Lisbon School of Economics & Management
Universidade de Lisboa

MASTER

FINANCE

MASTER´S FINAL WORK

DISSERTATION

DETERMINANTS OF BANK PERFORMANCE IN OECD COUNTRIES

CARLA CONCEIÇÃO DA GRAÇA LIMA

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SUPERVISION:
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GLOSSARY

BRSS – Bank Regulation and Supervision Survey.

EBA – European Banking Authority.

ECB – European Central Bank.

EU – European Union.

GDP – Gross Domestic Product.

GLM – Generalized Linear Model.

GLS – Generalized Least Squares.

IMF – International Monetary Fund.

JEL – Journal of Economic Literature.

MENA – Middle East and North Africa.

MFW – Master's Final Work.

OECD – Organization for Economic Co-operation and Development.

OLS – Ordinary Least Squares.

ROA – Return on Assets.

WDI – World Development Indicators.

ABSTRACT, KEYWORDS AND JEL CODES

We examine the determinants of bank performance in the Organization for Economic Co-operation and Development (OECD) in the 2011–2019 period. We performed a regression analysis, running OLS, GLS and GLM models to identify the relevant variables and their impact on the Return on Assets ratio (ROA). Additionally, we also investigated the impact of supervision variables on banks' performance. To testify the results' robustness, we replicate the analysis *winsorizing* the dependent variable and some independent variables that had extreme values. We verified that size, leverage, assets quality and efficiency are factors that affect banks' performance. Additionally, we observed that supervisory measures are crucial since: ROA tends to be higher in countries in which the Central Bank is in charge of the supervision role, in which supervisors can take legal action against external auditors for negligence and in which the supervisory authority is independent. Also, macroeconomic factors are significant for bank performance.

Keywords: Bank supervision; Regulation; Bank performance; Basel Accords; OECD.

JEL Classification: G01; G20; G21

RESUMO, PALAVRAS-CHAVE E CLASSIFICAÇÃO JEL

Neste trabalho, examinamos os determinantes da performance dos bancos da Organização para a Cooperação e Desenvolvimento Económico (OCDE) no período de 2011-2019. Realizamos uma análise de regressão, sendo que examinamos os modelos OLS, GLS e GLM para identificar as variáveis relevantes e seu impacto no rácio de Retorno sobre Ativos (ROA). Além disso, também investigamos o impacto das variáveis de supervisão no desempenho dos bancos. Para testificar a robustez dos resultados, replicamos a análise aplicando um processo *winsor* à variável dependente e algumas variáveis independentes que tinham valores extremos. Verificamos que a dimensão, a alavancagem, a qualidade dos ativos e a eficiência são fatores que afetam o desempenho dos bancos. Adicionalmente, observamos que as medidas de supervisão são cruciais, uma vez que: a ROA tende a ser maior nos países em que o Banco Central é responsável pela função de supervisão, em que os supervisores podem tomar medidas legais contra auditores externos por negligência e nos quais a autoridade de supervisão é independente. Além disso, os fatores macroeconómicos são significativos para o desempenho dos bancos.

Palavras-chave: Supervisão Bancária; Regulação; Performance; Acordos Basel; OCDE.

Classificação JEL: G01; G20; G21.

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1. INTRODUCTION

The main purpose of this dissertation is to dive into the theoretical and empirical approaches in order to understand the main features of bank supervision and performance. The motivation for choosing this scheme was the vital function of banks for financial stability and the economy as a whole. Thus, prudential supervision on banks' activity seems to play an important role to predict bank performance's positive or negative behaviour (Barth, 2020).

Questions about the effectiveness of supervisory and regulatory arrangements have always been imperative for researchers and policymakers, particularly following the global financial crisis (2007–2008). Some post-crisis studies indicate that improper supervision measures contributed significantly to several bank sector weaknesses (Abdennour & Khediri, 2010). Thus, policy makers and industry participants across the world debated some questions about the appropriate role, structure and supervision of banking. (Anginer *et al.,* 2019).

Basel Core Principles for effective banking supervision are rules emanated by Basel Committee on Banking Supervision (hereafter, BCBS) in order to enhance the development of soundness supervisory agencies with the authority to discipline and monitor banks (Ayadi *et al.,* 2016). Despite the evolution of Basel Accords and the effort to converge supervision measures worldwide, different supervision cultures have been adopted. In this regard, several debates verify which are the main techniques to assess bank performance and whether aspects concerning the supervision practices can enhance or obstruct it.

The aim of the paper was to ascertain whether bank specific factors significantly impact on return on asset (ROA) as a measure of bank performance and also verify if supervisory measures are relevant in this regard. Our research questions are:

i. What are the determinants of Return on Assets?

ii. Do supervisory measures help to enhance or obstruct performance of banks?

In order to address these questions, we gathered annual data related to OECD banks from 2011 to 2019 and we scrutinised the impact of the independent variables on ROA.

We found that less leveraged, more efficient and low liquidity banks have greater performance. Moreover, we observed that supervisory measures matter. Banks in countries in which the Central Bank is the responsible body for bank industry supervision, in which supervisors can take legal action against external auditors for negligence and in which the supervisory authority have higher degree of independence are more profitable. However, our study suggest that deposit insurance schemes and the scope of supervision are not consistently significant to determine banks' performance. We also confirmed that macroeconomic variables are significant to enhance performance.

This paper extends the existing literature in several ways. First, we could note that there is little guidance from previous empirical work as to what to expect for the impact of these important dimensions of supervision on bank performance. Moreover, the analysis of the most recent data available regarding supervisory measures from the World Bank database (2019), reveals an important contribute to the existing literature about this topic.

This paper is structured as follows. Chapter 2 embodies the literature review of the related literature on bank supervision and performance. Chapter 3 describes the data and methodology implemented to perform the analysis. Chapter 4 presents the empirical results of the research. Finally, Chapter 5 summarizes the main conclusions achieved, the limitations of this research and discusses further studies.

2. LITERATURE REVIEW

This section is organized by subsections. In subsection 2.1, we will start highlighting the importance of bank regulation and supervision during the global financial crisis. Then, subsection 2.2 gives an overview on Basel Core Principles. In subsection 2.3, we present the evolution of Basel accords. In subsection 2.4, we will discuss intriguing topics regarding supervisory measures worldwide. Subsection 2.5 states the main ideas concerning to bank performance indicators. Subsection 2.6 highlights the main findings from the literature regarding supervisory measures effect on performance.

2.1. GLOBAL FINANCIAL CRISIS

It is a well-documented fact that the 2008 global financial crisis has incited interest in assessing the proper regulatory improvements to mitigate, if not prevent, shocks in banking sector in future crises (Laeven & Levine, 2009; Barth, 2020; Triki *et al.*, 2017). To do so, supervision and regulation are crucial tools to enhance integrity and stability in the financial sector (Blinder, 2010). Hence, regulators have the mission to refine their approach and procedures to force banks follow compliance requirements (Ayadi *et al.*, 2016).

Cihak *et al.* (2013) findings suggest that during the crisis, countries with rigorous supervision and regulatory framework had lower probability of enduring the crisis compared to those that suffered hardly. Moreover, the authors found that weak regulation and slighter extent of supervision meaningfully increase the chance of a county undergoing a crisis. In fact, Fahlenbrach *et al.* (2012) verified that bank performance during a certain period of crisis play an important role for predicting the behaviour and probability of failure in forthcoming crisis. This demonstrates that banks that have a weak performance in a crisis are more exposed to systemic risk, thus they are more likely to bankrupt during the next crisis.

In countries of the EU, the establishment of an integrated Banking Union in 2012 as response to the Eurozone crisis was a key factor to harmonize supervisory cultures (Carretta *et al*., 2015). Hereupon, ECB started supervising banks included in the Banking Union to exploit their tools and knowledge. Nevertheless, banks outside the Banking Union remained under national supervision and ECB scrutiny in order to safeguard robustness and stability of banking industry.

2.2. OVERVIEW ON BASEL CORE PRINCIPLES

Despite the global financial crisis that strongly affected the financial industry over the past decade, bank regulatory regimes are not fully converged (Barth *et al*., 2013). However, it is well known that the Basel Committee on Banking Supervision (hereafter, BCBS), as well as International Monetary Fund and World Bank are key institutions to boost the development of powerful bank supervisory agencies with the authority to discipline and monitor banks (Ayadi *et al.*, 2016).

Established by the Central Bank Governors of the Group of Ten (G-10) countries at the end of 1974, the BCBS became the major global standard entity for bank prudential regulations and the responsible for regular cooperation on banking supervisory topics[1]. BCBS's 45 members cover Central Banks and bank supervisors from 28 worldwide jurisdictions. Regarding the impact international regulatory standards can have in bank performance, Ayadi *et al.,* (2016) highlighted the importance of the adoption of Basel Core Principles (BCP) for effective bank supervision. These principles were emitted in 1997 by the BCBS and became from then onwards the global standards for bank regulation, broadly embraced by regulators both in developed and in emerging countries (Ayadi *et al.*, 2016).

BCP have the aim to help countries to evaluate their supervisory structures and detect areas for improvement (BCBS, 2019). Accordingly, on December of 2019 and after several amendments, BCBS published the last review of these rules covering 29 principles. Principles 1 to 13 state supervisory powers, responsibilities and functions, emphasising the effective risk-based supervision, and the necessity for timely intervention and supervisory actions. Principles 14 to 29 address supervisory prospects of banks, focusing on the importance of strong corporate governance and risk management, as well as compliance with supervisory standards (BCBS, 2019). These principles are inserted in the currently implemented Basel framework, the Basel III.

2.3. THE EVOLUTION OF BASEL ACCORDS

Basel frameworks are global standards that establish the main objectives of bank capital, rules concerning the minimum capital that a credit institution must ensure, tools to measure the degree of risk of bank assets, supervision and market discipline (Shakdwipee & Mehta, 2017). To do so, BCBS have implemented several reforms to the financial regulatory framework to harmonize it internationally (Triki *et al.,* 2017).

Basel I Accord (1988) was the first major international bank regulation (Balthazar, 2006). According to Bodellini (2019), this Accord determined risk weights of bank assets (RWA) and also the minimum level that banks had to keep between capital and assets weighted by risk level (capital adequacy). However, this framework was severely criticised for just focusing on key financial risk metrics to evaluate potential risk of banks

[1] See: https://www.bis.org/bcbs/membership.htm

and completely ignoring the need of a robust risk management process (Shakdwipee & Mehta, 2017).

As result, in 2004 BCBS published Basel II to convert the existing capital adequacy rules into risk management measures (Balthazar, 2006). Thus, as Shakdwipee and Mehta (2017) state, "it largely abandoned the one-size-fits-all rule for more elastic, institution-specific requirements". Basel II Accord came to emphasise pillars concerning to the minimum requirements of own funds, supervisory process for the bank activity and market discipline (Balthazar, 2006). However, this framework was recurrently criticised by leading banks, because it superficially integrated the latest risk management techniques (Balthazar, 2006).

Basel III regulatory framework was formulated at the end of 2010 in response of 2007-2008 Financial Crisis (BCBS, 2017). This accord is a tool to solidify resilience of internationally active banks through the improvement of the quality and quantity of capital components (Tier 1), leverage ratio, liquidity standards, and enhanced disclosures (BCBS, 2017). Despite this and according to Amorello (2016), Basel III has demonstrated some fragility in confronting systemic risks mainly in high leveraged credit institutions. This author stated that the main arguments against the effectiveness of this Accord were associated with dearth of disclosure, its complex requirements, the difficulty to fully detect off-balance sheet risks and the use of a model-based regulation to compute capital requirements.

As Bodellini (2019) said, "Over the last thirty years, capital has acquired an increasingly more important function in international banking regulation". So, notwithstanding the criticisms around the existing Basel III, this author testified that capital remains as an effective instrument to enhance credibility of banks and in this way contributing to preserve financial stability. Due to this, BCBS published some amendments to Basel III in December 2017, the so-called "Basel IV" (BCBS, 2017). These modifications came reduce excessive variability of RWA and further rise the capital of banks to promote safety and soundness of the banking industry (Bodellini, 2019). Due to the Covid-19 pandemic, the implementation of these requirements was postponed to January of 2023[2].

[2] See: https://www.bis.org/bcbs/publ/d500.htm

2.4. SUPERVISORY MEASURES WORLDWIDE

Ayadi *et al.* (2016) testified that despite the efforts that have been done in many countries to fortify banks' regulation and supervision there is no evidence that any common practice is universally applicable for endorsing well performing and safe banks. Barth *et al.* (2013) realised that measuring hundreds of regulations and supervisory measures, driven by different parts of national and local governments is challenging. In fact, Carretta *et al.* (2015) found heterogeneity in European supervision styles. For African countries, Triki *et al.* (2017) demonstrated that bank regulation should be adapted to the institutions' risk, size level and resources. Thus, the authors' findings support the argument that "one size fits all" is not a reliable approach for supervisory measures.

In order to properly identify the main conclusions regarding supervision practices, we analysed theoretical arguments in favour and against certain architecture of financial supervision.

2.4.1. CENTRAL BANK AS SUPERVISOR

A very judgmental topic regarding banking industry structure is whether the Central Bank should be responsible for banking supervision. There are some rational arguments for and against this topic.

a) Arguments for Central Bank supervision

For the specific case of OECD countries, which is the group of countries analysed in this study, a well discussed issue is whether Central Bank should safeguard supervisory power (Lumpkin, 2002). According to the insights of Abdennour & Khediri (2010), a Central Bank with the role of supervising banks permits a better access to information. In fact, as this institution is the entity responsible for macro level monetary decisions, it is crucial to have accurate and timely information concerning banks' performance as a requirement to develop it effectively (Herring and Carmassi, 2008; Goodhart and Schoenmaker, 1995). As already seen and supported Peek *et al*. (1999), the relation between bank supervision and monetary policy direction may be imperative for developing countries since their credit markets are commonly bank-centred. The base of this idea ponders their less complex financial structure, a greater likelihood of corruption, inefficiency and inadequacy of supervision funding outside the Central Bank. Thus, for emerging economies, a Central Bank committed with supervisory power is the most appropriate (Blinder, 2010). Moreover, in Abdennour & Khediri (2010) analysis to

MENA countries, it was verified that this kind of financial structure tends to be less robust and more dependent on commercial banking when compared to developed economies. These authors realised that removing the banking supervision task from the Central Bank would negatively impact the information flows.

Furthermore, Abdennour & Khediri (2010) also found that emerging countries are more susceptible to systemic disturbances, principally as a repercussion of a liberalisation of the banking system. In consonance with this idea, Goodhart (2002) verified that allowing a Central Bank to be both a systemic risk regulator and the supervisor of the systemically important financial institutions may lead to a vision of a more powerful institution.

b) Arguments against Central Bank supervision

Goodhart (2002) and Blinder (2010) noted that several developed countries with a complex financial system opted by placing their supervisory power to entities outside the Central Bank. These authors found that arguments for separating banking supervision from Central Banks and allocate it to a separated supervisory agency can be related to balance of power, conflict of interest and other aspects that can affect the industry performance and macro-monetary policy. Indeed, when the Central Bank is in charge of both banking supervision and conducting monetary policy, it may endure an attenuation in monetary policy actions to avoid rupture in bank earnings and credit quality (Briault, 1999). Goodhart (2000) realised that in cases of bank failures, if the Central Bank is responsible for bank supervision, the soundness of the institution could also be affected.

2.4.2. CONSOLIDATION IN SUPERVISION

A review of the financial supervision architectures indicates a tendency in the direction of concentrating supervisory powers (Masciandaro and Quintyn, 2009). In general, we want to analyse whether it would be more advantageous to have a single "consolidated" supervisor for all financial services (banks, securities firms, insurance companies, funds, finance houses and leasing companies).

a) Arguments for a consolidated supervisor

Several arguments have been advanced to defend unification of banking supervision. (Barth et al., 2002). Abdennour & Khediri (2010) mentioned that financial conglomerates that operate in the banking, securities and insurance industries are complex.

Consequently, to supervise this range of entities properly, it is required a supervisor with broad scope. The unification of supervisory power permits to achieve economies of scale in terms of employment of supervisory resources, allows to save costs for both governments and market participants as it employs personnel and other resources to accomplish similar supervisory responsibilities across different sectors of the financial services industry (Cihák and Podpiera, 2008; Herring and Carmassi, 2008). According to Abdennour & Khediri (2010), this argument is predominantly imperative for emerging market economies since the supervisory authority may be able offer a fast and flexible response to unexpected financial problems (Goodhart, 2002).

Furthermore, a body or agency in charge of supervising banks is also financial supervisory authority responsible for all other financial sectors could avoid regulatory arbitrage that could be present in a strategy opting by several authorities (Herring and Carmassi, 2008; Llewellyn, 2005). In fact, according to Abdennour & Khediri (2010) findings, the deficiency of supervisory resources is a serious problem in emerging and developing countries. Thus, in these circumstances, unification expands the accountability of regulation.

b) Arguments against a consolidated supervisor

A wide range of arguments have been built against unification of financial supervision. According to Kane (1996), a body or agency that is in charge of supervising banks as well as the financial supervisory authority responsible for all other financial sectors may be more subjugated to excessive bureaucracy. Consequently, there is a problematic issue to ensure an appropriate equilibrium towards different aims of regulation that comprehends the task of preventing systemic risk extending to the protection of individual consumer (Kane, 1996).

According to Padoa-Schioppa (2003) and Goodhart (2002), a consolidated supervisory authority may lead to an excessive concentration of power and consequently to rise of conflicts of interest. Furthermore, Llewellyn (2005) verified that single supervisor can create an excess of confidence for the public. Since consumers and creditors are protected from loss in the occurrence of bank failure, they may assume that all other financial institutions should receive the same treatment, expecting to be treated in similar manner (Llewellyn, 2005). In other words, there will be a trend to assume that

all creditors of institutions supervised by a given supervisor will receive equal protection conducting to moral hazard problems (Herring and Carmassi, 2008).

2.4.3. REGULATORY AND SUPERVISORY INDEPENDENCE

The idea of independence of supervisory authorities was found crucial for soundness and robustness of the financial system as a whole (Barth *et al*., 2002). Previous literature ascertains four dimensions of independence – institutional, budgetary, regulatory and supervisory (Quintyn and Taylor, 2002).

Barth *et al.* (2002) mentioned that institutional independence concerns to the power that classifies the agency as an institution separated from the executive and legislative branches of a government. Thus, if the agency participates in the executive branch, it typically leads to deficiencies in terms of independence (Quintyn and Taylor, 2002). Budgetary independence states the mission to legislate and execute the size and use of the agency's budget, including recruitment process and salary levels (Eichengreen and Dincer, 2011).

Fraccaroli *et al.* (2020) verified that regulatory and supervisory extensions are considered core aspects, while institutional and budgetary independence are found indispensable to ensure the accurate implementation of the core measures. Quintyn and Taylor (2003) argued that regulatory and supervisory independence can be considered crucial for financial stability likewise Central Bank independence is important for monetary stability. As stated by Barth et al. (2002), regulatory independence denotes the ability of the agency to possess a suitable degree of autonomy to implement rules and regulations in sectors under its supervision, within the limits of the law. In contrast, supervisory independence is predominantly allied to the implementation of the supervision policies (Quintyn and Taylor, 2002; Fraccaroli et al., 2020).

Abdennour & Khediri (2010) verified that supervisory independence provides tools for bank supervisors to monitor the financial condition of banks in a strict, professional and consistent way. Quintyn and Taylor (2002) highlighted that supervisory function regarding financial sector is more developed and crucial than in most other sectors of the economy. In line with this idea, Barth et al. (2002) realised that supervisory independence may be more challenging to establish and guarantee than the other dimensions of independence due to the crucial role it possesses for financial sector stability.

According to Quintyn and Taylor (2002), the supervisory function can be allocated to four areas: licensing, supervision *sensu stricto*, sanctioning and crisis management. All these areas concerning supervisory independence were considered vital and are supported by the actual experience that some countries where inadequate independence arrangements contributed to financial instability (Abdennour & Khediri, 2010). As an example, De Krivoy (2000) noted that political interference jointly with ineffective regulation, fragile and dispersed supervision were the major aspects that lead to the Venezuelan banking crisis of 1994. It is also important to note that, as Quintyn and Taylor (2003) argued, there are some evidences indicating that independence is a necessary but not a sufficient condition for an effective regulation and supervision.

2.5. BANK PERFORMANCE INDICATORS

Banking sector's performance has been widely investigated since this topic has received a lot of attention in the most recent years (Chortareas *et al.*, 2012). Some studies have been developed to analyse bank efficiency, performance and risk-taking worldwide. Some authors focused on Data Envelopment Analysis (DEA) to assess bank efficiency through efficiency score estimations (see: Ayadi *et al.*, 2016; Barth *et al.*, 2013). Others applied the most common measures evaluate profitability combining it with risk, respectively, ROA, Return on Equity (ROE), Cost-to-Income ratio (CIR), Net Interest Margin, Z-score and other related measures (see: Abdennour & Khediri, 2010; Liang *et al*, 2013).

It is a well-documented fact that most of the recent studies have scrutinised the impact of internal (bank specific) and external (macroeconomic and market specific) aspects on bank performance. However, Sufian and Noor Mohamad Noor (2012) emphasised that, since some developing countries incorporated reforms and liberalization of the financial sector, such factors can affect bank performance differently. In their analysis of the determinants of Indian banks' performance, the results suggested that in general bank's size increases bank profitability and enhances banks performance, but it negatively impacts the profitability of foreign banks from other Asian countries. Moreover, a positive relationship between credit risk and bank profitability was verified, with exception of foreign banks from the North America (Sufian & Noor Mohamad Noor, 2012). Lee & Kim. (2013) suggested that factors related to location and certain type of ownership can impact the performance of banks. The authors verified that foreign

international banks can significantly increase bank performance while the management control of government or foreign buyout funds has mainly the inverse effect.

Additionally, Liang *et al.*, (2013) suggested that other factors, such as those related to board composition and independency, political involvement of directors and gender are key drivers to evaluate asset quality and risk taking leading to good performance.

2.6. SUPERVISORY MEASURES EFFECTS ON PERFORMANCE

Financial supervisory measures can be a controversial issue when evaluating bank performance. Some authors provided suggestions that supervision enhances profitability of banks (Abdennour & Khediri, 2010). In fact, as Carretta *et al. (*2015) mentioned, an intensive bank supervision permit to deeply assess banks' condition and timely intervene to reduce risk and enhance performance.

Since regulation is employed for controlling bank' activities, it may negatively affect bank operations' efficiency (Barth *et al.*, 2013). This happens because a higher regulatory enforcement may induce banks to invest in ways that avoid regulation through riskier measures (Chortareas *et al.*, 2012). In fact, Ayadi *et al.* (2016) revealed that for the case of emerging markets, international standards regarding best regulatory practice can limit bank performance.

On the other hand, some authors found that some supervisory measures are not critical regarding bank performance in some countries (Barth *et al.*, 2003; Ayadi *et al.*, 2016). Indeed, in Ayadi *et al.* (2016) study, the authors also concluded that banks that correctly comply with regulatory and supervisory standards are not most likely to have better or worse performance.

3. DATA AND METHODOLOGY

The main objectives of our research are to assess the determinants of performance in OECD commercial banks and also verify if supervision can affect the performance of those banks. Thus, this research provides answers to the following questions:

i. What are the determinants of Return on Assets?

ii. Do supervisory measures help to enhance or obstruct performance of banks?

This section settles the objective and explains the data and the empirical methodology performed. It is structured as follows. Section 3.1 describes the sample used and the variables' source. Section 3.2 presents the dependent variable. Section 3.3 details the independent variables. Section 3.4 refers to the model followed in our research. Subsection 3.4.1 states to preliminary statistics. And section 3.5 presents the robustness analysis.

3.1. SAMPLE

The data used in this analysis was obtained annually and in terms of tree groups: bank-level data, supervision variables and macroeconomic variables. Bank-specific indicators were collected from *Bureau Van Dijk BankFocus*. A sample of 1,632 commercial banks belonging to the 38 OECD countries (Australia, Austria, Belgium, Canada, Chile, Colombia, Costa Rica, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Latvia, Lithuania, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovakia, Slovenia, Republic of Korea, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States of America) was selected. Supervisory measures variables were extracted from the most recent Bank Regulation and Supervision Survey (BRSS[3]) published by the World Bank in 2019. The survey contemplates bank regulation and supervisory practices. The macroeconomic variables were obtained from the World Development Indicators database. Due to some data limitations in terms of bank-level missing observations, it was considered a sample period from 2011-2019. In our sample, we have 12 550 observations of the dependent variable. Stata econometric software permitted the calculations and tests performed.

3.2. DEPENDENT VARIABLE

Our goal is to address the determinants of the banking sector performance. The choice of the dependent variable was done regarding the main objective of this research which is to determine the factors that affect Return on Assets (ROA). Note that, following the method of Abdennour & Khediri (2010), as a replacement for the end-year values of assets we took into consideration the average value of assets of two consecutive years as profits are a variable flow generated during the year.

[3] See: https://www.worldbank.org/en/research/brief/BRSS

ROA refers to the net income divided by total average assets. This profitability ratio is widely used in banking literature to evaluate management performance and profitability by analysing how efficiently the resources of the banks are managed to produce profits (Liang *et al.*, 2013). The higher the ratio, the better for both debt and equity holders as reposted by Khrawish (2011). Moreover, Lee *et al. (*2013) mentioned that *ROA* depends on the bank's policy decisions as well as exogenous factors relating to the economy and government regulations. The authors also testified that ROA represents one of the best measures of the ability of the firm to generate returns on its portfolio of assets. Thus, this variable seems to be a reliable instrument to evaluate shareholder value by taking into consideration the leverage effect.

In order to check residuals' normality, we perform a Shapiro-Wilk test. Therefore, if the p-value is less than the alpha level (1%, 5% or 10%), the null hypothesis is rejected, and consequently there is no statistical evidence to assume a standard normal distribution. Performing this test, our p-value was 0,000%, so the null hypothesis was rejected. Nevertheless, it's possible to verify that, in Figure 4 in Appendix, the kernel density graph stands similar to a normal distribution despite being lightly sensitive to deviances. Hence, this means that residuals distribution tends to be normal. Moreover, Figure 1, demonstrates that the Standardized Normal Probability plot fits the diagonal line.

3.3. INDEPENDENT VARIABLES

With the objective to determine the factors that affect ROA, we used independent variables previous examined in the literature. In our research, we analysed the influence of the following variables: size, equity to total assets ratio, net loans to total assets ratio, cost-to-income ratio, deposit insurance, central bank, scope, audit, independence, inflation and GDP growth.

Size of banks was measured by the logarithm of total assets. It was testified that banks with higher resources are more profitable (Sufian & Noor Mohamad Noor, 2012). In contradiction, Lee & Kim (2013) verified that Chinese banks are expected to experience diseconomies of scale due to the increase of assets. As far as we could verify, few studies implemented this variable when analysing bank performance jointly with supervisory measures, thus this came as a value added to the existing literature.

ETA represents the total equity divided by total assets. According to Abdennour & Khediri (2010), Sufian & Noor Mohamad Noor (2012) and Liang *et al.* (2013), well-capitalised banks have lower probability to go bankrupt leading to a higher ROA. In fact, as Antwi, (2019) mentioned, a higher capital to assets ratio should decrease banks' cost of funds by reducing the price and the quantity of funds required, refining a bank's net interest income and enhancing profitability. However, Abdul Hadi *et al.* (2018) verified a detrimental effect of this variable.

NLTA is the ratio of net loans divided by total assets. This ratio was analysed in order to assess bank liquidity. Ayadi *et al. (*2016) and Liang *et al.* (2013) testified that this indicator has a positive impact on bank performance. According to Liang *et al.* (2013), a higher level of loans may imply that banks are unable to cover unpredicted fund requirements. In fact, the higher is this ratio, the riskier are bank's activities leading to better levels of profitability (Liang *et al.,* 2013). However other authors such as Abdennour & Khediri (2010) and Barth *et al.* (2003) verified that this variable doesn't seem to be relevant.

CIR, the Cost-to-Income ratio, is computed by operating expenses by the operating income generated. This ratio represents managerial efficiency (Shehzad & De Haan, 2015). According to Abdennour & Khediri (2010) and Antwi (2019), an adverse impact of this variable to bank performance was found. This may happen due to the fact that a efficient management of expenses is strongly related to bank's performance and in a competitive market costs are difficultly transferred to customers.

Deposit_Insurance is a dummy variable that takes a value of 1 if an explicit deposit insurance protection system is required in a determined country and a value of 0 otherwise. According to Abdennour & Khediri (2010) and Barth *et al.* (2003), this variable contributes to lower bank performance. The authors testified that this may happen because for a given level of risk, banks may lend money more cheaply, leading to lower profitability.

Central_Bank is a dummy variable that is equal to 1 if the Central Bank is a bank supervisory and a value of 0 otherwise. According to Abdennour & Khediri (2010) this variable is positively connected to bank performance. In contrast, Barth *et al.* (2003) verified a negative influence of this variable. However, the author testified that this

negative effect is just verified when the Central Bank is the same supervisor of other financial institutions (Barth *et al*., 2003).

Scope takes a value of 1 if there is a single financial supervisory authority responsible for all main financial institutions and a value of 0 otherwise. Abdennour & Khediri (2010) testified that for the case of banks in MENA countries, when there is a single financial supervisory agency for all of the main financial sectors, banks are less profitable.

Audit takes a value of 1 if supervisors can take legal action against external auditors for negligence and a value of 0 otherwise. The existing literature shows that this variable strongly contributes to the increase of performance (Abdennour & Khediri, 2010).

Indep takes a value from 1 to 3 for low, medium and high independence of supervisory authorities, respectively. Previous studies didn't find a significant impact of this variable (Abdennour & Khediri, 2010; Barth *et al.*, 2003), however we preserve this variable to validate the conclusion regarding our sample.

Inflation is a country control variable that is measured by consumer price index (CPI). This variable can influence performance positively (see: Abdennour & Khediri, 2010; Athanasoglou *et al.*, 2008; Demirgüç-Kunt & Huizinga, 1999; Sufian & Noor Mohamad Noor, 2012).

Gdp is a macroeconomic control variable that is measured by the Gross Domestic Product Growth rate. This variable was found positive for bank performance by Lee & Kim (2013).

3.4. REGRESSION MODEL

Following the literature previously analysed, we defined a panel data and afterwards performed the regression analysis. We tested our independent variables in order to detect problems such as: multicollinearity, heteroskedastic and omitted variables.

The generic regression model is written as follows:

$$ROA_{i,t,j}=\beta_0+\beta_1 Size_{i,t}+\beta_2 ETA_{i,t}+\beta_3 NLTA_{i,t}+\beta_4 CIR_{j,t}+\beta_5 Central\_Bank_{j,t}+\beta_6 Deposit\_Insurance_{j,t}+\beta_7 Scope_{j,t}+\beta_8 Audit_{j,t}+\beta_9 Indep_{j,t}+\beta_{10} inflation_{i,t}+\beta_{11} gdpg_{j,t}+\varepsilon_{i,t}$$

where $ROA_{i,t}$ return of assets of bank i at time t ; $ETA_{i,t}$ total equity to total assets ratio of bank i at time t; $NLTA_{i,t}$ total equity to total assets ratio of bank i at time t; $Size_{i,t}$ represents the natural logarithm of total assets of bank i at time t; $CIR_{i,t}$ cost-to-

income ratio of bank i at time t; ***Central_Bank j,t,*** a dummy variable: equals one if the Central Bank is a bank supervisor and 0 otherwise, of country j at time t; ***Deposit_Insurance j,t,*** a dummy variable: equals one if an explicit deposit insurance protection system is required and 0 otherwise, of country j at time t; ***Scope j,t,*** a dummy variable: equals one if the same authority in charge of supervising banks is also financial supervisory authority responsible for all other financial sectors and zero otherwise, of country j at time t; ***Audit j,t,*** a dummy variable: equals 1 if supervisors can take legal action against external auditors for negligence and a value of 0 otherwise, country j at time t ; ***Indep j,t,*** 1 through 3 for low, medium, and high independence, respectively, country j at time t; ***inflation j,t,*** the annual inflation rate of country j at time t; ***gdpg j,t*** the gross domestic product growth rate of country j at time t and $\varepsilon i,t$ is the error term.

In our study we use three different models: OLS, GLS and GLM regressions. We implemented heteroskedasticity-consistent standard errors from OLS as Abdennour & Khediri (2010) and Barth *et al.* (2003) in eight of our regressions.

Given the fact that some authors testified that GLS is more efficient than OLS in suspicious cases of heteroscedasticity or autocorrelation (Meliciani & Peracchi, 2006), this was the motivation to implement it since our data have heteroscedasticity. Our data has heteroscedasticity and residuals are not normally distributed. Thus, OLS could not be a reliable model to perform it, explaining the usage of GLS. GLM is a generalization of ordinary linear regression that provides a flexible approach permitting dependent variables to have error distribution models other than the normal distribution. This model was found relevant to implement regarding the characteristics of our data.

Furthermore, to test individually the effects of our supervisory variables, we performed 5 regressions controlling for bank-specific and macro level variables sequentially as follows: First, we include only the *Deposit_Insurance* supervisory authority's variable. Next, we only incorporate the *Central_Bank* as authority variable. Third, we include the scope of supervision. Our fourth specification includes only the *Audit* variable. Fifth, we include only the independence variable.

3.4.1. PRELIMINARY STATISTICS

After determining our sample and variables, we estimated the chosen variables for our model. In Table VI in annex, descriptive statistics compiles the features of our data collection. We can verify that our sample has 12 550 observations of the dependent

variable with a mean of 0.8%.

The observed maximum value for *ROA* belongs to the bank BANCA 5 SPA in 2019. This Italian company provides retail banking and insurance products and services to private individuals and companies. On the other hand, the minimum observed value for ROA is reported by bank ZKB VARLIK KIRALAMA A.S. in 2017, the year in which the company was founded. This is a Turkish bank that offers important opportunities for funds, investment and portfolio management companies to release their resources available to the real sector.

Concerning the observed minimum value for *size* variable corresponds to the bank ALLIANCE & LEICESTER LIMITED in 2018. The maximum reflects DEUTSCHE BANK AG 's reported size of 2011.

Regarding the *ETA* variable, the maximum value of 1 was reported by the Belgium MEDIRECT BANK in 2004, the Turkish bank BEREKET VARLIK KIRALAMA AS in 2013, the NATIONAL-BANK VERMOEGENSTREUHAND GMBH in 2012 and STANDARD CHARTERED BANK AG in 2017, both banks from Germany. The minimum reflects the amount reported by the Latvian bank NORVIK BANKA AS, in 2019.

The minimum of the variable *NLTA* reflects CYNERGY BANK LIMITED reported in 2011. The maximum refers to the bank BANCO DEL BIENESTAR, S. N. C., INSTITUCION DE BANCA DE DESARROLLO's amount in 2019.

For *CIR*, the minimum value belongs to the Canadian bank ZAG BANK in 2016. The maximum amount reflects the Cost-to-income of bank PARAGON BANK PLC in the United Kingdom in year 2014.

Regarding *Deposit_Insurance,* we could verify that 92% of OECD countries implement deposit insurance schemes to prevent bank overruns. However, in Costa Rica, Israel and New Zealand, this requirement is not applied.

In 28 of the analysed countries such as Austria, Germany and Portugal, the Central Bank is involved in bank supervision. In other countries such as Republic of Korea, Japan and Mexico this method is not followed.

In terms of *Scope,* in 13 countries (for instance, Finland, Iceland and Norway) there is consolidation of banking supervision. However, in certain countries as in the case of

Canada, Luxembourg and Portugal, other agencies are in charge to monitor the different financial sectors.

Concerning to *Audit* variables, countries such as Japan, the United Stated and Portugal, supervisors can state judicial proceedings against external auditors for negligence. Nonetheless, for 66% of the analysed countries this is not relevant.

It was found that 45% of OECD countries have a high degree of independence of the supervisory authority. Countries such as the United Kingdom, Portugal and Spain are concerned about this topic. However, the body responsible for supervising banks in the 16 countries including Republic of Korea, Costa Rica and Chile have a low degree of independence.

With reference to the macroeconomic control variables, both the minimum values were reported in Greece in 2011 and 2015 for *gdpg* and *Inflation*, respectively. The maximum value for *gdpg* was verified in Ireland (2015) and for *Inflation* in Turkey (2018).

Subsequently, Table VIII displays the correlation matrix of the variables used in our regression analysis.

As we can verify, the *size* variable has a positive relationship with the dependent variable, meaning that an increase in total assets will reflect an increase in ROA. This is in accordance with previous literature (Sufian & Noor Mohamad Noor, 2012; Lee & Kim, 2013).

ETA also exhibits a positive correlation with the dependent variable. This responds to our expectations and is also in line with previous literature (See: Abdennour & Khediri, 2010; Sufian & Noor Mohamad Noor, 2012; Liang *et al.*, 2013).

The ratio between net loans and total assets presents a positive correlation with ROA, Past studies also confirm this positive association (Abdennour & Khediri, 2010; Ayadi *et al.*, 2016; Liang *et al.*, 2013).

CIR has a negative correlation with our dependent variable, this deteriorating effect is pursuant to what we expected taking previous studies on bank performance into consideration (Abdennour & Khediri, 2010).

It is observed that *Deposit_Insurance* has also a negative correlation with the dependent variable. This conclusion goes in accordance with Abdennour & Khediri

(2010) and Barth *et al.* (2003) analysis.

Central_Bank exibts a positive correlation with ROA. Which means that when the the Central Bank is the financial supervisor, ROA tends to increase. Although the impact of this variable is not consensual in the literature, our results are in line with Abdennour & Khediri (2010).

It was verified that *Scope* seems to be negatively correlated to our dependent variable, meaning that when a certain authority is responsible for supervising the other financial sectors, bank industry performance tends to deteriorate. This is aligned with our expectations presented in the previous section (Abdennour & Khediri, 2010).

Audit presents a positive relationship with ROA. Past studies also confirm that this variable shows a positive impact on our dependent variable (Abdennour & Khediri, 2010).

Regarding *Indep,* it has a positive impact on ROA. This is a surprising result that means that the level of independence of the supervisory authority positively affects performance. In fact, a higher degree of independence permits supervisors to modify supervisory practices in order to enhance better performance of the institution (Abdennour & Khediri, 2010).

Regarding the macroeconomic variable *inflation*, it is positively correlated to ROA. Past studies also confirm that this variable shows a positive impact on performance (see: Abdennour & Khediri, 2010; Athanasoglou *et al.*, 2008; Sufian & Noor Mohamad Noor, 2012). *Gdpg* has a positive relationship with the dependent as was verified by Lee & Kim (2013).

3.5. ROBUSTNESS ANALYSIS

Conducting a robustness analysis permits to verify the variability of the result given a certain chance in the inputs. Subsequently, we replicate the model noting for fixed, country, year and firm effects. Additionally, we submitted some variables to the winsor process: *ROA, CIR, inflation* and *gdpg*.

Winsorizing it is a process that cut extreme values in data in order to diminish the effect of possible spurious outliers (Leroy & Rousseeuw, 1987). Thus, we implemented this process since our data is not normally distributed and considering the fact that the distribution can be prejudiced by outliers (Mehmetoglu & Jakobsen, 2016).

Hence, we applied it to *ROA*, *CIR*, *inflation* and *gdpg* because these variables had more extreme values and we expect that winsorized estimators are usually more robust than the standard ones.

Table VII displays the descriptive statistics considering the corrections previously mentioned (signalized with "_w").

Regarding the correlation between ROA and the independent variables, it is close to our model with the standard variables (Table IX). The main divergence found is concerning *size*, that previously presented a positive and significant coefficient but after winsorizing the abovementioned variables was found insignificant.

Additionally, reinforce the conclusions obtained, we also performed different regressions. Thus, applying several investigations around our research questions, the results obtained will be ensured.

4. RESULTS

This chapter exhibits and discusses the results. Section 4.1 displays the results arising from our determinants' estimation of *ROA* and the impact of supervision variables. Section 4.2 presents the robustness analysis results.

4.1 DETERMINANTS OF ROA

i. What are the determinants of Return on Assets?

ii. Do supervisory measures help to enhance or obstruct bank performance of banks?

In order to answer our research questions, we assess the determinants of the ROA ratio and present the results in Table I.

As we can observe, *size* exhibits a significant and positive impact in ROA in all regressions. This means that larger banks appear to have a greater performance as verified by Sufian & Noor Mohamad Noor (2012) and Lee & Kim (2013).

In all models, *ETA* positively impact the dependent variable as expected (see: Abdennour & Khediri, 2010; Sufian & Noor Mohamad Noor, 2012; Liang *et al.*, 2013). In line with Athanasoglou *et al.* (2008) idea, this positive impact can be related to the fact that bank capital is the amount of own funds available to support a bank's business, thus it acts as a safety net in the case of adverse expectations.

The results are consistent in all Models regarding *NLTA.* This variable exhibits a

positive correlation with the ROA as seen in previous literature (Liang *et al.*, 2013).

CIR seem to be negatively related to bank performance in all specifications. This follows the results obtained by Abdennour & Khediri (2010).

For the three regressions in Model 1, 7 and 8, *Deposit_Insurance* has a positive coefficient, which is the opposite of what we expected. Deposit insurance schemes are projected to prevent bank attacks by settling available resources to support banks' weaknesses (Triki *et al.*, 2017).

Regarding *Central_Bank*, this dummy variable presents a positive impact on ROA when analysed individually (Model 2) and also in Models 7 and 8. As was verified by Abdennour & Khediri (2010), Central Bank with the role of bank supervisor helps to enhance performance.

Scope is not significant in all the Models with exception of Model 7 in which it appears with a significant and positive coefficient.

The results are consistent in all regression in which *Audit* was inserted both individually (Models 4) and together with other supervision variables (Models 6 to 10). This variable presents a positive correlation with the *ROA.* As seen in previous literature, banks in countries in which supervisors can proceed legal action against external auditors for negligence are more profitable (Abdennour & Khediri, 2010).

In relation to the degree of independence of supervisory authorities, we observe in Models 5, 6, 9 and 10 that it has a significant and positive correlation with the ROA. Nonetheless, the coefficient sign follows the one obtained by Abdennour & Khediri, 2010. However, in two of our regressions (Models 7 and 8) this variable exhibits a negative impact on the dependent variable as verified by Barth *et al. (*2003).

Regarding our macroeconomic control variables, *inflation* appears to have a positive and statistical significance previously verified by Athanasoglou *et al.* (2008) and Sufian & Noor Mohamad Noor (2012) in all models except in Model 8. *Gdp*g also presents a positive correlation with the *ROA* as expected by Lee & Kim (2013).

Table I- Determinants of ROA

VARIABLES	(1) OLS Regression	(2) OLS Regression	(3) OLS Regression	(4) OLS Regression	(5) OLS Regression	(6) OLS Regression	(7) OLS Regression	(8) OLS Regression	(9) FGLS Regression	(10) GLM Regression
size	0.0008***	0.0008***	0.0007***	0.0006***	0.0008***	0.0006***	0.0009***	0.0017**	0.0006***	0.0006***
	(0.0002)	(0.0002)	(0.0001)	(0.0002)	(0.0002)	(0.0001)	(0.0001)	(-0.0006)	(0.0001)	(0.0001)
ETA	0.0410***	0.0405***	0.0408***	0.0411***	0.0405***	0.0407***	0.0397***	0.0385***	0.0383***	0.0414***
	(0.0066)	(0.0066)	(0.0065)	(0.0065)	(0.0066)	(0.0065)	(0.0067)	(0.0147)	(0.0020)	(0.0074)
NLTA	0.0053***	0.0054***	0.0053***	0.0040**	0.0047***	0.0036**	0.0011	0.0126***	0.0038***	0.0037***
	(0.0014)	(0.0014)	(0.0014)	(0.0014)	(0.0014)	(0.0014)	(0.0016)	(0.0042)	(0.0009)	(0.0013)
CIR	-0.0000**	-0.0000**	-0.0000**	-0.0000**	-0.0000**	-0.0000**	-0.0000***	-0.0000***	-0.0000***	-0.0000**
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Deposit_Insurance	0.0014**					-0.0003	0.0237***	0.0351***	-0.0003	-0.0002
	(0.0006)					(0.0006)	(0.0064)	(0.0110)	(0.0013)	(0.0006)
Central_Bank		0.0015***				0.0007	0.0090***	0.0107***	0.0003	0.0006
		(0.0004)				(0.0005)	(0.0015)	(0.0019)	(0.0005)	(0.0006)
Scope			-0.0010			0.0007	0.0033***	0.0007	0.0006	0.0006
			(0.0008)			(0.0008)	(0.0013)	(0.0026)	(0.0006)	(0.0006)
Audit				0.0043***		0.0043***	0.0091***	0.0060***	0.0043***	0.0042***
				(0.0003)		(0.0003)	(0.0006)	(0.0021)	(0.0004)	(0.0004)
Indep					0.0017***	0.0011***	-0.0149***	-0.0227***	0.0011***	0.0010**
					(0.0003)	(0.0003)	(0.0035)	(0.0055)	(0.0004)	(0.0005)
inflation	0.0008***	0.0009***	0.0008***	0.0009***	0.0010***	0.0010***	0.0004**	-0.0001	0.0007***	0.0008***
	(0.0002)	(0.0002)	(0.0002)	(0.0001)	(0.0002)	(0.0001)	(0.0002)	(0.0003)	(0.0001)	(0.0002)
gdpg	0.0012***	0.0012***	0.0012***	0.0013***	0.0012**	0.0012***	0.0010***	0.0009***	0.0014***	0.0012***
	(0.0003)	(0.0004)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0002)	(0.0002)	(0.0001)	(0.0002)
Constant	-0.0172***	-0.0169***	-0.0153***	-0.0152***	-0.0198***	-0.0185***	-0.0075	-0.0110	-0.0178***	-0.0179***
	(0.0041)	(0.0038)	(0.0037)	(0.0039)	(0.0040)	(0.0038)	(0.0053)	(0.0125)	(0.0024)	(0.0030)
Year Effects	NO	NO	NO	NO	NO	NO	YES	NO	NO	NO
Country Effects	NO	NO	NO	NO	NO	NO	YES	YES	NO	NO
Wald Test	FE	FE	FE	FE	FE	FE	-	-	-	-
Observations	12,289	12,289	12,289	12,289	12,250	12,250	12,126	12,119	12,250	12,250
R-squared	0.0442	0.0449	0.0444	0.0509	0.0455	0.0519	-	-	-	-

Note: This table presents the results of the determinants of ROA. Model 1 to Model 6 are Heteroscedasticity standard errors OLS regressions with fixed effect. Model 7 refers to an OLS regression with year and country, while Model 8 is with just with country effects. Model 9 is based on a Feasible GLS regression and Model 10 is a Generalised Linear Model. Robust standard errors in parentheses. OLS= ordinary least squares; GLM= generalized linear model; GLS= generalized least square

4.2 ROBUSTNESS ANALYSIS RESULTS

Table II disclosures the results obtained replicating the models used and applying a winsorized process to *ROA, CIR, inflation* and *gdpg*. We adopt this transformation given the discrepancy of minimum and maximum values verified in variables, limiting extreme values (Leroy & Rousseeuw, 1987). We analyse the achieved results with such transformations compared to the results presented previously.

As we can observe, *size* has a negative impact on ROA in all regressions. These results go against the ones previously found and can be justified by the fact that, given the limitation of data from the winsorization process and according to Antwi (2019) findings, "bank can take advantage of the economies of scale at a certain asset size level, but these economies of scale become exhausted as the bank's size increases".

The results are consistent in all Models regarding *ETA.* This variable positively impacts the dependent variable with and without winsorizing.

NLTA seem to have a negative correlation with *ROA* in Models 7 and 8. This impact is inconsistent with the previously obtained without winsor process.

CIR which was submitted to winsorization exhibits a negative and significant relation to bank performance in all specifications just like it had in the previous section.

For the three regressions in Model 1, 7 and 8, the dummy variable *Deposit_Insurance* has a positive coefficient, which is consistent since they are the same with and without winsorizing.

Regarding *Central_Bank*, it also presents a positive impact on ROA in Models 7 and 8 just like it had without winsorizing *ROA, CIR, inflation* and *gdpg*. The difference is that with this transformation, when analysed individually (Model 2), this variable maintains the positive sign but with no significance.

The *Scope* dummy variable, after winsorizing the abovementioned variables, poses a significant impact in our dependent variable in Model 3, maintaining the sign in the previous section and also in Model 9 (that previously was positive but not significant).

The results are consistent in all regression in which *Audit* was inserted both individually (Models 4) and together with other supervision variables (Models 6 to 10). These results are consistent since they are similar with and without winsorizing.

Table II - Determinants of ROA (winsorized)

VARIABLES	(1) OLS Regression	(2) OLS Regression	(3) OLS Regression	(4) OLS Regression	(5) OLS Regression	(6) OLS Regression	(7) OLS Regression	(8) OLS Regression	(9) FGLS Regression	(10) GLM Regression
size	-0.0002**	-0.0002**	-0.0002***	-0.0003***	-0.0002**	-0.0003***	-0.0001***	-0.0001***	-0.0003***	-0.0003***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0000)	(0.0000)	(0.0001)	(0.0001)
ETA	0.0305***	0.0303***	0.0302***	0.0306***	0.0302***	0.0304***	0.0299***	0.0301***	0.0311***	0.0309***
	(0.0019)	(0.0019)	(0.0018)	(0.0019)	(0.0019)	(0.0019)	(0.0019)	(0.0019)	(0.0010)	(0.0028)
NLTA	0.0005	0.0005	0.0005	-0.0004	0.0003	-0.0004	-0.0013**	-0.0012**	-0.0003	-0.0003
	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0006)
CIR_w	-0.0269***	-0.0269***	-0.0269***	-0.0267***	-0.0268***	-0.0266***	-0.0262***	-0.0262***	-0.0268***	-0.0267***
	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0006)	(0.0006)	(0.0004)	(0.0008)
Deposit_Insurance	0.0010**					0.0004	0.0141***	0.0171***	0.0005	0.0005
	(0.0003)					(0.0003)	(0.0034)	(0.0037)	(0.0007)	(0.0004)
Central_Bank		0.0004				0.0001	0.0074***	0.0072***	0.0000	0.0000
		(0.0002)				(0.0003)	(0.0005)	(0.0005)	(0.0002)	(0.0003)
Scope			-0.0013**			-0.0005	0.0000	-0.0002	-0.0005*	-0.0005
			(0.0004)			(0.0004)	(0.0008)	(0.0009)	(0.0003)	(0.0003)
Audit				0.0030***		0.0029***	0.0049***	0.0048***	0.0029***	0.0029***
				(0.0002)		(0.0002)	(0.0004)	(0.0004)	(0.0002)	(0.0002)
Indep					0.0005**	0.0001	-0.0106***	-0.0122***	0.0000	0.0000
					(0.0002)	(0.0002)	(0.0018)	(0.0019)	(0.0002)	(0.0002)
Inflation_w	0.0006**	0.0006**	0.0005***	0.0005***	0.0006***	0.0005***	0.0001	-0.0002	0.0004***	0.0004***
	(0.0002)	(0.0002)	(0.0002)	(0.0001)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0001)	(0.0001)
Gdpg_w	0.0008***	0.0008***	0.0009***	0.0009***	0.0008***	0.0009***	0.0008***	0.0007***	0.0009***	0.0009***
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Constant	0.0209***	0.0217***	0.0225***	0.0221***	0.0206***	0.0214***	0.0296***	0.0335***	0.0218***	0.0219***
	(0.0015)	(0.0014)	(0.0013)	(0.0012)	(0.0014)	(0.0015)	(0.0024)	(0.0022)	(0.0012)	(0.0015)
Year Effects	NO	NO	NO	NO	NO	NO	YES	NO	NO	NO
Country Effects	NO	NO	NO	NO	NO	NO	YES	YES	NO	NO
Wald Test	FE	FE	FE	FE	FE	FE	-	-	-	-
Observations	12,289	12,289	12,289	12,289	12,250	12,250	12,126	12,126	12,250	12,250
R-squared	0.3617	0.3617	0.3626	0.3719	0.3614	0,37	-	-	-	-

Note: This table presents the results of the determinants of ROA. Model 1 to Model 6 are Heteroscedasticity standard errors OLS regressions with fixed effect. Model 7 refers to an OLS regression with year and country, while Model 8 is with just with country effects. Model 9 is based on a Feasible GLS regression and Model 10 is a Generalised Linear Model. Robust standard errors in parentheses. OLS= ordinary least squares; GLM= generalized linear model; GLS= generalized least square

In relation to the degree of independence of supervisory authorities, we observe in Models 5 the same positive and significant impact as without applying the winsorization process. The difference is that with this transformation, in model 7 and 8 it shows a negative impact on ROA and none in the remaining Models.

Regarding our macroeconomic control variables, *inflation* the coefficient seems to be consistent in all regressions with exception of Models 7 and 8 that are not significant. *Gdp*g also presents a positive correlation with the *ROA* in all Models both before and after wisorizing *ROA, CIR, inflation* and *gdpg.*

5. CONCLUSION

In this dissertation we investigated the determinants of bank performance and additionally the effect of bank supervision on bank performance in OECD banks. The existing literature is divergent regarding certain aspects of supervisory measures worldwide.

It is a consensus amongst authors that imperfections in bank regulation and supervision were key drivers to financial crisis. Consequently, it brought into focus the awareness of implementing reforms in bank regulation to enhance bank development, performance and stability. Having that in mind, BCBS implemented several improvements to regulatory frameworks to enhance bank safety and soundness, systemic stability and development of banking system. However, different orientation is taken regarding this topic worldwide. Assessing the most common measures to evaluate bank performance, it was possible to conclude that the impact of supervision on bank performance is a controversial topic since it leads to different opinions.

We implemented different regressions to a sample of 1,632 commercial banks belonging to the 38 OECD countries over the years 2011-2019. Our results are quite aligned with existing literature.

Regarding bank specific characteristics, we observed that bigger banks tend to have less profit. We also verified that banks with lower leverage tend to be more profitable. A low equity to assets ratio means that banks primarily use debt to acquire assets, which is widely viewed as an indication of greater financial risk (Baker, 1973). Banks with higher *NLTA* ratio are more profitable since the amount of loans is high leading to lower

levels of liquidity (Liang *et al.*, 2013). In terms of *CIR*, we could verify that it decreases bank profitability, since higher values of this variables implies less efficiency (Tripe, 1998).

In terms of supervisory measures, we found statistical evidence that shows that banks operating in countries where there is a Deposit Insurance scheme and where the Central Bank is responsible for supervision are more profitable. We also verified that countries in which supervisors can take legal action against external auditors for negligence in their actions and in which there is a higher degree of independence of supervisory body are more prone to be profitable. However, our study suggest that the scope of supervision does not have a significant and consistent impact on performance.

Macroeconomic variables are also significant for bank performance. Both *inflation* and *gdpg* influence positively the return on assets of banks.

This present work contributes to the existing literature about this topic through the analysis of the most recent data regarding this subject. Nonetheless, further research would be necessary given the importance of this topic for financial stability.

Our study limitation regards mainly the data used. Due to unavailable data, it was not possible to analyse a longer period, which would be much more interesting. Moreover, regarding supervisory measures, we could not analyse an important variable considered in previous studies due to ambiguous answers in the World Bank database. We had constraints in the period used and also the data available by bank. A more extent period, would also permit to compare bank performance before and after the financial crisis, which was a crucial time for the banking sector. In fact, results would have been more robust and consistent if we had the same data available for all the banks in our sample, leading to a stronger contribute for the empirical analysis regarding bank's performance.

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ANNEX

Table III - Literature Review Table of Empirical Papers

This Table presents information about the author, methodology and respective conclusions for the literature review of empirical papers.

Notes: ETA is Equity/Total Assets; CIR is Cost-to-Income Ratio; NLTA is Net Loans/Total Assets; ROA is Return on Assets; ROE is Return on Equity; NPL is Non-Performing Loan; GDP is Gross Domestic Product; HHI is Herfindahl-Hirschman Index; NCO is Net Charge-Offs/total loans.

Author (year)	Region/ country	Period	Methodology	Dependent variables	Independent variables	Main conclusions
Abdennour & Khediri (2010).	11 MENA countries	1999-2006	Estimate the effect of bank supervision on bank profitability (OLS)	ROAA.	ETA; CIR; NLTA; GDP growth; Inflation rate; AUDIT (dummy equals 1 if there is legal action for external auditors' negligence); DI (dummy equals 1 for deposit insurance); PCBANK (dummy equals 1 if Central Bank is one of the supervision body); PSINGLE (dummy equals 1 if there is just one supervision body); SUPFIN (dummy equals 1 if there is a Single financial supervisor); Supervision Independence index.	Banks supervised by the Central Bank are more profitable. A single or more supervision body does not affect bank performance. The possibility of legal punishing external auditors for negligence is a key factor to enhance bank profitability. SUPFIN and DI have a negative impact on bank performance.
Abdul Hadi *et al.* (2018)	Middle East, Africa and Indian subcontinent.	2009-2016	Examine the relationship between bank's profitability and its loan growth (OLS)	ROA.	Loan growth; ETA; Liquidity ratio; NPL; Default risk premium.	There are evidences that loan growth is a critical factor that conduct to a higher bank's long-term performance.

						NPL and ETA are found to have a negative impact on ROA.
Antwi, (2019)	Ghana	2013-2018	Examine the relationship between capital adequacy, cost income ratio and performance (OLS).	ROA; ROE.	ETA; CIR; Size; Debt to Equity ratio; Asset growth.	The study revealed that ETA is negatively related to performance, however it is statistically insignificant for ROA but significant for ROE. CIR has a negative and significant relationship with ROA and ROE. Bank size has a negative relationship with performance, both ROA and ROE and it is statistically significant.
Athanasoglou *et al.* (2008)	Greece	1985–2001	Examine the effect of f bank-specific, industry-specific and macroeconomic determinants of bank profitability (Generalized Method of Moments).	ROA; ROE.	ETA; Loan loss provisions/loans; Productivity growth; Size; Ownership (dummy equals 1 for privately-owned banks or market share of privately-owned banks); HHI Inflation Cyclical output.	ETA increases of Greek banks' performance. Higher productivity growth generates income that is inserted on bank profits. Cyclical output has a positive, but asymmetric impact on bank ROA, being significant only in the upper phase of the cycle. Credit risk is negatively and significantly related to bank profitability.
Barth *et al.* (2003)	55 worldwide countries	1996-1999	Test the effects of supervisory structure on bank profitability (OLS).	EBT/Assets.	ETA; NLTA; Net deposits/Assets; Cash/Assets; Non-interest expenses/Assets; Taxes/EBT; GDP per capita;	Weak influence of supervisory measures on bank performance. Central bank supervision is negatively related to bank profitability.

					GDP growth; Inflation; Assets of 3 largest banks (%); Private credit/GDP; Domestic Equity traded/GDP; Government-owned bank assets/Assets; Foreign-owned bank assets /Assets; PCBANK (dummy equals 1 if Central bank is one of the supervision body); PSINGLE (dummy equals 1 if there is just one supervision body); Regulatory restrictions in securities, insurance and real estate ; Regulatory restrictions in bank ownership; Supervisory forbearance; SUBDEBT (dummy equals 1 if subordinated debt is allowable); DI (dummy equals 1 for deposit insurance); SCOPE (dummy equals 1 if banking regulator regulate insurance); Independence of Supervisory Authority.	Pursuing just one supervisory body is significantly positive to enhance bank performance.
Demirgüç-Kunt & Huizinga (1999)	80 worldwide countries	1988-1995	Examine the effect of different types of bank characteristics, macroeconomic conditions, taxation and overall financial structure indicators on interest margins and bank profitability (OLS).	Net interest margin; Net profit/TA.	Size; ETA; NLTA; Deposit Insurance (dummy) Non-interest earning assets/ta; Customer &short-term funding/ta; Foreign ownership dummy; Gdp/cap; GDP Growth; Inflation; Real interest; Reserves; Tax rate; Bank/gdp; Mcap/gdp;	Larger bank to asset to GDP ratio and a lower market concentration ratio conduct to a decrease of margins and profits. There is evidence that foreign banks have better margins and profits compared to domestic banks in developing countries. In developed countries domestic banks tend to have higher margins and profits.

					Concentration ; Contract enforcement dummy; Law & order índex; Corruption.	
Lee & Kim (2013).	China, Japan and Korea	2003-2010	Implement Malmquist index approach and other profitability measures to analyse the main determinants of bank performance (OLS fixed effect).	ROA; ROE; Malmquist índex.	Size; Loans/deposits; GOVERNMENT (dummy equal 1 for government ownership); FOREIGN (dummy equal 1 for management control of a foreign buyout fund); GOVERNMENT * GDP growth rate; FOREIGN * GDP growth rate; GDP growth; M&A (dummy equal 1 for the event of Mergers and Aquisitions transactions).	Foreign international banks have the potential have favourable for bank performance. Government ownership and foreign buyout funds has mainly negative effect on bank performance.
Liang *et al.* (2013)	China	2003-2010	Testify the effect of board characteristics on bank assets quality and performance (OLS).	ROA; ROE; Pre-provision profit ratio; NPL; Stock of NPLs; NCO ratio; Level of NCOs.	Board Size; Meetings; Duality (dummy equals 1 if CEO is also the chairman); Independent Director (%); Political Director (%); Busy Director (%); Foreign Director (%); Old Director (%); Female Director (%); Size; NLTA; ETA; Listed (dummy equals 1 if bank listed) ForStgInvestor (dummy equal 1 if a bank has foreign strategic investor); HHI; Foreig shareholder % share; Government shareholder % share;	The number of board meetings and the proportion of independent directors have positive impacts on both bank performance and asset quality. Board size negatively affect bank performance.

					Natural log of weighted average GDP per capita.	
Magweva Marime (2016)	Zimbabwe	2009-2015	Quantitative methodology to empirically measure the relationship between bank internal features and bank performance.	ROA ROE	Asset quality; Capital adequacy; Credit risk (loan loss provision / total loans); Size; Liquidity ratio; Management efficiency.	Bank specific indicators were not significant in determining bank performance. Level of capital does not significantly influence ROA of banks, though it boosts soundness and stability of the sector.
Sufian & Noor Mohamad Noor (2012)	India	2000-2008	Examine internal and external factors that affect the performance of banks (OLS).	ROA	LLP/Loans; Ln(deposits); ETA; Non-interest expense/Assets; Non-interest income/Assets; Total loans/ assets; Size; Ln(GDP); Inflation; Growth of money supply; Concentration ratio (3 largest banks); Market cap/GDP; DUMAMER (dummy equals 1 for foreign banks from North America); DUMEURO (dummy equals 1 for foreign banks from the Europe); DUMASIA (dummy equals 1 for foreign banks from other Asian countries); DUMMENA (dummy equals 1 for foreign banks from the MENA).	Liquidity have a negative impact on Indian bank profitability. In general bank size is a key factor to enhance profitability. impact of overhead expenses In general, there is a positive impact of overhead expenses on bank profitability.

Table IV - Literature Review Table of Independent Variables

This Table contains information about the independent variables, the studies in which they were used and main conclusions regarding them.

	Variable	Studies	Main Conclusions
Bank specific variables variables	Size	Antwi, (2019)	Banks' size is negatively related to ROA.
		Demirgüç-Kunt & Huizinga (1999)	Size is not significant for bank profitability.
		Magweva Marime (2016)	Bank assets are not statistically significant for performance.
		Lee & Kim (2013)	Studies in Chinese banks suggest a clearly nonlinear but positive relationship between bank size and profitability measured by ROA.
		Liang *et al.* (2013)	Bank size seems to have a negative but not significant impact on regional banks in China.
		Sufian & Noor Mohamad Noor (2012)	Size positively affect bank performance measured by ROA.
	Total Equity to Total Assets	Abdennour & Khediri (2010)	Well-capitalised banks tend to be less likely to bankrupt leading to a higher profitability (ROA).
		Abdul Hadi *et al.* (2018)	ETA ratio has a negative impact on bank's profitability.
		Antwi, (2019)	Capital to asset ratio has a negative but not significant effect on ROA.
		Athanasoglou *et al.* (2008)	The capital variable is positive and highly related to bank performance.
		Barth *et al.* (2003)	ETA have a positive impact on bank profitability but not always significant at 10% level.

		Demirgüç-Kunt & Huizinga (1999)	There is evidence that ETA helps to enhance bank profitability.
		Liang *et al.* (2013)	It was verified a positive and significant impact of ETA capital ratio on bank ROA.
		Sufian & Noor Mohamad Noor (2012)	Capital strength measured by ETA is positively related to Indian banks' profitability (ROA).
	Net Loans to Total Assets	Abdennour & Khediri (2010)	The coefficient on NLTA is has a positive but not statistically significant for banks' ROA.
		Barth *et al.* (2003)	Loans to total assets have a negative but it's not significant for bank performance.
		Demirgüç-Kunt & Huizinga (1999)	NLTA was found positive and significant for bank profitability.
		Liang *et al.* (2013)	Capital ratio measured by loans to total assets ratio have a positive impact on ROA.
	Cost-to-Income ratio	Abdennour & Khediri (2010)	CIR is significantly and negatively connected to bank profitability.
		Antwi, (2019)	CIR is negatively connected to ROA.
Supervision Variables	Deposit_Insurance	Abdennour & Khediri (2010)	Deposit insurance has a significant and negative effect on MENA countries' ROA.
		Barth *et al.* (2003)	DI has a negative and significant relationship with bank profitability.
		Demirgüç-Kunt & Huizinga (1999)	There is no evidence that DI has statistical significance for bank profitability.
	Central_Bank	Abdennour & Khediri (2010)	Banks in MENA countries supervised by the Central Bank definitively more profitable.
		Barth *et al.* (2003)	CBANK has both negative and significant association with profitability.
	Scope	Abdennour & Khediri (2010)	The existence of a single financial supervisory authority responsible for all main financial institutions it's negative and significant for bank ROA.
		Barth *et al.* (2003)	SCOPE is positive but doesn't seem to be significant for bank profitability.

	Audit	Abdennour & Khediri (2010)	In MENA banks, taking legal measures against external auditor's negligence ameliorate profitability.
	Independence	Abdennour & Khediri (2010) Barth *et al.* (2003)	The independence of MENA banks is positive but not relevant for profitability. Independence is negative but not a relevant factor for bank performance.
Macroeconomic control variables	Inflation	Abdennour & Khediri (2010) Athanasoglou *et al.* (2008) Barth *et al.* (2003) Demirgüç-Kunt & Huizinga (1999) Sufian & Noor Mohamad Noor (2012)	Inflation has a significant and positive impact on bank profitability. Higher inflation leads to higher performance of Greek banks. Inflation is not a significant variable to analyse performance. There is empirical evidence that inflation is positive and significant for bank profitability. Inflation is positively associated with Indian banks' profitability (ROA).
	GDP Growth	Abdennour & Khediri (2010) Barth *et al.* (2003) Demirgüç-Kunt & Huizinga (1999) Lee & Kim (2013)	There is no evidence suggesting that GDP growth is significant for bank profitability. Economic growth is not significant for bank profitability. It was not found evidence that GDP growth is significant for bank profitability. Positive and statistically significant impact on ROA.

Table V – Details and expected signal of independent variables

Variable	Type	Description	Source	Expected sign
Size	numerical	Logarithm of total assets	BankFocus	+/-
ETA	numerical	Total Equity to Total Assets	BankFocus	+/-
NLTA	numerical	Net Loans to Total Assets	BankFocus	+
CIR	numerical	Cost-to-Income ratio	BankFocus	-
DI	dummy	DI takes a value of 1 an explicit deposit insurance protection system is required and a value of 0 otherwise	World Bank (BRSS, 2019)	+/-
Central Bank	dummy	Central Bank takes a value of 1 if the Central Bank is a bank supervisory and a value of 0 otherwise	World Bank (BRSS, 2019)	+/-
Scope	dummy	Scope takes a value of 1 if the body/agency in charge of supervising banks is also financial supervisory authority responsible for all other financial sectors (insurance, securities and pension funds) and a value of 0 otherwise.	World Bank (BRSS, 2019)	-
Audit	dummy	Audit takes a value of 1 if supervisors can take legal action against external auditors for negligence and a value of 0 otherwise.	World Bank (BRSS, 2019)	+
Indep	numerical	Indep takes values of 1 through 3 for low, medium, and high independence, respectively.	Authors' calculations using World Bank data (BRSS, 2019) and based on Barth *et al*. (2008)	0
Inflation	numerical	Annual inflation rate.	World Bank (WDI)	+
GDP growth	numerical	Gross Domestic Product growth	World Bank (WDI)	+

Table VI– Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
ROA	12550	0	.03	-.765	.785
size	12581	15.051	2.242	.239	21.657
ETA	12550	.128	.136	-.5	1
NLTA	12339	.587	.234	-.001	1
CIR	12525	.894	18.964	-196.587	2046
Deposit Insurance	14409	.975	.156	0	1
Central Bank	14409	.642	.479	0	1
Scope	14409	.171	.376	0	1
Audit	14409	.519	.5	0	1
Indep	14360	2.503	.664	1	3
inflation	14409	1.827	1.939	-1.74	16.33
gdpg	14409	2.124	1.674	-9.13	25.16

Table VII - Descriptive statistics (robustness check)

Variable	Obs	Mean	Std. Dev.	Min	Max
ROA_w	12550	0	.015	-.059	.075
size	12581	15.051	2.242	.239	21.657
ETA	12550	.128	.136	-.5	1
NLTA	12339	.587	.234	-.001	1
CIR_w	12525	.674	.296	.057	2.376
Deposit Insurance	14409	.975	.156	0	1
Central Bank	14409	.642	.479	0	1
Scope	14409	.171	.376	0	1
Audit	14409	.519	.5	0	1
Indep	14360	2.503	.664	1	3
inflation_w	14409	1.778	1.645	-.87	8.89
gdpg_w	14409	2.11	1.421	-1.84	7.47

Table VIII - Correlation matrix

Variable	ROA	size	ETA	NLTA	CIR	Deposit Insurance	Central Bank	Scope	Audit	Indep	inflation	gdpg
ROA	1											
size	0.017*	1										
ETA	0.101*	-0.426*	1									
NLTA	0.010	0.099*	-0.240*	1								
CIR	-0.025*	-0.022*	0.043*	-0.025*	1							
Deposit Insurance	-0.004	-0.020*	0.002	-0.067*	0.002	1						
Central Bank	0.017*	-0.024*	0.053*	-0.050*	0.003	0.007	1					
Scope	-0.008	-0.111*	-0.014	0.019*	-0.003	0.072*	-0.162*	1				
Audit	0.062*	0.199*	-0.127*	0.148*	-0.015	0.044*	0.064*	-0.211*	1			
Indep	0.026*	0.030*	-0.042*	0.085*	0.005	0.118*	0.444*	-0.189*	0.109*	1		
inflation	0.063*	-0.044*	0.145*	-0.028*	-0.005	-0.005	-0.150*	-0.005	-0.033*	-0.198*	1	
gdpg	0.065*	-0.050*	0.069*	0.010	0.002	-0.113*	-0.137*	0.127*	-0.060*	-0.074*	0.202*	1

Table IX- Correlation matrix (robustness check)

Variable	ROA w	size	ETA	NLTA	CIR_w	Deposit Insurance	Central Bank	Scope	Audit	Indep	inflation_w	gdpg_w
ROA_w	1											
size	-0.010	1										
ETA	0.177*	-0.426*	1									
NLTA	0.042*	0.099*	-0.240*	1								
CIR_w	-0.508*	-0.216*	0.130*	-0.172*	1							
Deposit Insurance	-0.008	-0.020*	0.002	-0.067*	0.012	1						
Central Bank	0.022*	-0.024*	0.053*	-0.050*	-0.026*	0.007	1					
Scope	-0.010	-0.111*	-0.014	0.019*	-0.015*	0.072*	-0.162*	1				
Audit	0.103*	0.199*	-0.127*	0.148*	-0.092*	0.044*	0.064*	-0.211*	1			
Indep	0.040*	0.030*	-0.042*	0.085*	-0.081*	0.118*	0.444*	-0.189*	0.109*	1		
inflation_w	0.133*	-0.037*	0.139*	-0.020*	-0.068*	-0.010	-0.137*	0.008	-0.008	-0.209*	1	
gdpg_w	0.131*	-0.065*	0.074*	0.013	-0.053*	-0.135*	-0.147*	0.154*	-0.056*	-0.085*	0.254*	1

Figure 1 - Standardized normal probability plot

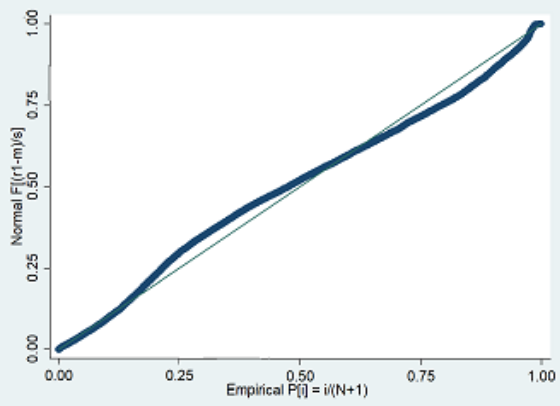

Figure 2- Standardized normal probability plot (robustness check)

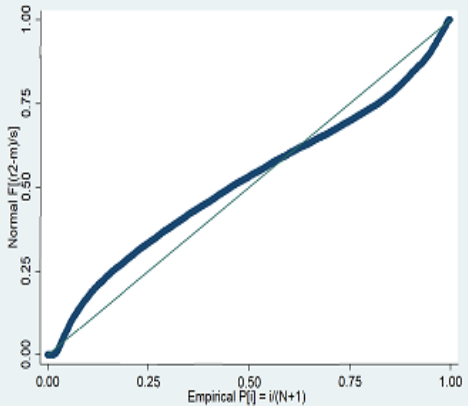

Figure 3- Dependent variable's Histogram

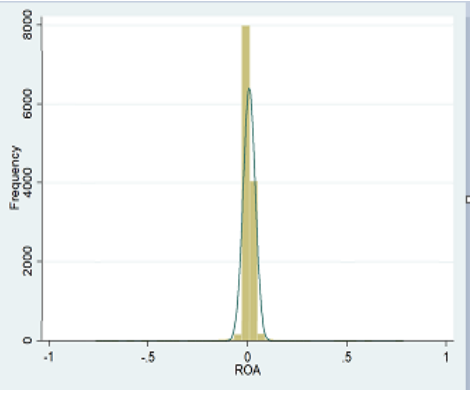

Figure 4- Kernel density graph

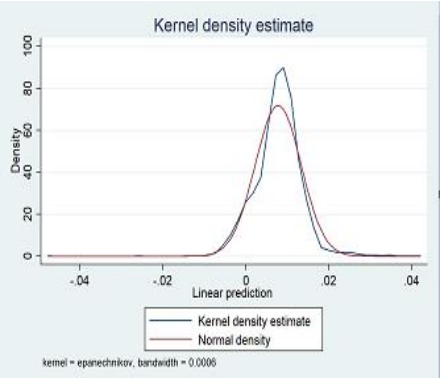

Figure 5- Kernel density graph (robustness check)

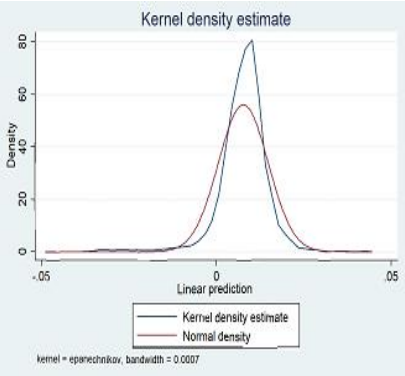

Figure 6- Residuals histogram

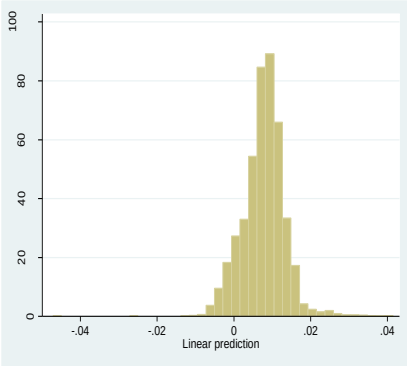

Figure 7- Residuals histogram (robustness check)