	Eurozone Cooperative Banks			U.S. Cooperative Banks		
2013	Total Equity	Total Assets	ROA	Total Equity	Total Assets	ROA
Mean	579643.59	9541216.65	29.84%	325472.03	3208680.78	95.35%

Max	66035443.63	2094592197.09	221.80%	6237459.89	55502976.27	227.80%
Min	4460.08	36300.55	-881.60%	27246.09	276208.86	4.70%
Std	3492431.51	88967918.79	66.17%	544748.88	5127836.52	43.35%
2014	Total Equity	Total Assets	ROA	Total Equity	Total Assets	ROA
Mean	545609.49	8783647.58	35.45%	362178.12	3466595.40	90.63%
Max	68185103.76	1929259272.70	303.90%	6972990.28	63632027.59	238.40%
Min	4469.18	48166.28	-333.60%	107212.62	996305.99	-84.10%
Std	3370831.97	82507466.90	41.05%	609942.16	5782672.23	42.38%
2015	Total Equity	Total Assets	ROA	Total Equity	Total Assets	ROA
Mean	517253.87	7797907.36	30.66%	392772.08	3804860.65	88.38%
Max	64706880.75	1664942281.25	187.10%	7701002.00	73279078.87	191.00%
Min	2612.88	46925.07	-534.30%	112705.21	1134877.40	-53.30%
Std	3173390.46	70949015.60	42.47%	671200.00	6570631.71	38.28%
2016	Total Equity	Total Assets	ROA	Total Equity	Total Assets	ROA
Mean	527160.93	7884358.52	29.20%	429447.16	4167005.42	89.61%
Max	67395963.55	1606692280.21	181.80%	8727339.44	79775661.54	196.60%
Min	4178.93	48470.66	-386.70%	114063.26	1347691.76	0.40%
Std	3218937.50	69962234.71	39.81%	756014.47	7177961.80	37.21%
2017	Total Equity	Total Assets	ROA	Total Equity	Total Assets	ROA
Mean	625609.89	9153111.67	31.16%	474094.28	4540867.15	91.28%
Max	77601878.23	1859253741.32	219.20%	10230628.26	90565764.13	184.00%
Min	4888.72	54780.41	-247.30%	115779.18	1508908.89	1.30%
Std	3683829.18	79688530.94	35.06%	875993.47	8044629.12	34.59%
2018	Total Equity	Total Assets	ROA	Total Equity	Total Assets	ROA
Mean	621678.40	9003927.18	30.49%	519480.66	4870810.12	98.96%
Max	75015857.80	1859932067.23	177.80%	11404681.74	96962446.02	205.30%
Min	4671.03	52387.21	-325.20%	109769.96	1602430.32	9.50%
Std	3615561.38	78405146.74	32.44%	972549.90	8587154.55	34.58%
	Eurozone Savings Banks			U.S. Savings Banks		
2013	Total Equity	Total Assets	ROA	Total Equity	Total Assets	ROA
Mean	527136.81	7206510.05	23.84%	861225.84	7550034.21	95.43%
Max	25226496.56	371197262.66	360.30%	5740592.00	62866954.00	479.50%
Min	13108.35	30661.53	-135.70%	85737.00	981166.00	-65.90%
Std	1625085.22	26863291.08	45.04%	1193301.80	11169436.49	65.53%
2014	Total Equity	Total Assets	ROA	Total Equity	Total Assets	ROA
Mean	500626.65	6422975.10	20.42%	937895.81	8176426.14	102.16%
Max	23420000.56	320954778.03	523.00%	6102439.00	67301894.00	464.90%
Min	11958.89	30116.98	-268.80%	109175.00	972551.00	14.30%
Std	1556181.61	22940447.67	34.66%	1272885.73	11792094.78	68.75%
2015	Total Equity	Total Assets	ROA	Total Equity	Total Assets	ROA

Mean	475978.74	5726122.73	19.75%	985061.56	9006662.81	95.51%
Max	21866538.23	283402746.67	355.30%	6302454.00	71130930.00	396.30%
Min	10867.40	29803.16	-111.00%	132771.00	988439.00	-13.10%
Std	1446700.47	19425841.76	27.23%	1234458.28	12410375.30	59.39%
2016	Total Equity	Total Assets	ROA	Total Equity	Total Assets	ROA
Mean	489148.92	5579963.89	19.72%	1069088.57	9873009.35	103.86%
Max	22281556.49	270511461.83	256.40%	6752766.00	77760914.00	362.90%
Min	10772.90	28360.55	-77.00%	142686.00	1207688.00	22.10%
Std	1433535.95	18086695.11	24.63%	1346051.14	13542260.02	56.94%
2017	Total Equity	Total Assets	ROA	Total Equity	Total Assets	ROA
Mean	596574.92	6563107.58	21.91%	1227194.76	11176543.19	92.29%
Max	26354608.14	302042398.39	389.60%	7199504.00	80522765.00	335.80%
Min	13230.67	32845.22	-82.00%	152572.00	1376902.00	-0.60%
Std	1741566.84	21355575.39	33.39%	1530647.42	15237008.86	51.82%
2018	Total Equity	Total Assets	ROA	Total Equity	Total Assets	ROA
Mean	587646.49	6468562.79	16.68%	1354800.65	12081513.89	118.92%
Max	25203752.70	296298669.31	196.10%	7919154.00	81602818.00	379.70%
Min	13303.76	31127.99	-229.40%	164125.00	1765651.00	21.00%
Std	1655504.50	20461706.07	23.71%	1664349.34	16307502.02	53.98%

Note: The variables are measured in thousands USD.

Section 2.5: Empirical Results

In this section, we present the empirical results of our analysis. Initially, we compare the results of the efficiency of Eurozone and U.S. banking institutions, which are measured by D.E.A. analysis. Following the same pattern, bank capital (estimated by the value of total equity to total assets) and risk results (measured by Z-score) are then analyzed.

2.5.1. Efficiency

The efficiency estimates are examined by employing D.E.A. separately to the groups and subgroups of our sample. Our results are derived from "rDEA" package version 4.47 in R software developed by Simm and Besstremyannaya, (2016) are presented in the Figure 7 & Figure 8 and the descriptive statistics of the results are reported in Table 13.

Figure 7: D.E.A. efficiency results for Eurozone banks.

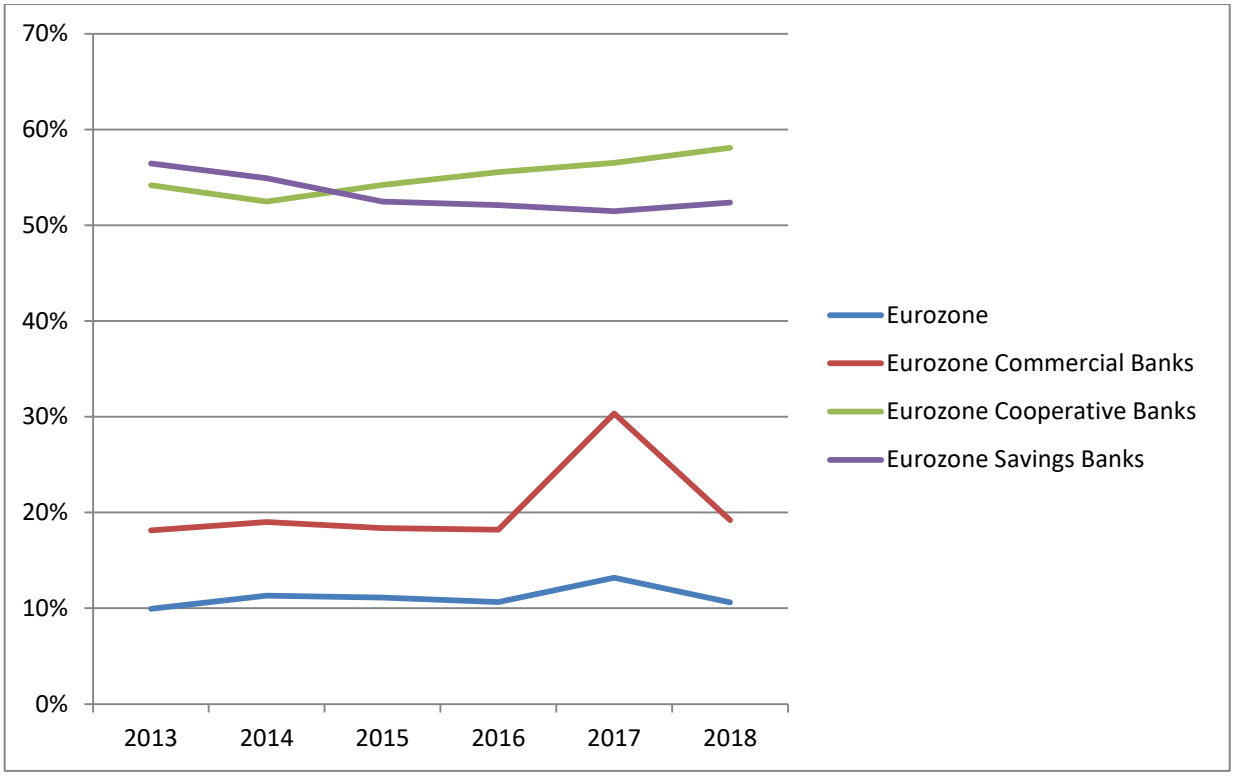
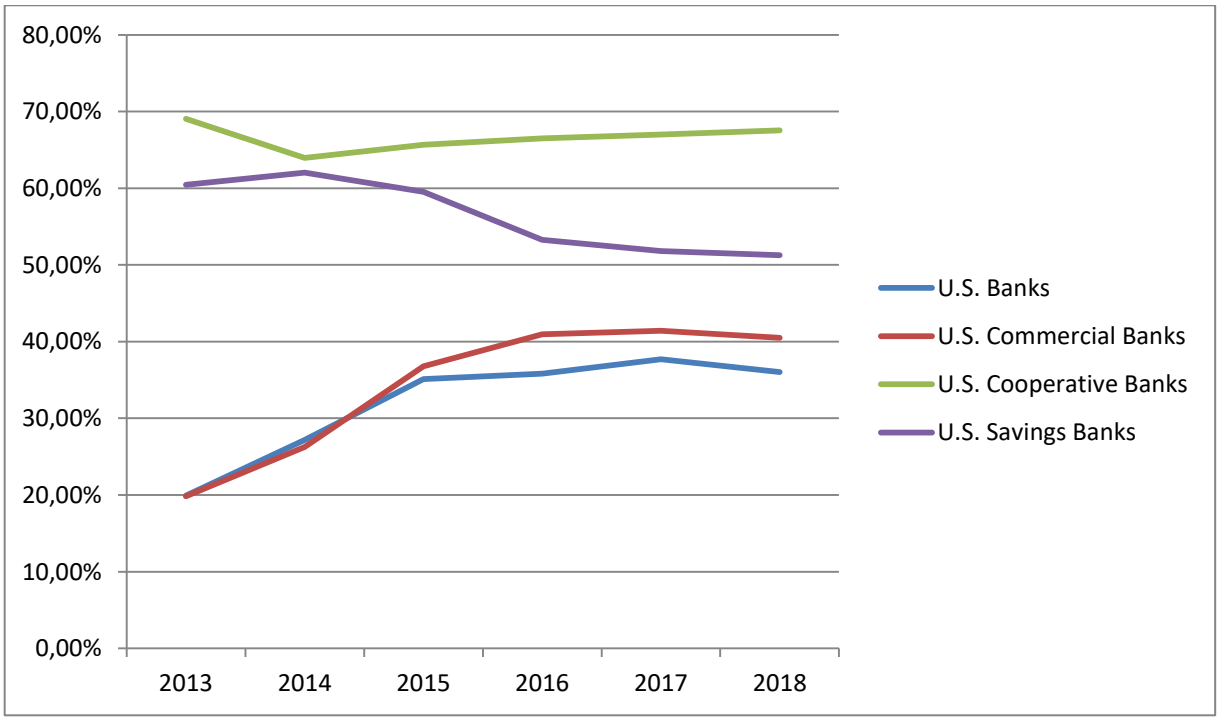


Figure 8: D.E.A. efficiency results for U.S. banks.



Our findings indicate that the average efficiency of the U.S. banks, the efficiency of the United States banks increases to a large degree, while that of Eurozone banks is

almost steady. This could be attributed to the recovery that followed the financial crisis 2007–2009 which is faster than that of the European Union (Kollmann et al., (2016), Kollmann et al., (2017)). It is important to note that in most cases the efficiency of U.S. banks is higher than 10% as well as higher than the efficiency of Eurozone banks. This finding is in line with Christopoulos (2020) suggesting that the efficiency of Eurozone banking is low during the reported period. This significant discrepancy regarding average efficiency is associated with i.) the different interest rate policies implemented by central banks, ii.) the different levels of after-crisis regulatory flexibility and iii.) the different speed of recovery for the two economies (Lakhani et al., (2019); McLannahan and Arnold, (2017)). It is also linked with the after-crisis restructuring of the Eurozone banking system which was greatly lower than that of the U.S. Additionally, the Troubled Asset Relief Program was signed in 2008 and U.S. banks were rapidly recapitalized after the crisis, whereas no relative program was created in the Eurozone (Jenkins, (2015)). A very important explanatory factor could also be that European banks have almost double non-performing loans ratios in comparison to U.S. banks, and the outcome is worse for the Eurozone since Italian, Spanish, Irish and Greek banks are those with the highest rates of bad loans (Binham and Noonan, (2015)). Finally, the market share for U.S. banks increases, in contrast to that of European banking decreases during the reported period (Goodhart and Schoenmaker, (2016); Reboul et al., (2018)).

As concerns commercial banks, we observe that this is the least efficient sector of banks in our sample. The decreased efficiency of commercial banks, when compared to cooperative and savings banks, is also supported by the survey of Spulbar et al., (2015) and a possible explanation given is that smaller cooperative and savings banks manage their costs better than commercial banks. The efficiency of Eurozone commercial banks slightly rises during the reported period reaching its peak in the year 2017, while the efficiency of United States banks increases more than 100% during the same period. Additionally, the efficiency levels of U.S. commercial banks is enhanced compared to Eurozone commercial banks. This finding is in line with Weigand (2016) who provides evidence that U.S. commercial banks are more efficient than the European ones during the period 2014–2015.

A similar pattern is observed for cooperative and savings banks. According to the figures 5 and 6, the efficiency of the U.S. cooperative and savings banks improves more than that of Eurozone banks. We also notice that the cooperative banks are the most efficient banking sector both of in the Eurozone and the United States. This finding is in line with Makinen & Jones, (2015) concluding that the efficiency of cooperative banks is higher than that of savings and commercial banks. Also, regarding savings banks, what is interesting is that, the efficiency levels continue to decrease steadily, whereas the efficiency of all the other reported types of banks either increases or is stable during the reported period. A possible explanation could

be that the efficiency of savings banks highly depends on their loan portfolio, which includes poorer-quality loans than those of the commercial and cooperative banks (Trujillo-Ponce, (2012)).

Finally, the graphs convey (Figure 7 & Figure 8) that the general samples of Eurozone and U.S. banks are, on average, the least efficient and that the efficiency of Eurozone general banks falls to the lowest level. The efficiency levels of the U.S. general sample in the year 2013 are almost the same as those of commercial banks. This could be attributed to the fact that the greatest part of the general sample mostly consists of commercial banks. Finally, the average efficiency of the Eurozone general sample in 2013 is slightly under 10% being the lowest recorded.

Table 13: Descriptive statistics of D.E.A. results.

	Eurozone Banks					
	2018	2017	2016	2015	2014	2013
mean	10,61%	13,18%	10,67%	11,11%	11,31%	9,94%
median	8,66%	11,58%	8,98%	9,22%	9,56%	8,30%
st.dev	9,93%	9,59%	9,51%	9,66%	9,45%	8,96%
min	0,01%	0,00%	0,08%	0,05%	0,09%	0,22%
max	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%
	Eurozone Commercial Banks					
	2018	2017	2016	2015	2014	2013
mean	19,22%	30,34%	18,21%	18,36%	19,00%	18,15%
median	14,50%	24,95%	12,39%	13,83%	14,37%	12,91%
st.dev	18,79%	20,88%	19,30%	17,64%	17,88%	18,42%
min	0,01%	0,00%	0,08%	0,05%	0,09%	0,22%
max	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%
	Eurozone Cooperative Banks					
	2018	2017	2016	2015	2014	2013
mean	58,09%	56,50%	55,54%	54,22%	52,48%	54,16%
median	55,45%	53,51%	52,65%	51,07%	49,43%	51,27%
st.dev	14,15%	13,70%	13,45%	13,77%	13,85%	13,62%
min	21,53%	21,82%	14,52%	23,18%	6,20%	8,51%
max	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%
	Eurozone Savings Banks					
	2018	2017	2016	2015	2014	2013
mean	52,36%	51,47%	52,12%	52,47%	54,90%	56,45%
median	50,57%	49,38%	50,37%	50,23%	53,15%	54,25%
st.dev	12,16%	11,90%	12,02%	11,90%	11,01%	11,53%
min	5,28%	11,90%	12,64%	16,34%	34,03%	35,18%
max	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%
	United States Banks					

	2018	2017	2016	2015	2014	2013
mean	36,04%	37,71%	35,83%	35,12%	27,16%	19,94%
median	31,84%	34,07%	31,84%	32,21%	24,62%	17,04%
st.dev	15,58%	15,46%	15,71%	15,46%	14,06%	13,64%
min	1,61%	0,00%	3,06%	3,28%	1,25%	0,84%
max	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%
	United States Commercial Banks					
	2018	2017	2016	2015	2014	2013
mean	40,49%	41,39%	40,97%	36,79%	26,24%	19,82%
median	40,24%	40,79%	39,16%	34,08%	23,33%	16,45%
st.dev	11,93%	12,66%	13,46%	14,44%	15,09%	15,22%
min	2,02%	0,00%	3,53%	3,70%	1,25%	0,84%
max	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%
	United States Cooperative Banks					
	2018	2017	2017	2015	2014	2013
mean	67,54%	67,01%	66,49%	65,67%	63,97%	69,06%
median	65,16%	62,96%	64,45%	62,98%	60,34%	66,02%
st.dev	16,04%	16,31%	16,33%	16,28%	16,57%	16,57%
min	38,72%	40,43%	39,58%	38,18%	34,18%	37,98%
max	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%
	United States Savings Banks					
	2018	2017	2016	2015	2014	2013
mean	51,25%	51,81%	53,27%	59,54%	62,04%	60,45%
median	43,26%	44,92%	47,73%	54,91%	57,75%	55,08%
st.dev	20,60%	22,43%	21,78%	21,40%	19,86%	20,79%
min	22,72%	14,77%	15,26%	17,26%	17,61%	15,78%
max	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%

2.5.2. Capital

Figure 9 & Figure 10 present the average capital ratio estimated by the value of total equity to total assets and Table 14 the descriptive statistics. The findings indicate that the capital ratio of U.S. banks is considerably higher than that of Eurozone banks regardless of the type of bank. This could connected with the fact that the capital ratio of U.S. banks is higher than the minimum capital regulations suggest, as it is formed by market discipline. To be more precise, the U.S. banks can attain capital by equity or securitize debt more easily and at better prices if they have higher capital ratios because both the capital market in the U.S. and its securitization are considerably more developed than the Eurozone as sources of funding (Lakhani et al., (2019), European Central Bank, (2007)).

During the reported period, the capital ratio of Eurozone banks gradually rises, while the capital ratio of U.S. banks reaches its lowest level in 2016. U.S. regulatory easing (Reboul et al., (2018)) and new capital requirements in the Eurozone (Kok et al., (2016)) might be other factors explaining this outcome since the Eurozone regulations enforce banks to attain higher capital levels than U.S. banks (Goodhart and Schoenmaker, (2016)) and during the reported period Eurozone banks also reduced their lending in order to adapt to capital standards (Schildbach, (2017)).

It is also interesting to mention that the capital ratios of the banks of the same sector of the Eurozone and the U.S. have striking differences with each other. For instance, saving banks attain the highest levels of capital in the United States, whereas savings banks reach the lowest levels in the Eurozone. Moreover, the cooperative U.S. banks indicate the lowest levels of capital recorded, yet the levels of Eurozone cooperative banks present the opposite and are among the highest.

Figure 9: Average capital ratio of Eurozone banks

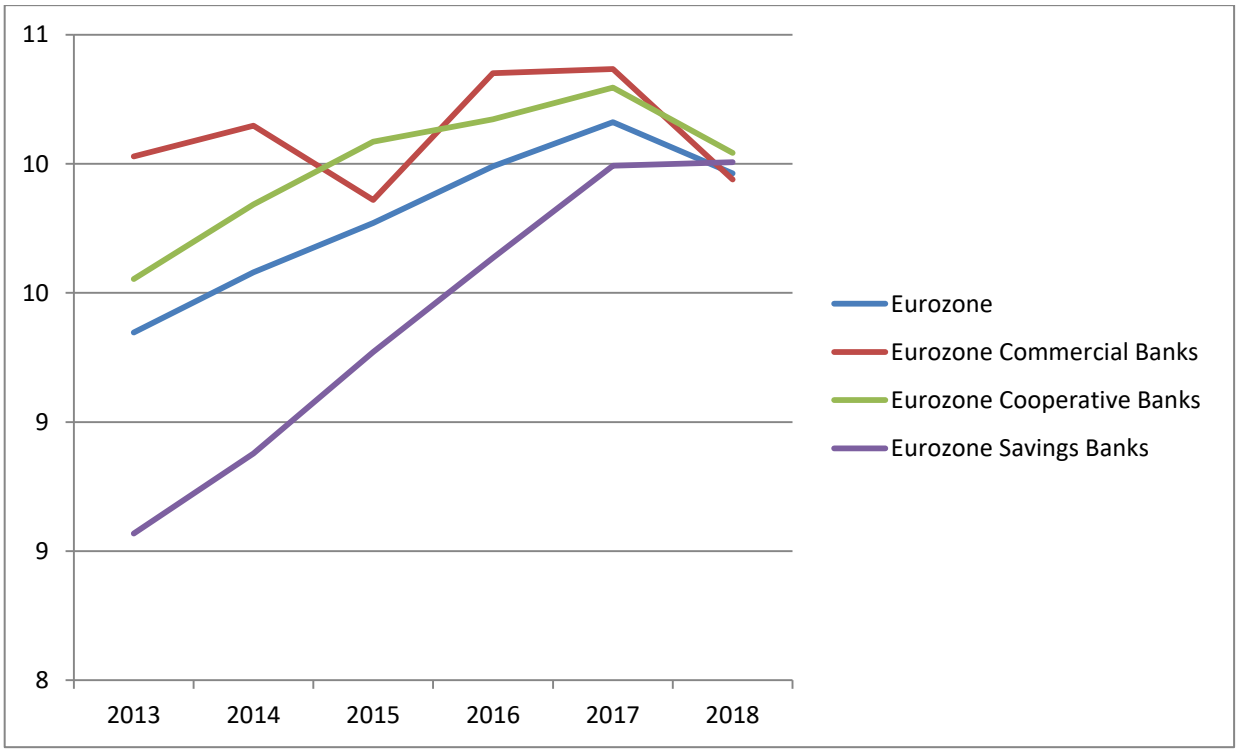


Figure 10:Average capital ratio of U.S. banks

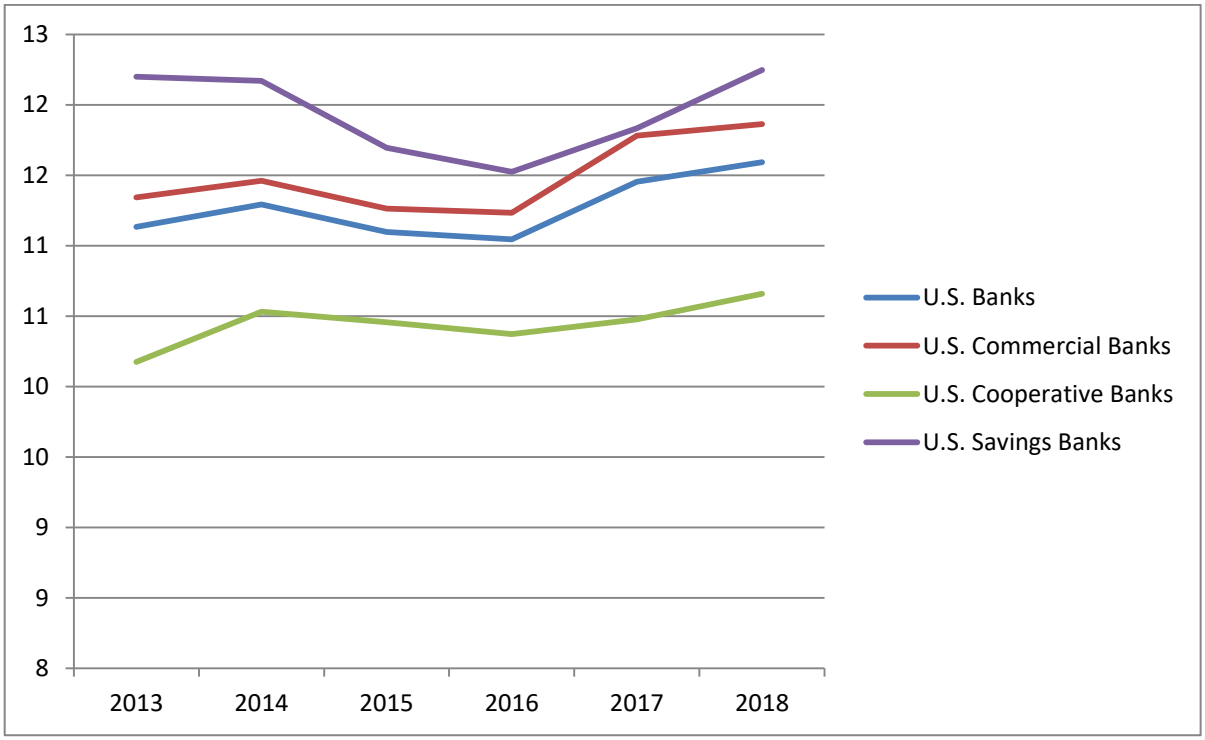


Table 14: Descriptive statistics capital & risk.

	Eurozone Banks			U.S. Banks	
2013	Capital	Risk		Capital	Risk
Mean	9.35	2.36		11.13	1.66
Max	71.98	4.48		50.16	3.82
Min	0.06	-4.06		5.17	1.04
Std	4.75	0.47		3.36	0.25
2014	Capital	Risk		Capital	Risk
Mean	9.58	2.60		11.29	1.69
Max	76.60	4.75		50.44	3.81
Min	0.24	-2.75		5.16	0.87
Std	4.64	0.45		3.38	0.25
2015	Capital	Risk		Capital	Risk
Mean	9.77	2.39		11.10	1.32
Max	60.21	4.32		34.91	3.36
Min	0.40	-0.54		4.92	0.49
Std	4.25	0.41		2.84	0.24
2016	Capital	Risk		Capital	Risk
Mean	9.99	2.58		11.04	1.53
Max	67.74	4.56		32.36	3.49
Min	0.59	-0.95		4.60	0.43

Std	4.67	0.42		2.69	0.23
2017	Capital	Risk		Capital	Risk
Mean	10.16	2.51		11.45	2.92
Max	71.80	4.49		82.25	4.83
Min	0.89	0.00		4.31	2.03
Std	4.63	0.38		4.12	0.23
2018	Capital	Risk		Capital	Risk
Mean	9.96	2.62		11.59	2.94
Max	74.17	4.70		42.18	4.25
Min	-0.16	-0.30		3.83	1.86
Std	4.75	0.41		3.11	0.23
	Eurozone Commercial Banks			U.S. Commercial Banks	
2013	Capital	Risk		Capital	Risk
Mean	10.03	1.59		11.34	1.47
Max	71.98	3.79		50.16	3.61
Min	1.10	-4.76		5.17	0.82
Std	7.84	0.78		3.64	0.26
2014	Capital	Risk		Capital	Risk
Mean	10.15	1.88		11.46	1.49
Max	76.60	4.09		50.44	3.60
Min	0.69	-1.26		5.90	0.74
Std	7.75	0.67		3.68	0.26
2015	Capital	Risk		Capital	Risk
Mean	9.86	1.57		11.26	1.12
Max	49.98	3.34		34.91	3.14
Min	0.75	-1.30		6.01	0.52
Std	6.28	0.60		2.96	0.25
2016	Capital	Risk		Capital	Risk
Mean	10.35	1.81		11.23	1.33
Max	59.17	3.68		30.27	3.28
Min	0.96	-1.65		5.76	0.21
Std	7.38	0.67		2.78	0.24
2017	Capital	Risk		Capital	Risk
Mean	10.37	1.72		11.78	2.80
Max	60.14	3.61		82.25	4.69
Min	1.55	-0.38		4.79	1.99
Std	7.07	0.61		4.75	0.25
2018	Capital	Risk		Capital	Risk
Mean	9.94	1.82		11.86	2.86
Max	59.86	3.57		42.18	4.14
Min	-0.16	-1.00		4.34	1.80
Std	7.05	0.62		3.21	0.23
	Eurozone Cooperative			U.S. Cooperative Banks	

	Banks				
2013	Capital	Risk		Capital	Risk
Mean	9.55	2.87		10.17	3.25
Max	24.03	3.85		16.40	3.72
Min	2.52	0.00		6.43	2.76
Std	3.19	0.33		1.76	0.17
2014	Capital	Risk		Capital	Risk
Mean	9.84	3.16		10.53	3.26
Max	27.54	4.31		17.09	3.73
Min	1.24	0.00		5.16	2.51
Std	3.26	0.33		1.85	0.18
2015	Capital	Risk		Capital	Risk
Mean	10.08	3.15		10.46	3.37
Max	42.33	4.62		17.54	3.91
Min	0.40	0.00		4.92	2.60
Std	3.32	0.34		1.91	0.18
2016	Capital	Risk		Capital	Risk
Mean	10.17	3.22		10.37	3.39
Max	67.74	5.15		17.93	3.95
Min	2.21	0.28		4.60	2.60
Std	3.56	0.32		1.89	0.18
2017	Capital	Risk		Capital	Risk
Mean	10.29	3.37		10.48	3.48
Max	71.80	5.30		17.98	4.03
Min	3.41	2.01		4.31	2.67
Std	3.61	0.29		1.90	0.18
2018	Capital	Risk		Capital	Risk
Mean	10.04	3.41		10.66	3.50
Max	74.17	5.45		18.28	4.04
Min	2.16	0.76		3.83	2.51
Std	3.71	0.33		1.96	0.18
	Eurozone Savings Banks			U.S. Savings Banks	
2013	Capital	Risk		Capital	Risk
Mean	8.57	3.33		12.19981	2.96
Max	64.64	5.42		29.313	3.94
Min	3.19	2.38		7.8	2.59
Std	3.71	0.28		3.97736	0.26
2014	Capital	Risk		Capital	Risk
Mean	8.88	3.22		12.17	2.92
Max	62.81	5.28		30.45	3.90
Min	3.40	2.25		7.88	2.51
Std	3.63	0.28		3.96	0.25
2015	Capital	Risk		Capital	Risk
Mean	9.27	3.51		11.69	3.03

Max	60.21	5.46		31.61	4.02
Min	3.46	2.59		7.19	2.64
Std	3.58	0.26		3.69	0.24
2016	Capital	Risk		Capital	Risk
Mean	9.63	3.65		11.52	3.07
Max	63.65	5.59		32.36	4.08
Min	4.53	2.93		6.84	2.59
Std	3.69	0.25		3.45	0.22
2017	Capital	Risk		Capital	Risk
Mean	9.99	3.38		11.83	3.17
Max	65.02	5.31		32.93	4.18
Min	4.74	2.65		7.58	2.80
Std	3.73	0.24		3.67	0.23
2018	Capital	Risk		Capital	Risk
Mean	10.01	3.72		12.25	3.18
Max	67.31	5.68		32.88	4.15
Min	4.66	2.60		6.13	2.66
Std	3.89	0.26		4.21	0.25

2.5.3. Risk

Concerning the estimation of risk parameter, we measure insolvency risk by employing the Z-score index. The average risk ratio of the groups and subgroups of our sample is illustrated in Figure 11 & Figure 12 and the descriptive statistics in Table 14. Firstly, we notice the risk level of all the banking groups and subgroups of our sample rises during the reported period and peaking during the year 2018. Also, the risk level of the U.S. commercial banks increased significantly and more than the risk of the other banking groups, that is 94.68%.

Moreover, we observe that cooperative and savings banks attain the highest levels of risk compared to the other types of banks and the general sample while the risk ratio of commercial banks is the lowest reported. This finding concurs with Zheng et al. (2017), suggesting that commercial banks are more risk averse than the other types of banks. The same pattern is repeated with the efficiency results per banking sector, implying that there is a positive relationship between risk and efficiency.

As regards the capital requirements and bank risk, the results are conflicting. The U.S. regulatory easing (Reboul et al. (2018)) caused an increase in bank risk ratios during the reported period, while new capital requirements in the Eurozone (Kok et al., (2016)), did not lead to a decrease in the risk ratio of the reported sample. In

fact, the risk ratio of Eurozone banks hit the lowest point during the year 2015 and afterwards it gradually increased. A possible explanation of the disparity in the results could be that there is a U-shaped relationship between capital and risk (Zheng et al. (2017)), suggesting that the regulatory pressure leads to reduced solvency only at the initial stage.

Figure 11: Average risk ratio of Eurozone banks

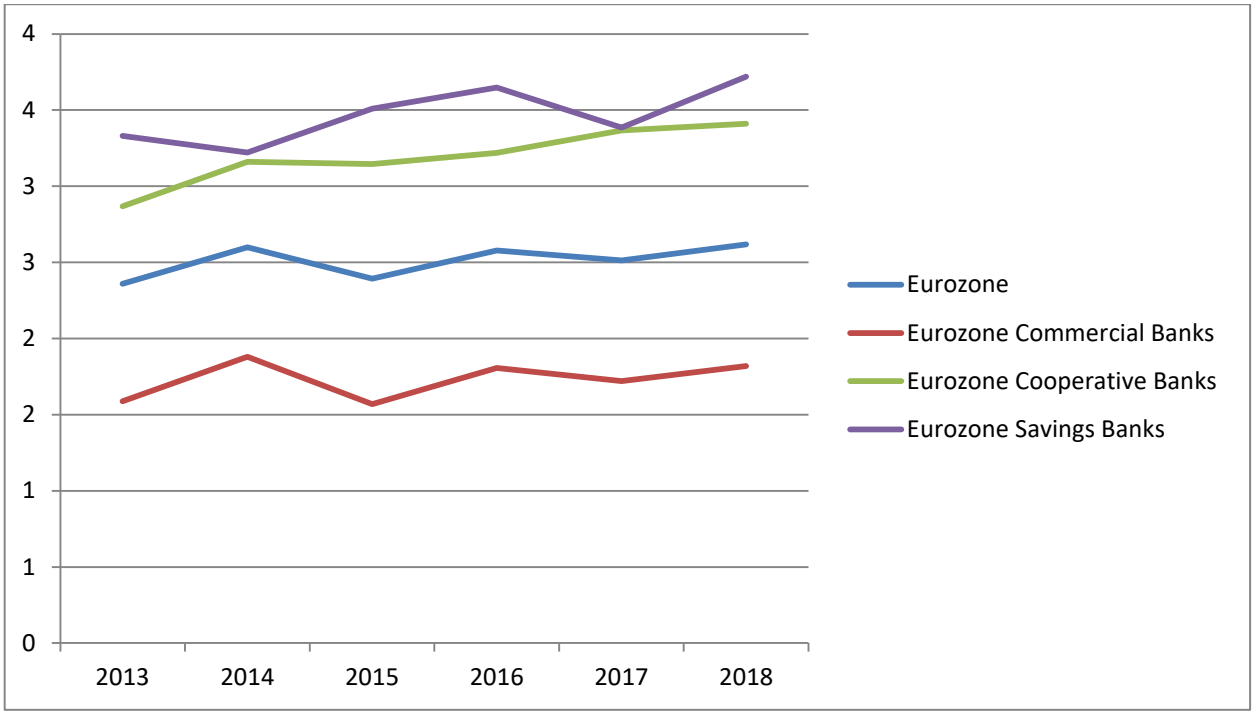
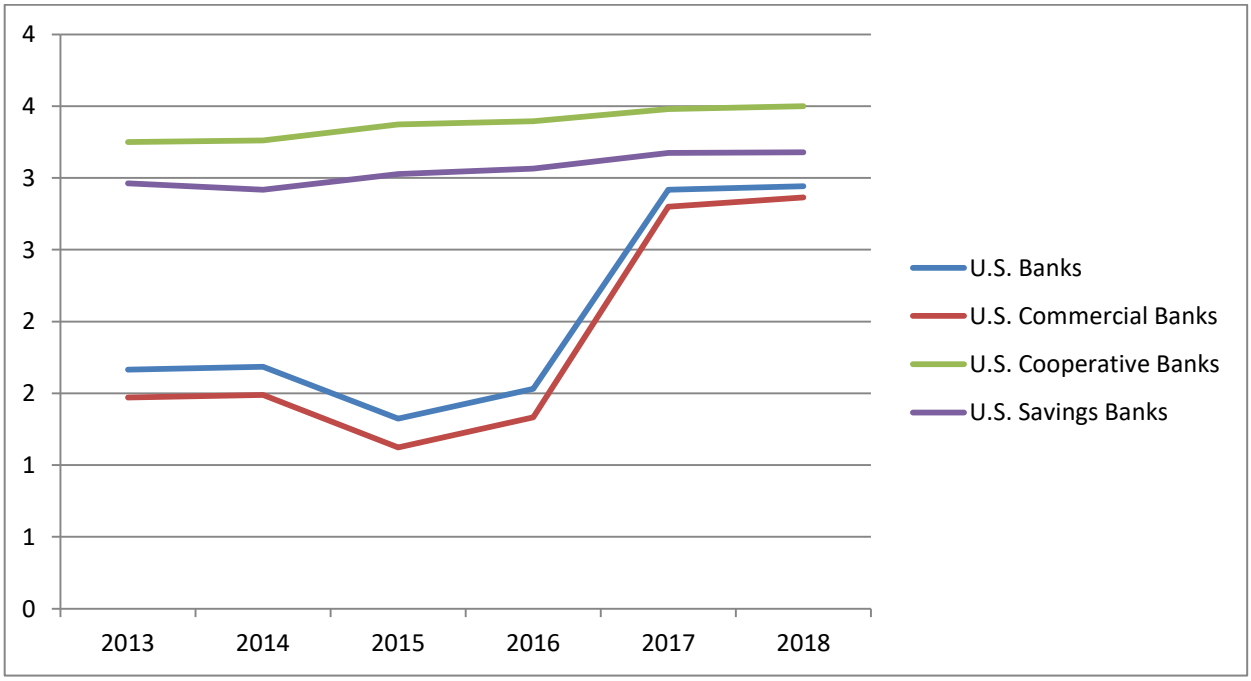


Figure 12: Average risk ratio of Eurozone banks



Section 2.6: Concluding Remarks

In this study, we examine the development of bank risk, capital and efficiency of the Eurozone and the United States after the global financial crisis. Our sample consists of aggregate balance sheets and income statement data from a large data set of banking institutions during the period 2013–2018. Concerning the methodology, we estimate bank efficiency by applying the input-oriented C.C.R. model of Data Envelopment Analysis developed by Charnes et al. (1978). We estimate bank capital by employing the ratio of the value of total equity to total assets and the Z-score is used as an indicator of bank risk.

Initially, we estimated the efficiency from which the findings convey that the efficiency level of the Eurozone banks is considerably lower than that of the U.S. banks. Our findings also indicate that the average efficiency of the U.S. banks increases dramatically, while that of Eurozone and European Union banks remains quite steady. Regarding the banking sectors, a similar pattern is observed as the efficiency of the U.S. commercial, cooperative and savings banks is enhanced compared to that of Eurozone subgroups of banks. Moreover, we observe that commercial banks are the least efficient of banks in our sample, while the cooperative banks appear to be the most efficient banking sector both of Eurozone and United States banks.

Secondly, concerning capitalization, our findings indicate that the capital ratio of U.S. banks is significantly higher than that of Eurozone banks regardless of the type of bank. We also suggest that, during the reported period, the capital ratio of Eurozone banks steadily increases, while the capital ratio of U.S. banks reaches its lowest level in 2016. Finally, it is also interesting to mention that the capital ratios of the banks of the same sector in both the Eurozone and the U.S. have striking differences.

As for the risk ratio, initially we notice that the risk level of all the banking groups and subgroups of our sample increases during the period investigated and peaks during the year 2018. Moreover, cooperative and savings banks attain the highest levels of risk compared to the other types of banks and the general sample while the risk ratio of commercial banks is the lowest recorded. Finally, the results lead us to the conclusion that there is a positive relationship between risk and efficiency.

Our study contributes to the existing literature in multiple ways. Initially, the research with data from 2013 and onwards in the field of bank capital, risk and efficiency is very limited. Moreover, to the extent of our knowledge, our study is the first to compare the capital, risk and efficiency of U.S. and the Eurozone banking systems and also to separately examine the results per bank type (commercial, cooperative and savings banks).

Overall, we witness great discrepancies between the two banking groups and among the different sectors of banks in terms of capital, risk as well as efficiency. Therefore, our findings indicate the importance of the assessment of the interrelationship among capital, risk and efficiency of banking institutions. The sign of the relationship, the direction of the causality and the determinants of those three parameters could become an incentive for further research that resolves these issues. Additionally, the comparison of U.S. and Eurozone banking systems after the financial crisis as well as the speed of recovery is a topic that could be further investigated. Lastly, our approach could be enhanced with the estimation of other D.E.A. methodologies (for example the two-stage semi-parametric double bootstrap DEA method of Simar and Wilson (2007) and by the investigation of a sample covering more years after the financial crisis.

Apart from the contribution to the empirical research, our results are important from a bank prudential supervisory perspective. Our findings indicate great discrepancies of capital, risk and efficiency among different banking sectors and banking systems with different characteristics. Thus, regulators should consider the banking sector and the location of the banking institutions when implementing regulations concerning the financial stability.

Chapter 3:

A Comparative Analysis of the Relationship among Capital, Risk and Efficiency in the Eurozone and the United States Banking Institutions.

Section 3.1: Introduction

Multiple studies have focused on the interrelationship between risk and efficiency (Williams, (2004); Nguyen & Nghiem, (2015)), between capital and risk (Anginer & Demirguc-Kunt, (2014); Tan & Floros, (2013)) and between efficiency and capital (Bitar et al., 2018; Le, 2018). However, the existing literature remains inconclusive, which has resulted in a new wave of studies, the study of capital, risk and efficiency of banking institutions as one system. Interestingly, the number of studies investigating this interrelationship is limited (Deelchand & Padgett, (2009); Bashir & Hassan, (2017)), while the studies examining this field for Eurozone and U.S. banking are even more restricted (Fiordelisi et al., (2011b); Ding & Sickles, (2019)). Thus, the interrelationship among capital, risk and efficiency of banking institutions is unresolved, as the results concerning the sign of the relationship as well as the direction of causality are conflicting.

Concerning Eurozone and U.S. banking systems, the recent financial crisis has affected both, with more bank failures occurring in the U.S. However, the speed of recovery of Eurozone banking institutions is considerably lower than that of the U.S. (McLannahan & Arnold, (2017); Ackermann, (2019)). This outcome could be attributed to the different characteristics of the economies, the banking systems and the monetary policies of the Eurozone and the United States[11]. Therefore, the financial crisis has indicated how differently banking systems may behave after financial shocks. The different speed of recovery between the two reported country unions is the reason for this selection, as it helps us to investigate how differently interrelationships among capital, risk and efficiency develop over the post-crisis period. To the extent of our knowledge, the only study that compares the results of the abovementioned relationship for U.S. and European banks is that of Altunbas et al., (2007) which employs pre-crisis data while no recent study compares the results between the Eurozone and the U.S. banking systems by employing post-crisis data.

[11] For instance: i. Different monetary policies between European Central Bank (negative interest rates) and Federal Reserve (interest rates positive or close to zero) ii. Different levels of post-crisis regulatory flexibility, U.S. regulatory framework is more flexible than Eurozone's (Lakhani et al., (2019)) iii. The after-crisis restructure of the Eurozone banking system was significantly lower than that of U.S. (Jenkins, 2015) iv. Large stock of non-performing loans, almost double than that of U.S. (Binham & Noonan, 2015)).

This study attempts to take into consideration the type of bank (cooperative, commercial and savings) and provides empirical evidence about how the interrelationships among risk, capital and efficiency and the managerial behavior vary per type of bank. We concentrate on different types of banks because the objectives and managerial behaviors may vary across them. To be more precise, commercial banks may confront different types of risk, attain more or less capital and operate differently to cooperative or savings banks.

In order to clarify these relationships we examine the validity of a set of managerial hypotheses about the expected relationships, following a great number of academic surveys, for instance; Berger & DeYoung, (1997); Williams, (2004); Fiordelisi et al., (2011b); Fiordelisi & Mare, (2014) etcetera. More specifically, seven hypotheses are tested; regulatory hypothesis, moral hazard hypothesis, bad management hypothesis, bad management hypothesis, cost skimming hypothesis, the hypothesis of the positive relationship between efficiency and capital and the shareholders-managers hypothesis.

For the aforementioned purposes, we employ a data sample consisting of aggregated balance sheet and financial data retrieved from 1584 Eurozone and 601 U.S. banks. It involves data from the period 2013-2018 and the selected types of banks are commercial, cooperative, investment, savings, real estate and mortgage banks. We investigate separately the relationship of capital, risk and efficiency of both economic unions, Eurozone and the United States. We also examine the three subgroups of Eurozone and those of U.S. banks depending on the banking sector (commercial, cooperative and savings banks). Furthermore, we control for environmental and bank-specific variables which affect or explain the capital, risk and efficiency relationship.

Regarding methodology, at the first step of our study we employ the input-oriented C.C.R. model of Data Envelopment Analysis developed by Charnes, (1978) to estimate efficiency. Afterwards, we apply the Z-score to calculate bank risk and the ratio of the value of total equity to total assets as an indicator of bank capital. In the final step, we examine the relationship among capital, risk and efficiency of banking institutions by employing the Three-Stage Least Squares (3SLS) model, developed by Zellner & Theil, (1962).

This study contributes to empirical research on the interrelationship among risk, capital and efficiency in multiple ways. Firstly, this study is the first to comparing the capital risk and efficiency relationship between Eurozone and U.S. banks by employing post-crisis data. Moreover, the majority of studies investigate the European banking institutions, while our survey focuses on a Eurozone bank sample. Lastly, we fill in the gap from previous literature by examining separately three

banking sectors (cooperative, commercial and savings banks) and provide evidence of whether the links among risk, capital and efficiency vary per type of bank.

The remainder of this chapter is organized as follows: Section 2 reviews the existing literature regarding the links among risk, capital and efficiency of banking institutions. Section 3 presents our hypotheses and Section 4 the research methodology. Section 5 describes the data employed in the study. Section 6 describes our empirical results while Section 7 summarizes the findings and presents the conclusions.

Section 3.2: Literature Review

The interrelationship among capital, risk and efficiency in the banking industry is an issue of significant importance because of the essential role of the banking institutions in the economy. Thus, a great number of academic surveys have focused over the years on the theoretical and the empirical study of the determinants of risk, capital and efficiency and on the examination of the relationships linking those three variables. However, the existing literature yields conflicting results (Fiordelisi et al., (2011b); Tan & Floros, (2013); Nguyen & Nghiem, (2015); Le, (2018)).

The inconsistencies among the results of the literature concerning the relationship between capital, risk and efficiency have led to the simultaneous examination of those three variables as one system. Hughes et al., 1996 is the first to introduce the theoretical argument of the importance of efficiency in the determination of the relationship between risk and capital. Following that study, Kwan & Eisenbeis, (1997) were the first to conduct empirical research on the interrelationship between **capital, risk and efficiency** by employing a simultaneous equation framework. The sample of their study is U.S. banks between 1986 and 1995 and the results indicate that a positive relationship between capital and efficiency and an adverse relationship between efficiency and risk exists. Since then, several authors have focused on the aforementioned relationship but it remains unresolved.

For instance, Tan & Floros, (2013); Mosko & Bozdo, (2016) ; Le, (2018) employ Three-stage Least Squares technique to examine the relationship among capital, risk and efficiency. More specifically, Tan & Floros, (2013) assess a sample that consists of Chinese commercial banks and the reported period is 2003-2009. Their results suggest that risk and efficiency are positively and significantly related, whilst the relationship between bank risk and capital is negative and statistically significant. Mosko & Bozdo, (2016) examined the relationship among efficiency, capital and risk in the Albanian banking system from 2002 until 2014. The method applied is the

Three-stage Least Squares and their results demonstrate that the relationship between risk and capital is positive and the level of efficiency determines both variables. In a recent study, Le, (2018) assesses the relationship among risk, capital and efficiency in Vietnamese banking over the period 2007-2011. The results imply that there is an adverse relationship between risk and capital and a direct association between risk and efficiency. The findings additionally suggest that banking institutions with lower risk and higher efficiency have higher capital.

In this context, Deelchand & Padgett, (2009) focus on cooperative banks in Japan and examine the relationship among capital, risk and cost inefficiency during 2003-2006 by employing the two-stage least squares method. The results indicate that there is an adverse relationship between capital and risk and that inefficient banks tend to attain more capital and higher risk. Moreover, Bashir & Hassan, (2017) employ the Generalized Method of Moments technique to assess the relationship among risk, capital and efficiency during the period 1997-2015 and the findings present differences depending on the Basel Accord of each period. More specifically, Basel II Accord was more effective in decreasing the levels of bank risk than the previous accord, Basel I. Additionally, the impact of higher capital ratios on risk and efficiency is examined by Bitar et al., (2018). The researchers use data for 1992 banks from 39 countries over the period 1999-2013 and their results show that higher capital ratios are negatively related with bank risk and positively related with efficiency.

Concerning the studies focusing on the European, the Eurozone and the U.S. banking institutions, the results are contradictory. It is also rather surprising that the number of those studies is very limited. For instance, Altunbas et al., (2007) investigate the relationship among capital, efficiency and risk for European banks over the period 1992-2000. Their results indicate that inefficient banks tend to have more capital and lower risk levels. Furthermore, their findings show that there is a positive association between risk and capital. They separately tested how the aforementioned relationships are developed by the banking sector and their results suggest that savings and commercial banks do not present great diversification, while co-operative banks' capital responded differently to risk changes.

The causality among risk, capital and efficiency is also assessed by Fiordelisi et al., (2011b) where the researchers employ the Granger-causality methodology in a panel data framework to investigate a sample of European commercial banks between 1995-2007. Their results show that a decrease in bank efficiency may lead to higher risk and a decrease in capital precedes to lower cost efficiency. Fiordelisi et al., (2011a) assess the relationships among risk, efficiency, capital and competition in U.S. investment banks during the period 2000-2008. The findings indicate that an increase in efficiency results in an increase in risk levels, an increase in risk temporally forgoes an increase in capital and lower capital leads to higher risk levels.

In a more recent study, Ding & Sickles, (2019) investigate the impact of capital regulations on capital, risk and efficiency in the U.S. market between 2001 and 2016 by employing fixed effects, GMM fixed effects and spatial effects models. The results show that stricter capital requirements lead to lower risk-weighted assets, to more non-performing loans and to changes in managerial practices.

However, it is rather surprising that there is only one study which investigates this relationship for European and U.S. banking institutions, and the comparison is not with post-crisis data. Williams, (2004) assesses the relationships between efficiency, capital and loan loss provisions on European savings banks during the period 1990-1998 and performs a robustness test for U.S. banks. The findings suggest that there is a direct relationship between inefficiency and non-performing loans and that the managerial behavior problems of European banks are inconsistent with those of U.S. banks.

Concerning the bank type, there is only limited empirical evidence suggesting that different types of banks present different results in the estimation of the relationship among capital, risk and efficiency. For instance, Altunbas et al., (2007) tests separately commercial, savings and co-operative banks and finds consistency between commercial and savings banks, while the results for co-operative banks have major differences.

Overall, the majority of studies supported that there is a link connecting capital, risk and efficiency (Le, (2018); Kwan & Eisenbeis, (1997), Berger & DeYoung, (1997)). However, the existing literature concerning these issues remains inconclusive as it yields conflicting results. The differences on the results are mainly focused on the direction of causality as well as the temporal order.

Section 3.3: Research Hypotheses

In order to clarify these relationships, and before introducing our empirical model, we examine the validity of a set of managerial hypotheses about the expected relationships, following a great number of academic surveys, for instance; Berger & DeYoung, (1997); Williams, (2004); Fiordelisi et al., (2011b); Fiordelisi & Mare, (2014) etcetera.

3.3.1 Capital & Risk

null Hypothesis ($H_{1.0}$): "REGULATORY HYPOTHESIS"

The first hypothesis is based on the **Regulatory Hypothesis**. It indicates that there is a positive relationship between risk and capital (Altunbas et al., (2007); Bashir & Hassan, (2017)). More specifically, according to this hypothesis banks are required by the regulators to increase the amount of bank capital when the undertaken bank risk increases in order to counter the risk of default.

alternative hypothesis ($H_{1.1}$) : "MORAL HAZARD HYPOTHESIS"

The second hypothesis is the alternative to the regulatory hypothesis; it states that capital has a negative impact on risk (and vice versa) and it is studied as the **Moral Hazard Hypothesis** (Berger & DeYoung, (1997); Williams, (2004); Anginer & Demirgüç-Kunt, (2014)). According to this hypothesis, the managers of poorly capitalized banks have moral hazard incentives to take on increased portfolio risks as those banks face more risks as a result of lower capital adequacy.

3.3.2 Risk & Efficiency

null Hypothesis ($H_{2.0}$): "BAD MANAGEMENT HYPOTHESIS"

The third hypothesis examined is the **Bad Management Hypothesis** (Berger & DeYoung, (1997), Williams, (2004)). Under this hypothesis, we assume that there is an inverse relationship between risk and efficiency since an decrease in efficiency could provide motivation to the managers to increase the risk levels of the bank and offset the low efficiency levels. Moreover, badly managed banks suffer from higher costs, credit and operational problems and lower efficiency as a result of the inefficient controlling of the operating expenses and of the risk monitoring.

alternative hypothesis ($H_{2.1}$): "BAD LUCK HYPOTHESIS "

Another hypothesis that advocates the negative relationship between risk and capital is the **Bad Luck Hypothesis**, developed by Berger & DeYoung, (1997). According to this hypothesis an exogenous event (for instance financial shocks) which cannot be controlled by the bank manager, may cause an increase in risk. For example, an increase in the non-performing loans of the banks. In this case, the costs of monitoring and managing the problematic loans, the bank provisions and the managerial efforts may increase, so the efficiency is reduced. Therefore, an increase in risk results in a decrease in the levels of efficiency (Tan & Floros, (2013); Williams, (2004); Le, (2018)).

Although both the Bad Luck and the Bad Management hypotheses suggest that there is a negative association between risk and efficiency, they follow the opposite causality order. As stated in the bad luck hypothesis, the increase in risk occurs before the decrease in the levels of efficiency. According to the bad management hypothesis, the decrease in efficiency comes first.

alternative hypothesis ($H_{2.2}$): "COST SKIMMING HYPOTHESIS"

The fifth hypothesis is the **Cost Skimming Hypothesis**, which is the alternative hypothesis to the Bad Management Hypothesis. In this hypothesis risk and efficiency are assumed to be positively correlated.

Under this hypothesis, banks that do not spend resources on risk monitoring and especially credit risk monitoring (monitoring of non-performing loans as well as of loans) appear to be more efficient in the short term. On the contrary, they take on higher risk in the medium and long term as this managerial behavior affects the quality of future loans (Altunbas et al., (2007); Bashir & Hassan, (2017), Williams, (2004); Nguyen & Nghiem, (2015)).

3.3 Efficiency & Capital

null Hypothesis ($H_{3.0}$): "There is a positive relationship between efficiency and capital"

The sixth hypothesis of our analysis states that capital affects efficiency positively. According to this hypothesis, the higher capital is, the higher the incentives of shareholders are to carefully monitor the managerial behavior and investment decisions, and thus bank efficiency would be expected to increase. (Chortareas et al., (2012)).

alternative hypothesis ($H_{3.1}$): "SHAREHOLDERS-MANAGERS HYPOTHESIS"

Last but not least, **Shareholders-Managers Hypothesis** suggests that the relationship between efficiency and capital is negative due to moral hazard incentives of the bank managers.

Section 3.4: Research Methodology

For the purposes of our survey we employ a four-step approach. At first, the efficiency of our banking institutions is measured by applying the input-oriented C.C.R. model of Data Envelopment Analysis (D.E.A.) developed by Charnes et al., (1978). This methodology evaluates the ability of a Decision Making Unit (D.M.U.) to convert a number of inputs into outputs.

$$max \quad Z_0 = \sum_t (u_t * y_{t0})$$

s.t

j=1,….,n

i=1,….,m

t=1,….,s

$\sum_r (u_t * y_{tj})$ - $\sum_i (v_i * x_{ij})$ = 0

$\sum_i (v_i \; x_{i0}) = 1$,

$v_i \geq \varepsilon \geq 0$

$u_t \geq \varepsilon \geq 0$

where:

i=inputs

t=outputs

j=Decision Making Units (D.M.U.)

v_i *= relative importance of input i*

u_t*= relative importance of output t*

ε = non-Archimedean value

If the D.M.U.$_0$ is efficient (equal to 1), this means that there is at least one optimal solution to the aforementioned equation and the efficiency of a D.M.U. is higher when the efficiency score increases. In this survey, the selected inputs are staff expenses, book value of fixed assets and time and demand deposits. While, the selected outputs are loans and advances to banks and customers and net interest income.

In the next step of our study, we measure bank capital by employing the ratio of the value of total equity to total assets. This ratio is mainly employed in the literature (Deelchand & Padgett, (2009)). Subsequently, we employ the Z-score as the measurement of bank Risk, due to the fact that it serves as an indicator of financial stability in the banking industry.

$$Z - score_{(t,i)} = \frac{\frac{equity_{(t,i)}}{total\ assets_{(t,i)}} + ROA_{(t,i)}}{\sigma(ROA)_{(T,i)}}$$

Where:

T= full sample period

t= time

i= bank

ROA= ratio of return on average assets

In the final step, we examine the relationship among capital, risk and efficiency of banking institutions by employing the Three-Stage Least Squares (3SLS) model, developed by Zellner & Theil, (1962).

Apart from 3SLS model, various approaches have been employed in the literature, such as the Granger-causality techniques (Fiordelisi et al., (2011b); Williams, (2004)). Nonetheless, the results of this model are sensitive to model specification and to the number of lags (Nguyen & Nghiem, (2015)). Another technique vastly employed is Ordinary Least Squares, but the 3SLS is preferred, as it supplies consistent estimates of the parameters (Jacques & Nigro, (1997)). Furthermore, the Ordinary Least Squares model is not considered as a robust model because it disregards the correlation of error terms across equations (Tan & Floros, (2013)).

In our study, we employ the 3SLS model in a panel data framework, selected as it considers potential endogeneity between variables as well as cross correlation of error terms(Tan & Floros, (2013); Shim, (2013)). Additionally, the 3SLS model incorporates the Two-Stage Least Squares and the Seemingly Unrelated Regression (S.U.R.) approach and is preferred in many studies; Tan & Floros, (2013); Le, (2018); Nguyen & Nghiem, (2015)). The two-Stage Least Squares is also in much of the literature (Deelchand & Padgett, (2009); Kwan & Eisenbeis, (1997)), as well as the S.U.R. approach (Altunbas et al., (2007)). Moreover, the 3SLS procedure is chosen over the Two-Stage Least Squares as it is a “full-information estimation technique which estimates all parameters simultaneously” and thus “ because it incorporates the cross-equation correlations, it produces parameter estimates which are asymptotically more efficient than 2SLS” (Jacques & Nigro, (1997)).

The system of simultaneous equations employed in our survey, in order to investigate the relationship among capital, risk and efficiency, is defined as follows:

$$RISK_{i,t} = \alpha_0 + \alpha_1 CAP_{i,t} + \alpha_2 EFF_{i,t} + \alpha_3 ENV_{i,t} + \alpha_4 LEND_{i,t} + \alpha_5 LIQ_{i,t} + \varepsilon_{i,t} \quad (1)$$

$$EFF_{i,t} = \beta_0 + \beta_1 CAP_{i,t} + \beta_2 RISK_{i,t} + \beta_3 LEND_{i,t} + \beta_4 ENV_{i,t} + \beta_5 SIZE_{i,t} + \beta_6 LIQ_{i,t} + \theta_{i,t} \quad (2)$$

$$CAP_{i,t} = \gamma_0 + \gamma_1 EFF_{i,t} + \gamma_2 RISK_{i,t} + \gamma_3 INT_{i,t} + \gamma_4 PROF_{i,t} + \gamma_5 ENV_{i,t} + \omega_{i,t} \quad (3)$$

Where,

RISK: the measure of risk

CAP: the measure of capital

EFF: the measure of efficiency

SIZE: the natural logarithm of total assets

PROF: the ratio of profit before tax to average total assets

INT: the ratio of gross loans to total deposits

ENV: the environmental variables; GDP real growth rate('GDP'), inflation rate('INFL'), budget balance('BUDG'), public debt('PUBD'), unemployment ('UNE'), current account balance ('CURR') and trade balance ('TRA').

LEND: the ratio of gross loans to total assets

LIQ: the ratio of liquid assets to total assets

ε,θ,ω : random errors

i: bank dimension

t: time dimension

The first equation (1) examines whether changes in the level of bank capital and bank efficiency temporarily precede variations in bank risk. The second equation (2) investigates if capital and risk temporarily forego variations in efficiency while the third equation (3) analyzes if efficiency and risk variations reflect changes in the level of bank capital.

In addition to capital, risk and efficiency of the banking institutions, in our study we also control for other variables which both affect and explain the relationship of the above mentioned variables. Firstly, we include environmental variables (ENV) as explanatory variables. It is very important to take them into consideration, especially for the Eurozone sample, as it presents a wide diversity of the environmental variables of each Eurozone country. More specifically, the selected factors indicate the country-specific conditions of each bank: GDP real growth rate, inflation rate, budget balance, public debt, the unemployment rate, current account balance and trade balance.

Moreover, following Nguyen & Nghiem, (2015), the control variables for capital include: i. an indicator of profitability (PROF) which is the ratio of profits before taxes to average total assets and ii. an indicator of bank intermediation (INT) which is the ratio of gross loans to total deposits. The profitability indicator is expected to affect positively the capital ratio, as it is easier for a bank with higher retained earnings (all else being equal) to acquire more capital (Le, (2018)). In the same pattern, banks with higher ratio of gross loans to total deposits are more profitable and therefore attain more capital.

The control variable of the size of the bank (SIZE) was employed as an indicator for efficiency and is calculated as the natural logarithm of total assets. According to Drake, (2001), it is expected that the size of bank assets and efficiency are positively connected because of economies of scale.

Moreover, following Le, (2018) and Nguyen & Nghiem, (2015) in both efficiency and risk equations we employ the following indicators; lending specialization (LEND) and liquidity (LIQ).

Regarding lending specialization, it is measured as the ratio of gross loans to total assets. According to many studies, excessive lending and risk are positively related, as new loan productivity possibly is offered to borrowers who were rejected in the past or do not have sufficient collateral (Le, (2018)). Moreover, a greater lending specialization level is positively connected to efficiency as more efficient banks have lower production costs, and therefore can provide loans with lower rates and costs than their competitors (Nguyen & Nghiem, (2015)).

Risk and efficiency are influenced by the explanatory variable liquidity. This variable can be calculated by the ratio of liquid assets to total assets (Ben Salah Mahdi & Boujelbene Abbes, (2018)) and it is expected to affect risk negatively, as a bank with higher liquidity ratios has greater capability to meet its liabilities (Zhang et al., (2013)).

Section 3.5: Data

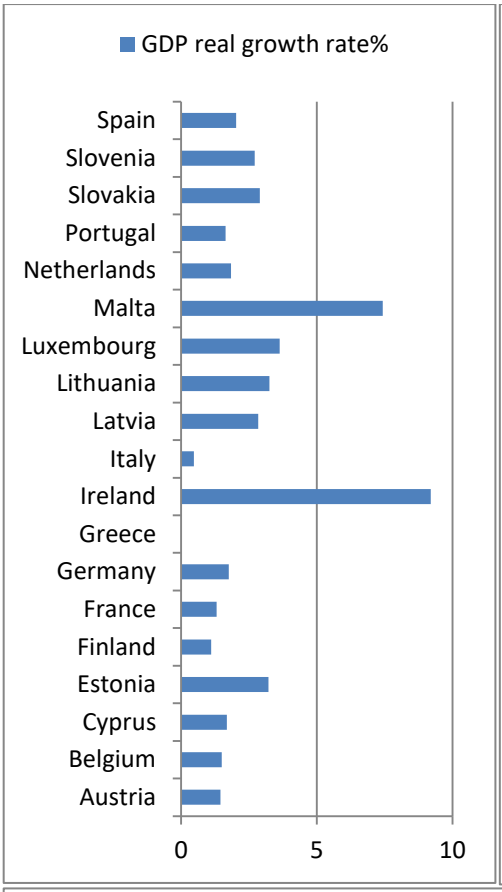
Our sample is comprised of aggregated balance sheets and financial data retrieved from 2185 banks and it is separated into two parts; Eurozone and the United States banks (Table 9). The types of banking institutions selected include commercial, cooperative, investment, savings, real estate and mortgage banks. We also adjust our data omitting banks with incomplete or missing annual financial data over the reported period.

The financial data employed in our survey are the following: total expenses of staff, book value of fixed assets, time and demand deposits, net loans and advances to banks, net loans and advances to customers, interest income, interest expenses, total equity, total assets, return on average assets (R.O.A.), liquid assets, profit before tax, gross loans and total deposits.

The analyzed period of our study spans the time period of 2013 until 2018. This period is selected because the research in the banking field when employing post-crisis data is limited and the examination of the development of the relationships among capital, risk and efficiency after the financial crisis is even more limited.

Moreover, in the following figure (Figure 13), which reports the average environmental variables during the reported period 2013-2018, we notice that differences among the European countries are evident. For example, Greece and Cyprus have the two lowest inflation rates, which are less than -0.2%, while the inflation rates of Estonia, the United Kingdom as well are more than 1.5%. Furthermore, it is very interesting to note the great disparity of unemployment rates. More specifically, Germany has the lowest unemployment level and the highest levels are found in Greece and Spain. Similarly, there are differences in the unemployment rates amongst European countries. Thus, the data lead us to the conclusion that there is still a range of environmental variables in Eurozone countries, which highly affect banking efficiency, capital and risk, and should be taken into consideration.

Figure 13: Average Environmental Variables


GDP real growth rate%
Spain
Slovenia
Slovakia
Portugal
Netherlands
Malta
Luxembourg
Lithuania
Latvia
Italy
Ireland
Greece
Germany
France
Finland
Estonia
Cyprus
Belgium
Austria
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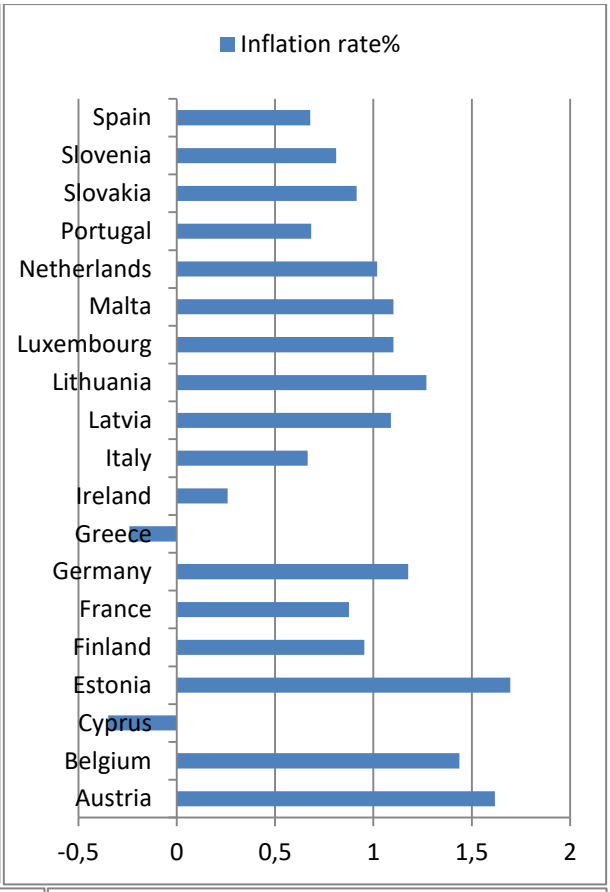
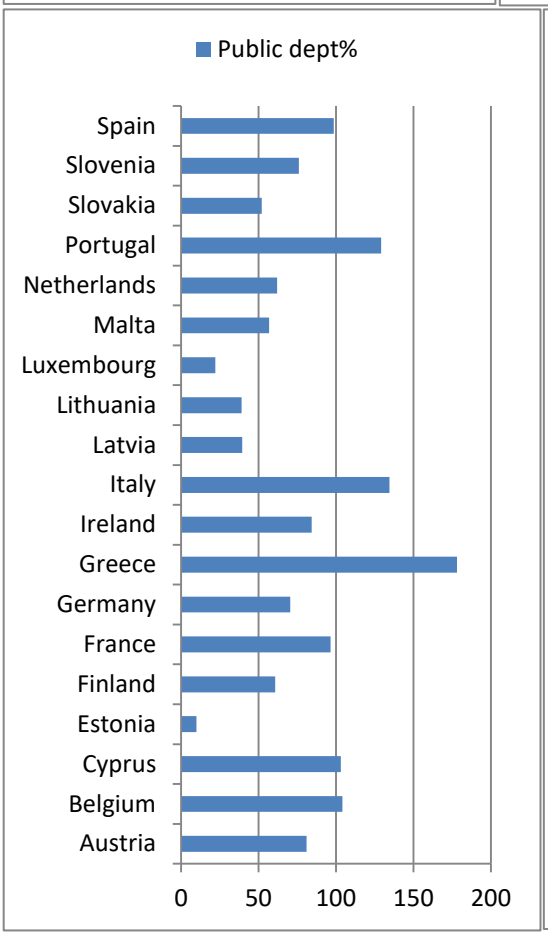
5
10


Inflation rate%
Spain
Slovenia
Slovakia
Portugal
Netherlands
Malta
Luxembourg
Lithuania
Latvia
Italy
Ireland
Greece
Germany
France
Finland
Estonia
Cyprus
Belgium
Austria
-0,5
0
0,5
1
1,5
2


Public dept%
Spain
Slovenia
Slovakia
Portugal
Netherlands
Malta
Luxembourg
Lithuania
Latvia
Italy
Ireland
Greece
Germany
France
Finland
Estonia
Cyprus
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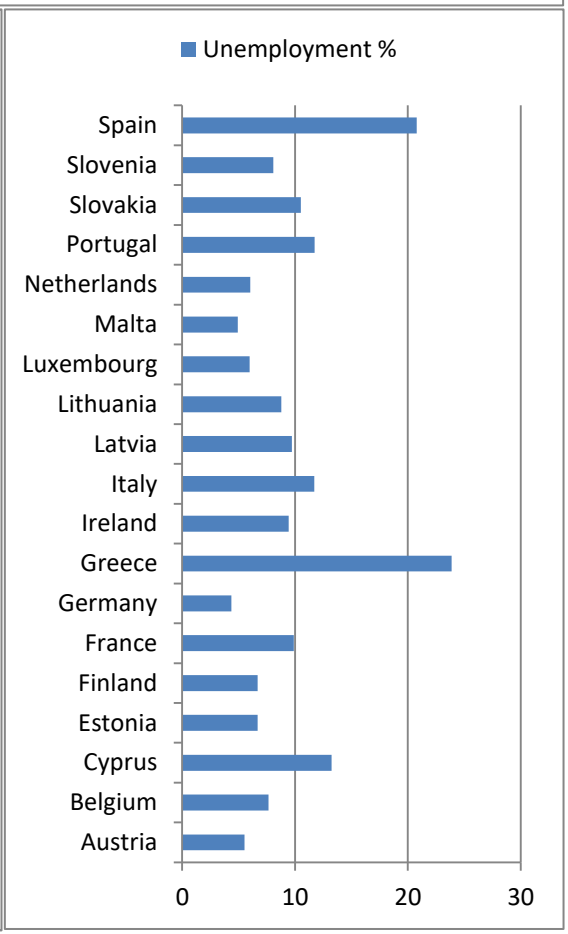
Austria
0
50
100
150
200


Unemployment %
Spain
Slovenia
Slovakia
Portugal
Netherlands
Malta
Luxembourg
Lithuania
Latvia
Italy
Ireland
Greece
Germany
France
Finland
Estonia
Cyprus
Belgium
Austria
0
10
20
30

Additionally, a summary of the average of the explanatory variables employed for the 3SLS model (the profitability ratio, the bank intermediation ratio, the liquidity ratio and the lending specialization ratio) is presented in the following figures, while the descriptive statistics are presented in Appendix . Initially, concerning the indicator of profitability (Figure 14), we notice the ratio of U.S. variables is almost double that of Eurozone variables.

Figure 14: The Profitability Ratio

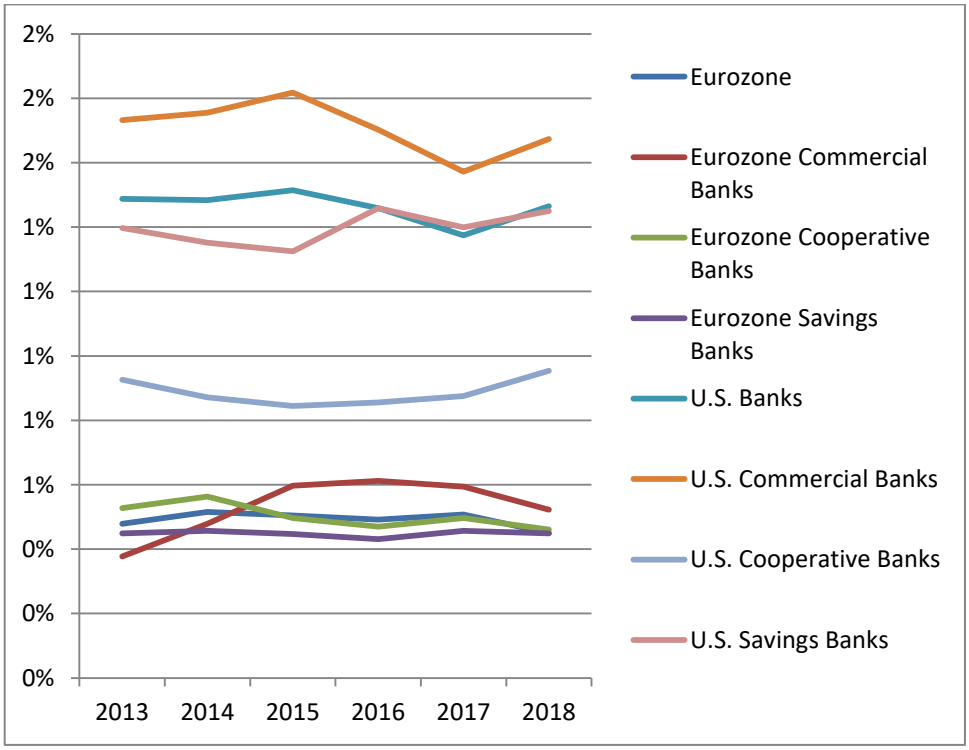
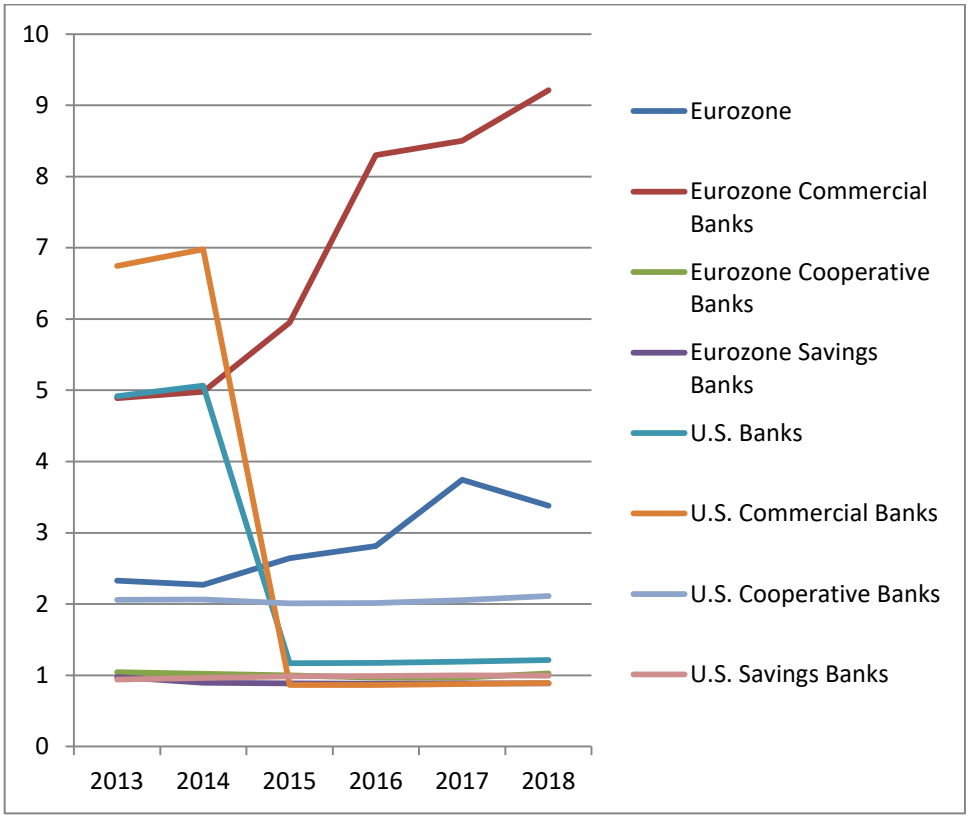


Figure 15 depicts the average ratio of bank intermediation. The ratio for the Eurozone general sample and Eurozone commercial banks sample is higher than that of the rest of the sample and it slightly improves during the reported period. The lower ratio of U.S. banks could be explained because the large U.S. capital markets are the main source of finance in the U.S., while in the Eurozone banks are the primary sources of capital.[12]

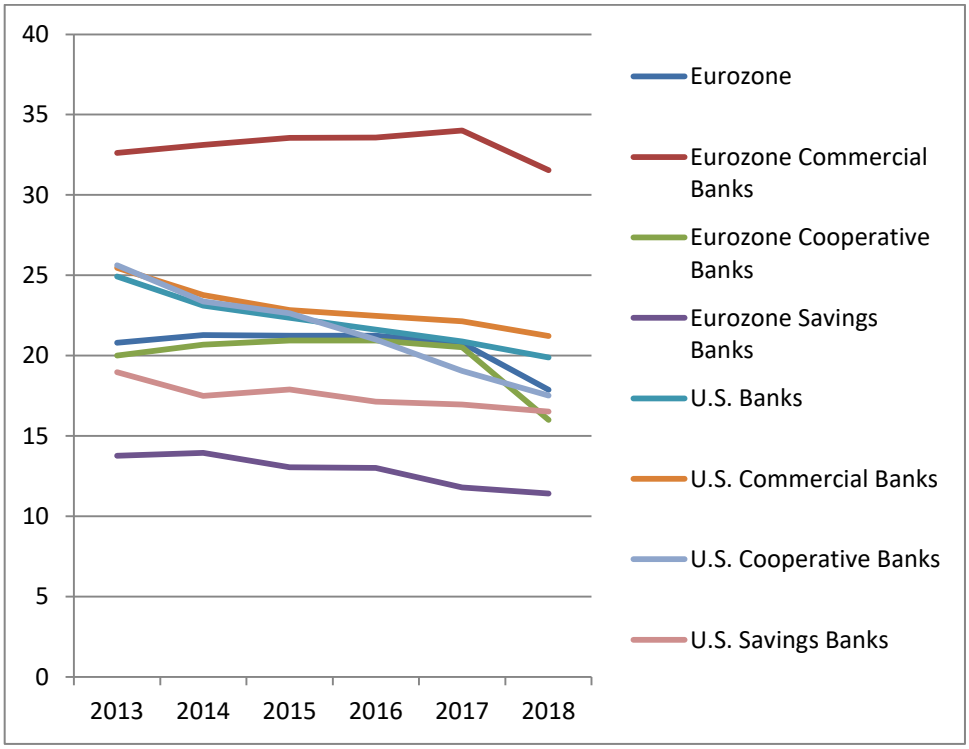
[12] According to Ackermann, J. (2019) capital markets provide 70% of financial needs in the U.S. and 30% of financial needs in the European Union.

Figure 15: The Bank Intermediation Ratio



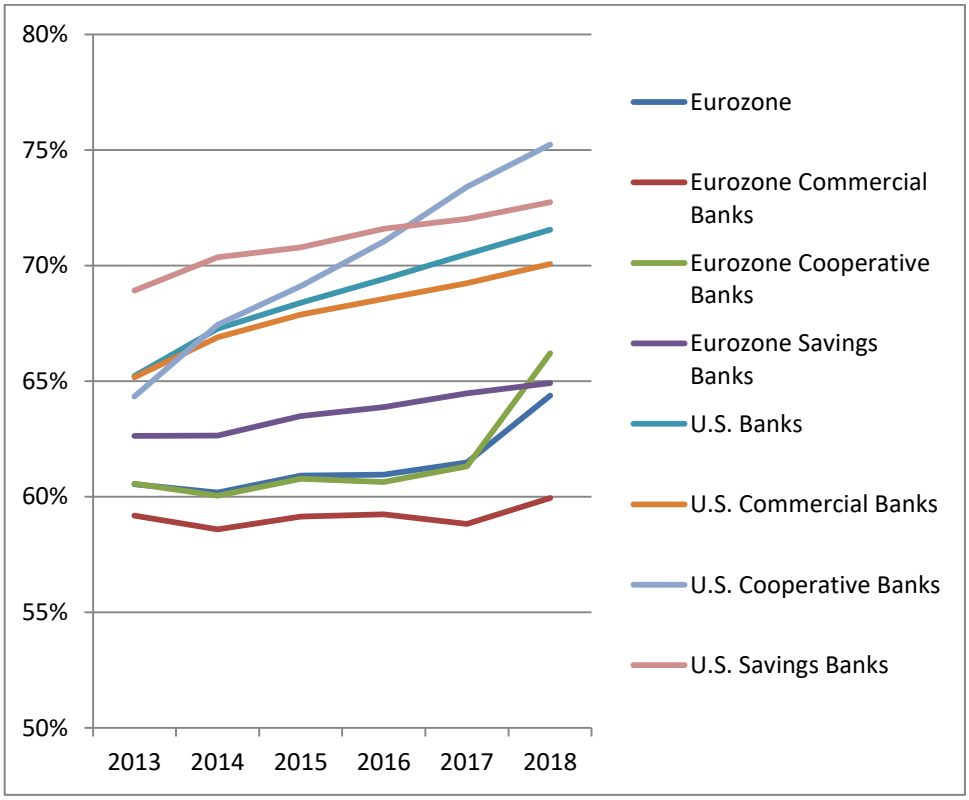
As regards the liquidity ratio (Figure 16), initially we observe that the ratio decreases for all types of banks in our sample during the period studied. We also notice that the decrease is more significant for U.S. banks than it is for Eurozone banks, with the exception of savings banks. Furthermore, it is interesting to note that Eurozone commercial banks are the most liquid in our sample. An explanation may be that during the reported period the E.C.B. provided repos to the banking institutions in return for collateral, and as a result they increased their liquidity levels (Cukierman, A. (2014)).

Figure 16: The Liquidity Ratio



According to Figure 17, which presents the average lending specialization of the different banking groups in our sample, the lending specialization ratio of U.S. banks is considerably higher than that of Eurozone banks. We also witness that the ratio increases during the reported period in all the banking groups. Moreover, the commercial banks are the least specialized in lending whereas the most specialized are the savings banks.

Figure 17: The Lending Specialization Ratio



Section 3.6: Empirical Results

The results of the estimation of equations (1), (2), (3), attained by using the 3SLS procedure for each type of bank, are presented in the following tables. What is more, the correlation matrix is also applied to test the association between dependent and independent variables and the results are reported in Appendix .

Table 15, Table 17 and Table 19 present the results of our model for the Eurozone banks general sample (all banks) and its three subgroups for the first equation, while Table 16, Table 18 and Table 20 convey the results of the U.S. banks sample and its three subgroups. We observe in Table 15 and Table 16 that the chi2 and P variables obtained from the 3SLS model for all bank groups in our sample indicate that the equation systems employed have statistical significance.

3.6.1 Risk Determinants

Table 15: Determinants of risk of Eurozone Banks

	EUROZONE	COMMERCIAL	COOPERATIVE	SAVINGS
		RISK		
CAP	0.130***	0.106***	0.0993***	0.0506***
	(0.00271)	(0.00495)	(0.00173)	(0.00273)
EFF	0.740***	1.228***	-0.337***	0.347
	(0.123)	(0.288)	(0.0476)	(0.182)
GDP	0.0130***	0.0166*	0.130***	-0.0305***
	(0.00346)	(0.00710)	(0.00300)	(0.00607)
INFL	-0.0110	-0.0205	0.0842***	-0.0473***
	(0.00587)	(0.0171)	(0.00456)	(0.00695)
PUBD	-0.000160	-0.000498	0.00210***	-0.00484***
	(0.000221)	(0.000480)	(0.000234)	(0.000425)
UNE	-0.0101***	0.00672	-0.00161	-0.00759**
	(0.00147)	(0.00369)	(0.00154)	(0.00270)
LEND	0.0145	-0.190	0.329***	-0.122
	(0.0352)	(0.118)	(0.0306)	(0.0944)
LIQ	-0.0000242	-0.00107	0.00165***	-0.0000828
	(0.000253)	(0.000836)	(0.000343)	(0.000113)
_CONS	1.220***	0.526***	1.712***	3.396***
	(0.0337)	(0.113)	(0.0231)	(0.0442)
N	9499	1638	5028	2448
R-SQ	0.306	0.406	0.745	0.602
CHI2 FOR EQUATION (1)	5023.34	629.73	7111.98	1320.11
P FOR EQUATION (1)	0	0	0	0
CHI2 FOR EQUATION (2)	7397.08	1840.90	2542.65	2844.96
P FOR EQUATION (2)	0	0	0	0
CHI2 FOR EQUATION (3)	1633.81	102.33	2119.44	1370.56
P FOR EQUATION (3)	0	0	0	0

Note: This table presents the regression results for the 3SLS estimation for the Eurozone sample of banks and its subgroups. Standard errors are presented in parentheses. * p<0.05, ** p<0.01, *** p<0.001

Table 16: Determinants of Risk of U.S. banks

	United States	Commercial	Cooperative	Savings
		RISK		
CAP	0.101***	0.0230*	0.120***	0.0681***
	(0.00343)	(0.00893)	(0.00291)	(0.00196)
EFF	0.728***	0.680***	0.0510	0.0217
	(0.0471)	(0.0341)	(0.0300)	(0.0308)
GDP	-0.457***	-0.442***	-0.130***	-0.183***
	(0.0113)	(0.0100)	(0.00954)	(0.0152)
INFL	1.209***	1.304***	0.0831***	0.108***
	(0.00847)	(0.00847)	(0.00685)	(0.0110)
PUBD	-0.391***	-0.418***	-0.0577***	-0.0755***
	(0.00524)	(0.00476)	(0.00442)	(0.00704)
UNE	-0.693***	-0.733***	-0.149***	-0.192***
	(0.00811)	(0.00727)	(0.00663)	(0.0107)
LEND	-0.395***	-0.204***	0.0103	0.0225
	(0.0154)	(0.0373)	(0.0207)	(0.0229)
LIQ	-0.00171***	-0.00106***	-0.00119***	-0.000104
	(0.0000713)	(0.000306)	(0.000266)	(0.000177)
_cons	44.29***	47.60***	9.037***	11.29***
	(0.594)	(0.564)	(0.500)	(0.795)
N	3606	2292	924	378
R-sq	0.935	0.943	0.884	0.924
Chi2 for equation (1)	64103.92	85769.15	3895.38	1999.78
P for equation (1)	0	0	0	0
Chi2 for equation (2)	202873.39	166.99	4072.56	1315.44
P for equation (2)	0	0	0	0
Chi2 for equation (3)	21839.89	2811.56	254.44	129.05
P for equation (3)	0	0	0	0

Note: This table presents the regression results for the 3SLS estimation for the U.S. sample of banks and its subgroups. Standard errors are presented in parentheses. * p<0.05, ** p<0.01, *** p<0.001

Concerning the drivers of bank risk (eq.1), as reported in Table 15 and Table 16, the variable of capital is suggested to have a positive effect on risk for all banks in our sample irrespective of the bank type. It is also interesting to note that this outcome is statistically highly significant (p<0.001) for all the reported groups, with the exception of U.S. commercial banks. Thus, our findings indicate that a rise in capital precedes an increase in bank risk. This finding rejects the second hypothesis as it

provides evidence that Eurozone and U.S. banks do not record moral hazard managerial incentives. Our results are consistent with Fiordelisi et al., (2011b) and Altunbas et al., (2007) as well as Anginer & Demirguc-Kunt, (2014). However, Nguyen & Nghiem, (2015); Le, (2018) and Kwan & Eisenbeis, (1997) support the Moral Hazard Hypothesis and seem to suggest that banks take advantage of deposit insurance. Yet, Bitar et al., (2018) and Cathcart et al., (2015) suggest that there is no association between capital and risk.

Furthermore, according to our findings, efficiency appears to have a positive and statistically highly significant ($p<0.001$) effect on bank risk for the majority of the reported banking groups. We should however also mention that the results for the savings banks are positive yet statistically insignificant. Therefore, the results lead us to the conclusion that an improvement in efficiency foregoes an increase in bank risk in the majority of the tested bank groups. The positive and significant effect of efficiency on bank risk may be attributed to the existence of cost skimming behavior. This outcome is comparable to Fiordelisi et al., (2011a) findings for investment banks over the period 2000-2008. However, the negative and highly significant effect of efficiency on bank risk of Eurozone cooperative banks can be attributed to the existence of bad management behavior, which could be explained by the fact that badly managed banks tend to attain higher risks in order to compensate for lower levels of efficiency. This outcome is in line with the findings of Williams, (2004); Fiordelisi et al., (2011b); Deelchand & Padgett, (2009) and Kwan & Eisenbeis, (1997).

Concerning the ratio of gross loans to total assets (LEND), we observe that it is directly and statistically significantly related only to the risk of Eurozone cooperative banks. This result is in line with our expectations as an increase in lending ratios may lead to an increase in the liquidity risk of banks and it is consistent with the results of the study of Le, 2018. However, the relationship is negative and statistically significant for the U.S. general sample and U.S. commercial banks and the result is insignificant for the rest of the sample.

Concerning the effect of liquidity on risk, we observe that the ratio of liquid assets to total assets (LIQ) has a negative effect on the majority of the banks in our sample. Thus, the results indicate that an increase in the liquidity levels precedes a decrease in the level of risk. This outcome is inconsistent with the results of Altunbas et al., (2007) for European banks during the pre-crisis period. When comparing their findings with our results of the post-crisis period, we notice that Eurozone banks have not yet started to react to an increase in the liquidity level by increasing their lending and investments levels, as they did before the financial crisis.

As regards the effect of environmental variables, all variables are statistically significant for the U.S. sample, whilst only the GDP real growth rate(GDP) is

significant for three out of four of the reported groups of Eurozone banks, whereas the inflation rate (INFL), public debt(PUBD) and unemployment (UNE) are statistically significant for half of the reported groups. This finding implies that the risk undertaken by U.S. banks is more significantly affected by macroeconomic variables than that of the Eurozone banks.

In addition to this, public debt(PUBD) and unemployment (UNE) have a negative yet significant effect on the majority of the banks of our sample. More specifically, public debt (PUBD) negatively affects banking risk in all the reported banking groups except for Eurozone cooperative banks, which are affected positively and highly significantly. The outcome is statistically insignificant for the Eurozone general sample and Eurozone commercial banks. Unemployment (UNE) negatively and significantly affects the risk of the other banks, while Eurozone commercial and cooperative banks are not-statistically affected.

However, we observe that the risk undertaken by Eurozone banks is affected by the real growth rate (GDP) and the inflation rate (INFL) in a different way to that of the U.S. banks. To be more precise, GDP real growth rate(GDP) impacts positively and significantly on the risk of Eurozone banks. This could be explained as banks boost their lending and investing policy during favorable economic circumstances, thus the levels of bank risk increase. However, the parameter of U.S. banks is negative and statistically highly significant. Following the same pattern, the inflation rate (INFL) variable is negative and insignificant for the majority of Eurozone banks, while for the U.S. banks it is positive and significant.

3.6.2 Efficiency Determinants

Table 17: Determinants of Efficiency of Eurozone Banks

	Eurozone	Commercial	Cooperative	Savings
		EFFICIENCY		
RISK	-2330.6***	0.998*	-0.468***	0.529***
	(414.3)	(0.487)	(0.0258)	(0.0676)
CAP	468.4***	0.0801	0.0735***	-0.0128***
	(84.25)	(0.188)	(0.00265)	(0.00381)
SIZE	208.3***	0.260	0.0344***	0.0192***
	(38.12)	(0.205)	(0.00160)	(0.00229)
LEND	-37.54***	1.620	0.385***	0.464***
	(-8768)	(-1254)	(0.0210)	(0.0188)
LIQ	-10.62***	0.0148	0.000376	0.000889***
	(-1953)	(0.0119)	(0.000267)	(0.000254)

GDP	19.35***	-0.0510*	0.0639***	0.000235
	(-3310)	(0.0243)	(0.00406)	(0.00382)
INFL	-49.35***	-0.00643	0.0412***	0.0201***
	(-8947)	(0.0440)	(0.00417)	(0.00505)
PUBD	3.739***	0.00160	0.00130***	0.00242***
	(0.687)	(0.00130)	(0.000196)	(0.000412)
UNE	-42.57***	-0.0341	0.00277*	0.00993***
	(-7685)	(0.0212)	(0.00118)	(0.00115)
_cons	-1497.9***	-7.473	0.324***	-2.030***
	(289.8)	(-5165)	(0.0546)	(0.239)

Note: This table presents the regression results for the 3SLS estimation for the Eurozone sample of banks and its subgroups. Standard errors are presented in parentheses. * p<0.05, ** p<0.01, *** p<0.001

Table 18: Determinants of Efficiency of U.S. banks

	United States	Commercial	Cooperative	Savings
EFFICIENCY				
RISK	0.00686	-0.0112	-57.71***	1.965*
	(0.0110)	(0.0333)	(11.77)	(0.993)
CAP	0.0119***	0.0920***	7.099***	-0.0905
	(0.00292)	(0.0229)	-1.450	(0.0681)
SIZE	0.0214***	0.00616**	0.708**	0.104***
	(0.00184)	(0.00190)	(0.215)	(0.0145)
LEND	0.547***	0.527***	1.162*	0.638***
	(0.0260)	(0.0854)	(0.475)	(0.0952)
LIQ	0.00138***	0.00138	-0.0750***	0.00968***
	(0.000288)	(0.000729)	(0.0165)	(0.00142)
GDP	-0.0233***	-0.0635***	-7.690***	0.412*
	(0.00553)	(0.0177)	-1.569	(0.187)
INFL	-0.0335***	-0.0396	4.879***	-0.272*
	(0.00814)	(0.0252)	(0.993)	(0.112)
PUBD	-0.00184***	-0.00527*	-3.404***	0.169*
	(0.000457)	(0.00219)	(0.695)	(0.0779)
UNE	-0.0501***	-0.0801***	-8.592***	0.448*
	(0.00281)	(0.00945)	-1.742	(0.192)
_cons	0	0	519.2***	-26.96*
	(.)	(.)	(104.6)	(11.39)

Note: This table presents the regression results for the 3SLS estimation for the U.S. sample of banks and its subgroups. Standard errors are presented in parentheses. * p<0.05, ** p<0.01, *** p<0.001

Table 17 and Table 18 present our findings in regard to the determinants of bank efficiency. Initially, we observe that an increase in risk impacts positively and significantly on the efficiency of the savings banks. This outcome is in line with Bashir

& Hassan, (2017) findings. Nevertheless, the relationship is adverse and highly significant for cooperative banks which concurs with the findings of Nguyen & Nghiem, (2015) and Le, (2018) and can be explained by the fact that a bank with high risk operations may need a higher level of resources to produce the same outcome. For instance, it requires more funds to manage loans associated with higher risks in comparison with a lower risk loan portfolio (Kwan & Eisenbeis, (1997)). Therefore, we may conclude that the type of bank is a very important parameter for the impact of risk on bank efficiency as the direction of causality is similar per banking sector for cooperative and savings banks. However, the effect of risk is diverse for the general sample of banks and for commercial banks. The relationship is negative and statistically highly significant for the general sample of Eurozone banks, positive and significant for Eurozone commercial banks and insignificant for the rest of the sample. Thus, the Bad Luck Hypothesis is confirmed for cooperative banks as well as Eurozone commercial banks and rejected for savings banks and Eurozone general sample of banks.

An increase in capital affects positively and significantly the efficiency of the majority of the sample. Therefore, our results indicate that banks that have more capital may have higher efficiency than those with less capital and therefore the sixth hypothesis is accepted for the majority of the reported banks. This outcome concurs with Le, (2018); Bitar et al., (2018), Fiordelisi et al., (2011b) and could be explained in the following way: the higher capital is, the higher the incentives of shareholders are to carefully monitor the managerial behavior and investment decisions, and thus bank efficiency would be expected to increase. Moreover, it is more likely that banks with a high capital ratio will reduce their costs (as depositors entrust the banking institution more) and increase efficiency more than those with lower levels of capital (Bitar et al., (2018)). However, the impact of an increase in capital on the efficiency of U.S. savings banks is negative and insignificant. This maybe so because when capital increases, so do the agency costs and the total amounts at the disposal of managers, thus leading to efficiency decreases. Hence, the Shareholders-Managers Hypothesis is accepted for U.S. savings banks, and this result is in line with Deelchand & Padgett, (2009) and Bashir & Hassan, (2017).

Furthermore, an increase in the explanatory variable SIZE precedes an increase in bank efficiency, irrespective of the type and location of banks. The outcome is positive, statistically significant and consistent with the findings reported by Le, 2018; Altunbas et al., (2007); Sufian, (2016) and Bitar et al., (2018) indicating that the larger banks are the more efficient they become because of higher economies of scale. We observe that the outcome of the subgroup of Eurozone commercial banks is not significant.

The explanatory variable LEND (gross loans to total assets) is positive and statistically significant in most cases. This finding complies with previous results (Nguyen & Nghiem, (2015); Bitar et al., (2018); Le, (2018) and Altunbas et al., (2007)), implying that banking institutions with higher gross loans to assets ratios are more efficient, and banks with higher levels of efficiency increase successfully their lending levels. However, the link is negative and statistically highly significant for the Eurozone general sample.

An increase in the liquidity ratio (LIQ) is not significant for the efficiency of the commercial banks and Eurozone cooperative banks in our sample. The relationship is positive and significant for the majority of the sample, while negative and significant for the Eurozone general sample and U.S. cooperative banks. Ding & Sickles, (2019) in their study report results that indicate that there is a positive relationship between liquidity and efficiency.

Concerning the environmental variables, it seems that the majority of the results are statistically significant except for i.) the variables of GDP real growth rate of Eurozone savings banks, ii.) the inflation rate of the commercial banks and the public debt together with iii.) the unemployment rate of Eurozone commercial banks.

Moreover, the results show that the inflation rate (INFL) as well as unemployment (UNE) have a negative and significant impact on the efficiency of the majority of the banks. Nevertheless, we observe that the banking type is a significant factor that should be taken into consideration as cooperative and savings banks behave differently. More specifically, Eurozone and U.S. cooperative banks' efficiency ratios are affected directly and significantly when there is an increase in the inflation rate. Additionally, an increase in unemployment (UNE) impacts positively and significantly on the savings banks of both samples.

Finally, the results lead us to the conclusion that bank location is a very important factor as regards the effect of GBP real growth rate and public debt variables on efficiency. More precisely, GDP real growth rate (GDP) affects negatively the efficiency of U.S. banks while positively affecting the efficiency of Eurozone banks. Bitar, et al., 2018 show that GDP real growth rate is positively related with bank efficiency levels. Similarly, public debt (PUBD) affects positively the Eurozone banks, while it negatively affects U.S. banks.

3.6.3 Capital Determinants

Table 19: Determinants of Capital of Eurozone Banks

	Eurozone	Commercial	Cooperative	Savings
		CAPITAL		
EFF	-6.587***	-3.683	-17.49***	-1.993
	(-1451)	(-3657)	-2.217	-1.161
RISK	7.589***	10.50***	8.597***	20.26***
	(0.276)	(0.622)	(0.447)	-1.340
PROF	0.248	-29.89**	67.77**	-66.87
	(-5074)	(-9795)	(20.95)	(49.62)
INT	0.000793	-0.00297	3.078***	0.00284
	(0.00115)	(0.00273)	(0.346)	(0.0655)
GDP	-0.0890**	-0.211**	-0.811***	0.670***
	(0.0316)	(0.0661)	(0.0964)	(0.0936)
INFL	0.0884	-0.00318	-0.419***	0.953***
	(0.0456)	(0.159)	(0.0987)	(0.129)
PUBD	0.00129	0.00781	-0.0149***	0.0966***
	(0.00175)	(0.00442)	(0.00425)	(0.00856)
UNE	0.0802***	-0.0718*	0.128***	0.113**
	(0.0115)	(0.0322)	(0.0253)	(0.0358)
_cons	-9.163***	-6.743***	-9.289***	-69.59***
	(0.719)	(-1726)	-1.401	-5.058

Note: This table presents the regression results for the 3SLS estimation for the Eurozone sample of banks and its subgroups. Standard errors are presented in parentheses. * p<0.05, ** p<0.01, *** p<0.001

Table 20: Determinants of Capital of U.S. Banks

	United States	Commercial	Cooperative	Savings
		CAPITAL		
EFF	1.550***	-5.020***	0.548	0.142
	(0.352)	-1.169	(0.377)	(0.549)
RISK	0.381**	14.38***	11.60***	15.46***
	(0.118)	-2.035	(0.328)	(0.736)
PROF	25.48***	-3.23e-08***	-94.77***	-8.494
	(0.857)	(7.49e-09)	-9.431	-6.051
INT	-0.00108***	0.0000577	-0.0663**	-0.338
	(0.0000426)	(0.000332)	(0.0237)	(0.236)
GDP	0.261***	6.628***	1.439***	2.764***
	(0.0632)	(0.928)	(0.0690)	(0.239)
INFL	-0.0986	-18.39***	-0.929***	-1.672***
	(0.0917)	-2.670	(0.0487)	(0.179)
PUBD	0.0762***	5.979***	0.647***	1.156***
	(0.00318)	(0.861)	(0.0322)	(0.113)
UNE	0.246***	10.83***	1.767***	2.929***
	(0.0321)	-1.530	(0.0637)	(0.191)
_cons	0	-675.7***	-106.3***	-173.7***

	(.)	(98.52)	-4.330	(13.96)

Note: This table presents the regression results for the 3SLS estimation for the U.S. sample of banks and its subgroups. Standard errors are presented in parentheses. * p<0.05, ** p<0.01, *** p<0.001

According to Table 19 and Table 20, efficiency is found to have a negative effect on bank capital in all eurozone banks as well as U.S. commercial banks. This may be due to the fact that banks tend to use their retained earnings when efficiency increases, and thus capital ratios are diminished while banks tend to adopt the precautionary measure of enhancing their capital when efficiency declines because of regulatory pressure (Nguyen & Nghiem, (2015); Le, (2018); Altunbas et al., (2007); Deelchand & Padgett, (2009); Kwan & Eisenbeis (1997); Bashir & Hassan, (2017)). Yet, the effect of efficiency on the capital of the U.S. general sample is positive and highly statistically significant, while the findings of the rest of the sample are not statistically significant.

Moreover, risk is suggested to have a positive and highly significant effect on the capital of all the reported groups in our sample. This outcome supports the first hypothesis (the Regulatory Hypothesis) for Eurozone and U.S. banks regardless of the type of bank, and it is in line with Le, (2018), Fiordelisi et al., (2011a) and Fiordelisi et al., (2011b). However, our result is inconsistent with Deelchand & Padgett, (2009) findings for the Japanese banking system.

The ratio of profits before taxes to average total assets (PROF) affects positively and is statistically highly significant in relation to the capitalization of the general U.S. bank sample and Eurozone cooperative banks sample, while the outcome for Eurozone general sample is also positive but not statistically significant. Therefore, this finding is in line with Le, (2018); Bitar et al., (2018) as well as Kwan & Eisenbeis, (1997), and it implies that higher profitability results in the enhancement of bank capital. Shim, (2013) mentions that as long as dividend payments tend to become less popular, it is easier for banks to attain more capital. So, when earnings are higher, banks prefer retained earnings as a cheaper solution to external borrowing. However, the relationship between profitability ratios and capital is adverse and highly significant for commercial banks and negative but insignificant for savings banks.

An increase in the ratio of gross loans to total deposits (INT) leads to an enhancement of bank capital in Eurozone cooperative banks. This outcome is statistically significant and could be explained as banks with higher ratios of gross loans to total deposits are more profitable and therefore attain more capital (Nguyen & Nghiem, (2015); Le, (2018)). Yet, the relationship is adverse for the U.S. general sample and U.S. cooperative banks and the results for the rest of the sample are not statistically significant.

As regards the environmental parameters, our findings reveal some interesting results. Initially, the parameter of unemployment (UNE) impacts positively and significantly on the capital of all banks in our sample, except for the Eurozone commercial banks. Additionally, an increase in public debt (PUBD) foregoes an increase in capital for the majority of the banks in our sample. However, Eurozone investment banks are affected negatively and significantly.

Concerning GDP real growth rate(GDP), the impact is positive and statistically highly significant for the Eurozone savings banks and all the U.S. reported samples. Nevertheless, the outcome is negative and statistically significant for the Eurozone general sample as well as the Eurozone commercial and cooperative banks. We can also observe that , the inflation rate (INFL) negatively influences the capital of the majority of the sample that is U.S. banks, Eurozone commercial and Eurozone cooperative banks. One possible explanation could be that the higher the inflation is, the lower deposits are, due to the deterioration of the value of money (Tan & Floros, (2013)).

Section 3.7: Concluding Remarks

In this study, we investigate the interrelationship among risk, capital and efficiency in a simultaneous equation model. We provide empirical evidence of how the interrelationships and the managerial behaviours vary per type of bank (commercial, cooperative and savings banks) and per country union (Eurozone, United States).

Apart from the contribution to the existing empirical research, our findings have significant implications for regulators, bank managers and shareholders. Initially, the results of our study convey that an increase in capital may precede an increase in risk. This finding supports the Regulatory Hypothesis, rejects the Moral Hazard Hypothesis, and may question the effectiveness of the traditional capital adequacy regulation framework as a measure of the stability of the banking system. Moreover, the empirical evidence also suggest that a rise in risk may precede an increase in capital. Therefore, the findings lead us to the conclusion that risk and capital are directly related regardless of the causality order.

Our results also confirm the necessity to consider bank efficiency when implementing measures of financial stability, since an increase in efficiency levels may precede an increase in risk. Hence, the Cost Skimming Hypothesis is accepted for the majority of the bank groups in our sample whilst the Bad Management Hypothesis is only accepted for Eurozone cooperative banks.

Additionally, our sixth hypothesis in the analysis states that capital affects efficiency positively and is accepted for all the banks in our sample, with one exception which is that of U.S. savings banks. Hence, the Shareholders-Managers Hypothesis is only accepted for U.S. savings banks and for this reason the shareholders of U.S. savings banks ought to carefully monitor agency costs. The findings also suggest that the type of banking institutions is a factor that should be considered, especially as an explanation variable for bank efficiency. More specifically, an increase in risk may precede a decline in the levels of efficiency of commercial banks and an increase in the levels of efficiency of savings banks. Thus, we accept the Bad Luck Hypothesis for commercial banks and reject it for savings banks.

As concerns the explanatory variables (liquidity, lending specialization ratio as well as size) our findings reveal some interesting conclusions. Initially, we observe that the ratio of liquid assets to total assets (LIQ) has a negative effect on risk, while the relationship between liquidity and efficiency is direct for the majority of the banks in our sample. Secondly, our results provide evidence that the explanatory variable LEND (gross loans to total assets) directly affects the efficiency of the majority of the banks studied, implying that banking institutions with higher gross loans to assets ratios are more efficient, and banks with higher levels of efficiency successfully increase their lending levels. Lastly, the size variable (SIZE) precedes an increase in bank efficiency, irrespective of the type and location of banks.

As regards the environmental variables, we observe that public debt (PUBD) and unemployment (UNE) impact negatively on risk and positively on bank capital. Moreover, the impact of GDP real growth rate (GDP) on capital is positive and statistically significant, whereas the influence of the inflation rate (INFL) on capital is negative for the majority of the banks. Regarding the effect of the inflation rate and unemployment on efficiency, the results convey that the banking sector is a significant factor that should be taken into consideration. It is also interesting to note that the findings lead us to the conclusion that bank location (Eurozone or United States) is a very essential factor in regard to i.) the effect of GBP real growth rate and public debt on efficiency ii.) the effect of real growth rate (GDP) and inflation rate (INFL) on risk.

Finally, it is worth mentioning that a limitation of our study is the use of levels of efficiency, capital and risk, while it could be more accurate to explore the changes of these variables. This method could not be applied in our study because of the small reported period (2013-2018). Therefore, our analysis could lead to further research into the development of the interrelationship between risk, capital and efficiency by employing a sample covering more years after the financial crisis and investigating the changes of the variables. Our approach could also be enriched with the use of the capital buffer, tier1 (AT1) debt or contingent capital (coco bonds) as indicators of

capital ratio together with the employment of non-performing loans (NPLs) or Unlikely-to-Pay (UTP) loans as indicators of risk.

Appendix B

Table 21: Descriptive Statistics of 3SLS Variables of Eurozone Banks

	Eurozone Banks			
2013	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	0,48%	2,33	20,80	60,54%
Max	7,60%	554,94	97,67	114,08%
Min	-13,69%	0,00	0,36	0,41%
Std	0,99%	22,96	17,23	17,16%
2014	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	0,52%	2,27	21,29	60,18%
Max	7,11%	613,86	97,73	107,45%
Min	-7,27%	0,00	0,27	0,53%
Std	0,81%	22,25	18,18	16,98%
2015	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	0,50%	2,64	21,24	60,91%

Max	19,23%	686,80	97,62	114,60%
Min	-16,48%	0,00	0,07	0,57%
Std	1,01%	29,51	18,03	16,80%
2016	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	0,49%	2,82	21,25	60,96%
Max	9,96%	1217,85	95,97	115,19%
Min	-9,41%	0,00	0,07	0,43%
Std	0,85%	37,23	17,87	16,54%
2017	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	0,51%	3,74	20,79	61,48%
Max	23,56%	2038,04	96,47	144,44%
Min	-4,69%	0,01	0,53	0,09%
Std	0,89%	61,05	17,48	16,18%
2018	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	0,45%	3,38	17,86	64,38%
Max	9,38%	1110,34	97,11	103,83%
Min	-10,18%	0,00	0,49	0,29%

Std	0,73%	45,99	14,76	16,53%

Table 22: Descriptive Statistics of 3SLS Variables of Eurozone Commercial Banks

Eurozone Commercial Banks				
2013	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	0,38%	4,89	32,63	59,18%
Max	4,90%	554,94	97,67	114,08%
Min	-13,69%	0,00	0,36	0,41%
Std	1,88%	40,27	21,61	25,04%
2014	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	0,48%	4,98	33,12	58,58%
Max	6,58%	613,86	97,73	107,45%
Min	-7,27%	0,00	0,65	0,53%
Std	1,55%	42,68	21,52	24,34%
2015	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	0,60%	5,95	33,56	59,14%

Max	19,23%	686,80	97,62	107,04%
Min	-16,48%	0,00	0,51	0,57%
Std	2,17%	51,99	20,91	23,87%
2016	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	0,61%	8,30	33,57	59,23%
Max	9,96%	1217,85	95,97	110,53%
Min	-9,41%	0,00	0,65	0,76%
Std	1,75%	83,03	20,61	23,59%
2017	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	0,59%	8,50	34,02	58,82%
Max	23,56%	1013,41	96,47	104,24%
Min	-4,69%	0,01	1,13	0,09%
Std	1,84%	78,80	20,05	22,56%
2018	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	0,52%	9,21	31,55	59,94%
Max	7,94%	1096,67	97,11	103,83%
Min	-10,18%	0,00	0,80	0,29%

Std	1,45%	86,38	19,91	22,72%

Table 23: Descriptive Statistics of 3SLS Variables of Eurozone Cooperative Banks

Eurozone Cooperative Banks				
2013	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	0,53%	1,04	20,01	60,57%
Max	2,78%	4,97	84,68	106,64%
Min	-10,23%	0,24	0,39	13,01%
Std	0,68%	0,55	15,61	13,79%
2014	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	0,56%	1,02	20,68	60,04%
Max	3,76%	6,78	85,48	104,20%
Min	-4,80%	0,07	0,86	5,70%
Std	0,51%	0,55	17,38	13,90%
2015	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	0,50%	1,00	20,94	60,78%

Max	2,17%	7,82	92,62	114,60%
Min	-6,02%	0,23	0,97	12,77%
Std	0,52%	0,54	17,24	13,78%
2016	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	0,47%	0,97	20,94	60,64%
Max	2,50%	7,29	87,32	115,19%
Min	-2,99%	0,13	1,08	11,76%
Std	0,46%	0,51	17,18	13,58%
2017	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	0,50%	0,97	20,53	61,31%
Max	2,73%	9,93	86,51	108,65%
Min	-2,24%	0,24	1,18	12,83%
Std	0,39%	0,54	16,60	13,22%
2018	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	0,46%	1,03	15,99	66,21%
Max	2,12%	6,33	62,05	98,39%
Min	-2,87%	0,23	1,27	20,08%

Std	0,35%	0,49	11,38	13,89%

Table 24: Descriptive Statistics of 3SLS Variables of Eurozone Savings Banks

Eurozone Savings Banks				
2013	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	0,45%	0,98	13,77	62,62%
Max	3,84%	31,29	69,67	101,21%
Min	-1,63%	0,16	1,22	3,11%
Std	0,38%	1,54	11,04	14,43%
2014	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	0,46%	0,90	13,94	62,64%
Max	7,11%	3,24	76,79	98,62%
Min	-3,61%	0,14	1,14	4,20%
Std	0,45%	0,33	11,25	14,19%
2015	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	0,45%	0,89	13,05	63,49%

Max	4,68%	3,18	79,36	92,65%
Min	-1,27%	0,16	0,88	6,89%
Std	0,34%	0,30	11,08	13,98%
2016	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	0,43%	0,88	13,01	63,88%
Max	3,63%	3,21	62,06	91,34%
Min	-0,81%	0,11	0,78	5,46%
Std	0,32%	0,29	10,55	13,53%
2017	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	0,46%	0,89	11,79	64,47%
Max	7,11%	3,28	59,54	95,56%
Min	-3,61%	0,18	1,86	9,63%
Std	0,45%	0,28	9,18	12,93%
2018	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	0,45%	0,88	11,43	64,92%
Max	3,84%	3,39	59,44	94,27%
Min	-1,63%	0,09	1,39	4,61%

Std	0,38%	0,29	7,82	13,06%

Table 25: Descriptive Statistics of 3SLS Variables of U.S. Banks

	U.S. Banks			
2013	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	1,49%	4,91	24,92	65,22%
Max	80,94%	2259,30	88,65	99,99%
Min	-3,02%	0,12	0,24	10,37%
Std	3,47%	92,12	14,43	15,66%
2014	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	1,48%	5,07	23,12	67,27%
Max	83,83%	2338,44	88,60	100,07%
Min	-1,58%	0,13	0,03	10,76%
Std	3,56%	95,34	14,19	15,69%
2015	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	1,51%	1,17	22,35	68,38%

Max	119,30%	10,58	88,66	99,79%
Min	-2,57%	0,11	0,21	9,52%
Std	4,93%	0,82	13,83	15,48%
2016	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	1,46%	1,17	21,61	69,41%
Max	76,53%	10,77	90,92	99,34%
Min	-1,42%	0,08	0,17	7,05%
Std	3,19%	0,79	13,63	15,51%
2017	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	1,37%	1,19	20,87	70,49%
Max	12,82%	13,64	94,64	99,57%
Min	-4,33%	0,00	0,16	0,00%
Std	0,90%	0,85	13,58	15,43%
2018	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	1,46%	1,21	19,88	71,54%
Max	12,94%	11,23	94,78	99,69%
Min	-0,18%	0,00	0,15	0,00%

Std	0,85%	0,81	12,97	15,18%

Table 26: Descriptive Statistics of 3SLS Variables of U.S. Commercial Banks

U.S. Commercial Banks				
2013	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	1,73%	6,74	25,46	65,17%
Max	80,94%	2259,30	88,65	96,27%
Min	-3,02%	0,13	1,85	10,51%
Std	4,30%	115,55	13,83	14,56%
2014	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	1,75%	6,98	23,77	66,90%
Max	83,83%	2338,44	88,60	96,41%
Min	-1,58%	0,13	3,17	10,76%
Std	4,41%	119,60	13,57	14,50%
2015	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	1,82%	0,86	22,83	67,88%

Max	119,30%	3,43	88,66	93,87%
Min	-2,57%	0,11	3,04	9,52%
Std	6,15%	0,25	13,03	14,14%
2016	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	1,70%	0,87	22,48	68,56%
Max	76,53%	2,58	90,92	96,70%
Min	-1,42%	0,08	2,27	7,05%
Std	3,96%	0,22	13,01	14,21%
2017	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	1,57%	0,88	22,14	69,23%
Max	12,82%	2,27	94,64	96,09%
Min	-4,33%	0,00	2,71	0,00%
Std	1,00%	0,22	13,18	14,11%
2018	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	1,67%	0,89	21,22	70,07%
Max	12,94%	2,28	94,78	95,56%
Min	-0,18%	0,00	2,19	0,00%

Std	0,93%	0,22	12,38	13,73%

Table 27: Descriptive Statistics of 3SLS Variables of U.S. Cooperative Banks

U.S. Cooperative Banks				
2013	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	0,93%	2,06	25,62	64,33%
Max	2,20%	10,26	70,78	94,82%
Min	0,05%	0,19	0,28	12,83%
Std	0,42%	1,23	15,03	16,76%
2014	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	0,87%	2,06	23,38	67,43%
Max	2,29%	11,18	70,31	94,57%
Min	-0,82%	0,17	1,02	11,51%
Std	0,40%	1,28	14,59	16,76%
2015	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	0,84%	2,01	22,64	69,11%

Max	1,83%	10,58	70,35	93,87%
Min	-0,52%	0,16	0,94	10,38%
Std	0,36%	1,20	14,12	16,30%
2016	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	0,86%	2,02	21,01	71,04%
Max	1,90%	10,77	72,61	94,90%
Min	0,00%	0,14	3,25	9,11%
Std	0,35%	1,14	13,90	16,24%
2017	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	0,88%	2,06	19,05	73,40%
Max	1,71%	13,64	74,34	94,15%
Min	0,01%	0,13	2,19	8,56%
Std	0,33%	1,27	13,27	16,04%
2018	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	0,95%	2,11	17,51	75,23%
Max	1,96%	11,23	74,75	93,62%
Min	0,08%	0,12	2,14	7,91%

Std	0,33%	1,14	12,67	15,58%

Table 28: Descriptive Statistics of 3SLS Variables of U.S. Savings Banks

U.S. Savings Banks				
2013	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	1,40%	0,94	18,96	68,91%
Max	7,21%	2,44	70,23	99,99%
Min	-1,44%	0,26	0,24	22,54%
Std	1,04%	0,32	14,23	17,56%
2014	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	1,35%	0,96	17,50	70,35%
Max	7,59%	2,33	77,62	100,07%
Min	-0,93%	0,26	0,03	21,39%
Std	0,99%	0,32	14,65	18,17%
2015	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	1,32%	0,99	17,90	70,78%

Max	5,78%	2,78	80,87	99,79%
Min	-0,32%	0,17	0,21	14,89%
Std	0,82%	0,37	16,09	19,22%
2016	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	1,46%	0,99	17,14	71,58%
Max	5,09%	2,98	74,95	99,34%
Min	0,34%	0,12	0,17	10,54%
Std	0,76%	0,38	15,14	19,17%
2017	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	1,40%	1,00	16,96	72,02%
Max	5,15%	3,01	73,51	99,57%
Min	0,31%	0,06	0,16	5,62%
Std	0,71%	0,38	14,65	18,83%
2018	PROFITABILITY RATIO	BANK INTERMEDIATION RATIO	LIQUIDITY RATIO	LENDING SPECIALIZATION RATIO
Mean	1,45%	0,99	16,52	72,73%
Max	4,93%	2,60	89,09	99,69%
Min	0,25%	0,05	0,15	4,24%

Std	0,68%	0,34	14,52	18,85%

Appendix C

Table 29: Correlation Matrix of Regression of Eurozone Banks Variables

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) RISK	1.000											
(2) CAP	0.8097*	1.000										
	0.0000											
(3) EFF	-0.2016*	-0.1231*	1.000									
	0.0000	0.0000										
(4) SIZE	-0.3265*	-0.3107*	0.2678*	1.000								
	0.0000	0.0000	0.0000									
(5) PROF	0.3529*	0.1652*	0.0645*	0.0083	1.000							
	0.0000	0.0000	0.0000	0.4210								
(6) INT	-0.0514*	-0.0287*	0.3277*	0.0136	0.0280*	1.000						
	0.0000	0.0051	0.0000	0.1852	0.0063							
(7) LEND	0.0020	-0.0580*	0.2045*	0.0811*	-0.0348*	0.1055*	1.000					
	0.8425	0.0000	0.0000	0.0000	0.0007	0.0000						

(8) LIQ	0.0352*	0.1242*	-0.0193	-0.0368*	0.0222*	-0.0453*	-0.5537*	1.000				
	0.0006	0.0000	0.0596	0.0003	0.0303	0.0000	0.0000					
(9) GDP	0.0726*	-0.0101	0.0802*	0.0933*	0.0882*	-0.0134	0.0020	-0.1687*	1.000			
	0.0000	0.3250	0.0000	0.0000	0.0000	0.1930	0.8431	0.0000				
(10) INFL	-0.0113	-0.0243*	-0.0170	0.0101	0.0094	-0.0146	0.0272*	-0.2143*	0.0160	1.000		
	0.2713	0.0180	0.0965	0.3259	0.3612	0.1559	0.0081	0.0000	0.1199			
(11) PUBD	0.0166	0.0752*	0.0331*	-0.0806*	-0.1013*	0.0655*	0.0012	0.5091*	-0.4658*	-0.3531*	1.000	
	0.1064	0.0000	0.0013	0.0000	0.0000	0.0000	0.9051	0.0000	0.0000	0.0000		
(12) UNE	0.0044	0.0709*	0.0916*	0.1069*	-0.0380*	0.0453*	-0.0138	0.5453*	-0.3211*	-0.4051*	0.7496*	1.000
	0.6666	0.0000	0.0000	0.0000	0.0002	0.0000	0.1799	0.0000	0.0000	0.0000	0.0000	

* shows significance at the 0.05 level. This table depicts the correlation matrix between variables used in the regression.

Table 30: Correlation Matrix of Regression of Eurozone Commercial Banks Variables

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) RISK	1.000											
(2) CAP	0.7958*	1.000										
	0.0000											
(3) EFF	-0.1214*	-0.1181*	1.000									
	0.0000	0.0000										
(4) SIZE	-0.3626*	-0.4095*	0.1339*	1.000								
	0.0000	0.0000	0.0000									
(5) PROF	0.3186*	0.0617*	0.0867*	0.0194	1.000							
	0.0000	0.0125	0.0004	0.4328								
(6) INT	-0.0525*	-0.0336	0.2365*	-0.0380	0.0300	1.000						
	0.0337	0.1743	0.0000	0.1242	0.2253							
(7) LEND	-0.0681*	-0.0940*	0.1843*	0.0572*	-0.0528*	0.1560*	1.000					
	0.0058	0.0001	0.0000	0.0206	0.0326	0.0000						
(8) LIQ	0.0418	0.0732*	-0.1280*	-0.1579*	0.0417	-0.1261*	-0.8695*	1.000				
	0.0905	0.0031	0.0000	0.0000	0.0919	0.0000	0.0000					

(9) GDP	0.1094*	0.0266	0.0830*	0.0313	0.1103*	-0.0179	-0.0250	0.0147	1.000			
	0.0000	0.2826	0.0008	0.2047	0.0000	0.4681	0.3124	0.5534				
(10) INFL	0.0141	0.0049	0.1210*	-0.0140	0.0269	-0.0092	-0.0178	-0.0334	0.0402	1.000		
	0.5676	0.8432	0.0000	0.5720	0.2767	0.7108	0.4722	0.1766	0.1041			
(11) PUBD	-0.0966*	-0.0344	-0.1087*	0.0401	-0.1545*	0.0909*	0.0318	0.0219	-0.4357*	-0.2788*	1.000	
	0.0001	0.1644	0.0000	0.1049	0.0000	0.0002	0.1987	0.3766	0.0000	0.0000		
(12) UNE	-0.0426	-0.0309	-0.0889*	0.1723*	-0.1000*	0.0164	0.0468	-0.0244	-0.2878*	-0.4157*	0.5574*	1.000
	0.0845	0.2107	0.0003	0.0000	0.0001	0.5065	0.0583	0.3236	0.0000	0.0000	0.0000	

* shows significance at the 0.05 level. This table depicts the correlation matrix between variables used in the regression.

Table 31: Correlation Matrix of Regression of Eurozone Cooperative Banks Variables

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) RISK	1.000											
(2) CAP	0.8090*	1.000										
	0.0000											
(3) EFF	0.1753*	0.1769*	1.000									
	0.0000	0.0000										
(4) SIZE	-0.1803*	-0.2033*	0.3217*	1.000								
	0.0000	0.0000	0.0000									
(5) PROF	0.4041*	0.3002*	0.2009*	0.0345*	1.000							
	0.0000	0.0000	0.0000	0.0144								
(6) INT	0.1708*	0.3065*	0.6014*	0.3957*	0.1345*	1.000						
	0.0000	0.0000	0.0000	0.0000	0.0000							
(7) LEND	0.0927*	0.0164	0.3337*	0.1576*	0.0062	0.4754*	1.000					
	0.0000	0.2445	0.0000	0.0000	0.6590	0.0000						
(8) LIQ	0.0957*	0.1921*	0.1205*	-0.0983*	-0.0837*	0.0399*	-0.3805*	1.000				
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0047	0.0000					

(9) GDP	0.2235*	-0.0740*	-0.0724*	0.0727*	0.0810*	-0.1614*	0.0094	-0.3968*	1.000			
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.5058	0.0000				
(10) INFL	0.0670*	-0.0440*	-0.0588*	0.0421*	0.0478*	-0.0919*	0.0391*	-0.3054*	0.0662*	1.000		
	0.0000	0.0018	0.0000	0.0028	0.0007	0.0000	0.0055	0.0000	0.0000			
(11) PUBD	0.0702*	0.1712*	0.2115*	-0.1108*	-0.1496*	0.2091*	0.0188	0.7669*	-0.5444*	-0.4061*	1.000	
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1830	0.0000	0.0000	0.0000		
(12) UNE	0.0430*	0.1554*	0.2758*	0.0265	-0.1040*	0.2704*	0.0467*	0.7077*	-0.4846*	-0.4259*	0.8709*	1.000
	0.0023	0.0000	0.0000	0.0606	0.0000	0.0000	0.0009	0.0000	0.0000	0.0000	0.0000	

* shows significance at the 0.05 level. This table depicts the correlation matrix between variables used in the regression.

Table 32: Correlation Matrix of Regression of Eurozone Savings Banks Variables

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) RISK	1.000											
(2) CAP	0.7708*	1.000										
	0.0000											
(3) EFF	0.0626*	0.1747*	1.000									
	0.0020	0.0000										
(4) SIZE	-0.2086*	-0.3001*	0.1252*	1.000								
	0.0000	0.0000	0.0000									
(5) PROF	0.3742*	0.5173*	0.2991*	-0.0707*	1.000							
	0.0000	0.0000	0.0000	0.0005								
(6) INT	0.1417*	0.3357*	0.3777*	-0.0216	0.2099*	1.000						
	0.0000	0.0000	0.0000	0.2864	0.0000							
(7) LEND	0.0323	0.0269	0.5431*	0.0685*	0.0135	0.3824*	1.000					
	0.1097	0.1832	0.0000	0.0007	0.5050	0.0000						
(8) LIQ	-0.1261*	-0.0177	-0.0508*	0.0283	0.0539*	-0.0834*	-0.4404*	1.000				
	0.0000	0.3809	0.0119	0.1616	0.0077	0.0000	0.0000					

(9) GDP	0.0585*	0.0739*	-0.1402*	0.0082	0.0302	-0.0743*	-0.0040	-0.1365*	1.000			
	0.0038	0.0003	0.0000	0.6855	0.1353	0.0002	0.8421	0.0000				
(10) INFL	-0.0087	0.0013	-0.0504*	-0.0010	-0.0322	-0.0262	0.0324	-0.1403*	-0.1407*	1.000		
	0.6666	0.9494	0.0126	0.9590	0.1114	0.1956	0.1087	0.0000	0.0000			
(11) PUBD	-0.1958*	-0.0070	0.2347*	0.0491*	-0.0125	0.1390*	0.0211	0.4955*	-0.3850*	-0.2716*	1.000	
	0.0000	0.7281	0.0000	0.0152	0.5363	0.0000	0.2977	0.0000	0.0000	0.0000		
(12) UNE	-0.1616*	-0.0126	0.2564*	0.1842*	0.0594*	0.1011*	-0.0608*	0.5425*	-0.2083*	-0.2724*	0.7043*	1.000
	0.0000	0.5345	0.0000	0.0000	0.0033	0.0000	0.0026	0.0000	0.0000	0.0000	0.0000	

* shows significance at the 0.05 level. This table depicts the correlation matrix between variables used in the regression.

Table 33: Correlation Matrix of Regression of U.S. Banks Variables

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) RISK	1.000											
(2) CAP	0.3604*	1.000										
	0.0000											
(3) EFF	0.1956*	0.0725*	1.000									
	0.0000	0.0000										
(4) SIZE	0.1279*	0.0545*	0.1404*	1.000								
	0.0000	0.0011	0.0000									
(5) PROF	0.1213*	0.2606*	0.0450*	-0.0378*	1.000							
	0.0000	0.0000	0.0069	0.0234								
(6) INT	0.0073	0.0355*	0.1058*	0.0044	0.0367*	1.000						
	0.6613	0.0329	0.0000	0.7900	0.0276							
(7) LEND	0.1097*	0.0092	0.4392*	-0.1691*	-0.0116	0.0465*	1.000					
	0.0000	0.5828	0.0000	0.0000	0.4845	0.0052						
(8) LIQ	-0.0976*	-0.0194	-0.3356*	0.0828*	0.0157	-0.0315	-0.8217*	1.000				
	0.0000	0.2437	0.0000	0.0000	0.3473	0.0584	0.0000					

(9) GDP	0.2732*	0.0323	0.1212*	0.0472*	0.0034	-0.0076	0.0497*	0.0467*	1.000			
	0.0000	0.0522	0.0000	0.0046	0.8393	0.6497	0.0029	0.0050				
(10) INFL	0.7973*	0.0487*	0.0222	0.0670*	-0.0088	0.0018	0.0560*	-0.0480*	-0.0432*	1.000		
	0.0000	0.0034	0.1826	0.0001	0.5957	0.9159	0.0008	0.0039	0.0094			
(11) PUBD	0.6297*	0.0331*	0.2343*	0.1142*	-0.0092	-0.0160	0.1050*	-0.0912*	-0.1446*	0.7144*	1.000	
	0.0000	0.0467	0.0000	0.0000	0.5815	0.3373	0.0000	0.0000	0.0000	0.0000		
(12) UNE	-0.6013*	-0.0345*	-0.3693*	-0.1401*	0.0068	0.0288	-0.1326*	0.1160*	-0.3868*	-0.3240*	-0.7412*	1.000
	0.0000	0.0383	0.0000	0.0000	0.6839	0.0833	0.0000	0.0000	0.0000	0.0000	0.0000	

* shows significance at the 0.05 level. This table depicts the correlation matrix between variables used in the regression.

Table 34: Correlation Matrix of Regression of U.S. Commercial Banks Variables

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) RISK	1.000											
(2) CAP	0.3624*	1.000										
	0.0000											
(3) EFF	0.2894*	0.1279*	1.000									
	0.0000	0.0000										
(4) SIZE	0.1267*	0.0592*	0.2073*	1.000								
	0.0000	0.0046	0.0000									
(5) PROF	0.0190	-0.0122	0.0442*	0.5453*	1.000							
	0.3644	0.5582	0.0344	0.0000								
(6) INT	0.0069	0.0405	0.1222*	0.0040	-0.0016	1.000						
	0.7410	0.0527	0.0000	0.8492	0.9376							
(7) LEND	0.1071*	0.0282	0.4299*	-0.2014*	-0.1552*	0.0597*	1.000					
	0.0000	0.1772	0.0000	0.0000	0.0000	0.0043						
(8) LIQ	-0.0953*	-0.0400	-0.3559*	0.0868*	0.1133*	-0.0391	-0.8553*	1.000				
	0.0000	0.0557	0.0000	0.0000	0.0000	0.0610	0.0000					

(9) GDP	0.2840*	0.0309	0.1105*	0.0468*	0.0100	-0.0096	0.0436*	- 0.0451*	1.000			
	0.0000	0.1392	0.0000	0.0250	0.6330	0.6465	0.0370	0.0307				
(10) INFL	0.7955*	0.0572*	0.0604*	0.0650*	0.0137	0.0020	0.0411*	-0.0296	-0.0432*	1.000		
	0.0000	0.0062	0.0038	0.0018	0.5114	0.9226	0.0493	0.1560	0.0385			
(11) PUBD	0.6304*	0.0402	0.3456*	0.1113*	0.0173	-0.0202	0.0857*	-0.0732*	-0.1446*	0.7144*	1.000	
	0.0000	0.0543	0.0000	0.0000	0.4084	0.3347	0.0000	0.0005	0.0000	0.0000		
(12) UNE	-0.6082*	-0.0409	-0.4911*	-0.1368*	-0.0206	0.0363	-0.1119*	0.1012*	-0.3868*	-0.3240*	-0.7412*	1.000
	0.0000	0.0502	0.0000	0.0000	0.3236	0.0825	0.0000	0.0000	0.0000	0.0000	0.0000	

* shows significance at the 0.05 level. This table depicts the correlation matrix between variables used in the regression.

Table 35: Correlation Matrix of Regression of U.S. Cooperative Banks Variables

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) RISK	1.000											
(2) CAP	0.8724*	1.000										
	0.0000											
(3) EFF	0.2083*	0.1963*	1.000									
	0.0000	0.0000										
(4) SIZE	0.1009*	-0.0149	0.2710*	1.000								
	0.0021	0.6508	0.0000									
(5) PROF	0.4701*	0.3954*	0.1714*	0.1394*	1.000							
	0.0000	0.0000	0.0000	0.0000								
(6) INT	0.0606	0.0173	0.4247*	0.1531*	0.2086*	1.000						
	0.0654	0.5996	0.0000	0.0000	0.0000							
(7) LEND	0.0317	-0.1164*	0.0954*	-0.0421	0.1442*	0.4790*	1.000					
	0.3353	0.0004	0.0037	0.2008	0.0000	0.0000						
(8) LIQ	0.0647*	0.2036*	-0.0496	0.0805*	-0.0689*	-0.4020*	-0.7895*	1.000				
	0.0492	0.0000	0.1321	0.0144	0.0361	0.0000	0.0000					

(9) GDP	0.1573*	0.0582	-0.0291	0.0681*	0.0192	0.0111	0.0792*	-0.0684*	1.000			
	0.0000	0.0771	0.3777	0.0384	0.5606	0.7354	0.0160	0.0376				
(10) INFL	0.1884*	0.0271	0.0301	0.1040*	0.0734*	0.0233	0.1044*	-0.1036*	-0.0432	1.000		
	0.0000	0.4110	0.3600	0.0015	0.0258	0.4790	0.0015	0.0016	0.1891			
(11) PUBD	0.3346*	0.0398	0.0042	0.1748*	0.0239	0.0106	0.1755*	-0.1571*	-0.1446*	0.7144*	1.000	
	0.0000	0.2269	0.8979	0.0000	0.4672	0.7477	0.0000	0.0000	0.0000	0.0000		
(12) UNE	-0.4545*	-0.0600	0.0101	-0.2119*	-0.0016	-0.0056	-0.2155*	0.1851*	-0.3868*	-0.3240*	-0.7412*	1.000
	0.0000	0.0684	0.7582	0.0000	0.9619	0.8655	0.0000	0.0000	0.0000	0.0000	0.0000	

* shows significance at the 0.05 level. This table depicts the correlation matrix between variables used in the regression.

Table 36: Correlation Matrix of Regression of U.S. Savings Banks Variables

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) RISK	1.000											
(2) CAP	0.8853*	1.000										
	0.0000											
(3) EFF	-0.0922	0.0249	1.000									
	0.0735	0.6288										
(4) SIZE	-0.0650	-0.1607*	0.2949*	1.000								
	0.2072	0.0017	0.0000									
(5) PROF	0.3858*	0.3432*	0.2700*	-0.0469	1.000							
	0.0000	0.0000	0.0000	0.3633								
(6) INT	0.3344*	0.3010*	0.2893*	0.0316	0.4964*	1.000						
	0.0000	0.0000	0.0000	0.5407	0.0000							
(7) LEND	0.1082*	0.0637	0.1431*	-0.0111	0.2278*	0.7991*	1.000					
	0.0355	0.2167	0.0053	0.8292	0.0000	0.0000						
(8) LIQ	-0.1848*	-0.1322*	0.0604	-0.1050*	-0.1978*	-0.6459*	-0.7317*	1.000				

	0.0003	0.0101	0.2414	0.0413	0.0001	0.0000	0.0000					
(9) GDP	0.0841	0.0242	0.0033	0.0551	-0.0239	0.0173	0.0236	-0.0170	1.000			
	0.1024	0.6390	0.9483	0.2852	0.6425	0.7378	0.6474	0.7412				
(10) INFL	0.1847*	0.0401	-0.1129*	0.0817	0.0353	0.0069	0.0284	-0.0261	-0.0432	1.000		
	0.0003	0.4375	0.0282	0.1126	0.4944	0.8934	0.5821	0.6130	0.4019			
(11) PUBD	0.2645*	-0.0074	-0.1748*	0.1385*	0.0460	0.0361	0.0542	-0.0453	-0.1446*	0.7144*	1.000	
	0.0000	0.8867	0.0006	0.0070	0.3720	0.4836	0.2936	0.3800	0.0048	0.0000		
(12) UNE	-0.3310*	0.0220	0.1747*	-0.1703*	-0.0241	-0.0542	-0.0661	0.0491	-0.3868*	-0.3240*	-0.7412*	1.000
	0.0000	0.6701	0.0006	0.0009	0.6399	0.2932	0.2000	0.3409	0.0000	0.0000	0.0000	

* shows significance at the 0.05 level. This table depicts the correlation matrix between variables used in the regression.

Chapter 4:

The Effect of Bank Diversification on the Capital, Risk, Profitability and Efficiency of the Eurozone and the United States Banks after the Global Financial Crisis.

Section 4.1: Introduction

Over the past few decades, the highly competitive environment, the deregulation policies (for example, the Gramm–Leach–Bliley Act (GLBA) of 1999), the managerial innovations and technological progress have created incentives for banking institutions to diversify their activities(Kim et al., (2020)). Thus, banking institutions have increasingly become involved in non-traditional banking activities resulting in the significant increase of non-interest income[13](Wu et al., (2020), Maudos, (2017), Demirgüç-Kuntand Huizinga, (2010), Ferreira et al., (2018)). By diversifying their activities, banking institutions attempted to sustain their profitability levels despite the changing conditions, but they were exposed to further risks (Luu et al., (2019)).

Nevertheless, in the aftermath of the financial crisis, many weaknesses of the regulatory framework were revealed, many concerns about the threats of bank diversification were raised and therefore the impact of the financial crisis on financial fragility has been thoroughly reassessed (Ashraf et al., (2016)). As a result, the non-traditional banking activities are now being carefully monitored and new regulations are being implemented (for example, Basel III framework), aiming at more resilient banking institutions as well as banking systems. Thus, in the post-crisis period, banks of advanced economies have started once again to rely more on traditional banking practices and less on non-interest earning activities (Abuzayed et al., (2018)). These modifications have, however, significantly affected bank profitability and income structure (Maudos, (2017)).

Bank diversification, and whether or not its benefits outweigh the threats, is a broadly examined issue. Yet the literature remains inconclusive, even the limited number of more recent papers which investigate the after-crisis period, yield conflicting results. A great part of those surveys suggest that bank diversification provides more benefits than drawbacks (such as Moudud-Ul-Huq et al., (2019), Ashraf et al., (2016) , Luu et al., (2019)), whereas many studies suggest that diversification is harmful for bank stability and/or profitability (such as Ngoc Nguyen, (2019) and Alfadli and Rjoub, (2019), Williams, (2016) and Ghosh, (2019)). Therefore,

[13] such as, investments, securities trading, clearing services, insurance, asset management et cetera

further empirical analysis on this crucial topic is required as it could shed more light on this issue.

In order to investigate bank diversification, in our survey, we attempt to convey how assets, income and non-income diversification influence the profitability, capital, risk and efficiency of banking institutions in the post-crisis period. Furthermore, we assess if diversification affects the Eurozone banking institutions differently than those of the United States and whether the impact of diversification varies across different types of banks (commercial, cooperative and savings banks). Finally, we investigate the sensitivity of our results to the bank characteristics and the general market conditions.

For the aforementioned purposes, we employ a data sample consisting of aggregated balance sheets and financial data retrieved from 1,584 Eurozone banks and 601 U.S. banks during the period 2013-2018. We investigate separately the impact of diversification on capital, risk, profitability and efficiency of both economic unions, that is, the Eurozone and the United States. We also examine the three subgroups of banks (commercial, cooperative and savings banks) in the Eurozone and the U.S. Moreover, we control for environmental and bank-specific variables which affect the examined relationship.

Concerning the methodology, the dependent variables of our empirical model are efficiency, capital, risk and profitability. We estimate efficiency by employing Data Envelopment Analysis (D.E.A.) developed by Charnes et al., (1978). Additionally, we employ three alternative variables to estimate bank profitability (the net interest margin, the ratio of return on average assets as well as the ratio of profit before tax to average total assets) and two variables to measure risk (Z-score and loan loss provisions ratio as indicators of default risk and credit risk, respectively). Moreover, the capitalization of the banks in our empirical model is calculated as the ratio of total equity to total assets. Regarding the independent variables, we apply the Adjusted Herfindahl Hirschman Indices (AHHI) for the estimation of the diversification measures (assets, income and non-interest income diversification) and a variety of bank-specific and macroeconomic indicators. In the final step of our survey, we implement the Two-step System Generalized Method of Moments Dynamic Panel Estimator (system-GMM) devised by Arellano and Bover, (1995) and further developed by Blundell and Bond, (1998), to estimate the relationships among the dependent and independent variables.

Our study contributes to the existing literature in four important ways. Firstly, unlike previous studies, we investigate a post-crisis period and provide evidence regarding the impact of bank diversification on capital, stability, efficiency and profitability after the global financial crisis. Secondly, our survey is the first to compare the above mentioned relationship between Eurozone and U.S. banking institutions by

employing post-financial crisis data. Thirdly, the literature examining the effect of diversification across different types of banks is very limited. Fourthly, to the best of our knowledge, our study differs from the former literature as it examines (i) the three categories of bank diversification (assets, income and non-interest income diversification) and(ii) the impact on the four following independent variables: profitability, efficiency, stability and capital. Therefore, our study fills the gap in the existing literature because it is one of the first to provide a broader understanding of how the impact of bank diversification on banking institutions is configured by the new regulations implemented after the global financial crisis.

The remainder of this chapter is structured as follows: section 2 reviews the existing literature, section 3 introduces our data sample and section 4 presents the selected variables together with the research methodology. Section 5 analyzes our empirical results while section 6 draws the conclusions.

Section 4.2: Literature Review

There is a large body of literature which provides empirical evidence regarding the impact of bank diversification on risk as well as profitability. Yet, amongst the existing literature there is very little, if any, consensus resulting in an ongoing debate on whether the above-mentioned relationships are direct or adverse.

4.2.1 Bank diversification and stability

The influence of bank diversification on stability is a well-studied topic and multiple papers employ bank data covering the period before the global financial crisis, however, no consensus is reached yet. Lepetit et al., (2008) examine a sample of European banks during the period 1996-2002 and suggest that income diversification and non-interest income diversification are directly connected with risk. They also control for size and non-interest income activities concluding that a positive relationship is mostly for small banks and for their commission and fee activities. However, there is no positive association between risk and trading income. Similarly, Baele et al., (2007) investigate the link among bank diversification, profitability and risk for European banks for the period 1989-2004 and deduce that income diversification accelerates both systematic risk and profitability. Demirgüç-Kunt and Huizinga, (2010), in like manner, assess the relationship among non-interest income and non-deposit funding before the financial crisis (1995-2007) suggesting that income diversification may lead to higher default risk and greater profitability.

Nevertheless, Lee, et al., (2014) demonstrate that the risk of Asian banks, during the period 1995-2009, is negatively affected by income diversification, whereas there is no significant impact on profitability. The study also highlights that important factors affecting the examined relationship are the country's income level and the type of bank (commercial, cooperative, investment and savings banks). Also, Ashraf et al., (2016), investigate the banks from the Gulf Cooperation Council (GCC) region during the period 2000-2011 and suggest that there is a positive relationship between income diversification and financial stability. They also indicate the significant role of bank ownership on the examined relationship. Therefore, we may conclude that there is a lack of consensus in the literature on the link between diversification and risk in the period preceding the financial crisis.

More recent studies including samples for periods during and after the global financial crisis, also report conflicting results. According to Maudos, (2017), diversification and risk of European banks are directly related, whereas this finding is less intense during the financial crisis. Interestingly, Kim et al., (2020) analyze OECD banks and conclude that the connection between bank diversification and financial stability diverge when a financial crisis emerges. More precisely, bank diversification was directly related with bank stability before the financial crisis, whereas the relationship was inverted after the global financial crisis. Moreover, they indicate that the association between financial stability and bank diversification is non-linear (inverted U-shaped), because bank stability increases until bank diversification hits the optimal level and then it begins to decrease above that level. Consistent with this finding, Edirisuriya et al., (2015) analyze Asian banks and conclude that bank diversification is positively related to stock market valuations as well as stability until an optimal level of diversification. Above this level of diversification the relationship is reversed, now negatively affecting stability.

Additionally, Moudud-Ul-Huq et al., (2019) employ data from Asian banks after the global financial crisis and convey that the revenue diversification is positively related to bank performance and bank stability, whereas the impact of asset diversification varies across the reported countries. However, Ferreira et al., (2018) assess a sample of Brazilian banks and find evidence that revenue diversification is directly connected with risk and positively, but insignificantly, connected with performance. Also, Lee et al., (2019) examine the effect of asset correlation on the relationship between income diversification and risk and their findings indicate that although the relationship is positive, it could be inverted because of asset correlation.

Moreover, even the studies analyzing the relationship between diversification and bank stability of conventional and Islamic banks are mixed. More specifically, Abuzayed et al., (2018) investigate the period 2001-2014 and conclude that both income and asset diversification are not related with an increase in bank stability.

Additionally, they find consistent evidence that conventional bank risk is adversely and more intensely connected with diversification than the Islamic bank risk levels. Paltrinieri et al. (2020) survey the period 2007-2016 and they also suggest that income diversification is not linked with stability for both conventional and Islamic banks. Their results provide evidence that income diversification is positively related with profitability and that the outcome is more enhanced for conventional banks rather than Islamic banks. Similarly, Daradkah & Al-Sayyah, (2020) conclude that, after the financial crisis (2010-2016), the income diversification is directly related with stability, especially from trading income. The sample consists of 16 Islamic banks in the Gulf Cooperation Council (GCC) countries. In contrast to the three previous studies, Alkhouri & Arouri, (2018) examine the period 2003-2015 and infer that non-interest and revenue diversification are negatively related with the stability of conventional banks and positively with the stability of Islamic banks.

Concerning the impact of diversification on different types of bank, researchers highlight the importance of considering the type of bank when examining the link of bank diversification with stability. Ghosh, (2019) investigates the relationship between non-interest income diversification and risk, and suggest that they are directly connected, but the outcome depends on the specialization of banks. Köhler, (2015) also examines the impact of the business model of the bank on the link between risk and diversification. More specifically, the author separately analyzes savings, investment, cooperative and commercial banks and provides evidence that savings and cooperative banks are retail-oriented while commercial and investment banks are investment-oriented. Köhler suggests that bank diversification positively affects stability and profitability, especially those of cooperative and savings banks. The survey further reveals that the results of each type of bank differ when examining the influence of diversification on bank stability.

4.2.2 Bank diversification and profitability

There has been a substantial amount of literature which has thoroughly investigated the effect of diversification on bank profitability. Concerning the pro-crisis period, Elsas et al., (2009) suggest that an increase in bank diversification may lead to a rise in profitability. Likewise, Sanya and Wolfe, (2010) point out that income and non-interest income diversification are directly related with performance. Whereas Mercieca et al., (2007) suggest that there is no link between profitability and diversification of Eurozone small banking institutions during the period 1997-2003.

Moreover, the empirical literature employing more recent data continues to be inconclusive. Ngoc Nguyen, (2019) and Alfadli and Rjoub, (2019) provide evidence

that a rise in income diversification is negatively related with profitability. Interestingly, Maudos, (2017) concludes that a rise in income diversification is only negatively related with profitability during the financial crisis. Contrary to these findings, Luu et al., (2019) suggest that income diversification impacts positively on bank performance and the outcome is more intense for more experienced banks in the market. This outcome is in line with that of Mostak Ahamed, (2017) indicating that income diversification is favorable for the profitability of Indian banks during the period 1998-2014. Finally, the findings of Edirisuriya et al., (2015) provide evidence that an increase in bank diversification does not necessarily precede a rise in the bank performance of Asian banks during the period 1999-2012.

The effect of diversification of the non-interest income activities on bank performance is also thoroughly investigated, yet no consensus has been reached. Minh and Thanh, (2019) assess the impact of non-interest income diversification on the performance of Vietnamese commercial banks and infer a positive relationship. In addition, Elyasiani and Jia, (2019) study the relationship between non-traditional banking activities and the performance of US banks during the period 2002-2006 and also convey a positive relationship. However, Alkhouri & Arouri, (2018) conclude that non-interest income diversification is adversely connected with the performance of conventional banks. Lastly, Ghosh, (2019) research the relationship of non-interest income and profitability and provide evidence that the results are mixed depending on the type of non-interest income activities of each bank.

Additionally, the relationship between diversification and profitability of conventional and Islamic banks is investigated by the following studies and yields conflicting results. Initially, Alkhouri&Arouri, (2018) draw the conclusion that asset diversification is positively related with bank performance. Ali &Khattak, (2020), in the same way, conclude that income diversification of Islamic and conventional banks in Indonesia is positively linked with bank performance during the period 2007-2017. Their findings also indicate no difference in the relationship between bank performance and income diversification for conventional and Islamic banks. Consistent with the above results, Moudud-Ul-Huq et al., (2020) provide evidence that during the financial crisis the banking institutions of South Africa and Bangladesh employ portfolio diversification in order to increase bank performance. Nevertheless, Chen et al., (2018) suggest that asset diversification negatively impacts on conventional bank performance, while insignificantly affecting Islamic banks.

4.2.3 Bank diversification in relation to efficiency and capital

The empirical literature focusing on the influence of bank diversification on efficiency and capital is rather limited as more studies investigate the impact on risk

and profitability. Concerning efficiency, Wu et al., (2020) investigate the impact of diversification on the risk and efficiency of a sample of 1000 commercial banks in emerging countries during the period 2000-2016. The empirical evidence suggests that there is a negative relationship between diversification and default risk and an indirect negative impact of diversification on efficiency. Regarding capital, Meng et al., (2017) examine the determinants of income diversification of Chinese banks during the period 2003-2010 and their findings suggest that bank diversification is directly related with insolvency risk and with the capital of commercial banks, whereas it is negatively related with the bank capital of national banks.

Overall, we may conclude that the recent literature analyzing the impact of bank diversification on stability, profitability, efficiency and capital provide conflicting results. Thus, this controversial issue warrants more investigation and motivates our research. We also observe that the type of bank and bank location significantly influence the examined relationship.

Table 37: Overview of the recent literature on bank diversification

Author	Examined Relationship	Reported Period	Countries	Methodology	Empirical Evidence
Abuzayed et al., (2018)	bank diversification, bank performance and bank stability	2001-2014	conventional and Islamic banks	Two-step System GMM methodology	Income and asset diversification are not related with bank stability. Non-interest income is adversely related with risk and conventional banks are more impacted than Islamic banks.
Ali &Khattak, (2020)	Non-interest income activities, profitability and risk	2007-2017	Islamic and conventional banks in Indonesia	a system generalized method of moments estimator (GMM)	Income diversification increases bank profitability.
Alkhouri and Arouri, (2018)	revenuediversification, non-interest incomediversification and asset diversification, performance, stability	2003-2015	conventional and Islamic banks	Two-step System GMM methodology	Non-interest and revenue diversification are negatively connected with the stability of conventional banks and positively with the stability of Islamic banks. Non-interest income diversification is adversely connected with the bank performance of conventional banks, asset diversification is positively related with bank performance.
Ashraf et al., (2016)	Income diversification, financial stability and ownership	2000-2011	Banks from GCC region	GLS random effect estimation	Positive relationship between income diversification, financial stability.
Baeleet al., (2007)	Diversification, performance and risk	1989-2004	European banks	regression analysis	Income diversification increases systematic risk and bank profitability.
Chen et al., (2018)	asset diversification, bank performance	2006-2012	Asian countries (conventional and Islamic banks)	one-step difference and system generalized method of moment (GMM) dynamic panel model	Asset diversification is adversely associated with bank performance of conventional banks, while it has minimum impact on the performance of Islamic banks.
Daradkahand Al-Sayyah, (2020)	Income, non-interest income diversification, risk	2010-2016	Banks in Gulf Cooperation Council (GCC) countries	Fixed panel analysis	Income diversification is positively associated with bank stability and especially trading income.

Demirgüç-Kuntand Huizinga, (2010)	Income diversification, risk, return	1995-2007	101 countries	Regression analysis	Positive impact of income diversification on bank risk and profitability
Edirisuriya et al., (2015)	stock markets and bank diversification	1999-2012	four South Asian countries (Bangladesh, India, Pakistan, and Sri Lanka)	A general class of panel models	Bank diversification is directly related to stock market valuations and solvency until an optimal level of diversification. From this level of diversification and higher the relationship is adverse. An increase in bank diversification does not necessarily precede a rise in bank performance.
Elsas et al., (2009)	Diversification, profitability	1996-2008	Australia, Canada, France, Germany, Italy, UK, USA, Spain, and Switzerland	fixed-effects regressions	An increase in diversification precedes an increase in bank profitability and thus, an increase in market valuation.
Elyasiani and Jia, (2019)	Nontraditional banking activities, performance and risk	2002-2006	Us banks	OLS with errors clustered, firm fixed effects regression	Increase of non-traditional banking activities may lead to a rise in bank performance and a decrease in systemic risk during the financial crisis.
Ferreira et al., (2018)	revenue diversification, risk and performance	2003-2014	Brazilian banks	Generalized Method of Moments (GMM)	Revenue diversification is directly connected with risk and insignificantly positively connected with performance.
Ghosh, (2019)	Non-interest income and bank risk and profitability	2001-2016	US commercial banks	OLS with robust standard errors clustered	Non-interest income and bank risk are related positively, whereas for the impact on profitability the results vary.
Kim et al., (2020)	bank diversification, bank stability	2002-2012	OECD commercial banks	The square of the diversification measure (Lag SQ non-interest income/TOR) and 2SLS method	Significantly non-linear relationship betweenbank diversification and bank stability. Bank diversification decreased the risk levels before the financial crisis, whereas it increased the risk levels during the financial crisis.
Köhler, (2015)	Risk, non-interest income, business model	2002-2011	European banks	Baseline regression model	Income diversification is positively associated with bank stability and profitability. The outcome is highly affected by the business model.
Lee et al., (2019)	income diversification, risk and performance	2006-2013	53 countries	Generalized Method of Moments (GMM)	Income diversification is directly related to systemic risk, yet the results depend on the asset correlation.

Lee, et al., (2014)	Non-interest income, profitability and risk	1995-2009	Asian banks from 22 countries	dynamic panel data model	Income diversification is negatively related with risk, while there is no significant impact on profitability. Important factors are the country's income level and the type of bank (commercial, cooperative, investment and savings banks).
Lepetit et al., (2008)	Risk and diversification	1996-2002	European banks	Ordinary Least Squares (OLS)	Income diversification and non-interest income diversification are directly connected with risk. The positive relationship is mostly for small banks and for the commission and fee activities, while there is no positive association between risk and trading income.
Luu et al., (2019)	Income diversification and performance	2007-2017	Vietnamese commercial banks	Panel OLS with fixed effects together with the two-step system GMM estimator	Income diversification impact positively on bank performance and the outcome is more intense for banks more experienced in the market.
Maudos, (2017)	Income structure, risk, profitability	2002-2012	European banks	Regression analysis	A rise in the diversification is negatively related with profitability during the financial crisis. Diversification and risk are directly related, whereas this finding is less intense during the financial crisis.
Meng et al., (2017)	Determinants of income diversification	2003-2010	Chinese banks	Pooled OLS, fixed effects, and GMM estimation	Bank income diversification is directly related with insolvency risk and bank capital of commercial banks, whereas negatively related with bank capital of national banks.
Mercieca et al., (2007)	Diversification and profitability	1997-2003	Small European banks	OLS regression	No significant relationship between profitability and diversification
Minh and Thanh, (2019)	non-interest income and performance	2008-2017	Vietnamese commercial banks	Generalized Method of Moments (GMM)	Non-interest income and the performance of Vietnamese commercial banks are positively related.
MostakAhamed, (2017)	Income diversification, profitability	1998-2014	Indian banks	Two-step System GMM methodology	income diversification is favorable for the profitability
Moudud-Ul-Huq et al., (2019)	Asset and revenue diversification, performance, risk	2011-2015	ASEAN-5 (Indonesia, Malaysia, the Philippines, Thailand, Vietnam)	Two-step System GMM methodology	Revenue diversification is positively related to bank performance and bank stability. The impact of asset diversification varies across the reported countries.
Moudud-Ul-Huq et al., (2020)	bank diversification, risk and performance	2004-2015	South Africa and Bangladesh	Generalized Method of Moments (GMM)	During the financial crisis the banking institutions of South Africa and Bangladesh employ portfolio diversification in order to increase bank performance.

Ngoc Nguyen, (2019)	revenue diversification, risk and performance	2010-2018	Vietnamese commercial banks	Generalized Method of Moments (GMM)	Revenue diversification is directly connected with risk and adversely with profitability.
Paltrinieri et al., (2020)	income diversification, bank performance and bank stability	2007-2016	conventional and Islamic banks	Two-step System GMM methodology	Income diversification is not linked with stability. Income diversification is positively related with profitability and the result is more enhanced for conventional banks than Islamic banks.
Sanya& Wolfe, (2010)	income and non-interest income diversification, risk and performance	2000-2007	11 emerging economies	Generalized Method of Moments (GMM)	Income and non-interest income diversification are indirectly connected with risk and directly related with performance.
Sissy et al., (2017)	Revenue diversification, cross border banking , risk and return	2002-2013	29 African countries	Two-step System GMM methodology	The exploration risk is adversely connected with cross border diversification, yet the capital is positively associated. African banks derive benefits by the simultaneous revenue and cross border diversification.
Williams, (2016)	Non-interest income and bank risk	2002-2014	Australian banks	Feasible GLS with panel specific corrections	Income diversification and non-interest income diversification are directly connected with risk. Yet, the outcome depends on the specialization of banks.
Wu et al., (2020)	Diversification, efficiency and risk	2000-2016	Banks from emerging economies	System generalized method of moments (GMM)	Negative relationship between diversification and default risk, indirect negative impact of diversification on efficiency.

Section 4.3: Data

Concerning the group of Eurozone banks, we analyze 1584 banks from countries participating in the European Economic Monetary Union; Austria, Belgium, Cyprus, Germany, Estonia, Spain, France, Greece, Ireland, Italy, Lithuania, Luxembourg, Latvia, Malta, the Netherlands, Portugal, Slovenia and Slovakia. Additionally, we investigate separately three subgroups of Eurozone banks: commercial, cooperative and savings banks which include 273, 838, 408 banks respectively. The United States bank group is separately examined and it comprises data from 601 banks with three subgroups: commercial, cooperative and savings banks consisting of 382, 154 and 63 banks. We adjust our data by omitting banks with incomplete or missing annual financial data over the investigated period. The number of banks in each country is presented in Table 38.

Table 38: The data sample per country

Country	Number of banks	Number of commercial banks	Number of cooperative banks	Number of savings banks
Austria	104	20	56	18
Belgium	12	8	2	2
Cyprus	9	8	0	0
Estonia	6	5	0	0
Finland	12	7	2	2
France	141	68	56	13
Germany	866	20	464	345
Greece	6	5	1	0
Ireland	4	3	0	0
Italy	311	51	239	13
Latvia	9	9	0	0
Lithuania	5	5	0	0
Luxembourg	17	15	1	1
Malta	4	4	0	0
Netherlands	8	7	1	0
Portugal	16	11	2	2
Slovakia	9	7	0	2
Slovenia	7	5	1	1
Spain	38	15	13	9
Eurozone	1584	273	838	408
United States	601	382	154	63

Section 4.4: Definition of Variables and Research Methodology

4.4.1 Definition of Variables

Efficiency, profitability, capital and risk are the dependent variables of our empirical model. As regards the independent variables, we incorporate three diversification measures, four macroeconomic variables and a variety of bank-specific indicators. The employed variables are extensively described in the following sections and illustrated in Table 39.

Table 39: Definition of the Employed Variables

Classification		Variable	Description	Measurement
Dependent Variables	Efficiency Measure	EFF	efficiency	Data Envelopment Analysis
	Profitability Measures	NIM	net interest margin	$\frac{\text{Interest Income} - \text{Interest Expenses}}{\text{Average Interest Earning Assets}}$
		ROA	return on average assets	$\frac{\text{Net Income}}{\text{Average Total Assets}}$
		PROF	the ratio of profit before tax to total assets	$\frac{\text{Profit before tax}}{\text{Average Total Assets}}$
	Capital Measure	CAP	capital	$\frac{total\ equity}{total\ assets}$
	Risk Measures	Z	insolvency risk (Z-score)	$\ln\left(\frac{\frac{equity}{total\ assets}+ROA}{\sigma(ROA)}\right)$
		Cr	credit risk	$\frac{\text{loan loss provisions}}{\text{net loans}}$
Independent Variables	Diversification Measures	DIVA	asset diversification	$1-\left[\left(\frac{\text{Non interest earning assets}}{\text{total assets}}\right)^2+\left(\frac{\text{Interest earning assets}}{\text{total assets}}\right)^2\right]$
		DIVI	income diversification	$1-\left[\left(\frac{\text{Non interest income}}{\text{net operating income}}\right)^2+\left(\frac{\text{Net interest income}}{\text{net operating income}}\right)^2\right]$
		DIVNI	non-interest income diversification	$1-\left[\left(\frac{\text{fee and commissions income}}{\text{Non interest income}}\right)^2+\left(\frac{\text{trading income}}{\text{Non interest income}}\right)^2+\left(\frac{\text{other operating income}}{\text{Non interest income}}\right)^2\right]$
	Bank-specific	SIZE	bank size	Ln(total assets)

	indicators	LIQ	liquidity rate	$\frac{liquid\ assets}{total\ assets}$
		INT	intermediation ratio	$\frac{gross\ loans}{total\ deposits}$
		LEND	lending strategy	$\frac{net\ loans}{total\ assets}$
	Macroeconomic Indicators	GDP	GDP real growth rate	GDP real growth rate
		INFL	inflation rate	inflation rate
		PUBD	public debt	public debt
		UNE	unemployment rate	unemployment rate

4.4.1.1 Dependent Variables

Efficiency measure

Following Kolia and Papadopoulos, (2020a), Zhang et al., (2013), Le, (2018) as well as Tan and Floros, (2013), we measure efficiency (EFF) by employing Data Envelopment Analysis (D.E.A.) developed by Charnes et al., (1978). The selected inputs are staff expenses, book value of fixed assets as well as time and demand deposits while the considered outputs are loans and advances to banks and customers together with net interest income. The estimation model is built as follows and analyzes the ability of a decision making unit to turn the inputs into outputs:

$$max \quad Z_0 = \sum_t (w_t * y_{t0})$$

s.t

l=1,….,n

i=1,….,b

t=1,….,k

$\sum_r (w_t * y_{tl})$ - $\sum_i (q_i * x_{il})$ = 0

$\sum_i (q_i\ x_{i0}) = 1$,

$q_i \geq \varepsilon \geq 0$

$w_t \geq \varepsilon \geq 0$

where:

i=inputs

t=outputs

l=Decision Making Units

q_i *= relative importance of i*

w_t*= relative importance of t*

ε = error term

Profitability measures

In consistence with Moudud-Ul-Huq et al., (2019), we employ the three following alternative variables to measure bank profitability. Firstly, we use **Net Interest Margin (NIM)** as a margin-type indicator of profitability:

$$NIM = \frac{Interest\ Income - Interest\ Expenses}{Average\ Interest\ Earning\ Assets}$$

Additionally, in line with Elyasiani & Jia, (2019) and Williams, (2016), we employ two return-type indicators of profitability: the ratio of return on average assets (ROA) and the ratio of profit before tax to average total assets (PROF).

$$ROA = \frac{Net\ Income}{Average\ Total\ Assets}$$

$$PROF = \frac{Profit\ before\ tax}{Average\ Total\ Assets}$$

Risk measures

Concerning the estimation of bank risk, we employ both Z-score and loan loss provisions ratio as indicators of default risk and credit risk respectively. Higher values of Z-score indicate a more resilient and, thus a more stable bank (Paltrinieri et al. (2020)) and as mentioned in Abuzayed et al., (2018) , "(the Z-score calculates)the number of standard deviations the returns have to fall before a bank becomes insolvent". We incorporate Z-score in our model in line with established literature; Nguyen and Nghiem, (2015), Kabir and Worthington, (2017), Deelch and Padgett, (2009), Ben Salah Mahdi and Boujelbene Abbes, (2018), Alkhouri & Arouri, (2018), Kim et al., (2020) as well as Sissy et al., (2017).

$$Z = \ln\left(\frac{\frac{equity}{total\ assets}+ROA}{\sigma(ROA)}\right)$$

Where:

Z = Z-score

ROA= ratio of return on average assets

Moreover, credit risk is estimated as the ratio of the loan loss provisions to net loans. This ratio denotes the ability of a bank to absorb the cost of non-performing loans, and as a result this variable indicates lower risk (Moudud-Ul-Huq et al.,(2020), Chen et al., (2018)). Thus, our credit risk ratio is built as follows:

$$Cr = \frac{loan\ loss\ provisions}{net\ loans}$$

Where,

Cr = credit risk

Capital measure

The capitalization(CAP) of the banks in our empirical model is measured as the ratio of total equity to total assets. This ratio is the most frequently used as a capital estimator, for example, Alkhouri and Arouri, (2018), Meng et al., (2017) and Kolia and Papadopoulos, (2020b).

4.4.1.2 Independent Variables

Diversification measures

For the purposes of our survey, we examine the degree of diversificationin banking activities; lending and non-lending activities. More specifically, our empirical model consists of the asset, revenue and non-interest income diversification. According to the literature, (Abuzayed et al.,(2018), Paltrinieri et al. (2020), Sanyaand Wolfe, (2010), Elsas et al., (2009)), we apply the Adjusted Herfindahl Hirschman Indices (AHHI) for the estimation of the diversification measures. The higher the AHHI is, the greater diversification is and as a result, the lower bank concentration is.

The diversification measures are the independent variables of our analysis and are explained in this section. Our first independent variable is the **asset diversification** (*DIVA*). This ratio has mainly been used in the recent literature (Moudud-Ul-Huq et al., (2019), Chen et al., (2018), Edirisuriya et al., (2015)) and is calculated by breaking

down interest and non-interest earning assets. An increased portion of non-interest earning assets indicates an increased diversification in banking activities.

$$DIVA = 1 - \left[\left(\frac{Non\ interest\ earning\ assets}{total\ assets}\right)^2 + \left(\frac{Interest\ earning\ assets}{total\ assets}\right)^2\right]$$

Where,

Non-interest earning assets = total assets – total loans and advances = securities + investments

Interest earning assets= total loans and advances

Secondly, the **income diversification** (*DIVI)* ratio is commonly employed (Moudud-Ul-Huq et al., (2019), Edirisuriya et al., (2015), Chen et al., (2018), Luu et al., (2019), Ferreira et al., (2018)). This measure breaks down the two major categories of income which are non-interest income and net interest income. A diversified bank is expected to retrieve a great portion of income from non-interest activities.

$$DIVI = 1 - \left[\left(\frac{Non\ interest\ income}{net\ operating\ income}\right)^2 + \left(\frac{Net\ interest\ income}{net\ operating\ income}\right)^2\right]$$

Where,

Non-interest income = fee and commissions income + trading income + other operating income

net operating income = non-interest income + net interest income

Finally, the effect of diversifying non-credit banking activities is also estimated in the established literature (Sissy et al., (2017), Minh and Thanh, (2019), Ghosh, (2019), Lee et al., (2019), Moudud-Ul-Huq et al.,(2020) and Edirisuriya et al, (2015)). We measure **non-interest income diversification** (*DIVNI*) by employing the same pattern that is, Adjusted Herfindahl Hirschman Indices (AHHI).

$$DIVNI = 1 - \left[\left(\frac{fee\ and\ commissions\ income}{Non\ interest\ income}\right)^2 + \left(\frac{trading\ income}{Non\ interest\ income}\right)^2 + \left(\frac{other\ operating\ income}{Non\ interest\ income}\right)^2\right]$$

Bank-Specific Indicators

In our model we control for the bank characteristics that may affect the impact of bank diversification on capital, risk, efficiency and profitability. Consistent with the prior literature (Abuzayed et al.,(2018), Paltrinieri et al. (2020), Moudud-Ul-Huq et

al., (2019), Meng et al., (2017), Luu et al., (2019) and Lee et al., (2019)), we account for the bank-specific indicators: size, liquidity, intermediation ratio and lending specialization.

More specifically, two very important parameters that are mainly employed by the literature and need to be controlled because they impact on capital, risk, efficiency and profitability are bank size and liquidity (Abuzayed et al.,(2018), Ferreira et al., (2018), Williams, (2016), Sanya and Wolfe, (2010)). In line with these studies, in our surveybank size (SIZE) is estimated as the natural algorithm of the ratio total equity to total assets and the liquidity rate (LIQ) is measured as the ratio of liquid assets to total assets. We also include the intermediation ratio (INT) in our model, which is calculated as the ratio of gross loans to total deposits. Lastly, the ratio of net loans to total assets is employed in our study as it is an indicator of the lending strategy (LEND) of the banks in our sample.

Macroeconomic indicators

Since macroeconomic conditions influence the effect of diversification on banking institutions, they are included in the bank diversification literature (i.e. Meng et al., (2017), Alkhouri and Arouri, (2018)). Thus, the consideration of environmental variables is essential for the purposes of our survey, especially due to the controversy regarding macroeconomic indicators among Eurozone countries. More explicitly, our model is comprised of the following macroeconomic indicators: GDP real growth rate (GDP), inflation rate (INFL), public debt (PUBD) and unemployment rate (UNE).

4.4.2 Research Methodology

In this survey, following Abuzayed et al., (2018), Paltrinieri et al., (2020), Alkhouri and Arouri, (2018), Moudud-Ul-Huq et al., (2019), Minh and Thanh, (2019),Sissy et al., (2017), Luu et al., (2019), we employ the two-step system generalized method of moments dynamic panel estimator (system-GMM) devised by Arellano and Bover(1995) and further developed by Blundell and Bond(1998). This model is designed for panel data analysis and applies the first differences of the variables in order to control for correlation between the lagged dependent variable and the error term.

Generally, the model of the data-generating process can be written as:

$$y_{i,t} = \alpha * y_{i,t-1} + x'_{i,t} * \beta + \varepsilon_{i,t} \quad (1)$$

Where,

$\varepsilon_{i,t} = \mu_i + u_{i,t}$

$u_{i,t}$ = idiosyncratic shocks

μ_i = fixed effects

t= 2, ….., T

i= 1,…,n

The embodied assumptions are: (i) the process may be dynamic, (ii)some regressors possibly are endogenous or predetermined but not strictly exogenous, (iii) the idiosyncratic disturbances can be uncorrelated, have heteroskedasticity and serial correlation, (iv)fixed individual effects may be arbitrarily distributed, (v) the number of periods can be very small, (vi) the available instruments are internal (Roodman, (2009)). Additionally, the equation is based on the following conditions:

$E(\mu_i) = E(u_{i,t}) = E(\mu_i * u_{i,t}) = 0$

$E(y_{i,t} * u_{i,t}) = 0$

Moreover, equation (1) can be rewritten, so that it highlights the key role of the level of y:

$$\Delta y_{i,t} = (\alpha-1) * y_{i,t-1} + x'_{i,t} * \beta + \varepsilon_{i,t} \quad (2)$$

In order to correct for endogeneity issues, system-GMM estimator transforms the data to remove the fixed effects or it instruments endogenous variables with variables that possibly are uncorrelated with the fixed effects (Roodman, 2009). So, equation (1) can be transformed as follows:

$$\Delta y_{i,t} = \alpha * \Delta y_{i,t-1} + \Delta x'_{i,t} * \beta + \Delta u_{i,t} \quad (3)$$

Nevertheless, this model (equation (2)) “suffers from potentially huge small sample bias when the number of time periods is small and the dependent variable shows a high degree of persistence” (Heid et al.,(2011)). To increase the efficiency of the model, Blundell and Bond (1998) employ the system-GMM approach, which is based not only on the above-mentioned conditions but also on the following conditions:

$|\alpha|<1$

$E(\varepsilon_{i,t} * \Delta y_{i,t-1}) = 0$, for t=4,5,.., T

$E(\varepsilon_{i,3} * \Delta y_{i,2}) = 0$

T≥3

Using those conditions, the system-GMM approach includes a stacked system of T-2 equations in first differences and T-2 equations in levels, for the periods 3,….T ,of the reported sample. The instrument matrix for this systems is as follows(Blundell & Bond, (1998)):

$$Z_*^+ = \begin{bmatrix} Z_i & 0 & 0 & \cdots & 0 \\ 0 & \Delta y_{i,2} & 0 & \cdots & 0 \\ 0 & 0 & \Delta y_{i,3} & \cdots & 0 \\ . & . & . & \cdots & 0 \\ 0 & 0 & 0 & \cdots & \Delta y_{i,T-1} \end{bmatrix}$$

Where,

$Z_i$is the following (T-2) * m matrix:

$$Z_i = \begin{bmatrix} y_{i,1} & 0 & 0 & \cdots & 0 & \cdots & 0 \\ 0 & y_{i,1} & y_{i,2} & \cdots & 0 & \cdots & 0 \\ . & . & . & \cdots & . & \cdots & . \\ 0 & 0 & 0 & \cdots & y_{i,1} & \cdots & y_{i,T-2} \end{bmatrix}$$

The System-GMM approach is preferred because it is appropriate for banking sector surveys as it effectively estimates samples (i) with possible endogeneity issues (Paltrinieri et al., (2020), Luu et al., (2019)), (ii) with autoregressive properties in the dependent variables (Trujillo-Ponce, (2012)), (iii) with heteroscedasticity problems (Moudud-Ul-Huq et al., (2019)), (iv) with unobserved bank-specific effects (Alkhouri&Arouri, (2018)) and (v) with missing data (Alkhouri&Arouri, (2018)).

Moreover, the System-GMM is selected because it is applied to surveys with data samples comprised of a small number of periods and a large number of observations (Abuzayed et al.,(2018)). The System-GMM also eliminates endogeneity by arranging the predetermined and endogenous variables to their own lags (Abuzayed et al.,(2018) and Alkhouri&Arouri, (2018)). This is a very important advantage of System-GMM model and the main reason for its selection since other vastly employed econometric models for instance *Ordinary Least Squares, Fixed Effect estimation approach* and G*eneralized Effect estimation approach* cannot address these endogeneity issues(Trabelsi and Trad, (2017)). Another drawback of the *Ordinary Least Squares* methodology is that it produces bias when attempting to control for autocorrelation and heterogeneity (Sissy et al., (2017)). Also, the Granger-

causality techniques are sensitive to model specification (Nguyen &Nghiem, (2015)), while the System-GMM approach "allows for the explicit modeling of the dynamic nature of the diversification–performance nexus by including past bank performance as one of the repressors where this is possible" (Luu et al., (2019)). Finally, the System-GMM is preferred as it is more developed than the *difference-GMM* of Arellano & Bond, 1991 because it applies regressions in level as well as in difference (Tran, et al.,(2016)).

Our adopted model can be specified as follows:

Y = f (Diversification, Bank-specific Indicators, Macroeconomic Indicators)

Y refers to the dependent variables of our regression analysis that is, profitability, capital, risk and efficiency[14]. Thus, we run this regression four separate times and the employed equations are the following[15]:

$$Prof_{i,t} = \alpha_0 + \beta_1 \cdot Prof_{i,t-1} + \beta_2 \cdot DIV_{i,t} + \beta_3 \cdot Bank_{i,t} + \beta_4 \cdot Env_{i,t} + \varepsilon_{i,t} \quad (4)$$

$$Cap_{i,t} = \alpha_0 + \beta_1 \cdot Cap_{i,t-1} + \beta_2 \cdot DIV_{i,t} + \beta_3 \cdot Bank_{i,t} + \beta_4 \cdot Env_{i,t} + \varepsilon_{i,t} \quad (5)$$

$$Risk_{i,t} = \alpha_0 + \beta_1 \cdot Risk_{i,t-1} + \beta_2 \cdot DIV_{i,t} + \beta_3 \cdot Bank_{i,t} + \beta_4 \cdot Env_{i,t} + \varepsilon_{i,t} \quad (6)$$

$$Effic_{i,t} = \alpha_0 + \beta_1 \cdot Effic_{i,t-1} + \beta_2 \cdot DIV_{i,t} + \beta_3 \cdot Bank_{i,t} + \beta_4 \cdot Env_{i,t} + \varepsilon_{i,t} \quad (7)$$

Where,

i = bank

t = year

$Prof_{i,t}$= the measures of profitability (NIM, ROA, EBIT/TA) of the bank i in the year t

$Prof_{i,t-1}$= the profitability of bank i in the year t-1

$Cap_{i,t}$= the measures of capital (CAP, TCAP) of the bank i in the year t

$Cap_{i,t-1}$= the capital of bank i in the year t-1

$Risk_{i,t}$ = the measures of risk (Z, CR) of the bank i in the year t

[14]Concerning the methodology, we should also mention that the dependent indicator is lagged by one period ($Y_{i,t-1}$) because bank profitability, risk, capital as well as efficiency may be persistent.

[15]For the estimation of the system-GMM we employed the module 'xtabond2' in Stata, developed by Roodman,(2009).

$Risk_{i,t-1}$= the risk of bank i in the year t-1

$Effic_{i,t}$= the measure of efficiency of the bank i in the year t

$Effic_{i,t-1}$= the efficiency of bank i in the year t-1

α_0 = constant

β_1-β_4= coefficient vectors

Div = the measures of diversification; asset diversification(DIVA), income diversification (DIVI) and non-interest income diversification (*DIVNI*)

Bank= the bank-specific indicators; SIZE (the natural logarithm of total assets), LIQ (the ratio of liquid assets to total assets), INT(the ratio of gross loans to total deposits), LEND (the ratio of gross loans to total assets)

Env= the environmental variables; GDP real growth rate (GDP), inflation rate(INFL), public debt (PUBD) and unemployment (UNE)

$\varepsilon_{i,t}$= error term

Section 4.5: Empirical Results

In this part of our survey, we empirically examine the impact of bank diversification (assets, income and non-interest income diversification) on the profitability, efficiency, capital and risk of Eurozone and United States banks as well as of their subgroups of commercial, cooperative and savings banks. The results are thoroughly investigated in the following sections of our survey and are shown per reported group in the Appendix (Table 46 - Table 53).

4.5.1 The effect of bank diversification on profitability

Table 40 and Table 41 depict the impact of bank diversification on the three profitability measures[16] of Eurozone and U.S. general samples, and the three subgroups of banks; commercial, cooperative and savings banks. Our findings seem to suggest that the profitability of Eurozone savings banks is adversely associated with bank diversification, regardless of the type of diversification. This outcome is in

[16] profitability measures : the net interest margin (NIM [1]), the ratio of profit before tax to total assets (PROF [2]) and the return on average assets (ROA [3])

line with the findings of Lee et al., (2014) for Asian savings banks yet it contradicts the findings of Köhler, (2015) for European savings banks.

Concerning the impact of asset diversification on profitability, our results provide evidence that for the majority of the U.S. groups examined, as well as Eurozone savings banks, the relationship is adverse and statistically highly significant. Additionally, the relationship with the net interest margin is negative and statistically significant in the majority of the reported samples. This outcome is in line with that of Chen et al., (2018) for the conventional banking group. Nevertheless, the coefficient of asset diversification for the ROA and the PROF is favorable for the Eurozone general sample, the Eurozone cooperative and the Eurozone savings banks, which is in line with Alkhouri & Arouri, (2018).

As regards non-interest income diversification, the results vary depending on the banking union and bank type. More specifically, the profitability of Eurozone banks, except for savings banks, is enhanced by a rise in non-interest income diversification. This outcome is in line with the results of Moudud-Ul-Huq et al., (2019), Sissy et al., (2017) and Sanya and Wolfe, (2010), Mostak Ahamed, (2017) and Baele et al., (2007). However, the majority of the U.S. banking groups is negatively affected by an increase in non-interest income diversification confirming the results of Alkhouri and Arouri, (2018) and Laevenand Levine, (2007). Interestingly, Stiroh, (2006) concludesthat there is no relationship between those two variables.

In relation to income diversification, the profitability of the greatest part of the reported groups is positively and statistically significantly affected, providing evidence that the profitability of a diversified bank is possibly enhanced when compared with a bank with lower levels of income diversification, therefore, confirming the results of Moudud-Ul-Huq et al., (2019), Ferreira et al., (2018), Ali & Khattak, (2020) and Luu et al., (2019), Mostak Ahamed, (2017) as well as Elsas et al., (2009). The results could be linked with operational synergies and/or higher income maximum capacity that are generated because of income diversification (Sanya and Wolfe, (2010), Baele et al., (2007)).However, the profitability of Eurozone savings banks and the U.S. general sample of banks is adversely related with income diversification.

Finally, Table 40 and Table 41 also indicate the impact of the bank-specific and the macroeconomic indicators on profitability measures. As concerns liquidity, the results for the majority of the sample provide evidence that bank profitability is negatively related with liquidity. Moreover, for the lending activity and the intermediation ratio, the outcome is contingent with the profitability measure. More specifically, lending is negatively associated with the net interest margin and positively related both with R.O.A. and the ratio of profit before tax to total assets. The intermediation ratio, however, is positively related for the majority of the

sample with net interest margin while negatively related with R.O.A. and the ratio of profit before tax to total assets. Moudud-Ul-Huq et al., (2019) also suggest a positive relationship between net interest margin and the intermediation ratio. Finally, the impact of size on profitability depends on whether the bank is in the Eurozone or in the U.S. The profitability of Eurozone banks, except for Eurozone cooperative banks, is negatively affected by an increase in bank size whereas the majority of the U.S. banking institutions is positively affected.

Concerning the macroeconomic variables, the impact of the unemployment rate together with the GDP real growth rate on the profitability of the greatest part of the examined banking institutions is positive. Furthermore, the impact of public debt on profitability depends on the banking union that is, the relationship is diverse for the majority of the Eurozone banking groups and negative for the greatest part of the U.S. banking groups. Lastly, the relationship between profitability and inflation is adverse and statistically significant for the vast majority of the reported sample. The outcome for inflation is in line with the findings of Sanya and Wolfe, (2010).

Table 40: The effect of bank diversification on the profitability of Eurozone banks

	EUROZONE BANKS			EUROZONE BANKS SAVINGS BANKS			EUROZONE BANKS COMMERCIAL BANKS			EUROZONE BANKS COOPERATIVE BANKS		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
VARIABLES	NIM	PROF	ROA	NIM	PROF	ROA	NIM	PROF	ROA	NIM	PROF	ROA
LAG	0.851***	0.363***	0.337***	0.894***	0.379***	0.305***	0.856***	0.356***	0.308***	0***	0.315***	0.287***
	(0.00102)	(0.00284)	(0.00249)	(0.00319)	(0.00148)	(0.00114)	(0.000725)	(0.00121)	(0.00148)	0	(0.00704)	(0.00632)
GDP	-0.00578***	0.000275***	0.0198***	-0.0164***	0.000412***	0.0308***	-0.0101***	0.000196***	0.0101***	1.15e-08***	0.000130***	0.00369***
	(0.00142)	(2.15e-05)	(0.00173)	(0.00265)	(2.55e-05)	(0.00141)	(0.00160)	(2.50e-05)	(0.00207)	0	(1.57e-05)	(0.000707)
INFL	0.00128	-0.000234***	-0.0132***	-0.0108***	-0.000255***	-0.00664***	-0.0546***	-0.000810***	-0.0831***	-3.04e-08***	0.000194***	0.0285***
	(0.00146)	(1.94e-05)	(0.00188)	(0.00185)	(2.27e-05)	(0.00129)	(0.00255)	(3.00e-05)	(0.00248)	0	(1.38e-05)	(0.00147)
PUBD	0.000270	-3.07e-05***	-0.00335***	0.000796***	-7.26e-05***	-0.00667***	-0.00164***	-4.54e-05***	-0.00507***	5.05e-10***	1.75e-05***	0.00207***
	(0.000232)	(4.10e-06)	(0.000363)	(0.000259)	(3.18e-06)	(0.000217)	(0.000193)	(3.00e-06)	(0.000298)	0	(4.77e-06)	(0.000392)
UNE	0.0172***	0.000223***	0.0261***	0.00837***	0.000270***	0.0296***	0.00267**	-6.58e-05***	0.00111	-1.85e-08***	0.000218***	0.0308***
	(0.00183)	(2.56e-05)	(0.00251)	(0.00179)	(1.72e-05)	(0.00108)	(0.00109)	(1.66e-05)	(0.00191)	0	(3.67e-05)	(0.00301)
SIZE	-0.0112***	-0.000539***	-0.0384***	-0.0649***	-0.00121***	-0.0883***	0.000591	-0.000930***	-0.0208***	1.54e-07***	9.41e-05	0.0140***
	(0.00233)	(4.83e-05)	(0.00347)	(0.00344)	(3.01e-05)	(0.00197)	(0.00296)	(7.72e-05)	(0.00482)	0	(5.99e-05)	(0.00474)
INT	-0.000251***	5.17e-06***	0.000433***	-0.102***	0.00930***	0.836***	-0.000799***	9.61e-06***	0.00120***	-1.02e-07***	0.00169***	0.0722***

	(7.24e-06)	(5.89e-08)	(6.10e-06)	(0.00769)	(7.74e-05)	(0.00442)	(8.48e-06)	(1.46e-07)	(1.64e-05)	0	(0.000107)	(0.00982)
LEND	0.344***	-0.00381***	-0.133**	0.301***	-0.0148***	-1.103***	0.340***	-0.00920***	-1.255***	5.14e-07***	-0.0136***	-0.937***
	(0.0296)	(0.000692)	(0.0542)	(0.0310)	(0.000623)	(0.0378)	(0.0228)	(0.000494)	(0.0453)	(2.42e-10)	(0.000445)	(0.0405)
LIQ	-0.00483***	-6.65e-06	0.00196***	-0.000971*	-4.48e-05***	-0.00168***	-0.00938***	7.32e-07	0.000451	2.67e-09***	-0.000130***	-0.00966***
	(0.000358)	(8.36e-06)	(0.000604)	(0.000511)	(5.65e-06)	(0.000342)	(0.000360)	(3.86e-06)	(0.000340)	0	(6.46e-06)	(0.000469)
DIVA	-0.285***	0.00149***	0.0769***	-0.322***	-0.000214	-0.0421***	-0.105***	0.00338***	0.157***	-5.63e-08***	0.00143***	0.0386*
	(0.0150)	(0.000224)	(0.0186)	(0.0170)	(0.000180)	(0.0109)	(0.00892)	(0.000146)	(0.0111)	0	(0.000125)	(0.0200)
DIVI	-3.36e-05***	4.42e-06***	0.000434***	-0.0956***	-0.0112***	-0.967***	0.000150***	2.77e-05***	0.00216***	1.08e-07***	-0.000884***	-0.119***
	(2.51e-06)	(2.97e-08)	(2.58e-06)	(0.0102)	(0.000144)	(0.00870)	(1.29e-05)	(3.34e-07)	(2.98e-05)	0	(5.16e-05)	(0.00482)
DIVIN	5.53e-06***	1.65e-07***	1.25e-05***	-0.0298***	-0.000977***	-0.0667***	-0.0228***	0.000151***	0.00798	1***	1.02e-07***	7.51e-06***
	(1.02e-06)	(8.12e-09)	(6.53e-07)	(0.00117)	(7.78e-06)	(0.000481)	(0.00381)	(5.93e-05)	(0.00529)	0	(3.31e-09)	(3.11e-07)
AR(1)	-2.97	-3.16	-2.33	-5.72	-3.02	-2.27	-2.63	-2.5	-1.88	-0.80	-5.46	-5.39
(p-val AR(1))	0.003	0.002	0.020	0.00	0.003	0.023	0.09	0.013	0.060	0.426	0.00	0.00
AR(2)	1.91	1.30	1.09	1.88	0.99	-0.15	0.83	1.15	1.01	0.45	1.93	1.97
(p-val AR(1))	0.057	0.194	0.276	0.060	0.321	0.877	0.404	0.251	0.312	0.655	0.054	0.049
Hansen	406.3	264.75	327.45	184.05	696.62	216.99	163.51	173.20	174.97	2.8e+10	277.74	282.26

p-hansen	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.002	0.002	0.00	0.00	0.00
Constant	0.153***	0.0141***	0.886***	1.015***	0.0315***	2.204***	0.583***	0.0279***	1.821***	-2.02e-06***	0.00816***	0.345***
	(0.0441)	(0.000859)	(0.0649)	(0.0570)	(0.000693)	(0.0478)	(0.0547)	(0.00149)	(0.0954)	(7.87e-10)	(0.000786)	(0.0682)
Observations	7,915	7,915	7,915	2,04	2,04	2,04	1,365	1,365	1,365	4,19	4,19	4,19
Number of bank	1,584	1,584	1,584	408	408	408	273	273	273	838	838	838

Note: The table indicates the system-GMM results for the Eurozone sample of banks and its subgroups (commercial, cooperative and savings banks). The estimated model is the XTABOND2 developed by Roodman, (2009). The dependent variables are the measures of profitability (i. the net interest margin (NIM) ii. the ratio of profit before tax to total assets (PROF) iii. the return on average assets (ROA)), the measure of efficiency (EFF) estimated by the D.E.A. methodology, the measure of capital (CAP) estimated as the ratio of total equity to total assets and the measures of risk (i. insolvency risk (Z) and ii. Credit risk (CR)). LAG is the one period lagged of dependent variables. The independent variables are: the measures of diversification; asset diversification (DIVA), income diversification (DIVI) and non-interest income diversification (DIVNI), the bank-specific indicators; SIZE (the natural logarithm of total assets), LIQ (the ratio of liquid assets to total assets), INT (the ratio of gross loans to total deposits), LEND (the ratio of gross loans to total assets) and the environmental variables; GDP real growth rate (GDP), inflation rate (INFL), public debt (PUBD) and unemployment (UNE). AR(1) and AR(2) indicate the first-order and the second-order autocorrelation (Arellano-Bond tests). Hansen-J variable tests over-identification. Standard errors are in parentheses. ***significant at 1%, ** significant at 5%, * significant at 10%

Table 41: The effect of bank diversification on the profitability of U.S. banks

UNITED STATES BANKS				UNITED STATES SAVINGS BANKS			UNITED STATES COMMERCIAL BANKS			UNITED STATES COOPERATIVE BANKS		
	PROFITABILITY			PROFITABILITY			PROFITABILITY			PROFITABILITY		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
VARIABLES	NIM	PROF	ROA	NIM	PROF	ROA	NIM	PROF	ROA	NIM	PROF	ROA
LAG	0.860***	0.864***	0.899***	0.813***	0.713***	0.671***	0.947***	1.045***	0.893***	0.825***	0.616***	0.642***
	(0.00135)	(0.00121)	(0.00120)	(0.0120)	(0.0118)	(0.0154)	(0.00153)	(0.000351)	(0.00136)	(0.00935)	(0.0111)	(0.0112)
GDP	0.0241*	0.000241***	0.359***	0.148***	0.00131***	0.523***	0.0341**	40,929***	0.482***	-0.0132*	0.000642***	0.0658***
	(0.0129)	(0.000103)	(0.0165)	(0.0194)	(0.000260)	(0.0141)	(0.0136)	-1,398	(0.0162)	(0.00728)	(7.30e-05)	(0.00767)
INFL	0.0228***	0.000408***	-0.163***	-0.0789***	-0.00181***	-0.363***	0.000934	-15,709***	-0.205***	0.0894***	-0.000211***	-0.0243***
	(0.00699)	(8.91e-05)	(0.0114)	(0.0128)	(0.000148)	(0.00909)	(0.00783)	(832.7)	(0.0127)	(0.00437)	(5.92e-05)	(0.00607)
PUBD	0.0158***	-0.000114*	0.126***	0.0864***	0.000991***	0.233***	0.0275***	12,757***	0.157***	-0.0152***	0.000251***	0.0270***
	(0.00463)	(6.13e-05)	(0.00794)	(0.00854)	(9.89e-05)	(0.00609)	(0.00470)	(398.3)	(0.00805)	(0.00318)	(3.32e-05)	(0.00348)
UNE	-0.000798	-0.000719***	0.0276**	0.0292***	0.000386***	0.130***	-0.0123	1,327	-0.0144	-0.0271***	-6.28e-05	-0.00201
	(0.00809)	(0.000111)	(0.0123)	(0.0105)	(0.000113)	(0.00686)	(0.0106)	(993.1)	(0.0129)	(0.00423)	(5.59e-05)	(0.00587)
SIZE	0.101***	-0.00153**	-0.142***	0.00870	3.33e-05	-0.00995	0.117***	30,578***	-0.289***	0.0616***	0.000113	0.00829

		*										
	(0.0109)	(0.000218)	(0.00618)	(0.0150)	(0.000210)	(0.0137)	(0.0120)	-1,295	(0.0203)	(0.00550)	(8.66e-05)	(0.00853)
INT	0.000166***	-1.50e-06***	-0.000118***	-0.0105	0.00291***	0.311***	-0.000135***	3.731***	0.000354***	-0.0207***	0.000211***	0.0224***
	(5.83e-06)	(9.11e-08)	(8.58e-06)	(0.0391)	(0.000681)	(0.0326)	(6.65e-06)	(0.605)	(7.86e-06)	(0.00298)	(2.04e-05)	(0.00199)
LEND	0.547***	-0.00987***	-2.013***	-0.0726	-0.00588***	-0.570***	1.028***	-649,914***	-4.992***	0.463***	0.000397	0.0612*
	(0.0832)	(0.00172)	(0.163)	(0.121)	(0.00201)	(0.104)	(0.133)	-38,176	(0.203)	(0.0460)	(0.000369)	(0.0359)
LIQ	-0.00581***	6.23e-05***	-0.00685***	-0.00470***	-5.91e-05***	-0.00494***	-0.00417**	-6,288***	-0.0149***	0.00253***	-1.02e-05**	-0.00106**
	(0.000983)	(1.85e-05)	(0.00183)	(0.00108)	(1.75e-05)	(0.000831)	(0.00164)	(370.2)	(0.00221)	(0.000548)	(4.52e-06)	(0.000465)
DIVA	-0.738***	-0.0212***	-1.595***	0.309**	-0.00477***	-0.259***	-0.207*	-367,386***	-1.268***	0.880***	-0.00341***	-0.382***
	(0.105)	(0.00189)	(0.132)	(0.121)	(0.00168)	(0.0631)	(0.121)	-21,781	(0.192)	(0.0500)	(0.000809)	(0.0895)
DIVI	-0.0708	-0.0227***	-2.008***	0.324***	0.00622***	0.520***	-0.0639	18,725***	-1.107***	0.881***	0.00422***	0.414***
	(0.0647)	(0.000201)	(0.0122)	(0.0389)	(0.000281)	(0.0310)	(0.0655)	-6,195	(0.0176)	(0.0710)	(0.000650)	(0.0747)
DIVIN	-0.00736***	3.39e-05**	0.00568***	-0.0133**	-0.00170***	-0.149***	-0.00805***	441.5***	0.00749***	-0.100***	-0.00127***	-0.0900**
	(0.00112)	(1.37e-05)	(0.00128)	(0.00616)	(6.13e-05)	(0.00920)	(0.000829)	(112.8)	(0.000792)	(0.0323)	(0.000360)	(0.0358)

AR(1)	-5.81	-1.27	-1.88	-2.4	-2.51	-2.41	-5.14	-1.64	-1.78	-4.48	-3.33	-3.36
(p-val AR(1))	0.00	0.205	0.060	0.016	0.012	0.016	0.00	0.100	0.075	0.00	0.001	0.001
AR(2)	0.97	0.89	0.11	1.76	0.43	-0.77	0.55	-0.68	0.14	0.28	-0.10	-0.24
(p-val AR(1))	0.331	0.376	0.914	0.078	0.671	0.441	0.581	0.496	0.887	0.777	0.924	0.811
Hansen	216.90	233.80	209.65	58.59	59.14	52.4	187.36	240.83	161.94	138.98	131.61	130.09
p-hansen	0.00	0.00	0.00	1.00	1.00	1.00	0.00	0.00	0.013	0.169	0.303	0.336
Constant	-2.886***	0.0565***	-8.988***	-8.861***	-0.0994***	-24.90***	-5.047***	-1.208e+06***	-8.019***	0.461	-0.0265***	-2.863***
	(0.532)	(0.00847)	(0.939)	(0.980)	(0.00957)	(0.677)	(0.502)	-54,658	-1.110	(0.327)	(0.00415)	(0.413)
Observations	3,003	3,003	3,003	315	315	315	1,908	1,908	1,908	770	770	770
Number of bank	601	601	601	63	63	63	382	382	382	154	154	154

Note: The table indicates the system-GMM results for the Eurozone sample of banks and its subgroups (commercial, cooperative and savings banks). The estimated model is the XTABOND2 developed by Roodman, (2009). The dependent variables are the measures of profitability (i. the net interest margin (NIM) ii. the ratio of profit before tax to total assets (PROF) iii. the return on average assets (ROA)), the measure of efficiency (EFF) estimated by the D.E.A. methodology, the measure of capital (CAP) estimated as the ratio of total equity to total assets and the measures of risk (i. insolvency risk (Z) and ii. Credit risk (CR)). LAG is the one period lagged of dependent variables. The independent variables are: the measures of diversification; asset diversification (DIVA), income diversification (DIVI) and non-interest income diversification (DIVNI), the bank-specific indicators; SIZE (the natural logarithm of total assets), LIQ (the ratio of liquid assets to total assets), INT (the ratio of gross loans to total deposits), LEND (the ratio of gross loans to total assets) and the environmental variables; GDP real growth rate (GDP), inflation rate (INFL), public debt (PUBD) and unemployment (UNE). AR(1) and AR(2) indicate the first-order and the second-order autocorrelation (Arellano-Bond tests). Hansen-J variable tests over-identification. Standard errors are in parentheses. ***significant at 1%, ** significant at 5%, * significant at 10%

4.5.2 The effect of bank diversification on efficiency

As concerns asset, capital and income diversification, the results (Table 42) indicate that the coefficient is negative and statistically highly significant for the efficiency indicators for the vast majority of the reported groups. Thus, we may conclude that the efficiency of both the Eurozone and the United States banking systems is negatively related to all the examined types of bank diversification. This outcome confirms the results of Alkhouri and Arouri, (2018), conveying that non-interest income diversification is negatively related with bank performance. It is also in line with the results of Wu et al., (2020), suggesting that this is an indirect influence of the increased risk levels that highly diversified banks have and could be attributed to the higher monitoring costs. However, our results seem to conflict with those of Chen et al., (2018) and Moudud-Ul-Huq et al., (2019) which suggest that there is no significant relationship between those two parameters.

Concerning the bank-specific indicators, the impact of the lending strategy on efficiency depends on whether the bank belongs to the Eurozone or the U.S. banking group. More precisely, a rise in lending activity may precede an increase in the efficiency of Eurozone banks and U.S. cooperative banks, while it negatively affects the efficiency of the other two U.S. banking samples. Regarding the intermediation ratio, it is noteworthy that bank efficiency is positively related with all the reported groups of our sample, while Moudud-Ul-Huq et al., (2019) find no significant relationship. Lastly, efficiency is directly related with bank size for the greater part of the sample.

Our findings also help us to understand how the environmental variables are associated with bank efficiency. The majority of Eurozone banks are directly affected by an increase in both the unemployment rate and the inflation rate, whereas the greatest part of the U.S. banking groups are adversely affected. Moreover, the efficiency of the greatest part of the reported sample is adversely related to an increase in public debt (PUBD). Regarding inflation, we observe that the outcome depends on the bank type; the efficiency of savings banks is directly related with changes in inflation whereas the efficiency of cooperative banks is adversely related.

Table 42: The effect of bank diversification on bank efficiency

	EUROZONE BANKS	EUROZONE BANKS SAVINGS BANKS	EUROZONE BANKS COMMERCIAL BANKS	EUROZONE BANKS COOPERATIVE BANKS	UNITED STATES BANKS	UNITED STATES SAVINGS BANKS	UNITED STATES COMMERCIAL BANKS	UNITED STATES COOPERATIVE BANKS
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
VARIABLES	EFF	EFF	EFF	EFF	EFF	EFF	EFF	EFF
LAG	0.554***	0.710***	0.423***	0.792***	0.778***	0.757***	0.706***	0.763***
	(0.00178)	(0.0119)	(0.00173)	(0.00482)	(0.00392)	(0.0148)	(0.00342)	(0.00808)
GDP	0.00619***	-0.00243***	0.00243***	0.00426***	-0.0374***	0.0260***	-0.0139***	-0.0110***
	(0.000213)	(0.000522)	(0.000174)	(0.000198)	(0.00130)	(0.00201)	(0.000770)	(0.00131)
INFL	-0.000342*	0.00548***	0.0156***	-0.00224***	0.0249***	0.0275***	-0.0286***	-0.0169***
	(0.000189)	(0.000471)	(0.000233)	(0.000236)	(0.000833)	(0.00195)	(0.000808)	(0.00110)
PUBD	0.000144***	-0.000260***	-0.000390***	0.000315***	-0.0252***	-0.00541***	-0.00431***	-0.00246***
	(2.85e-05)	(6.28e-05)	(3.61e-05)	(9.20e-05)	(0.000456)	(0.000822)	(0.000442)	(0.000618)
UNE	-0.000229	0.00266***	0.00116***	0.000157	-0.00733***	0.0313***	-0.0105***	-0.0309***
	(0.000240)	(0.000391)	(0.000126)	(0.000687)	(0.000947)	(0.00216)	(0.000861)	(0.000985)
SIZE	0.0114***	-0.000647	0.00157**	-0.00181	-0.00271***	0.0249***	0.00596***	0.00365***
	(0.000442)	(0.000722)	(0.000747)	(0.00123)	(0.000923)	(0.00549)	(0.000591)	(0.00119)
INT	0.000289***	0.0784***	0.000325***	0.0149***	3.25e-05***	0.0893***	4.32e-05***	0.0165***
	(1.08e-06)	(0.00410)	(1.67e-06)	(0.00204)	(5.71e-07)	(0.0141)	(5.96e-07)	(0.000963)
LEND	0.0455***	0.0466***	0.135***	0.169***	-0.0428**	-0.158***	-0.0428***	0.0221***
	(0.00576)	(0.00885)	(0.00638)	(0.00914)	(0.0194)	(0.0291)	(0.0150)	(0.00543)
LIQ	0.000247***	-0.000555***	0.00132***	-0.000493***	-0.00226***	-0.000399	-0.00233***	-0.000107
	(5.66e-05)	(0.000152)	(5.88e-05)	(0.000122)	(0.000235)	(0.000327)	(0.000150)	(9.66e-05)
DIVA	-0.0144***	-0.0110**	-0.00133**	0.108***	-0.339***	-0.253***	-0.209***	-0.0272**
	(0.000953)	(0.00488)	(0.000596)	(0.00256)	(0.0145)	(0.0244)	(0.0100)	(0.0126)
DIVI	-7.29e-05***	-0.129***	-0.000919***	-0.0478***	0.130***	-0.142***	-0.00664	-0.304***
	(6.62e-07)	(0.00585)	(6.03e-06)	(0.00144)	(0.00732)	(0.00870)	(0.00636)	(0.0157)

DIVIN	-1.84e-06***	-0.00824***	0.0134***	1.70e-06***	-0.000337**	-0.0207***	-7.05e-05	-0.0888***
	(2.48e-07)	(0.000420)	(0.000382)	(4.50e-08)	(0.000170)	(0.00106)	(9.35e-05)	(0.00958)
AR(1)	-2.98	-7.91	-5.92	-3.74	-4.17	-2.62	-4.47	-4.00
(p-val AR(1))	0.003	0.00	0.00	0.00	0.00	0.009	0.00	0.00
AR(2)	-0.13	1.80	-1.86	1.53	-1.72	-0.75	-1.72	-1.38
(p-val AR(1))	0.896	0.071	0.063	0.127	0.086	0.452	0.085	0.167
Hansen	1188.46	286.27	248.22	354.57	283.35	57.21	238.34	129.38
p-hansen	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.352
Constant	-0.167***	0.133***	-0.0265**	0.0127	2.936***	0.150	0.745***	0.678***
	(0.00875)	(0.0121)	(0.0128)	(0.0186)	(0.0548)	(0.148)	(0.0427)	(0.0686)
Observations	7,915	2,04	1,365	4,19	3,003	315	1,908	770
Number of bank	1,584	408	273	838	601	63	382	154

Note: The table indicates the system-GMM results for the Eurozone sample of banks and its subgroups (commercial, cooperative and savings banks). The estimated model is the XTABOND2 developed by Roodman, (2009). The dependent variables are the measures of profitability (i. the net interest margin (NIM) ii. the ratio of profit before tax to total assets (PROF) iii. the return on average assets (ROA)), the measure of efficiency (EFF) estimated by the D.E.A. methodology, the measure of capital (CAP) estimated as the ratio of total equity to total assets and the measures of risk (i. insolvency risk (Z) and ii. Credit risk (CR)). LAG is the one period lagged of dependent variables. The independent variables are: the measures of diversification; asset diversification (DIVA), income diversification (DIVI) and non-interest income diversification (DIVNI), the bank-specific indicators; SIZE (the natural logarithm of total assets), LIQ (the ratio of liquid assets to total assets), INT (the ratio of gross loans to total deposits), LEND (the ratio of gross loans to total assets) and the environmental variables; GDP real growth rate (GDP), inflation rate (INFL), public debt (PUBD) and unemployment (UNE). AR(1) and AR(2) indicate the first-order and the second-order autocorrelation (Arellano-Bond tests). Hansen-J variable tests over-identification. Standard errors are in parentheses. ***significant at 1%, ** significant at 5%, * significant at 10%

4.5.3 The effect of bank diversification on capital

Table 43 presents the impact of bank diversification on capital. A positive relationship between bank diversification and capital may indicate that the non-traditional activities of banks require further capital, whereas a negative association may indicate that the new activities require less capital than the traditional activities (Meng et al., (2017), Landi et al., (2001)). According to our outcome, initially we observe that the U.S. savings banking group is the only examined group whose capital is positively and statistically highly significantly affected by an increase in all types of bank diversification.

Our results convey the following empirical evidence. Firstly, we may conclude that the levels of capital employed by Eurozone and U.S. banks are both positively and negatively associated with increases in asset diversification. More analytically, the capital of Eurozone and U.S. cooperative banks tend to decrease when asset diversification rises whereas the capital of the other three U.S. banking groups is directly associated with asset diversification. In recent literature, Chen et al., (2018) suggest that an increase in asset diversification may lead to a decrease in capital levels while Meng et al., (2017) provide evidence showing the relationship is direct.

Secondly, with the exception of Eurozone cooperative banks, an increase in income diversification of both Eurozone and U.S. banks has a favorable effect on bank capital, which is in line with Sissy et al., (2017).

Thirdly, the impact of non-interest income diversification on capital is negative for the greatest part of the reported sample. This outcome is also consistent with Sissy et al., (2017). More specifically, the coefficient is negative for the U.S. general sample of banks, U.S. cooperative and commercial banks as well as for Eurozone savings and commercial banks. On the other hand, it is only positive for the Eurozone general sample, Eurozone cooperative and U.S. savings banks.

As regards bank-specific indicators, our results provide evidence that an increase in bank liquidity and lending strategy tend to negatively affect bank capital for the vast majority of the reported sample and the outcome is statistically highly significant. The only exception is the U.S. savings banks' capital which is positively related with both liquidity and lending strategy indicators. In addition, bank capital for the majority of the reported groups is adversely related with the bank intermediation ratio and directly related with bank size.

Furthermore, we observe that bank capital in most samples is adversely related with an increase in public debt. The results also show that the type of banks and the banking union (the Eurozone or the U.S.) in which a bank belongs to, are very

important parameters affecting the impact of macroeconomic conditions on bank capital. Moreover, as concerns the unemployment rate, we see that cooperative banks react differently (positively) than the rest of the samples. Also, an increase in inflation precedes an increase in capital levels of U.S. banks and Eurozone cooperative banks, while it negatively affects capital levels of the remaining three groups of Eurozone banks. Finally, the U.S. banks' capital decreases after a rise in the real GDP growth rate, in contrast to Eurozone banks where an adverse relationship appears to prevail.

Table 43: The effect of bank diversification on bank capital

	EUROZONE BANKS	EUROZONE BANKS SAVINGS BANKS	EUROZONE BANKS COMMERCIAL BANKS	EUROZONE BANKS COOPERATIVE BANKS	UNITED STATES BANKS	UNITED STATES SAVINGS BANKS	UNITED STATES COMMERCIAL BANKS	UNITED STATES COOPERATIVE BANKS
	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
VARIABLES	CAP	CAP	CAP	CAP	CAP	CAP	CAP	CAP
LAG	0.900***	1.003***	0.743***	0.888***	0.804***	1.002***	0.742***	1.009***
	(0.00359)	(0.00113)	(0.00226)	(0.00398)	(0.00575)	(0.00724)	(0.00636)	(0.00562)
GDP	0.0599***	0.129***	0.107***	0.0955***	-0.0406	0.0166	-0.188***	0.177***
	(0.00703)	(0.00736)	(0.00763)	(0.00519)	(0.0330)	(0.0441)	(0.0386)	(0.0157)
INFL	-0.0707***	-0.169***	-0.232***	0.0311***	0.330***	0.342***	0.423***	0.215***
	(0.00984)	(0.00645)	(0.00986)	(0.00349)	(0.0215)	(0.0528)	(0.0268)	(0.0137)
PUBD	1.61e-07	-0.00106	0.00169	-0.0113***	-0.0793***	-0.0341	-0.135***	0.0140*
	(0.000841)	(0.000911)	(0.00111)	(0.00168)	(0.0106)	(0.0228)	(0.0127)	(0.00770)
UNE	0.0287***	-0.0119***	-0.0158**	0.0817***	-0.0462*	-0.0994***	-0.184***	0.185***
	(0.00712)	(0.00436)	(0.00733)	(0.0108)	(0.0237)	(0.0183)	(0.0250)	(0.0121)
SIZE	0.159***	0.0341***	-0.183***	-0.410***	0.0796***	0.145***	0.0653**	0.0571***
	(0.0118)	(0.0118)	(0.0144)	(0.0168)	(0.0285)	(0.0406)	(0.0263)	(0.0163)
INT	-8.29e-05***	0.143***	-0.00205***	1.729***	-0.000362***	-1.295***	-0.000124***	-0.0365***

	(2.20e-05)	(0.0218)	(3.24e-05)	(0.0355)	(1.79e-05)	(0.111)	(1.98e-05)	(0.00439)
LEND	-1.738***	-0.530***	-3.438***	-5.281***	-0.446	2.302***	-2.234***	-0.744***
	(0.130)	(0.115)	(0.168)	(0.119)	(0.286)	(0.405)	(0.234)	(0.101)
LIQ	-0.0223***	-0.00274	-0.0774***	-0.0240***	-0.0175***	0.0131***	-0.0603***	0.00170
	(0.00145)	(0.00185)	(0.000973)	(0.00138)	(0.00317)	(0.00421)	(0.00192)	(0.00121)
DIVA	-0.811***	-0.381***	-0.371***	-0.809***	2.097***	0.196	3.673***	-0.570***
	(0.0523)	(0.0592)	(0.0439)	(0.0497)	(0.211)	(0.498)	(0.335)	(0.185)
DIVI	0.000342***	0.00842	0.00347***	-0.393***	1.420***	0.730***	1.448***	1.005***
	(1.50e-05)	(0.0382)	(6.41e-05)	(0.0155)	(0.0671)	(0.165)	(0.165)	(0.132)
DIVIN	1.99e-05***	-0.0729***	-0.141***	1.10e-05***	-0.00777**	0.0719***	-0.0135***	-0.760***
	(1.64e-06)	(0.00305)	(0.0187)	(6.49e-07)	(0.00320)	(0.0210)	(0.00241)	(0.0926)
AR(1)	-2.52	-6.01	-2.11	-4.11	-2.34	-4.13	-2.23	-4.08
(p-val AR(1))	0.012	0.00	0.035	0.00	0.019	0.00	0.026	0.00
AR(2)	0.85	0.80	0.53	-0.82	-0.40	-0.54	-0.13	0.47
(p-val AR(1	0.394	0.426	0.594	0.415	0.686	0.591	0.896	0.640

))								
Hansen	396.69	235.87	169.98	1568.46	207.37	47.46	183.58	132.78
p-hansen	0.00	0.00	0.004	0.00	0.00	1.00	0.00	0.279
Constant	0.151	0.113	10.01***	9.455***	8.959***	0.356	18.40***	-3.408***
	(0.219)	(0.207)	(0.301)	(0.284)	-1.367	-2.325	-1.560	(0.869)
Observations	7,915	2,04	1,365	4,19	3,003	315	1,908	770
Number of bank	1,584	408	273	838	601	63	382	154

Note: The table indicates the system-GMM results for the Eurozone sample of banks and its subgroups (commercial, cooperative and savings banks). The estimated model is the XTABOND2 developed by Roodman, (2009). The dependent variables are the measures of profitability (i. the net interest margin (NIM) ii. the ratio of profit before tax to total assets (PROF) iii. the return on average assets (ROA)), the measure of efficiency (EFF) estimated by the D.E.A. methodology, the measure of capital (CAP) estimated as the ratio of total equity to total assets and the measures of risk (i. insolvency risk (Z) and ii. Credit risk (CR)). LAG is the one period lagged of dependent variables. The independent variables are: the measures of diversification; asset diversification (DIVA), income diversification (DIVI) and non-interest income diversification (DIVNI), the bank-specific indicators; SIZE (the natural logarithm of total assets), LIQ (the ratio of liquid assets to total assets), INT (the ratio of gross loans to total deposits), LEND (the ratio of gross loans to total assets) and the environmental variables; GDP real growth rate (GDP), inflation rate (INFL), public debt (PUBD) and unemployment (UNE). AR(1) and AR(2) indicate the first-order and the second-order autocorrelation (Arellano-Bond tests). Hansen-J variable tests over-identification. Standard errors are in parentheses. ***significant at 1%, ** significant at 5%, * significant at 10%

4.5.4 The effect of bank diversification on risk

For the purposes of our survey, we separately examine the effect of bank diversification on the default and credit risk of the Eurozone and U.S. banking systems. The results are reported in the following tables (Table 44 & Table 45) as well as in the Appendix (in columns 6 and 7 of Table 46- Table 53).

Our findings suggest that the coefficient of z-score for income diversification is positive for the majority of the examined banking institutions. As a result of this, an increase in income diversification leads to a rise in bank stability. This outcome could be attributed to economies of scope and concurs with Sanyaand Wolfe, (2010). Yet, Paltrinieri et al., (2020), Köhler, (2015), Lee et al., (2014), Moudud-Ul-Huq et al., (2019), Menget al., (2017), Demirgüç-Kuntand Huizinga, (2010) and Lepetit et al., (2008) conclude that the relationship between stability and income diversification is negative. However, Kim et al., (2020) provide evidence that income diversification is directly related with bank stability until an optimal level of income diversification, and beyond that level, the relationship is adverse.

The outcome is unfavorable for non-interest income and asset diversification, though, it seems that an increase in those two types of diversification negatively influences bank stability by increasing default risk. Confirming the findings ofLepetit (2008), Alkhouri&Arouri, (2018) as well as DeYoung and Torna, (2013), the results can be explained if we take into consideration the increased risk of non-traditional banking activities of highly diversified banks (Stiroh, (2006), Abuzayed et al., (2018)). However, Alkhouri&Arouri, (2018) suggest that asset diversification and bank stability are directly associated while Edirisuriyaet al., (2015) suggest that there is no significant connection.

Moreover, bank-specific indicators (liquidity, lending strategy and size) negatively affect the stability of the vast majority of the investigated banking institutions. This finding is in accordance with Abuzayed et al., (2018), indicating that “larger banks are more stable” while it contradicts the findings of Alkhouri & Arouri, (2018). As regards banks’ lending strategy, one potential explanation of the negative relationship could be that the higher lending activity is, the higher bank profitability and risk will be(Paltrinieri et al., (2020)). However, the therelationship between default risk and the intermediation ratio are mixed and therefore cannot lead to definitive conclusions. Similarly, Moudud-Ul-Huq et al., (2019) suggest that there is no significant relationship between stability and net interest income.

It is also very interesting to note that Eurozone and U.S. banks react differently to an increase in the unemployment rate; Eurozone banks’ default risk is negatively affected whilst U.S. banks’ default risk is positively influenced. In addition, the risk of

the vast majority of the reported banks is positively influenced when public debt and real GDP growthrate rise[17], while it is negatively affected when the inflation rate increases. This empirical evidence is in line with Alkhouri & Arouri, (2018).

Regarding credit risk, initially we observe that the coefficient of income diversification is positive for the majority of the sample indicating a greater ability for banks to absorb the cost of non-performing loans. A bank with highly diversified activities also has greater ability to collect information, which may help in avoiding lending to clients with poor credit history and as a result lower credit risk(Wu et al., (2020)). Conversely, non-interest income diversification is directly related with credit risk for most banking samples under investigation. Finally, concerning the effect of asset diversification, we may conclude that it depends on whether the bank belongs to the Eurozone or the U.S. banking group. More precisely, the credit risk of the U.S. banks and of the Eurozone general sample of banks is negatively linked with an increase in asset diversification, yet the risk of the three other Eurozone banking groups is positively related with increases in asset diversification.

Regarding the bank-specific indicators, we observe that the credit risk of the majority of banking institutions is negatively affected by an increase in liquidity, size and lending strategy. On the other hand, the bank intermediation ratio positively affects the stability of U.S. banking groups and the Eurozone general sample while it negatively affects the stability of the other three Eurozone banking groups. We also observe that the credit risk of the majority of the reported sample is directly affected by changes in public debtand real GDP growth rate. For the other two macroeconomic indicators (inflation and unemployment rate) the outcome is mixed, hence we may not draw any conclusions.

[17]According to Sanyaand Wolfe, 2010, GDP and bank risk are positively related because “banks take onhigher risk during periods of high economic growth. This is because economic booms canfuel credit expansion and undiscriminating diversification strategies.”.

Table 44: The effect of bank diversification on the default risk

	EUROZONE BANKS	EUROZONE BANKS SAVINGS BANKS	EUROZONE BANKS COMMERCIAL BANKS	EUROZONE BANKS COOPERATIVE BANKS	UNITED STATES BANKS	UNITED STATES SAVINGS BANKS	UNITED STATES COMMERCIAL BANKS	UNITED STATES COOPERATIVE BANKS
	-6	-6	-6	-6	-6	-6	-6	-6
VARIABLES	Z	Z	Z	Z	Z	Z	Z	Z
LAG	0.299***	0.449***	0.461***	0.648***	0.837***	0.947***	0.807***	0.973***
	(0.00476)	(0.00576)	(0.00180)	(0.00535)	(0.00589)	(0.0172)	(0.00522)	(0.00599)
GDP	-0.00102	-0.195***	-0.00137	0.0301***	-2.106***	-0.176***	-2.117***	-0.106***
	(0.00121)	(0.00200)	(0.000842)	(0.000615)	(0.0134)	(0.00547)	(0.0127)	(0.00179)
INFL	0.0290***	-0.0606***	0.0159***	0.0958***	1.825***	0.0720***	1.892***	0.0658***
	(0.00138)	(0.00165)	(0.00143)	(0.00108)	(0.00538)	(0.00515)	(0.00505)	(0.00152)
PUBD	-0.000373**	-0.00839***	-0.00113***	0.000698***	-0.914***	-0.0858***	-0.936***	-0.0642***
	(0.000183)	(0.000275)	(0.000140)	(0.000220)	(0.00416)	(0.00268)	(0.00396)	(0.000821)
UNE	0.00391**	0.00631***	0.00814***	0.0167***	-1.045***	-0.149***	-1.100***	-0.0896***
	(0.00189)	(0.00103)	(0.00101)	(0.00168)	(0.00366)	(0.00277)	(0.00386)	(0.00134)
SIZE	-0.0110***	-0.0287***	-0.0279***	-0.0159***	0.00668**	0.00778	-0.00499	-0.00480***
	(0.00289)	(0.00316)	(0.00172)	(0.00259)	(0.00307)	(0.00496)	(0.00352)	(0.00130)
INT	-0.000261***	0.441***	-0.000198***	0.116***	-2.94e-05***	-0.0636***	6.30e-06***	-0.00211***
	(3.74e-06)	(0.00548)	(4.67e-06)	(0.00512)	(1.47e-06)	(0.0207)	(1.46e-06)	(0.000506)
LEND	-0.160***	-0.548***	-0.429***	-0.862***	-0.0235	0.179***	-0.303***	-0.0385***
	(0.0398)	(0.0375)	(0.0126)	(0.0156)	(0.0251)	(0.0492)	(0.0283)	(0.00703)
LIQ	-0.000939**	-0.00292***	-0.00640***	-0.00485***	-0.000939***	0.000660	-0.00405***	0.000403***
	(0.000419)	(0.000506)	(8.69e-05)	(0.000123)	(0.000297)	(0.000580)	(0.000349)	(9.32e-05)
DIVA	-0.212***	0.919***	-0.0827***	-0.458***	-0.0755***	-0.0129	-0.110***	-0.0175
	(0.0135)	(0.00892)	(0.00580)	(0.00803)	(0.0250)	(0.0537)	(0.0247)	(0.0174)
DIVI	0.000190***	-0.358***	0.00226***	-0.0386***	-0.0514***	0.0649***	0.0743***	0.00180
	(2.23e-06)	(0.0138)	(1.27e-05)	(0.00199)	(0.00435)	(0.00940)	(0.00452)	(0.0103)

DIVIN	4.33e-06***	-0.000825	-0.0411***	4.59e-06***	-0.000210	-0.00830***	-0.000266	-0.0628***
	(2.91e-07)	(0.00119)	(0.00287)	(1.21e-07)	(0.000284)	(0.00163)	(0.000215)	(0.00787)
AR(1)	-10.74	-13.67	-6.49	-5.28	-7.00	-4.44	-5.99	-5.02
(p-val AR(1))	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AR(2)	12.32	4.45	5.59	1.31	-0.5	-0.21	-0.67	0.99
(p-val AR(1))	0.00	0.00	0.00	0.189	0.614	0.831	0.500	0.323
Hansen	1396.98	388.83	260.44	1369.22	187.39	46.97	149.98	130.32
p-hansen	0.00	0.00	0.00	0.00	0.00	1.00	0.056	0.331
Constant	2.062***	3.527***	1.905***	1.689***	102.7***	9.942***	105.6***	7.516***
	(0.0701)	(0.0656)	(0.0383)	(0.0443)	(0.481)	(0.296)	(0.458)	(0.0946)
Observations	7,915	2,04	1,365	4,19	3,003	315	1,908	770
Number of bank	1,584	408	273	838	601	63	382	154

Note: The table indicates the system-GMM results for the Eurozone sample of banks and its subgroups (commercial, cooperative and savings banks). The estimated model is the XTABOND2 developed by Roodman, (2009). The dependent variables are the measures of profitability (i. the net interest margin (NIM) ii. the ratio of profit before tax to total assets (PROF) iii. the return on average assets (ROA)), the measure of efficiency (EFF) estimated by the D.E.A. methodology, the measure of capital (CAP) estimated as the ratio of total equity to total assets and the measures of risk (i. insolvency risk (Z) and ii. Credit risk (CR)). LAG is the one period lagged of dependent variables. The independent variables are: the measures of diversification; asset diversification (DIVA), income diversification (DIVI) and non-interest income diversification (DIVNI), the bank-specific indicators; SIZE (the natural logarithm of total assets), LIQ (the ratio of liquid assets to total assets), INT (the ratio of gross loans to total deposits), LEND (the ratio of gross loans to total assets) and the environmental variables; GDP real growth rate (GDP), inflation rate (INFL), public debt (PUBD) and unemployment (UNE). AR(1) and AR(2) indicate the first-order and the second-order autocorrelation (Arellano-Bond tests). Hansen-J variable tests over-identification. Standard errors are in parentheses. ***significant at 1%, ** significant at 5%, * significant at 10%

Table 45: The effect of bank diversification on the credit risk

	EUROZONE BANKS	EUROZONE BANKS SAVINGS BANKS	EUROZONE BANKS COMMERCIAL BANKS	EUROZONE BANKS COOPERATIVE BANKS	UNITED STATES BANKS	UNITED STATES SAVINGS BANKS	UNITED STATES COMMERCIAL BANKS	UNITED STATES COOPERATIVE BANKS
	-7	-7	-7	-7	-7	-7	-7	-7
VARIABLES	CR	CR	cr	CR	CR	CR	CR	cr
LAG	0.116***	0.0555***	0.260***	0.376***	0.776***	0.740***	0.769***	0.643***
	(0.000956)	(0.00502)	(0.00190)	(0.00731)	(0.00313)	(0.00505)	(0.00326)	(0.00657)
GDP	0.000300*	-0.00149***	-0.000958***	-0.00226***	-0.000727***	0.000872***	-0.000996***	-0.00100***
	(0.000173)	(9.11e-05)	(3.70e-05)	(0.000120)	(3.41e-05)	(6.22e-05)	(4.04e-05)	(5.78e-05)
INFL	0.00960***	0.000877***	-0.00193***	0.000187***	-7.28e-05	-0.000251***	-0.000366***	0.000787***
	(0.000272)	(7.60e-05)	(3.40e-05)	(2.77e-05)	(5.33e-05)	(6.94e-05)	(4.88e-05)	(3.94e-05)
PUBD	-9.37e-05**	9.23e-05***	-5.86e-05***	-0.000113***	-0.000169***	0.000383***	-0.000208***	-0.000373***
	(4.31e-05)	(1.27e-05)	(4.26e-06)	(9.57e-06)	(1.76e-05)	(3.94e-05)	(2.07e-05)	(2.14e-05)
UNE	0.00824***	7.53e-05	0.000607***	0.000105	-0.000542***	0.000574***	-0.000494***	-0.000235***
	(0.000316)	(6.30e-05)	(2.45e-05)	(7.85e-05)	(5.32e-05)	(8.78e-05)	(5.23e-05)	(3.87e-05)
SIZE	-0.0215***	0.000741***	0.000356***	0.000436***	-0.000307***	-0.000612***	0.000791***	0.000411***
	(0.000447)	(8.99e-05)	(8.16e-05)	(0.000108)	(4.49e-05)	(0.000130)	(7.28e-05)	(7.89e-05)
INT	0.000109***	-0.00611***	-1.54e-05***	-0.00706***	2.70e-06***	0.00231***	6.74e-07***	-9.78e-05***
	(2.42e-06)	(0.000312)	(2.17e-07)	(0.000233)	(3.15e-08)	(0.000351)	(2.92e-08)	(3.71e-05)
LEND	-0.485***	0.0159***	0.0780***	0.0231***	0.0135***	0.0152***	0.00923***	0.00267***
	(0.00969)	(0.00153)	(0.00155)	(0.000758)	(0.000885)	(0.00102)	(0.000927)	(0.000414)
LIQ	-0.00302***	7.78e-05***	0.000799***	0.000408***	7.17e-05***	0.000191***	3.96e-05***	1.33e-06
	(9.81e-05)	(2.03e-05)	(1.44e-05)	(1.51e-05)	(1.01e-05)	(1.33e-05)	(1.07e-05)	(5.00e-06)
DIVA	0.00339**	-0.00181***	-0.00463***	-0.0136***	0.00753***	0.00939***	0.00354***	0.00742***
	(0.00141)	(0.000674)	(0.000267)	(0.000396)	(0.000599)	(0.000936)	(0.000679)	(0.000590)
DIVI	-3.00e-05***	0.00897***	-1.75e-05***	0.00288***	0.00290***	0.00154***	-0.0118***	8.96e-05
	(1.26e-06)	(0.000503)	(5.50e-07)	(0.000170)	(9.18e-05)	(0.000227)	(9.36e-05)	(0.000552)
DIVIN	2.02e-06***	-0.000305***	-0.00221***	-7.10e-08***	-2.92e-05***	0.00276***	-1.10e-05**	-0.00243***

	(1.04e-07)	(3.46e-05)	(0.000139)	(2.71e-09)	(9.07e-06)	(3.64e-05)	(5.18e-06)	(0.000367)
AR(1)	-1.02	-4.13	-2.05	-5.65	-1.95	-1.52	-1.70	-1.52
(p-val AR(1))	0.308	0.00	0.040	0.00	0.051	0.127	0.090	0.128
AR(2)	1	-1.27	1.39	1.11	-0.98	-1.13	-0.83	0.82
(p-val AR(1))	0.316	0.0204	0.164	0.267	0.327	0.260	0.406	0.411
Hansen	618.01	182.03	193.46	329.04	197.26	56.18	188.84	133.91
p-hansen	0.00	0.01	0.00	0.00	0.00	1.00	0.00	0.256
Constant	0.624***	-0.0251***	-0.0674***	-0.00621***	0.0143***	-0.0539***	0.0111***	0.0352***
	(0.0114)	(0.00193)	(0.00178)	(0.00149)	(0.00233)	(0.00626)	(0.00225)	(0.00301)
Observations	7,915	2,04	1,365	4,19	3,003	315	1,908	770
Number of bank	1,584	408	273	838	601	63	382	154

Note: The table indicates the system-GMM results for the Eurozone sample of banks and its subgroups (commercial, cooperative and savings banks). The estimated model is the XTABOND2 developed by Roodman, (2009). The dependent variables are the measures of profitability (i. the net interest margin (NIM) ii. the ratio of profit before tax to total assets (PROF) iii. the return on average assets (ROA)), the measure of efficiency (EFF) estimated by the D.E.A. methodology, the measure of capital (CAP) estimated as the ratio of total equity to total assets and the measures of risk (i. insolvency risk (Z) and ii. Credit risk (CR)). LAG is the one period lagged of dependent variables. The independent variables are: the measures of diversification; asset diversification (DIVA), income diversification (DIVI) and non-interest income diversification (DIVNI), the bank-specific indicators; SIZE (the natural logarithm of total assets), LIQ (the ratio of liquid assets to total assets), INT (the ratio of gross loans to total deposits), LEND (the ratio of gross loans to total assets) and the environmental variables; GDP real growth rate (GDP), inflation rate (INFL), public debt (PUBD) and unemployment (UNE). AR(1) and AR(2) indicate the first-order and the second-order autocorrelation (Arellano-Bond tests). Hansen-J variable tests over-identification. Standard errors are in parentheses. ***significant at 1%, ** significant at 5%, * significant at 10%

Section 4.6: Concluding Remarks

In this study, we investigate the influence of bank diversification on bank capital, risk, profitability and efficiency in a dynamic panel estimator. We also reveal how the influence differs depending on three specific parameters, that is (i) the type of diversification (asset, income, non-interest income diversification), (ii) the type of bank (commercial, cooperative and savings banks) and (iii) the country union (the United States and the Eurozone).

As regards bank diversification and profitability, initially we observe that the impact of income diversification on profitability is direct for the majority of the reported groups and that asset diversification negatively affects the net interest margin of most of the reported banks. Our review of the empirical literature leads to the conclusion that the banking union to which a bank belongs and the type of bank are significant parameters that need to be taken into consideration when investigating the effect of diversification on bank profitability. This happens because: (i) the profitability of Eurozone savings banks is the only examined banking group which is negatively affected by an increase in any type of diversification, (ii) the effect of asset diversification and non-interest income diversification on profitability depends on the banking union for the majority of the reported sample, as it is negative for U.S. banks and positive for Eurozone banking groups with the exception of Eurozone savings banks.

A similar pattern is observed with the relationship between capital and diversification, highlighting the fact that the outcome depends on the type of bank and whether the bank belongs to the Eurozone or the U.S. Our findings show that the U.S. savings banking group is the only examined group whose capital is positively affected by an increase in all the three types of bank diversification. We also conclude that, except for the Eurozone cooperative banks, an increase in the income diversification of both Eurozone and U.S. banks has a favorable effect on bank capital. Also, with the exception of U.S. cooperative banks, U.S. banking groups are directly associated with asset diversification, whereas the capital of Eurozone and U.S. cooperative banks tend to decrease when asset diversification rises. Finally, the impact of non-interest income diversification on capital is negative for the greatest part of the reported sample.

Furthermore, our results indicate that the impact of assets, capital and income diversification on bank efficiency is negative and statistically significant for the vast majority of the Eurozone and the United States banking institutions.

Our results indicate that income diversification precedes a decrease in both the credit and default risk for the vast majority of the reported sample. Thus, we may

conclude that income diversification enhances bank stability. While non-interest income diversification is directly related with default and credit risk for the greatest part of the sample and asset diversification negatively influences bank stability by increasing default risk. Finally, the effect of asset diversification on credit risk depends on whether the bank belongs to the Eurozone or the U.S.. The reason being is that the credit risk of U.S. banks and the Eurozone general sample of banks is negatively related with an increase in asset diversification, while the risk of the three other Eurozone banking groups is positively related with an increase in asset diversification.

Overall, we find consistent evidence that income diversification has substantial benefits when compared to other types of diversification since it positively affects stability, profitability as well as the capital of the majority of the reported banks, yet these benefits are not so great for Eurozone savings banks. By contrast, non-interest income diversification has the most unfavorable results for the reported groups. This occurs because non-interest income diversification decreases for all four dependent variables (efficiency, capital, stability and profitability),for the majority of the reported sample. Finally, the impact of asset diversification is mixed and is determined by whether a bank belongs to the Eurozone or the U.S.. Our conclusion is consistent with Moudud-Ul-Huq et al., (2019) for Asian countries after the global financial crisis, indicating that the impact of income diversification on performance and bank stability is positive and that of asset diversification varies across the reported countries.

It is also very important to note that some of the results diverge depending on the type of banking institution (commercial, cooperative or savings banks). This outcome is in line with Köhler, (2015) and emphasizes the importance of the incorporation of different bank types in the examined sample when investigating the effect of diversification on risk, capital, efficiency and profitability of banking institutions.

Our findings have substantial implications for shareholders, regulators and bank managers. Firstly, our results suggest that non-interest income diversification creates more threats than opportunities. In this regard, the supervision of non-traditional banking activities need to be reviewed and improved. Secondly, income diversification offers additional benefits for banks in comparison to asset diversification, which causes a mixed outcome. It is therefore advisable that bank managers ought to consider that various diversification strategies differently influence banking institutions when setting risk management policies, prioritizing banking activities and taking investment decisions. Thirdly, the efficiency of banking institutions is negatively affected by bank diversification and this outcome affects shareholders' interests. Fourthly, the impact of bank diversification on capital, risk, efficiency and profitability is dissimilar across different types of banks. Therefore,

bank managers should consider following different strategies for each category in order to be more benefitted by diversification and supervisors ought to separately analyze the impact of new regulations on each category of banks. Fifthly, the country union (the Eurozone or the U.S.) to which a bank belongs affects the examined relationship and needs to be taken into consideration.

Lastly, the limitation of our survey is that it does not provide evidence regarding which type of non-interest income is more beneficial for banks. Thus, our survey could be extended and enriched by employing(i) a data set covering more years after the global financial crisis, (ii)more capital indicators such as capital buffers and coco bonds and (iii) a number of market-based variables for example stock prices and their volatility.

Appendix D

Table 46: The effect of bank diversification on Eurozone banks

	EUROZONE BANKS						
		PROFITABILITY		EFFICIENCY	CAPITAL	RISK	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	NIM	PROF	ROA	EFF	CAP	Z	CR
LAG	0.851***	0.363***	0.337***	0.554***	0.900***	0.299***	0.116***
	(0.00102)	(0.00284)	(0.00249)	(0.00178)	(0.00359)	(0.00476)	(0.000956)
GDP	-0.00578***	0.000275***	0.0198***	0.00619***	0.0599***	-0.00102	0.000300*
	(0.00142)	(2.15e-05)	(0.00173)	(0.000213)	(0.00703)	(0.00121)	(0.000173)
INFL	0.00128	-0.000234***	-0.0132***	-0.000342*	-0.0707***	0.0290***	0.00960***
	(0.00146)	(1.94e-05)	(0.00188)	(0.000189)	(0.00984)	(0.00138)	(0.000272)
PUBD	0.000270	-3.07e-05***	-0.00335***	0.000144***	1.61e-07	-0.000373**	-9.37e-05**
	(0.000232)	(4.10e-06)	(0.000363)	(2.85e-05)	(0.000841)	(0.000183)	(4.31e-05)
UNE	0.0172***	0.000223***	0.0261***	-0.000229	0.0287***	0.00391**	0.00824***
	(0.00183)	(2.56e-05)	(0.00251)	(0.000240)	(0.00712)	(0.00189)	(0.000316)
SIZE	-0.0112***	-0.000539***	-0.0384***	0.0114***	0.159***	-0.0110***	-0.0215***
	(0.00233)	(4.83e-05)	(0.00347)	(0.000442)	(0.0118)	(0.00289)	(0.000447)
INT	-0.000251***	5.17e-06***	0.000433***	0.000289***	-8.29e-05***	-0.000261***	0.000109***
	(7.24e-06)	(5.89e-08)	(6.10e-06)	(1.08e-06)	(2.20e-05)	(3.74e-06)	(2.42e-06)
LEND	0.344***	-0.00381***	-0.133**	0.0455***	-1.738***	-0.160***	-0.485***
	(0.0296)	(0.000692)	(0.0542)	(0.00576)	(0.130)	(0.0398)	(0.00969)
LIQ	-0.00483***	-6.65e-06	0.00196***	0.000247***	-0.0223***	-0.000939**	-0.00302***
	(0.000358)	(8.36e-06)	(0.000604)	(5.66e-05)	(0.00145)	(0.000419)	(9.81e-05)
DIVA	-0.285***	0.00149***	0.0769***	-0.0144***	-0.811***	-0.212***	0.00339**

	(0.0150)	(0.000224)	(0.0186)	(0.000953)	(0.0523)	(0.0135)	(0.00141)
DIVI	-3.36e-05***	4.42e-06***	0.000434***	-7.29e-05***	0.000342***	0.000190***	-3.00e-05***
	(2.51e-06)	(2.97e-08)	(2.58e-06)	(6.62e-07)	(1.50e-05)	(2.23e-06)	(1.26e-06)
DIVIN	5.53e-06***	1.65e-07***	1.25e-05***	-1.84e-06***	1.99e-05***	4.33e-06***	2.02e-06***
	(1.02e-06)	(8.12e-09)	(6.53e-07)	(2.48e-07)	(1.64e-06)	(2.91e-07)	(1.04e-07)
AR(1)	-2.97	-3.16	-2.33	-2.98	-2.52	-10.74	-1.02
(p-val AR(1))	0.003	0.002	0.020	0.003	0.012	0.00	0.308
AR(2)	1.91	1.30	1.09	-0.13	0.85	12.32	1
(p-val AR(1))	0.057	0.194	0.276	0.896	0.394	0.00	0.316
Hansen	406.3	264.75	327.45	1188.46	396.69	1396.98	618.01
p-hansen	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Constant	0.153***	0.0141***	0.886***	-0.167***	0.151	2.062***	0.624***
	(0.0441)	(0.000859)	(0.0649)	(0.00875)	(0.219)	(0.0701)	(0.0114)
Observations	7,915	7,915	7,915	7,915	7,915	7,915	7,915
Number of bank	1,584	1,584	1,584	1,584	1,584	1,584	1,584

Note: The table indicates the system-GMM results for the Eurozone sample of banks. The estimated model is the XTABOND2 developed by Roodman, (2009). The dependent variables are the measures of profitability (i. the net interest margin (NIM) ii. the ratio of profit before tax to total assets (PROF) iii. the return on average assets (ROA)), the measure of efficiency (EFF) estimated by the D.E.A. methodology, the measure of capital (CAP) estimated as the ratio of total equity to total assets and the measures of risk (i. insolvency risk (Z) and ii. Credit risk (CR)). LAG is the one period lagged of dependent variables. The independent variables are: the measures of diversification; asset diversification (DIVA), income diversification (DIVI) and non-interest income diversification (DIVNI), the bank-specific indicators; SIZE (the natural logarithm of total assets), LIQ (the ratio of liquid assets to total assets), INT (the ratio of gross loans to total deposits), LEND (the ratio of gross loans to total assets) and the environmental variables; GDP real growth rate (GDP), inflation rate (INFL), public debt (PUBD) and unemployment (UNE). AR(1) and AR(2) indicate the first-order and the second-order autocorrelation (Arellano-Bond tests). Hansen-J variable tests over-identification. Standard errors are in parentheses. ***significant at 1%, ** significant at 5%, * significant at 10%

Table 47: The effect of bank diversification on Eurozone savings banks

EUROZONE BANKS SAVINGS BANKS							
	PROFITABILITY			EFFICIENCY	CAPITAL	RISK	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	NIM	PROF	ROA	EFF	CAP	Z	CR
LAG	0.894***	0.379***	0.305***	0.710***	1.003***	0.449***	0.0555***
	(0.00319)	(0.00148)	(0.00114)	(0.0119)	(0.00113)	(0.00576)	(0.00502)
GDP	-0.0164***	0.000412***	0.0308***	-0.00243***	0.129***	-0.195***	-0.00149***
	(0.00265)	(2.55e-05)	(0.00141)	(0.000522)	(0.00736)	(0.00200)	(9.11e-05)
INFL	-0.0108***	-0.000255***	-0.00664***	0.00548***	-0.169***	-0.0606***	0.000877***
	(0.00185)	(2.27e-05)	(0.00129)	(0.000471)	(0.00645)	(0.00165)	(7.60e-05)
PUBD	0.000796***	-7.26e-05***	-0.00667***	-0.000260***	-0.00106	-0.00839***	9.23e-05***
	(0.000259)	(3.18e-06)	(0.000217)	(6.28e-05)	(0.000911)	(0.000275)	(1.27e-05)
UNE	0.00837***	0.000270**	0.0296***	0.00266***	-	0.00631**	7.53e-05

		*			0.0119***	*	
	(0.00179)	(1.72e-05)	(0.00108)	(0.000391)	(0.00436)	(0.00103)	(6.30e-05)
SIZE	-0.0649***	-0.00121***	-0.0883***	-0.000647	0.0341***	-0.0287***	0.000741***
	(0.00344)	(3.01e-05)	(0.00197)	(0.000722)	(0.0118)	(0.00316)	(8.99e-05)
INT	-0.102***	0.00930***	0.836***	0.0784***	0.143***	0.441***	-0.00611***
	(0.00769)	(7.74e-05)	(0.00442)	(0.00410)	(0.0218)	(0.00548)	(0.000312)
LEND	0.301***	-0.0148***	-1.103***	0.0466***	-0.530***	-0.548***	0.0159***
	(0.0310)	(0.000623)	(0.0378)	(0.00885)	(0.115)	(0.0375)	(0.00153)
LIQ	-0.000971*	-4.48e-05***	-0.00168***	-0.000555***	-0.00274	-0.00292***	7.78e-05***
	(0.000511)	(5.65e-06)	(0.000342)	(0.000152)	(0.00185)	(0.000506)	(2.03e-05)
DIVA	-0.322***	-0.000214	-0.0421***	-0.0110**	-0.381***	0.919***	-0.00181***
	(0.0170)	(0.000180)	(0.0109)	(0.00488)	(0.0592)	(0.00892)	(0.000674)
DIVI	-0.0956***	-0.0112***	-0.967***	-0.129***	0.00842	-0.358***	0.00897***
	(0.0102)	(0.000144)	(0.00870)	(0.00585)	(0.0382)	(0.0138)	(0.000503)
DIVIN	-0.0298***	-0.000977***	-0.0667***	-0.00824***	-0.0729***	-0.000825	-0.000305***
	(0.00117)	(7.78e-06)	(0.000481)	(0.000420)	(0.00305)	(0.00119)	(3.46e-05)
AR(1)	-5.72	-3.02	-2.27	-7.91	-6.01	-13.67	-4.13
(p-val AR(1))	0.00	0.003	0.023	0.00	0.00	0.00	0.00
AR(2)	1.88	0.99	-0.15	1.80	0.80	4.45	-1.27
(p-val AR(1))	0.060	0.321	0.877	0.071	0.426	0.00	0.0204
Hansen	184.05	696.62	216.99	286.27	235.87	388.83	182.03
p-hansen	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Constant	1.015***	0.0315***	2.204***	0.133***	0.113	3.527***	-0.0251***
	(0.0570)	(0.000693)	(0.0478)	(0.0121)	(0.207)	(0.0656)	(0.00193)
Observations	2,040	2,040	2,040	2,040	2,040	2,040	2,040
Number of bank	408	408	408	408	408	408	408

Note: The table indicates the system-GMM results for the Eurozone saving banks. The estimated model is the XTABOND2 developed by Roodman, (2009). The dependent variables are the measures of profitability (i. the net interest margin (NIM) ii. the ratio of profit before tax to total assets (PROF) iii. the return on average assets (ROA)), the measure of efficiency (EFF) estimated by the D.E.A. methodology, the measure of capital (CAP) estimated as the ratio of total equity to total assets and the measures of risk (i. insolvency risk (Z) and ii. Credit risk (CR)). LAG is the one period lagged of dependent variables. The independent variables are: the measures of diversification; asset diversification (DIVA), income diversification (DIVI) and non-interest income diversification (DIVNI), the bank-specific indicators; SIZE (the natural logarithm of total assets), LIQ (the ratio of liquid assets to total assets), INT (the ratio of gross loans to total deposits), LEND (the ratio of gross loans to total assets) and the environmental variables; GDP real growth rate (GDP), inflation rate (INFL), public debt (PUBD) and unemployment (UNE). AR(1) and AR(2) indicate the first-order and the second-order autocorrelation (Arellano-Bond tests). Hansen-J variable tests over-identification. Standard errors are in parentheses. ***significant at 1%, ** significant at 5%, * significant at 10%

Table 48: The effect of bank diversification on Eurozone commercial banks

EUROZONE BANKS COMMERCIAL BANKS							
	PROFITABILITY			EFFICIENCY	CAPITAL	RISK	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	NIM	PROF	ROA	EFF	CAP	Z	CR

LAG	0.856***	0.356***	0.308***	0.423***	0.743***	0.461***	0.260***
	(0.000725)	(0.00121)	(0.00148)	(0.00173)	(0.00226)	(0.00180)	(0.00190)
GDP	-0.0101***	0.000196***	0.0101***	0.00243***	0.107***	-0.00137	-0.000958***
	(0.00160)	(2.50e-05)	(0.00207)	(0.000174)	(0.00763)	(0.000842)	(3.70e-05)
INFL	-0.0546***	-0.000810***	-0.0831***	0.0156***	-0.232***	0.0159***	-0.00193***
	(0.00255)	(3.00e-05)	(0.00248)	(0.000233)	(0.00986)	(0.00143)	(3.40e-05)
PUBD	-0.00164***	-4.54e-05***	-0.00507***	-0.000390***	0.00169	-0.00113***	-5.86e-05***
	(0.000193)	(3.00e-06)	(0.000298)	(3.61e-05)	(0.00111)	(0.000140)	(4.26e-06)
UNE	0.00267**	-6.58e-05***	0.00111	0.00116***	-0.0158**	0.00814***	0.000607***
	(0.00109)	(1.66e-05)	(0.00191)	(0.000126)	(0.00733)	(0.00101)	(2.45e-05)
SIZE	0.000591	-0.000930***	-0.0208***	0.00157**	-0.183***	-0.0279***	0.000356***
	(0.00296)	(7.72e-05)	(0.00482)	(0.000747)	(0.0144)	(0.00172)	(8.16e-05)
INT	-0.000799***	9.61e-06***	0.00120***	0.000325***	-0.00205***	-0.000198***	-1.54e-05***
	(8.48e-06)	(1.46e-07)	(1.64e-05)	(1.67e-06)	(3.24e-05)	(4.67e-06)	(2.17e-07)
LEND	0.340***	-0.00920***	-1.255***	0.135***	-3.438***	-0.429***	0.0780***
	(0.0228)	(0.000494)	(0.0453)	(0.00638)	(0.168)	(0.0126)	(0.00155)
LIQ	-0.00938***	7.32e-07	0.000451	0.00132***	-0.0774***	-0.00640***	0.000799***
	(0.000360)	(3.86e-06)	(0.000340)	(5.88e-05)	(0.000973)	(8.69e-05)	(1.44e-05)
DIVA	-0.105***	0.00338***	0.157***	-0.00133**	-0.371***	-0.0827***	-0.00463***
	(0.00892)	(0.000146)	(0.0111)	(0.000596)	(0.0439)	(0.00580)	(0.000267)
DIVI	0.000150***	2.77e-05***	0.00216***	-0.000919***	0.00347***	0.00226***	-1.75e-05***
	(1.29e-05)	(3.34e-07)	(2.98e-05)	(6.03e-06)	(6.41e-05)	(1.27e-05)	(5.50e-07)
DIVIN	-0.0228***	0.000151**	0.00798	0.0134***	-0.141***	-0.0411***	-0.00221***
	(0.00381)	(5.93e-05)	(0.00529)	(0.000382)	(0.0187)	(0.00287)	(0.000139)
AR(1)	-2.63	-2.5	-1.88	-5.92	-2.11	-6.49	-2.05
(p-val AR(1))	0.09	0.013	0.060	0.00	0.035	0.00	0.040
AR(2)	0.83	1.15	1.01	-1.86	0.53	5.59	1.39
(p-val AR(1))	0.404	0.251	0.312	0.063	0.594	0.00	0.164
Hansen	163.51	173.20	174.97	248.22	169.98	260.44	193.46
p-hansen	0.01	0.002	0.002	0.00	0.004	0.00	0.00
Constant	0.583***	0.0279***	1.821***	-0.0265**	10.01***	1.905***	-0.0674***
	(0.0547)	(0.00149)	(0.0954)	(0.0128)	(0.301)	(0.0383)	(0.00178)
Observations	1,365	1,365	1,365	1,365	1,365	1,365	1,365
Number of bank	273	273	273	273	273	273	273

Note: The table indicates the system-GMM results for the Eurozone saving banks. The estimated model is the XTABOND2 developed by Roodman, (2009). The dependent variables are the measures of profitability (i. the net interest margin (NIM) ii. the ratio of profit before tax to total assets (PROF) iii. the return on average assets (ROA)), the measure of efficiency (EFF) estimated by the D.E.A. methodology, the measure of capital (CAP) estimated as the ratio of total equity to total assets and the measures of risk (i. insolvency risk (Z) and ii. Credit risk (CR)). LAG is the one period lagged of dependent variables. The independent variables are: the measures of diversification; asset diversification (DIVA), income diversification (DIVI) and non-interest income diversification (DIVNI), the bank-specific indicators; SIZE (the natural logarithm of total assets), LIQ (the ratio of liquid assets to

total assets), INT (the ratio of gross loans to total deposits), LEND (the ratio of gross loans to total assets) and the environmental variables; GDP real growth rate (GDP), inflation rate (INFL), public debt (PUBD) and unemployment (UNE). AR(1) and AR(2) indicate the first-order and the second-order autocorrelation (Arellano-Bond tests). Hansen-J variable tests over-identification. Standard errors are in parentheses. ***significant at 1%, ** significant at 5%, * significant at 10%

Table 49: The effect of bank diversification on Eurozone cooperative banks

EUROZONE BANKS COOPERATIVE BANKS							
		PROFITABILITY		EFFICIENCY	CAPITAL	RISK	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	NIM	PROF	ROA	EFF	CAP	Z	CR
LAG	0***	0.315***	0.287***	0.792***	0.888***	0.648***	0.376***
	(0)	(0.00704)	(0.00632)	(0.00482)	(0.00398)	(0.00535)	(0.00731)
GDP	1.15e-08***	0.000130***	0.00369***	0.00426***	0.0955***	0.0301***	-0.00226***
	(0)	(1.57e-05)	(0.000707)	(0.000198)	(0.00519)	(0.000615)	(0.000120)
INFL	-3.04e-08***	0.000194***	0.0285***	-0.00224***	0.0311***	0.0958***	0.000187***
	(0)	(1.38e-05)	(0.00147)	(0.000236)	(0.00349)	(0.00108)	(2.77e-05)
PUBD	5.05e-10***	1.75e-05***	0.00207***	0.000315***	-0.0113***	0.000698***	-0.000113***
	(0)	(4.77e-06)	(0.000392)	(9.20e-05)	(0.00168)	(0.000220)	(9.57e-06)
UNE	-1.85e-08***	0.000218***	0.0308***	0.000157	0.0817***	0.0167***	0.000105
	(0)	(3.67e-05)	(0.00301)	(0.000687)	(0.0108)	(0.00168)	(7.85e-05)
SIZE	1.54e-07***	9.41e-05	0.0140***	-0.00181	-0.410***	-0.0159***	0.000436***
	(0)	(5.99e-05)	(0.00474)	(0.00123)	(0.0168)	(0.00259)	(0.000108)
INT	-1.02e-07***	0.00169***	0.0722***	0.0149***	1.729***	0.116***	-0.00706***
	(0)	(0.000107)	(0.00982)	(0.00204)	(0.0355)	(0.00512)	(0.000233)
LEND	5.14e-07***	-0.0136***	-0.937***	0.169***	-5.281***	-0.862***	0.0231***
	(2.42e-10)	(0.000445)	(0.0405)	(0.00914)	(0.119)	(0.0156)	(0.000758)
LIQ	2.67e-09***	-0.000130***	-0.00966***	-0.000493***	-0.0240***	-0.00485***	0.000408***
	(0)	(6.46e-06)	(0.000469)	(0.000122)	(0.00138)	(0.000123)	(1.51e-05)
DIVA	-5.63e-08***	0.00143***	0.0386*	0.108***	-0.809***	-0.458***	-0.0136***
	(0)	(0.000125)	(0.0200)	(0.00256)	(0.0497)	(0.00803)	(0.000396)
DIVI	1.08e-07***	-0.000884***	-0.119***	-0.0478***	-0.393***	-0.0386***	0.00288***
	(0)	(5.16e-05)	(0.00482)	(0.00144)	(0.0155)	(0.00199)	(0.000170)
DIVIN	1***	1.02e-07***	7.51e-06***	1.70e-06***	1.10e-05***	4.59e-06***	-7.10e-08***
	(0)	(3.31e-09)	(3.11e-07)	(4.50e-08)	(6.49e-07)	(1.21e-07)	(2.71e-09)

AR(1)	-0.80	-5.46	-5.39	-3.74	-4.11	-5.28	-5.65
(p-val AR(1))	0.426	0.00	0.00	0.00	0.00	0.00	0.00
AR(2)	0.45	1.93	1.97	1.53	-0.82	1.31	1.11
(p-val AR(1))	0.655	0.054	0.049	0.127	0.415	0.189	0.267
Hansen	2.8e+10	277.74	282.26	354.57	1568.46	1369.22	329.04
p-hansen	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Constant	-2.02e-06***	0.00816***	0.345***	0.0127	9.455***	1.689***	-0.00621***
	(7.87e-10)	(0.000786)	(0.0682)	(0.0186)	(0.284)	(0.0443)	(0.00149)
Observations	4,190	4,190	4,190	4,190	4,190	4,190	4,190
Number of bank	838	838	838	838	838	838	838

Note: The table indicates the system-GMM results for the Eurozone saving banks. The estimated model is the XTABOND2 developed by Roodman, (2009). The dependent variables are the measures of profitability (i. the net interest margin (NIM) ii. the ratio of profit before tax to total assets (PROF) iii. the return on average assets (ROA)), the measure of efficiency (EFF) estimated by the D.E.A. methodology, the measure of capital (CAP) estimated as the ratio of total equity to total assets and the measures of risk (i. insolvency risk (Z) and ii. Credit risk (CR)). LAG is the one period lagged of dependent variables. The independent variables are: the measures of diversification; asset diversification (DIVA), income diversification (DIVI) and non-interest income diversification (DIVNI), the bank-specific indicators; SIZE (the natural logarithm of total assets), LIQ (the ratio of liquid assets to total assets), INT (the ratio of gross loans to total deposits), LEND (the ratio of gross loans to total assets) and the environmental variables; GDP real growth rate (GDP), inflation rate (INFL), public debt (PUBD) and unemployment (UNE). AR(1) and AR(2) indicate the first-order and the second-order autocorrelation (Arellano-Bond tests). Hansen-J variable tests over-identification. Standard errors are in parentheses. ***significant at 1%, ** significant at 5%, * significant at 10%

Table 50: The effect of bank diversification on U.S. banks

	UNITED STATES BANKS						
		PROFITABILITY		EFFICIENCY	CAPITAL	RISK	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	NIM	PROF	ROA	EFF	CAP	Z	CR
LAG	0.860***	0.864***	0.899***	0.778***	0.804***	0.837***	0.776***
	(0.00135)	(0.00121)	(0.00120)	(0.00392)	(0.00575)	(0.00589)	(0.00313)
GDP	0.0241*	0.000241**	0.359***	-0.0374***	-0.0406	-2.106***	-0.000727***
	(0.0129)	(0.000103)	(0.0165)	(0.00130)	(0.0330)	(0.0134)	(3.41e-05)
INFL	0.0228***	0.000408***	-0.163***	0.0249***	0.330***	1.825***	-7.28e-05
	(0.00699)	(8.91e-05)	(0.0114)	(0.000833)	(0.0215)	(0.00538)	(5.33e-05)
PUBD	0.0158***	-0.000114*	0.126***	-0.0252***	-0.0793***	-0.914***	-0.000169***
	(0.00463)	(6.13e-05)	(0.00794)	(0.000456)	(0.0106)	(0.00416)	(1.76e-05)
UNE	-0.000798	-0.000719***	0.0276**	-0.00733***	-0.0462*	-1.045***	-0.000542***
	(0.00809)	(0.000111)	(0.0123)	(0.000947)	(0.0237)	(0.00366)	(5.32e-05)
SIZE	0.101***	-0.00153***	-0.142***	-0.00271***	0.0796***	0.00668**	-0.000307***
	(0.0109)	(0.000218)	(0.00618)	(0.000923)	(0.0285)	(0.00307)	(4.49e-05)

INT	0.000166***	-1.50e-06***	-0.000118***	3.25e-05***	-0.000362***	-2.94e-05***	2.70e-06***
	(5.83e-06)	(9.11e-08)	(8.58e-06)	(5.71e-07)	(1.79e-05)	(1.47e-06)	(3.15e-08)
LEND	0.547***	-0.00987***	-2.013***	-0.0428**	-0.446	-0.0235	0.0135***
	(0.0832)	(0.00172)	(0.163)	(0.0194)	(0.286)	(0.0251)	(0.000885)
LIQ	-0.00581***	6.23e-05***	-0.00685***	-0.00226***	-0.0175***	-0.000939***	7.17e-05***
	(0.000983)	(1.85e-05)	(0.00183)	(0.000235)	(0.00317)	(0.000297)	(1.01e-05)
DIVA	-0.738***	-0.0212***	-1.595***	-0.339***	2.097***	-0.0755***	0.00753***
	(0.105)	(0.00189)	(0.132)	(0.0145)	(0.211)	(0.0250)	(0.000599)
DIVI	-0.0708	-0.0227***	-2.008***	0.130***	1.420***	-0.0514***	0.00290***
	(0.0647)	(0.000201)	(0.0122)	(0.00732)	(0.0671)	(0.00435)	(9.18e-05)
DIVIN	-0.00736***	3.39e-05**	0.00568***	-0.000337**	-0.00777**	-0.000210	-2.92e-05***
	(0.00112)	(1.37e-05)	(0.00128)	(0.000170)	(0.00320)	(0.000284)	(9.07e-06)
AR(1)	-5.81	-1.27	-1.88	-4.17	-2.34	-7.00	-1.95
(p-val AR(1))	0.00	0.205	0.060	0.00	0.019	0.00	0.051
AR(2)	0.97	0.89	0.11	-1.72	-0.40	-0.5	-0.98
(p-val AR(1))	0.331	0.376	0.914	0.086	0.686	0.614	0.327
Hansen	216.90	233.80	209.65	283.35	207.37	187.39	197.26
p-hansen	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Constant	-2.886***	0.0565***	-8.988***	2.936***	8.959***	102.7***	0.0143***
	(0.532)	(0.00847)	(0.939)	(0.0548)	(1.367)	(0.481)	(0.00233)
Observations	3,003	3,003	3,003	3,003	3,003	3,003	3,003
Number of bank	601	601	601	601	601	601	601

Note: The table indicates the system-GMM results for the Eurozone saving banks. The estimated model is the XTABOND2 developed by Roodman, (2009). The dependent variables are the measures of profitability (i. the net interest margin (NIM) ii. the ratio of profit before tax to total assets (PROF) iii. the return on average assets (ROA)), the measure of efficiency (EFF) estimated by the D.E.A. methodology, the measure of capital (CAP) estimated as the ratio of total equity to total assets and the measures of risk (i. insolvency risk (Z) and ii. Credit risk (CR)). LAG is the one period lagged of dependent variables. The independent variables are: the measures of diversification; asset diversification (DIVA), income diversification (DIVI) and non-interest income diversification (DIVNI), the bank-specific indicators; SIZE (the natural logarithm of total assets), LIQ (the ratio of liquid assets to total assets), INT (the ratio of gross loans to total deposits), LEND (the ratio of gross loans to total assets) and the environmental variables; GDP real growth rate (GDP), inflation rate (INFL), public debt (PUBD) and unemployment (UNE). AR(1) and AR(2) indicate the first-order and the second-order autocorrelation (Arellano-Bond tests). Hansen-J variable tests over-identification. Standard errors are in parentheses. ***significant at 1%, ** significant at 5%, * significant at 10%

Table 51: The effect of bank diversification on U.S. savings banks

	UNITED STATES SAVINGS BANKS						
	PROFITABILITY			EFFICIENCY	CAPITAL	RISK	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	NIM	PROF	ROA	EFF	CAP	Z	CR
LAG	0.813***	0.713***	0.671***	0.757***	1.002***	0.947***	0.740***
	(0.0120)	(0.0118)	(0.0154)	(0.0148)	(0.00724)	(0.0172)	(0.00505)
GDP	0.148***	0.00131***	0.523***	0.0260***	0.0166	-0.176***	0.000872***
	(0.0194)	(0.000260)	(0.0141)	(0.00201)	(0.0441)	(0.00547)	(6.22e-05)

INFL	-0.0789***	-0.00181***	-0.363***	0.0275***	0.342***	0.0720***	-0.000251***
	(0.0128)	(0.000148)	(0.00909)	(0.00195)	(0.0528)	(0.00515)	(6.94e-05)
PUBD	0.0864***	0.000991***	0.233***	-0.00541***	-0.0341	-0.0858***	0.000383***
	(0.00854)	(9.89e-05)	(0.00609)	(0.000822)	(0.0228)	(0.00268)	(3.94e-05)
UNE	0.0292***	0.000386***	0.130***	0.0313***	-0.0994***	-0.149***	0.000574***
	(0.0105)	(0.000113)	(0.00686)	(0.00216)	(0.0183)	(0.00277)	(8.78e-05)
SIZE	0.00870	3.33e-05	-0.00995	0.0249***	0.145***	0.00778	-0.000612***
	(0.0150)	(0.000210)	(0.0137)	(0.00549)	(0.0406)	(0.00496)	(0.000130)
INT	-0.0105	0.00291***	0.311***	0.0893***	-1.295***	-0.0636***	0.00231***
	(0.0391)	(0.000681)	(0.0326)	(0.0141)	(0.111)	(0.0207)	(0.000351)
LEND	-0.0726	-0.00588***	-0.570***	-0.158***	2.302***	0.179***	0.0152***
	(0.121)	(0.00201)	(0.104)	(0.0291)	(0.405)	(0.0492)	(0.00102)
LIQ	-0.00470***	-5.91e-05***	-0.00494***	-0.000399	0.0131***	0.000660	0.000191***
	(0.00108)	(1.75e-05)	(0.000831)	(0.000327)	(0.00421)	(0.000580)	(1.33e-05)
DIVA	0.309**	-0.00477***	-0.259***	-0.253***	0.196	-0.0129	0.00939***
	(0.121)	(0.00168)	(0.0631)	(0.0244)	(0.498)	(0.0537)	(0.000936)
DIVI	0.324***	0.00622***	0.520***	-0.142***	0.730***	0.0649***	0.00154***
	(0.0389)	(0.000281)	(0.0310)	(0.00870)	(0.165)	(0.00940)	(0.000227)
DIVIN	-0.0133**	-0.00170***	-0.149***	-0.0207***	0.0719***	-0.00830***	0.00276***
	(0.00616)	(6.13e-05)	(0.00920)	(0.00106)	(0.0210)	(0.00163)	(3.64e-05)
AR(1)	-2.4	-2.51	-2.41	-2.62	-4.13	-4.44	-1.52
(p-val AR(1))	0.016	0.012	0.016	0.009	0.00	0.00	0.127
AR(2)	1.76	0.43	-0.77	-0.75	-0.54	-0.21	-1.13
(p-val AR(1))	0.078	0.671	0.441	0.452	0.591	0.831	0.260
Hansen	58.59	59.14	52.4	57.21	47.46	46.97	56.18
p-hansen	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Constant	-8.861***	-0.0994***	-24.90***	0.150	0.356	9.942***	-0.0539***
	(0.980)	(0.00957)	(0.677)	(0.148)	(2.325)	(0.296)	(0.00626)
Observations	315	315	315	315	315	315	315
Number of bank	63	63	63	63	63	63	63

Note: The table indicates the system-GMM results for the Eurozone saving banks. The estimated model is the XTABOND2 developed by Roodman, (2009). The dependent variables are the measures of profitability (i. the net interest margin (NIM) ii. the ratio of profit before tax to total assets (PROF) iii. the return on average assets (ROA)), the measure of efficiency (EFF) estimated by the D.E.A. methodology, the measure of capital (CAP) estimated as the ratio of total equity to total assets and the measures of risk (i. insolvency risk (Z) and ii. Credit risk (CR)). LAG is the one period lagged of dependent variables. The independent variables are: the measures of diversification; asset diversification (DIVA), income diversification (DIVI) and non-interest income diversification (DIVNI), the bank-specific indicators; SIZE (the natural logarithm of total assets), LIQ (the ratio of liquid assets to total assets), INT (the ratio of gross loans to total deposits), LEND (the ratio of gross loans to total assets) and the environmental variables; GDP real growth rate (GDP), inflation rate (INFL), public debt (PUBD) and unemployment (UNE). AR(1) and AR(2) indicate the first-order and the second-order autocorrelation (Arellano-Bond tests). Hansen-J variable tests over-identification. Standard errors are in parentheses. ***significant at 1%, ** significant at 5%, * significant at 10%

Table 52: The effect of bank diversification on U.S. commercial banks

UNITED STATES COMMERCIAL BANKS							
		PROFITABILITY		EFFICIENCY	CAPITAL	RISK	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	NIM	PROF	ROA	EFF	CAP	Z	CR
LAG	0.947***	1.045***	0.893***	0.706***	0.742***	0.807***	0.769***
	(0.00153)	(0.000351)	(0.00136)	(0.00342)	(0.00636)	(0.00522)	(0.00326)
GDP	0.0341**	40,929***	0.482***	-0.0139***	-0.188***	-2.117***	-0.000996***
	(0.0136)	(1,398)	(0.0162)	(0.000770)	(0.0386)	(0.0127)	(4.04e-05)
INFL	0.000934	-15,709***	-0.205***	-0.0286***	0.423***	1.892***	-0.000366***
	(0.00783)	(832.7)	(0.0127)	(0.000808)	(0.0268)	(0.00505)	(4.88e-05)
PUBD	0.0275***	12,757***	0.157***	-0.00431***	-0.135***	-0.936***	-0.000208***
	(0.00470)	(398.3)	(0.00805)	(0.000442)	(0.0127)	(0.00396)	(2.07e-05)
UNE	-0.0123	1,327	-0.0144	-0.0105***	-0.184***	-1.100***	-0.000494***
	(0.0106)	(993.1)	(0.0129)	(0.000861)	(0.0250)	(0.00386)	(5.23e-05)
SIZE	0.117***	30,578***	-0.289***	0.00596***	0.0653**	-0.00499	0.000791***
	(0.0120)	(1,295)	(0.0203)	(0.000591)	(0.0263)	(0.00352)	(7.28e-05)
INT	-0.000135***	3.731***	0.000354***	4.32e-05***	-0.000124***	6.30e-06***	6.74e-07***
	(6.65e-06)	(0.605)	(7.86e-06)	(5.96e-07)	(1.98e-05)	(1.46e-06)	(2.92e-08)
LEND	1.028***	-649,914***	-4.992***	-0.0428***	-2.234***	-0.303***	0.00923***
	(0.133)	(38,176)	(0.203)	(0.0150)	(0.234)	(0.0283)	(0.000927)
LIQ	-0.00417**	-6,288***	-0.0149***	-0.00233***	-0.0603***	-0.00405***	3.96e-05***
	(0.00164)	(370.2)	(0.00221)	(0.000150)	(0.00192)	(0.000349)	(1.07e-05)
DIVA	-0.207*	-367,386***	-1.268***	-0.209***	3.673***	-0.110***	0.00354***
	(0.121)	(21,781)	(0.192)	(0.0100)	(0.335)	(0.0247)	(0.000679)
DIVI	-0.0639	18,725***	-1.107***	-0.00664	1.448***	0.0743***	-0.0118***
	(0.0655)	(6,195)	(0.0176)	(0.00636)	(0.165)	(0.00452)	(9.36e-05)
DIVIN	-0.00805***	441.5***	0.00749***	-7.05e-05	-0.0135***	-0.000266	-1.10e-05**
	(0.000829)	(112.8)	(0.000792)	(9.35e-05)	(0.00241)	(0.000215)	(5.18e-06)
AR(1)	-5.14	-1.64	-1.78	-4.47	-2.23	-5.99	-1.70
(p-val AR(1))	0.00	0.100	0.075	0.00	0.026	0.00	0.090
AR(2)	0.55	-0.68	0.14	-1.72	-0.13	-0.67	-0.83
(p-val AR(1))	0.581	0.496	0.887	0.085	0.896	0.500	0.406
Hansen	187.36	240.83	161.94	238.34	183.58	149.98	188.84
p-hansen	0.00	0.00	0.013	0.00	0.00	0.056	0.00
Constant	-5.047***	-1.208e+06***	-8.019***	0.745***	18.40***	105.6***	0.0111***
	(0.502)	(54,658)	(1.110)	(0.0427)	(1.560)	(0.458)	(0.00225)
Observations	1,908	1,908	1,908	1,908	1,908	1,908	1,908
Number of bank	382	382	382	382	382	382	382

Note: The table indicates the system-GMM results for the Eurozone saving banks. The estimated model is the XTABOND2 developed by Roodman, (2009). The dependent variables are the measures of profitability (i. the net interest margin (NIM) ii. the ratio of profit before tax to total assets (PROF) iii. the return on average assets (ROA)), the measure of efficiency (EFF) estimated by the D.E.A. methodology, the measure of capital (CAP) estimated as the ratio of total equity to total assets and the measures of risk (i. insolvency risk (Z) and ii. Credit risk (CR)). LAG is the one period lagged of dependent variables. The independent variables are: the measures of diversification; asset diversification (DIVA), income diversification (DIVI) and non-interest income diversification (DIVNI), the bank-specific indicators; SIZE (the natural logarithm of total assets), LIQ (the ratio of liquid assets to total assets), INT (the ratio of gross loans to total deposits), LEND (the ratio of gross loans to total assets) and the environmental variables; GDP real growth rate (GDP), inflation rate (INFL), public debt (PUBD) and unemployment (UNE). AR(1) and AR(2) indicate the first-order and the second-order autocorrelation (Arellano-Bond tests). Hansen-J variable tests over-identification. Standard errors are in parentheses. ***significant at 1%, ** significant at 5%, * significant at 10%

Table 53: The effect of bank diversification on U.S. cooperative banks

UNITED STATES COOPERATIVE BANKS							
	PROFITABILITY			EFFICIENCY	CAPITAL	RISK	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	NIM	PROF	ROA	EFF	CAP	z	cr
LAG	0.825***	0.616***	0.642***	0.763***	1.009***	0.973***	0.643***
	(0.00935)	(0.0111)	(0.0112)	(0.00808)	(0.00562)	(0.00599)	(0.00657)
GDP	-0.0132*	0.000642***	0.0658***	-0.0110***	0.177***	-0.106***	-0.00100***
	(0.00728)	(7.30e-05)	(0.00767)	(0.00131)	(0.0157)	(0.00179)	(5.78e-05)
INFL	0.0894***	-0.000211***	-0.0243***	-0.0169***	0.215***	0.0658***	0.000787***
	(0.00437)	(5.92e-05)	(0.00607)	(0.00110)	(0.0137)	(0.00152)	(3.94e-05)
PUBD	-0.0152***	0.000251***	0.0270***	-0.00246***	0.0140*	-0.0642***	-0.000373***
	(0.00318)	(3.32e-05)	(0.00348)	(0.000618)	(0.00770)	(0.000821)	(2.14e-05)
UNE	-0.0271***	-6.28e-05	-0.00201	-0.0309***	0.185***	-0.0896***	-0.000235***
	(0.00423)	(5.59e-05)	(0.00587)	(0.000985)	(0.0121)	(0.00134)	(3.87e-05)
SIZE	0.0616***	0.000113	0.00829	0.00365***	0.0571***	-0.00480***	0.000411***
	(0.00550)	(8.66e-05)	(0.00853)	(0.00119)	(0.0163)	(0.00130)	(7.89e-05)
INT	-0.0207***	0.000211***	0.0224***	0.0165***	-0.0365***	-0.00211***	-9.78e-05***
	(0.00298)	(2.04e-05)	(0.00199)	(0.000963)	(0.00439)	(0.000506)	(3.71e-05)
LEND	0.463***	0.000397	0.0612*	0.0221***	-0.744***	-0.0385***	0.00267***
	(0.0460)	(0.000369)	(0.0359)	(0.00543)	(0.101)	(0.00703)	(0.000414)
LIQ	0.00253***	-1.02e-05**	-0.00106**	-0.000107	0.00170	0.000403***	1.33e-06
	(0.000548)	(4.52e-06)	(0.000465)	(9.66e-05)	(0.00121)	(9.32e-05)	(5.00e-06)
DIVA	0.880***	-0.00341***	-0.382***	-0.0272**	-0.570***	-0.0175	0.00742***
	(0.0500)	(0.000809)	(0.0895)	(0.0126)	(0.185)	(0.0174)	(0.000590)
DIVI	0.881***	0.00422***	0.414***	-0.304***	1.005***	0.00180	8.96e-05
	(0.0710)	(0.000650)	(0.0747)	(0.0157)	(0.132)	(0.0103)	(0.000552)
DIVIN	-0.100***	-0.00127***	-0.0900**	-0.0888***	-0.760***	-0.0628***	-0.00243***
	(0.0323)	(0.000360)	(0.0358)	(0.00958)	(0.0926)	(0.00787)	(0.000367)
AR(1)	-4.48	-3.33	-3.36	-4.00	-4.08	-5.02	-1.52
(p-val AR(1))	0.00	0.001	0.001	0.00	0.00	0.00	0.128
AR(2)	0.28	-0.10	-0.24	-1.38	0.47	0.99	0.82
(p-val AR(1))	0.777	0.924	0.811	0.167	0.640	0.323	0.411
Hansen	138.98	131.61	130.09	129.38	132.78	130.32	133.91

p-hansen	0.169	0.303	0.336	0.352	0.279	0.331	0.256
Constant	0.461 (0.327)	-0.0265*** (0.00415)	-2.863*** (0.413)	0.678*** (0.0686)	-3.408*** (0.869)	7.516*** (0.0946)	0.0352*** (0.00301)
Observations	770	770	770	770	770	770	770
Number of bank	154	154	154	154	154	154	154

Note: The table indicates the system-GMM results for the Eurozone saving banks. The estimated model is the XTABOND2 developed by Roodman, (2009). The dependent variables are the measures of profitability (i. the net interest margin (NIM) ii. the ratio of profit before tax to total assets (PROF) iii. the return on average assets (ROA)), the measure of efficiency (EFF) estimated by the D.E.A. methodology, the measure of capital (CAP) estimated as the ratio of total equity to total assets and the measures of risk (i. insolvency risk (Z) and ii. Credit risk (CR)). LAG is the one period lagged of dependent variables. The independent variables are: the measures of diversification; asset diversification (DIVA), income diversification (DIVI) and non-interest income diversification (DIVNI), the bank-specific indicators; SIZE (the natural logarithm of total assets), LIQ (the ratio of liquid assets to total assets), INT (the ratio of gross loans to total deposits), LEND (the ratio of gross loans to total assets) and the environmental variables; GDP real growth rate (GDP), inflation rate (INFL), public debt (PUBD) and unemployment (UNE). AR(1) and AR(2) indicate the first-order and the second-order autocorrelation (Arellano-Bond tests). Hansen-J variable tests over-identification. Standard errors are in parentheses. ***significant at 1%, ** significant at 5%, * significant at 10%

Conclusion

Our thesis consists of four research areas investigating bank capital, risk, efficiency, profitability, diversification as well as integration and comparing the results of the Eurozone and the United States Banking Institutions in the post-crisis period. This section provides a brief summary and the main conclusions. It also includes the contributions, the policy implications together with the limitations and suggestions for further research.

The **first chapter** undertakes the task of examining the convergence of efficiency in the Eurozone, European and American banking markets which is of utmost importance as it sheds light on the process of banking integration.

Regarding the evolution of banking efficiency (first research question - *RQ1: How has the level of bank efficiency developed in the Eurozone, the European Union and the United States during the post-crisis period?)*, our findings show that the efficiency of the United States banking system is considerably higher, more than double, than that of the Eurozone and European Union banks. Moreover, throughout the reported period (2013-2018), the efficiency of United States banks increased about 80%, while that of the Eurozone and European Union banks is almost steady, fluctuating between 8%-11%. Finally, we notice that the efficiency of the European Union banking group is slightly increased, when compared to that of Eurozone banks.

The second research question (*RQ2,* also presented in Table 1) investigates whether the levels of bank efficiency vary depending on the different subgroups of banks (cooperative, commercial and savings banks). We observe that the efficiency of all the Eurozone banking sectors is considerably lower than that of the United States. Our results also provide evidence that the efficiency of cooperative banks is the highest reported in both Eurozone and United Stated banking and that the efficiency of commercial banks is the lowest reported.

We also test for bank convergence in order to address the research questions, related to integration, that were posed in our paper. The third research question (*RQ3*) examines whether the European, Eurozone and United States banking systems are integrated. Our findings suggest that there is no evidence of convergence across these banking sectors, when considering all banks. Therefore, the European, the Eurozone as well as the United States banking systems are not yet integrated.

The fourth research question (RQ4) aims at testing whether an advanced level of financial integration is associated with higher convergence of efficiency in banking. For this purpose, this thesis examines whether banking integration among Eurozone

countries has developed more than that of European countries. We compare the results of the above mentioned convergence analysis of European and Eurozone banking and also the speed of convergence. We find that the indicator of convergence and the speed of convergence of Eurozone banks are slightly higher than that of European Union banks. However, the difference is so minimal that it cannot help us to draw definitive conclusions.

Furthermore, our fifth research question (RQ5) is associated with the control of bank-specific barriers hampering European integration, and examines whether the integration of commercial, cooperative and savings Eurozone and United States banks is greater than the integration of the total sample of banks. Our findings suggest that the integration of savings and cooperative banks is less developed than that of the total sample of banks, as the indicator of convergence and the speed of convergence of Eurozone banks are higher than those reported for the banking subgroups. However, both the commercial Eurozone and United States banks are closer to convergence than the total sample of banks. Thus, the answer to the fifth research question can be positive only for commercial banks.

Additionally, we tried to determine whether the samples of the United States banks and the subgroups of commercial, cooperative and savings banks are more integrated than those of the Eurozone banks (*RQ6*). Our results indicate that the United States banks, apart from cooperative banks, are more integrated than the total sample of Eurozone banks throughout the reported period. Therefore, the forth hypothesis is confirmed.

In the **second chapter** of the thesis, we examine the development of bank risk, capital and efficiency of the Eurozone and the United States after the global financial crisis. In this stage of our analysis we aim at testing how the levels of bank capital and risk have developed in the post-crisis period *(RQ7).* Our findings indicate that during the reported period (2013-2018), the capital ratio of Eurozone banks steadily increases, while the capital ratio of U.S. banks reaches its lowest level in 2016. As for the risk ratio, we notice that the risk level of all banking groups and subgroups of our sample increases during the period investigated and peaks during the year 2018.

Concerning the eighth research question *(RQ8: How do the levels of bank capital and risk vary between Eurozone and U.S. banks?)*, our findings convey that the capital ratio of U.S. banks is significantly higher than that of Eurozone banks regardless of the type of bank. Moreover, the risk level of the Eurozone and U.S. banks vary mainly depending on the banking sector.

Regarding banking sectors and the ninth research question, we investigate whether the levels of bank capital, risk and efficiency diverge for different banking sectors *(RQ9).* Our findings convey that the efficiency of the U.S. commercial, cooperative

and savings banks is enhanced compared to that of Eurozone subgroups of banks. Moreover, we observe that commercial banks are the least efficient of banks in our sample, while the cooperative banks appear to be the most efficient among Eurozone and United States banks. It is also interesting to mention that the capital ratios of banks of the same sector in both the Eurozone and the U.S. have striking differences. Moreover, cooperative and savings banks attain the highest levels of risk compared to other types of banks and the general sample while the risk ratio of commercial banks is the lowest recorded. Interestingly, the risk level of U.S. commercial banks increased significantly and more than the risk of the other banking groups, that is 94.68%.

In the **third chapter** of this thesis, we investigate the interrelationship among risk, capital and efficiency in a simultaneous equation model. We provide empirical evidence of how the interrelationships and the managerial behaviours vary per type of bank (commercial, cooperative and savings banks) and per country union (Eurozone, United States).

Addressing the tenth research question, we examine the relationship between bank capital, risk and efficiency in the post-crisis period (*RQ10*). Our research reveals that an increase in capital may precede an increase in risk. This finding supports the Regulatory Hypothesis, rejects the Moral Hazard Hypothesis, and may question the effectiveness of the traditional capital adequacy regulation framework as a measure of stability of the banking system. Moreover, the empirical evidence also suggests that a rise in risk may precede an increase in capital. Therefore, the findings lead us to the conclusion that risk and capital are directly related regardless of the causality order. Our results also confirm the necessity to consider bank efficiency when implementing measures of financial stability, since an increase in efficiency levels may precede an increase in risk. Hence, the Cost Skimming Hypothesis is accepted for the majority of the bank groups in our sample whilst the Bad Management Hypothesis is only accepted for Eurozone cooperative banks.

Additionally, our findings indicate that capital affects the efficiency of all banks in our sample positively, with one exception which is that of U.S. savings banks. Hence, the Shareholders-Managers Hypothesis is only accepted for U.S. savings banks and for this reason the shareholders of U.S. savings banks ought to carefully monitor agency costs. The findings also suggest that the type of banking institutions is a factor that should be considered, especially as an explanation variable for bank efficiency. More specifically, an increase in risk may precede a decline in the levels of efficiency of commercial banks and an increase in the levels of efficiency of savings banks. Thus, we accept the Bad Luck Hypothesis for commercial banks and reject it for savings banks.

Moreover, we examine how the relationship among capital, risk and efficiency differs depending on the banking sector (*RQ13) and* we may conclude that the relationship between risk and capital and risk and efficiency does not depend on the banking sector of the reported bank, whilst the relationship between capital and efficiency may differ depending on the banking sector in which a bank belongs.

We also investigate the eleventh research question which aims at testing the influence of the environmental variables and the explanatory variables on the Eurozone and the U.S. banks *(RQ11)*. As concerns the explanatory variables (liquidity, lending specialization ratio as well as size) our findings reveal some interesting conclusions. Initially, we observe that the ratio of liquid assets to total assets has a negative effect on risk, while the relationship between liquidity and efficiency is direct for the majority of banks in our sample. Secondly, our results provide evidence that the lending specialization ratio (gross loans to total assets) directly affects the efficiency of the majority of the banks studied, implying that banking institutions with higher gross loans to assets ratios are more efficient, and banks with higher levels of efficiency successfully increase their lending levels. Lastly, the size variable precedes an increase in bank efficiency, irrespective of the type and location of banks.

As regards the environmental variables, we observe that public debt and unemployment impact negatively on risk and positively on bank capital. Moreover, the impact of GDP real growth rate on capital is positive and statistically significant, whereas the influence of the inflation rate on capital is negative for the majority of banks. Regarding the effect of the inflation rate and unemployment on efficiency, the results convey that the banking sector is a significant factor that should be taken into consideration.

As concerns the twelfth research question of our study (*RQ12: How does the relationship among capital, risk and efficiency vary between Eurozone and U.S. banks?*), we observe that the majority results for the relationships among risk, capital and efficiency do not differ for the two different banking groups. However, it is interesting to note that the findings lead us to the conclusion that bank location (the Eurozone or the United States) is a very essential factor in regard to i.) the effect of GBP real growth rate and public debt on efficiency ii.) the effect of real growth rate and inflation rate on risk.

In the **fourth chapter** of this thesis, we investigate the influence of bank diversification on bank capital, risk, profitability and efficiency in a dynamic panel estimator. We also reveal how the influence differs depending on three specific parameters, that is (i) the type of diversification (asset, income, non-interest income), (ii) the type of bank (commercial, cooperative and savings banks) and (iii) the country union (the United States and the Eurozone).

As regards the fourteenth research question(*RQ14: How does diversification affect the profitability of banking institutions in the Eurozone and the United States in the post-crisis period?*), we examine the effect of bank diversification on profitability. Initially we observe that the impact of income diversification on profitability is direct for the majority of the reported groups and that asset diversification negatively affects the net interest margin of most of the reported banks. Our review of the empirical literature leads to the conclusion that the banking union to which a bank belongs and the type of bank are significant parameters that need to be taken into consideration when investigating the effect of diversification on bank profitability. This happens because: (i) the profitability of Eurozone savings banks is the only examined banking group which is negatively affected by an increase in any type of diversification, (ii) the effect of asset diversification and non-interest income diversification on profitability depends on the banking union for the majority of the reported sample, as it is negative for U.S. banks and positive for Eurozone banking groups with the exception of Eurozone savings banks.

A similar pattern is observed with the relationship between capital and diversification, highlighting the fact that the outcome depends on the type of bank and whether the bank belongs to the Eurozone or the U.S. So, addressing the fifteenth research question of this thesis (*RQ15: How does diversification impact the capital of banking institutions in the Eurozone and the United States in the post-crisis period?*), our findings show that the U.S. savings banking group is the only examined group whose capital is positively affected by an increase in all three types of bank diversification. We also conclude that, except for the Eurozone cooperative banks, an increase in the income diversification of both Eurozone and U.S. banks has a favorable effect on bank capital. Also, with the exception of U.S. cooperative banks, U.S. banking groups are directly associated with asset diversification, whereas the capital of Eurozone and U.S. cooperative banks tend to decrease when asset diversification rises. Finally, the impact of non-interest income diversification on capital is negative for the greatest part of the reported sample.

Concerning the sixteenth research question (*RQ16: How does diversification influence the risk of banking institutions in the Eurozone and the United States in the post-crisis period?*), our results indicate that the impact of assets, capital and income diversification on bank efficiency is negative and statistically significant for the vast majority of the Eurozone and the United States banking institutions.

This thesis also aims at testing the impact of bank diversification on bank efficiency of the Eurozone and the United States in the post-crisis period (*RQ17*). Our results indicate that income diversification precedes a decrease in both credit and default risk for the vast majority of the reported sample. Thus, we may conclude that income diversification enhances bank stability. While non-interest income

diversification is directly related with default and credit risk for the greatest part of the sample and asset diversification negatively influences bank stability by increasing default risk. Finally, the effect of asset diversification on credit risk depends on whether the bank belongs to the Eurozone or the U.S. More specifically, the credit risk of U.S. banks and the Eurozone general sample of banks is negatively related with an increase in asset diversification, while the risk of the three other Eurozone banking groups is positively related with an increase in asset diversification.

Overall and answering the eighteenth research question (*RQ18: How does this influence differ depending on the type of diversification (asset, income and non-interest income diversification)?*), we find consistent evidence that income diversification has substantial benefits when compared to other types of diversification since it positively affects stability, profitability as well as the capital of the majority of the reported banks, yet these benefits are not so great for Eurozone savings banks. By contrast, non-interest income diversification has the most unfavorable results for the reported groups. This occurs because non-interest income diversification decreases for all four dependent variables (efficiency, capital, stability and profitability), for the majority of the reported sample. Finally, the impact of asset diversification is mixed and is determined by whether a bank belongs to the Eurozone or the U.S. Our conclusion is consistent with Moudud-Ul-Huq et al., (2019) for Asian countries after the global financial crisis, indicating that the impact of income diversification on performance and bank stability is positive and that of asset diversification varies across the reported countries.

Finally, we examine the impact of diversification on different banking sectors (*RQ19*). As mentioned above, some of the results diverge depending on the type of banking institution (commercial, cooperative or savings banks). This outcome is in line with Köhler, (2015) and emphasizes the importance of the incorporation of different bank types in the examined sample when investigating the effect of diversification on risk, capital, efficiency and profitability of banking institutions.

Contributions

This paper provides various contributions to the ongoing empirical literature. Firstly, in our paper unlike any previous papers special consideration was given to the comparison of commercial, cooperative and savings banks, as subsets of our banking groups. Secondly, our study builds on the existing literature by thoroughly examining bank capital, risk and efficiency and their interrelationships with a contemporaneous data set, while the recent research on Eurozone banking (2013-onwards) is very limited and this includes the recovery period after the global financial crisis.Thirdly, our study is the first to focus on the comparison of U.S. and Eurozone bank samples. The comparison is of utmost importance as the country unions have different characteristics and a different speed of recovery from the financial crisis. Fourthly,

our survey is unique in trying to check for convergence while controlling for country-specific and bank-specific factors that affect the efficiency of European and Eurozone banks. Lastly, our analysis varies from previous research as it examines (i) the three categories of bank diversification (assets, income and non-interest income diversification) and (ii) the impact of bank diversification on the four following independent variables: profitability, efficiency, stability and capital. Therefore, our study fills the gap in the existing literature because it is one of the first to provide a broader understanding of how the impact of bank diversification on banking institutions is configured by the new regulations implemented after the global financial crisis.

Policy implications

Apart from the contribution to the empirical research, our results are important from a bank prudential supervisory perspective. Our findings indicate great discrepancies of capital, risk and efficiency among different banking sectors and banking systems with different characteristics. Thus, regulators should consider the banking sector and the location of the banking institutions when implementing regulations concerning financial stability. Additionally, our findings have significant implications for regulators, bank managers and shareholders by clarifying the relationships of capital, risk and efficiency and by examining separately for the Eurozone and the United States banks and for different banking sectors the validity of a set of managerial hypotheses (Regulatory Hypothesis, Moral Hazard Hypothesis, Bad Management Hypothesis, Bad Luck Hypothesis, Cost Skimming Hypothesis and Shareholders-Managers Hypothesis).

Concerning diversification, our findings have substantial implications for shareholders, regulators and bank managers. Firstly, our results suggest that non-interest income diversification creates more threats than opportunities. In this regard, the supervision of non-traditional banking activities needs to be reviewed and improved. Secondly, income diversification offers additional benefits for banks in comparison to asset diversification, which causes a mixed outcome. It is therefore advisable that bank managers ought to consider that various diversification strategies have different effects on banking institutions when setting risk management policies, prioritizing banking activities and taking investment decisions. Thirdly, the efficiency of banking institutions is negatively affected by bank diversification and this outcome affects shareholders' interests. Fourthly, the impact of bank diversification on capital, risk, efficiency and profitability is dissimilar across different types of banks. Therefore, bank managers should consider following different strategies for each category in order to be more benefitted by diversification and supervisors ought to separately analyze the impact of new regulations on each category of banks. Fifth, the country union (the Eurozone or the

U.S.) to which a bank belongs affects the examined relationship and needs to be taken into consideration.

Limitations and suggestions for further research

It is worth mentioning that a limitation of our study is the use of levels of efficiency, capital and risk, while it could be more accurate to explore the changes of these variables. This method could not be applied in our study because of the small reported period (2013-2018). Therefore, our analysis could lead to further research into the development of the interrelationship between risk, capital and efficiency by employing a sample covering more years after the financial crisis and investigating the changes of the variables. Another limitation of our survey is that it does not provide evidence regarding which type of non-interest income is more beneficial for banks. Our approach could also be enriched with the use of the capital buffer, tier1 (AT1) debt or contingent capital (coco bonds) as indicators of capital ratio together with the employment of non-performing loans (NPLs) or Unlikely-to-Pay (UTP) loans as indicators of risk. Finally, our analysis could lead to further research into whether the recent increase in banking efficiency and the improvement of the banking integration process will have an impact on economic growth.

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