
The Single Supervisory Mechanism, Market Power and Bank Stability

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Abstract

This study investigates how the establishment of the Single Supervisory Mechanism (SSM) affects the stability and market power of eurozone banks by means of a difference-in-differences approach. Investigating the intricate relationship between supervision, market power and bank risk, also sheds further light on the competition-stability nexus. Our analysis is based on a sample of 125 banks from 9 non-eurozone European countries and 15 eurozone countries over the 2011 to 2018 period. Accounting for endogeneity and simultaneity in our model, we employ 3SLS estimation to a system of simultaneous equations. After controlling for bank-specific characteristics, industry structure and country-level factors, we provide evidence that the introduction of the SSM reduced the risk levels and the market power of ECB supervised banks. Our results also suggest the existence of a trade-off between stability and competition in the European banking sector. In our analysis, we include battery of robustness tests that confirm the consistency of our results.

Key-words: Single Supervisory Mechanism; Bank Stability; Market Power; Supervision; Eurozone.

JEL classification: C33; C36; G21; G28

Resumo

Este estudo tem como objetivo investigar o impacto do Mecanismo Único de Supervisão (MUS) no nível de risco e de poder de mercado dos bancos da zona euro, através de uma abordagem *difference-in-differences*. Além disso, neste estudo também nos propomos a clarificar a relação entre estabilidade e concorrência bancária, no contexto europeu. A nossa análise é baseada numa amostra de 125 bancos provenientes de 9 países Europeus fora zona euro e de 15 países pertencentes à zona euro. De forma acomodar questões relacionadas com a endogeneidade e simultaneidade, adotamos o método de estimação de 3SLS. Tendo em consideração diferentes determinantes internos e externos que influenciam o nível de risco e a posição competitiva de cada banco, verificamos que o MUS reduziu o nível de risco e o poder de mercado dos bancos da zona euro. Os nossos resultados também indicam que existe um *trade-off* entre estabilidade e concorrência bancária no mercado Europeu. Na nossa análise incluímos um conjunto de testes que atestam a robustez dos nossos resultados.

Palavras-Chave: Mecanismo Único de Supervisão; Estabilidade Bancária; Poder de Mercado; Supervisão; Zona Euro.

Classificação JEL: C33; C36; G21; G28;

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Acronyms List

CA	– Comprehensive Assessment
DiD	– Difference-in-Differences
EBA	– European Banking Authority
ECB	– European Central Bank
EBU	– European Banking Union
EDIS	– European Deposit Insurance Scheme
EU	– European Union
GDP	– Gross Domestic Product
GFC	– Global Financial Crisis
HHI	– Hirschman-Herfindahl Index
IMF	– International Monetary Fund
LOLR	– Lender of Last Resort
LSI	– Less Significant Institutions
NIM	– Net Interest Margin
NPL	– Non-Performing Loans
NCA	– National Competent Authorities
OLS	– Ordinary Least Squares
ROAA	– Return on Average Assets
SRM	– Single Resolution Mechanism
SSM	– Single Supervisory Mechanism
SUR	– Seemingly Unrelated Regression
2SLS	– Two-stage Least Squares
3SLS	– Three-stage Least Squares

1. Introduction

As it has been proven, both in times of stability and in times of turmoil, banks are undoubtedly one of the most systemically important elements in the economy. A stable and well-functioning banking system is central to ensure conditions for an efficient allocation of resources and to stimulate economic growth. However, as it was demonstrated by repeated banking crisis, banks can also be a huge source of vulnerabilities and adverse feedback effects on the real economy. The onset of the 2008 financial crisis and the collapse of critical financial intermediaries caused deep disruptions on the functioning of financial markets with pervasive consequences for the economy, while imposing major costs to governments and taxpayers associated with the bailout of systemically important institutions. The weaknesses in the banking system that were exposed during the global financial crisis placed the failure of financial supervision on the center of the public debate and exposed the pressing need to reshape bank regulation and supervision.

The experience of the 2008 financial crisis showed that the increasing integration of the cross-border financial markets within the eurozone monetary union inevitably meant that problems in the banking system of a country, can rapidly spread threaten the financial stability across the whole euro area. Recognizing the need to reform banking supervision, in 2012 the European Commission proposed a major revision to the supervisory infrastructure of the euro-area financial sector by introducing the Single Supervisory Mechanism (SSM). In November 2014, when the SSM became fully effective, the direct supervision of eurozone financial institutions was transferred to the European level, as the ECB became the direct supervisor of the most important institutions across 19 euro-area countries. This reform was introduced with the ultimate goal of increasing the resilience of banks and enhancing the stability of the financial system by ensuring that supervision across the euro area is of a high standard and consistently applied to all banks (ECB, 2018).

The general purpose of supervision and regulation is to ensure the safety and soundness of banks and the banking system, while reducing the probability and impact of bank failures and promoting a well-functioning financial system (Basel Committee, 2012; Santos, 2000). In fact, a vast number of studies recognize that the supervisory and

regulatory environment plays a crucial role in what concerns bank stability (Barth, Caprio, & Levine, 2004; Cihák, Demirguc-Kunt, Martinez Peria, & Mohseni, 2012, and Delis & Staikouras, 2011). However, as the SSM is a relatively new feature in the European regulatory framework, the research dedicated to empirically assess the repercussions of the introduction of uniform supervision is still scarce. Exploring the impact that this new mechanism may have on the risk levels of the banking institutions of participating countries is of extreme relevance, not only because there is a gap in the literature but also because it could produce valuable policy implications.

In a vast number of economic sectors, competition is perceived as a positive dynamic that fosters efficiency and innovation. The banking industry is no exception, and the benefits that the presence of dynamic competitive pressures may produce in terms of efficiency, quality of provision and innovation, are the rationale under which regulators and authorities took several deregulatory initiatives and liberalized the sector in an effort to foster competition in banking systems all over the world (Maudos & Vives, 2019; Weill, 2013). However, policy makers cannot ignore that there are several theoretical arguments defending that intensified competition and deteriorated market power may generate incentives for excessive risk taking. In fact, a number of empirical studies seem to support the existence of a trade-off between competition and stability. Even though the conclusions are far from consensual, the literature acknowledges that competition and market power may be significant drivers of bank risk.

Over the last decades, bank competition in the European banking sector evolved in a pattern that seems to be non-linear. Several studies document a pattern of intensification of competitive pressure up until the eruption of the global financial crisis. However, the financial crisis reverted the trend and lessened the intensity of competition on the European banking industry. While fewer studies focus on the post-crisis period, there seems to be evidence that indicates that competition in the euro-zone banking system is now slowly resuming to the pre-crisis trend toward an intensification of competitive conditions (De Guevara & Maudos, 2017; De Jonghe, Diepstraten, & Schepens, 2016; Karadima & Louri, 2020, and Maudos & Vives, 2019).

At the present moment, the issues concerning the evolution of competition on the euro-zone banking sector as well as its effects in terms of bank stability, become especially

relevant as the EU, with the introduction of the SSM as a pillar of the Banking Union, takes further steps to remove any remaining barriers to cross-border competition and reinforce the integration of the euro-zone banking industry. As pointed by Constâncio (2014a, 2014b) and Ferrarini (2015), the introduction of a uniform European-level supervisory framework creates a level playing field for financial institutions in the euro area, ensuring the conditions and incentives for deeper integration of the European banking system with diminished barriers to cross-border competition. The compliance costs that came from having to conform to different sets of rules and having to deal with several different authorities are now reduced, enhancing the incentives for cross-border integration by making the operating conditions more uniform across Member States. On the one hand, alleviating the regulatory differences between member states lowers the cross-border entry barriers which might intensify competition. On the other hand, the introduction of the SSM may create incentives for market concentration by triggering a consolidation wave in a sector characterized by excess capacity, possibility implying a deterioration in banking competition (Barata & Smoleńska, 2017; Constâncio, 2014a, 2014b; Maudos & Vives, 2019; Okolelova & Bikker, 2019). These confounding predictions and the scarce empirical results demand further research to investigate the competitive implication produced by the introduction of the Single Supervisory Mechanism.

Having all the above-mentioned in consideration, the present study has the following research objectives:

(i) To compare the evolution of the risk levels of Eurozone banks and non-Eurozone EU banks during the 2011-2018 period, in order to assess the quantitative impact that the introduction of the SSM had in terms of bank stability for banks operating under different supervisory regimes;

(ii) To compare the evolution of the market power of Eurozone banks and non-Eurozone EU banks during the 2011-2018 period, in order to assess the quantitative impact that the introduction of the SSM had in terms of competitive conditions for banks operating under different supervisory regimes;

(iii) To assess the effect of market power on bank risk for a sample of European Union banks;

(iv) To identify the explanatory variables that may affect the market power of European Union banks;

(v) To identify the explanatory variables that may affect the risk levels of European Union banks.

As such, this study aims to contribute to the literature by clarifying the impact that the introduction of the SSM had in the eurozone banking system, both in terms of bank stability as in terms of competitive conditions. Moreover, our study will contribute to the literature on the relationship between competition and bank risk, by clarifying the effect that the level of market power of a bank may have on the corresponding risk level.

The methodology used in this study is based on panel data, with a sample comprised of 125 banks from 15 Eurozone countries and 9 non-eurozone EU countries, over a time period spanning from 2011 to 2018. Our baseline model is specified as a system of simultaneous equations with two dependent variables: the Lerner Index as a proxy for market power (and, therefore, for the level of competition) and the Z-score as our measure of bank risk (and, therefore, of banking stability).

The remainder of this study proceeds as follows: Chapter 2 reviews the existing literature on the SSM, bank supervision and regulation, bank risk and banking competition. Chapter 3 describes the methodological approach, the sample and data sources, and contains a description of all the variables included in our study. Chapter 4 presents the empirical results and their interpretation and discussion. Chapter 5 provides additional robustness checks to assess the reliability of our results. Chapter 6 contains the conclusions of this study and their implications. In Chapter 7 we present the main limitations of our study and provide suggestions for future research.

2. Literature Review

2.1. Background on the European Banking Sector

2.1.1. The Banking Union and the Single Supervisory Mechanism

The fact that the European financial system evolved to a reality where cross-border financial markets became increasingly integrated and interconnected, inevitably meant that individual national supervisory models were no longer adequate to this modern reality where supervision affects not only domestic banking sectors but also other countries (Constâncio, 2014a).

The 2008 financial crisis further highlighted the pressing need to reshape the regulatory framework and the supervisory mechanisms that were in force. Ineffective regulation and design flaws in the banking supervisory system were repeatedly appointed as critical factors leading to the outbreak of the financial crisis (Levine, 2012; U.S. Financial Crisis Inquiry Commission, 2011). At that time, it became clear that the Economic and Monetary Union needed to be supported by stronger integration, namely in the form of unified supervision, instead of the asymmetric national basis that was previously established (Junevičius & Puidokas, 2015; Lagarde, 2012; U.S. Financial Crisis Inquiry Commission, 2011).

The June 2012 euro-area Summit marks the starting point of the EBU, where heads of state and government agreed with the creation of a Banking Union. In the Summit statement, the European Council declared that it was imperative to break the vicious circle between banks and sovereigns by establishing a single supervisory mechanism and to use the European Stability Mechanism (ESM) for direct recapitalization of individual banks (Euro Area Summit, 2012). The Banking Union then became the EU-level supervision and resolution system, operating on the basis of a single rulebook that applies to all banks in the euro-area (and any non-euro Member States that voluntarily choose to join). This new system is based on three pillars: The Single Supervisory Mechanism (SSM), the Single Resolution Mechanism (SRM) and the European Deposit Insurance Scheme (EDIS). These three pillars combined with the establishment of the single rulebook were designed

with the ultimate aim of contributing to the stability and soundness conditions of the European financial system.

The SSM became fully operational in November 2014 with the three main aims of ensuring the safety and soundness of the European banking system, increasing financial integration and stability and to ensure consistent supervision (ECB, 2018). At the time of its enforcement, bank supervision was partially transferred from national authorities to the ECB, that became the ultimate supervisory authority for significant banks in the participating countries. The participating countries include all euro-area member states, and non-euro member states that decide to voluntarily join by establishing close cooperation with the ECB. In this context, the ECB directly supervises significant banks, while National Competent Authorities (NCA) retain the functions of daily supervision of Less Significant Institutions (LSI). The decision to deem a bank as significant - and therefore under ECB's direct supervision - is based on its material economic relevance. To be qualified as significant, a bank must fulfil at least one of the following criteria: (i) the total value of its assets exceeds €30 billion; (ii) economic importance for the specific country or the EU economy as a whole; (iii) the total value of its assets exceeds €5 billion and the ratio of its cross-border assets/liabilities in more than one other participating Member State to its total assets/liabilities is above 20%; (iv) the bank requested or was given assistance from the European Stability Mechanism or the European Financial Stability Facility; (v) a supervised bank can also be considered significant if it is one of the three most significant banks established in a particular country (ECB, 2018).

As of January 2020, the ECB directly supervises 117 significant banks that in aggregate hold almost 82% of banking assets in the euro area (ECB, 2020).

The second pillar of the Banking Union- the SRM- became fully operational on 1 January 2016 and it applies to banks covered by the SSM. If supervision provided by the SSM fails at preventing bank failure, the SRM ensures orderly resolution of failing banks through a common resolution fund financed by the banking sector. While these two pillars are already in place and fully operational, the negotiations on the proposals for the effective establishment of the EDIS are still ongoing and have not yet been adopted by the European Parliament and the Council (Carmassi et al., 2018; European Commission, 2017).

The financial crisis in Europe emphasized the contagion effects between bank risk and sovereign risk. Before the introduction of the Banking Union, the ECB was mostly equipped with micro-prudential regulatory powers that tackle risk at the individual bank level. However, it became apparent that this micro approach was not enough to address the escalating systemic risk and the spillover effects from banks to sovereigns and vice-versa (Sáiz, Azofra, & Olmo, 2019; Carboni, Fiordelisi, Ricci, & Lopes, 2017; Constâncio, 2015). The SSM, with the introduction of supervision at the European level, offered the possibility to complete the micro-prudential regulatory powers with a set of macroprudential tools that cover macroeconomic and sovereign aspects and that ensure the stability of Europe’s financial system by limiting the build-up of aggregate risk within the system (European Central Bank, 2020). In the context of micro-prudential regulation, the ECB has the power to (i) carry out supervisory reviews, including stress tests; (ii) conduct on-site inspections and investigations; (iii) grant or withdraw banking licenses; (iv) authorize banks’ acquisitions of qualifying holding; (v) ensure compliance with EU prudential rules (vi) set higher capital requirements (“buffers”) in order to counter any financial risks and (vii) impose corrective measures and sanctions; On the other hand, in the macroprudential context, the ECB has the power to (i) apply higher requirements for banks, such as counter-cyclical buffers and to (ii) comment and object to measures by national authorities (European Central Bank, 2020).

2.2. The Concept and Measurement of Bank Stability

The literature has different definitions for bank stability. We can divide these definitions and their measurements in two main groups: the first group encompasses those studies that measure banking stability by identifying the occurrence or the absence of systemic distress; the second group defines banking stability relying on a set of indicators measuring individual bank risk. Comparing the two dimensions of bank stability – systemic and individual – our study aligns the most with the second one, as we aim to measure and evaluate the impact of some variables on individual bank risk.

Concerning the first dimension, bank stability is typically measured by identifying its polar opposite condition: systemic banking crisis. While there is no univocal definition for banking crisis, there is a group of authors who combine a set of quantitative and qualitative indicators to be used as criteria to identify banking distress. The literature

covering the topic repeatedly associates systemic banking crisis with circumstances and events such as exhaustion of all or most of banking capital, a sharp increase in the share of non-performing loans, a large number of defaults in a country's corporate and financial sector, bank runs, and government assistance of important financial institutions (Caprio & Klingebiel, 1996; Demirguc-Kunt & Detragiache, 1998, 2005; Laeven & Valencia, 2008; Laeven et al., 2012; Reinhart & Rogoff, 2008). Even if we admit that policy makes, regulators and supervisors are mostly concerned with systemic banking crisis, the last years of experience proved that individual bank distress have an enormous potential to disrupt stability conditions of overall financial systems.

The second stream of literature focuses on bank stability at individual bank level, using mostly accounting data to build proxies for bank fragility and risk. The vast majority of these studies uses either the Z-Score or the Non-Performing Loans ratio (NPLr) as measures of individual bank distress. The NPLr is defined as the ratio of non-performing loans to total gross loans of a bank. In this context, a higher (lower) value for the NPL ratio would indicate higher (lower) bank risk. A considerable number of studies uses this ratio as a proxy for bank fragility (e.g. Agoraki, Delis, & Pasiouras, 2011; Baselga-Pascual, Trujillo-Ponce, & Cardone-Riportella, 2015; Berger & DeYoung, 1997; Berger, Klapper, & Turk-Ariss, 2009; Delis & Kouretas, 2011; Jiménez, Lopez, & Saurina, 2013; and Salas, Jiménez, & Lopez, 2011). Albeit frequently used, NPLr as a proxy for bank distress has considerable limitations. First, this indicator focuses on credit risk and loan portfolio quality and fails to capture other risk dimensions that have an effect on bank distress. Second, as argued by (Delis & Staikouras, 2011), even as an indicator of credit risk, the NPLr mostly captures risk taken in the past and does not capture changes in the riskiness of the bank. Third, as pointed by Beck (2008), this indicator cannot be related directly to the likelihood of bank failure - the primary concern for policy makers and supervisors. Recognizing these shortcomings, the large majority of studies on the topic (Agoraki et al., 2011; Berger et al., 2009; Laeven & Levine, 2009; Yeyati & Micco, 2007; Mirzaei & Moore, 2014; and Nguyen, Skully, & Perera, 2012) employ another measure of bank distress: The Z-Score. In this context, the Z-score is an inverse proxy for a bank's probability of default, and it is computed as follows:

$$(2.1) \quad Z - Score = \frac{(ROA + CAR)}{\sigma (ROA)}$$

where ROA stands for returns on assets and it is calculated as $ROA = \frac{Net\ Income}{Total\ Assets}$, CAR represents the capital to assets ratio and it is computed as $CAR = \frac{Equity\ Capital}{Total\ Assets}$ and $\sigma(ROA)$ represents the standard deviation of return on assets. The measure expresses the number of standard deviations in ROA that a bank is away from insolvency, it is thus an indicator of likelihood of bank failure (Beck, 2008). A larger (smaller) Z-Score value indicates lower (higher) bank risk. In a single indicator, and using only accounting data, the Z-Score encompasses measures of profitability, leverage or capitalization and of return volatility. The main advantages attributed to this indicator are its relatively simple computation that requires only accounting data, and the fact that when compared to the NPL_t, the Z-Score represents a more comprehensive measure of bank risk, since it captures more than credit risk and loan portfolio quality. However, the metric also has its limitations. First, as noted by Doumpos, Gaganis, & Pasiouras (2016), there is no guidance as for the number of years that should be used for the calculation of the standard deviation of return on assets. Second, the Z-score focuses on profitability and capitalization while ignoring other relevant aspects such as liquidity, asset quality, cost management and contagion risk.

2.3. Measuring Competition

The literature on the subject presents two different approaches to define and measure competition. The structural approach focuses on overall market structure indicators such as the k-firm Concentration Ratio (CR_k) and the Hirschman–Herfindahl Index (HHI) and relies on the idea that competition and market power can be inferred from the market structure. Under this approach, higher levels of market concentration are associated to uncompetitive behavior.

The most frequently used measures of market structure are the CR_k , which is computed as sum of the market shares of the top k firms in the industry, and the HHI, which is computed as the sum of the squares of the market shares of all the firms in the industry. The CR_k index approaches zero for an infinite number of equally sized firms and equals one if the firms included in the calculation make up the entire industry, while the HHI ranges between $\frac{1}{N}$, for equally sized firms, and one for monopolies.

The main advantage of these indicators is the low data requirements for their computation. However, many authors appoint substantial shortcomings to these indices. These indicators only measure the degree of concentration on the market but they do not allow direct inferences regarding competitive conduct (Claessens & Laeven, 2004; X. (Maggie) Fu, Lin, & Molyneux, 2014; Leon, 2014; Okolelova & Bikker, 2019).

The second approach relies on non-structural measures to quantify market power and competitive conduct. This second approach measures competition based on indicators such as the Lerner Index, the Panzar-Rosse H-Statistic and the Boone indicator. These indicators focus on bank-level data to infer about the competition in the market.

The Lerner Index is one of the most frequently used measures of market power. Under this approach, the market power of the bank is identified by the difference between the bank's price and marginal cost. Under perfect competition conditions, price and marginal cost should be equal. Divergences between price and marginal costs signal the existence of greater market power. This index is frequently used on empirical research on the effects of competition on bank risk (e.g. Anginer et al., 2014; Berger, Klapper, & Turk-Ariss, 2009; Jiménez et al., 2013; Yeyati & Micco, 2007, and Nguyen et al., 2012) .

Following Cruz-García, De Guevara, & Maudos (2017), De Guevara, Maudos, & Pérez (2005), Gropp & Vesala (2004) and others, the Lerner index defines the disparity between price and marginal cost as a percentage of price, and it is computed as:

$$(2.2) \quad L_{it} = \frac{P - MC}{P}$$

where P is the price of total assets, proxied by the ratio of total revenues to total assets for bank i at time t , and MC is the marginal cost of total assets. The marginal cost is estimated with recourse to a translogarithmic function, where total costs depend on the prices of three inputs (labour, physical capital and funds), and on the bank's total production output (total assets).

The main advantages of the Lerner Index are its straightforward interpretation, and the fact that it does not pose stringent data requirements. Moreover, because it provides a firm-year specific measure of market power, the Lerner Index offers the possibility of studying the evolution of bank pricing behavior over time (Leon, 2014).

The Panzar-Rosse H-Statistic is another frequently used measure of bank competition. This indicator catches the transmission of input prices on bank's revenues by measuring the elasticity of the revenue with respect to the prices of labor, capital and deposits. Under conditions of perfect competition, an increase in input prices would generate a proportional increase in revenue and marginal costs and the H-Statistic would take the value of one. Under monopoly (where marginal costs=marginal revenues), an increase in input prices would generate an increase in marginal costs, and a decrease in total output, which would translate into lower revenues. The H-Statistic is null or negative for a monopoly, ranges from zero to one under collusive oligopoly or monopolistic competition and takes the value of one under perfect competition. Thus, the indicator ranges from $-\infty$ to $+1$. The higher the transmission of costs into revenue changes, the more competitive the market is (Leon, 2014; Okolelova & Bikker, 2019; Panzar & Rosse, 1987).

The main advantages of the H-Statistic are its relatively simple computation and the fact that it does not pose rigorous data requirements. Moreover, it can be obtained from a relatively small number of observations, which makes it especially useful for studies on developing industries. However, there are some concerns about the interpretation of the index, as recent theoretical studies report that the H-Statistic can be negative in competitive markets and positive for highly uncompetitive settings (Bikker, Shaffer, & Spierdijk, 2011; Leon, 2014; Shaffer & Spierdijk, 2015).

The Boone Indicator is a newer indicator of competition that is based on the idea that more efficient firms achieve higher market shares and higher profits at the expense of their rivals, and that this effect is stronger in more competitive settings, which means that less efficient firms are punished more harshly in more competitive markets. The Boone indicator is estimated as the coefficient on marginal cost in an equation where profits or market shares are the regressors. This coefficient measures the profit elasticity relative to costs. Because higher marginal costs are associated with lower profits, the Boone Indicator is expected to take negative values. Higher absolute values of the coefficient are obtained for more competitive markets (Boone, 2008; Leon, 2014; van Leuvensteijn, Bikker, van Rixtel, & Sørensen, 2011). The main novelty of the Boone Indicator is its focus on capturing one important market dynamic affected by competition, however it disregards other relevant aspects. Moreover, efficiency gains may not be directly translatable into lower prices or higher profits in the short term, as banks may choose to invest these gains

in order to cope with future competition. An advantage of the Boone Indicator is that since the relationship between costs and profits is both continuous and monotonic, Boone indicators are monotonically related to competition, which makes it a more reliable and straight-forward measure when compared to the Panzar-Rosse H-Statistic. However, because the Boone Indicator is a newer measure it has not been extensively applied nor thoroughly scrutinized by the literature (Leon, 2014).

2.4. Previous Studies on the Impact of the SSM on the Banking Sector

The amount of research focusing on the effects that the SSM may have on bank behavior is still very limited and the majority of the available research is focused on changes in bank behavior and in stock market reactions in the run-up to implementation of the SSM.

Performing an event study on bank's stock returns Loipersberger (2018) investigates how the introduction of the SSM affected the banking sector in Europe. The author finds significant effects on two main event days. The first one is the date of the Euro Area Summit (June 29, 2012) when the European Council declared the intention to establish a single supervisory mechanism and to extend the competences of the European Stability Mechanism. The second relevant event is one date when the European Commission presented the official proposal for the SSM (September 12, 2012). For a sample comprised of 249 listed banks (88 euro-area banks and 161 non-euro European banks) the author finds that both events had a positive impact on stock returns of euro-area banks. Smaller, but still positive effects are also reported for non-euro European banks stocks. The author also reports that the positive effect of the SSM on abnormal returns is more pronounced for banks located in institutionally weaker countries and for banks with lower capitalization. These results seem to indicate that when banks are perceived as less stable ex-ante, the SSM could produce even more significant stabilizing effects. Having these findings in consideration, the author argues that these empirical results are consistent with the hypothesis that investors in European banks believe that the SSM prevents banks from taking excessive risks and thereby stabilizing the financial sector, and that the SSM had a positive impact on investors' perceptions about bank profitability.

On October 23, 2013 it was announced that the ECB and the participating national competent authorities (NCAs) would be carrying out a Comprehensive Assessment (CA) as “an essential element of the preparations for the SSM, providing the necessary clarity on the banks that will be subject to the ECB’s direct supervision” (European Central Bank, 2013, p. 1). This assessment consisted of a supervisory risk assessment, an asset quality review, and a stress test for all the significant institutions. The exercise had the main goals of increasing transparency on the condition of banks, applying the necessary corrective actions to their balance sheet, and building confidence among stakeholders (Carboni et al., 2017; European Central Bank, 2013). On the same note, it was also announced that “If capital shortfalls are identified against a capital benchmark, banks will be required to adopt corrective measures” (European Central Bank, 2013, p. 2). The results of this procedure were published on October 26, 2014, few days prior to the official start of the SSM (November 4, 2014).

Carboni et al. (2017) analyze the market reaction to these three events (announcement of the procedure, publication of the results and the official launch of the SSM) in order to assess if the CA reached the goal of increasing transparency by producing new valuable information for the market. Moreover, the authors analyze the effects that the CA and the official launch of the SSM had on the stock price of involved institutions. Analyzing stock data of sample of 158 banks (50 under ECB’s direct supervision and a control sample of 108 European banks retaining the direct supervision of national authorities), the authors report that investors had a generally negative reaction both at the date when the CA was announced and at the date when results were disclosed. The results indicate that at the announcement of the procedure, in October 2013, investors were already able to identify weak banks (those that would register a capital shortfall) as these banks suffered a negative reaction of higher magnitude. When the official results were disclosed on October 2014, banks registering a capital shortfall were once again penalized by investors. The authors argue that even though investors were able to identify weak banks at the announcement of the procedure, they were only fully aware of the magnitude of the capital shortfall in October 2014, when the results were announced. This seems to indicate that the CA was successful in increasing transparency and producing valuable information for the market. In respect to the market reaction at the time of the official start date for the SSM, the study reports that banks subject to the direct supervision of the ECB were penalized in comparison to those banks maintaining their national supervisors.

These results seem to suggest that investors were expecting a stricter and more intrusive approach by the ECB or at least, that they were concerned about possibly heterogeneous application of supervision rules for banks under ECB's supervision and those retaining the supervision of national authorities.

Fiordelisi, Ricci, & Stentella Lopes (2017) focus on accounting data relative to a sample of 336 euro-area banks during the 2011 to 2014 period to study how significant banks adjusted their lending behavior in the run-up to the implementation of the SSM. Prior to the implementation of the SSM, the ECB announced that a Comprehensive Assessment would be conducted in order to evaluate banks' lending portfolios to assess the capitalization conditions of significant banks. The authors anticipated that these banks would adjust their lending activities in order to reduce the probability of capital shortfalls and costly capital adjustments. The results of the study indicate that significant banks (those that are now under the direct supervision of the ECB) reduced their lending activity more than less significant banks in order to shrink their balance sheets and increase their capitalization. The authors argue that banks seemed to expect ECB's supervision to be stricter compared to national supervisors. Furthermore, the authors argue that the decrease in credit supply resulted in a credit crunch as an unintended consequence of the SSM.

One of the most relevant and immediate goal of the Banking Union is to reduce the contagion effects between bank debt and sovereign debt by eliminating the negative bank-sovereign feedback loop (Constâncio, 2015). These spillover effects were highlighted during the global financial crisis, when the fragility in the banking system forced governments to rescue systemically important banks. These rescues, together with the subsequent economic recession, raised national deficits and deteriorated public finances, raising concerns about sovereign risk. The aggravated sovereign risk was in turn transmitted to the domestic banking sectors, making domestic banks riskier, degrading their ratings, which in turn aggravated their funding conditions. Additionally, as government indebtedness increased to concerning levels sovereign bonds became riskier. In turn, banks holding large amounts of bonds issued by their own indebted government also saw an increase in their own asset risk, caused by their exposure to these bonds (Loipersberger, 2018).

Focusing on this particular topic, Cantero Sáiz et al. (2019) conduct a study aimed at analyzing how the SSM might have affected contagion between bank and sovereign risk in the eurozone during its launch and first quarters of operation, while also testing whether this contagion is transmitted from banks to sovereign, or vice versa. In this context, the authors detail three channels through which the introduction of the SSM may contribute to mitigate the contagion between bank and sovereign risk. First, the common regulatory framework brought by the Banking Union produces more homogeneous financial conditions across European banks, making them less dependent on their home country's sovereign risk and reducing the uncertainty premium that these banks may pay. Second, the sharper supervision that the SSM promotes and the Comprehensive Assessments carried out before its adoptions will improve the resilience of the banking system, hence reducing the probability of economic recessions that can spill over to sovereign risk. And third, the SSM enables the direct intervention of the European Stability Mechanism (ESM) to support banks experiencing liquidity problems, avoiding the need of government intervention on troubled banks and the credit risk transfer from banks to sovereign. Cantero Sáiz et al. (2019) conduct their empirical analysis based on two different indicators: bank's stock returns and CDS spreads over the 2009-2016 period. When using stock data as an indicator, the authors do not find compelling evidence that the SSM reduced contagion from sovereign risk to bank's stock return. However, when using sovereign and bank CDS spreads as indicators, there is evidence that the announcement of the SSM, in March 2013, reduced contagion between bank and sovereign risk. Moreover, the authors find that after the announcement of the SSM, an increase in sovereign risk produced lower contagion effects on bank risk, reducing the interdependency between the two.

Focusing on the competitive implications brought about by the uniform supervisory framework, Okolelova & Bikker (2019) investigate whether the commencement of the SSM has significantly affected the market power of the entire banking sector, as well as the two sub-groups of significant and less significant banks in five EU economies (Austria, France, Germany, Italy and Spain). The authors employ two measures of competition: the Boone index, and the Lerner index. On the basis of the Boone indicator analysis, the authors find significant increase in competition, in the years 2015-16 as compared to the 2013-14 time period, in the sub-market comprising of significant supervised entities (those under direct ECB supervision) in all five EU

economies under analysis. Similarly, when using the results of the Lerner Index, the authors find evidence of significant decrease in market power for the ECB supervised entities in Austria, France, Germany and Spain. As for the sub-sample comprised of banks remaining under the national supervision, the authors find no significant affects, whereas the results for the total market are mixed. When analyzing the banking sector consolidation patterns, the authors report that only Italy and Spain exhibit an increase in concentration after the implementation of the SSM. However, there is no significant grow in the market power of banks in these countries, suggesting that these increases in concentration do not necessarily result in anticompetitive conduct. The authors suggest that more likely, “consolidation is a tool for banks to mitigate poor earnings and reduce inefficiencies arising from double marginalization of administrative and operating costs, rather than significantly increasing their influence in the market” (Okolelova & Bikker, 2019, p. 35)

Avignone, Altunbas, Polizzi, & Reghezza (2021) investigate how the establishment of the SSM impacted the credit risk of ECB supervised banks, in comparison to other financial institutions that retained the direct supervision of NCA. The authors use a sample of 746 European banks over the 2011-2018 period. Their results indicate that the introduction of the SSM was successful in respect to its goal of reducing European bank risk. The authors find that banks supervised directly by the ECB reduced their credit risk exposures more than their nationally supervised peers after the establishment of the SSM.

2.5. The Impact of Regulation and Supervision on Bank Stability and Competition

Regulation and supervision have long been widely researched subjects in the financial literature. In the last years, banking regulation has suffered changes that impose more than ever careful consideration of all the possible effects that regulation and supervision may have on bank risk taking, performance, and on the resilience of overall financial systems. In the following section, we will be exploring the predictions that existing studies make about the relationship between different types of regulatory features and bank stability.

After uncovering different channels through which regulation may affect bank risk, this section will also be dedicated to surveying the conclusions of different studies that

investigate the effects that regulatory policies may produce in terms of competitive conditions on the banking system.

2.5.1. Regulation, Supervision and Bank Stability

The literature on bank stability recognizes that regulatory and supervisory policies are important features that impact risk-taking incentives for banks and that produce observable effects in terms of the resilience or fragility conditions of the banking system. The existing studies suggest that the different features that characterize the regulatory framework under which banks operate, have the potential to impact risk-taking differently.

As a first example let's consider one of the most debated topics on the literature: the existence (or inexistence) of a deposit insurance scheme. Many authors appoint the main benefit of deposit insurance to be its stabilizing effect as a mechanism that prevents and decreases the probability of bank runs (Diamond & Dybvig, 1983; Hazlett, 1997). Deposit insurance may be seen as a mechanism to sustain depositor confidence on the safety of their funds and to avoid contagious bank runs that might compromise the overall stability of the banking and payment system (Bernet & Walter, 2009; Marini, 2003). In fact, some authors document stabilizing effects associated with the adoption of deposit insurance (Gropp & Vesala, 2004; Karels & McClatchey, 1999). However, the theory is virtually unanimous in acknowledging that deposit insurance originates moral hazard problems, increasing the predisposition of bank managers to take on excessive risk. The existence of this insurance mechanism protects bank depositors from losses, reducing their incentives to properly monitor the banks' actions (Cull, Senbet, & Sorge, 2005; Demirguc-Kunt & Detragiache, 2002; Ioannidou & Penas, 2010; Ristolainen, 2018; Wheelock & Wilson, 1995). Moreover, a number of studies (Angkinand & Wihlborg, 2007; Dewenter, Hess, & Brogaard, 2013) showed that institutional characteristics have a significant impact on the relation between deposit insurance and bank risk taking. For instance, Demirguc-Kunt & Detragiache (2002) show that while explicit deposit insurance increases the probability of a banking crisis, the effect is stronger in countries with a weak institutional environment.

As second example, consider capital regulations. A commonly cited rationale for capital regulation is that by imposing stricter capital requirements, bank shareholders are obliged to have more “skin-in-the-game”, reducing their incentives for excessive risk taking in order to avoid bank default and loss of shareholder equity (Cooper & Ross, 2002). In this context, a number of authors argue that imposing capital requirements would reduce bank’s incentives to increase asset risk, diminishing the probability of bank failure while preventing moral hazard behavior induced by the deposit insurance scheme (Freixas & Rochet, 1997; Furlong & Keeley, 1987, 1989). Supporting this idea, Danisman & Demirel (2019), using a sample of 6936 banks in 25 developed countries between 2007 and 2015, provide empirical evidence indicating that capital requirements are the strongest regulatory tool for decreasing bank risk. However, authors such as Alkadamani (2015), Homolle (2004), Kim & Santomero (1988), Koehn & Santomero (1980) and Laeven & Levine (2009) reach opposing conclusions, arguing that imposing more stringent capital requirements results in a loss of utility for shareholders, which may actually increase the risk-taking incentives for bank owners.

Additionally, regulators may also impose activity restrictions, influencing banks’ freedom to pursue a narrower or wider scope of different activities. In this context, Boyd, Chang, & Smith (1998) argue that allowing banks to operate in a wider range of activities (beyond the traditional lending activities) may lead them to pursue riskier investments, exacerbate moral hazard problems and induce excessive risk-taking. However, a considerable body of evidence rejects this hypothesis and suggests that these restrictions may produce unintended effects: Barth et al. (2004) find that the imposition of tighter restrictions on bank activities is associated to lower bank stability and higher banking crisis probability, similarly, Beck, Demirgüç-Kunt, & Levine (2006) report a positive association between activities restrictions and probability of systemic crisis while Danisman & Demirel (2019) find that higher activity restrictions strongly increase bank risk for developed markets. Moreover, Laeven & Levine (2009) also suggest that activity restrictions increase bank risk and offer a possible explanation for these results: as with capital requirements, restrictions in non-lending activities could reduce the utility of owning a bank, exacerbating the risk-taking incentives for bank owners.

Before the global financial crisis, the main focus of bank regulation rested on capital regulation while liquidity regulation did not gather much attention. In the aftermath of the liquidity problems observed during the crisis, the Basel III accord introduced two required liquidity standards¹. In this context, Diamond & Kashyap (2016) and Hoerova, Mendicino, Nikolov, & Schepens (2018) denote that while capital requirements are the most direct tool to control solvency risk and to mitigate risk-taking incentives, liquidity requirements are particularly relevant in addressing the risk of a bank run. Additionally, Stein (2013) argues that in the absence of liquidity requirements, banks do not have the incentives to voluntarily hold sufficient liquidity because they would have to bear the costs of holding these liquid assets without attaining all the social benefits in terms of enhanced financial stability and lower costs to taxpayers in the event of failure. On the other hand, authors such as König (2015) warn that more stringent liquidity requirements may hurt bank's returns, which may in turn hurt the bank's long term solvency position.

Another group of authors compare Liquidity Regulation with other policy tool available to deal with severe liquidity problems that may arise in the banking system during crisis periods: The Lender of Last Resort (LOLR) tool. In their role as LOLR, Central Banks provide emergency liquidity assistance, lending against the illiquid assets of a bank in order to avoid fire-sales, bank-run problems and the incidence of bank failures. Some authors argue that the LOLR mechanism may induce moral hazard on the part of the bank, creating incentives for banks to act less prudently. Anticipating authorities' intervention, banks may take excessive exposure in the expectation that in the scenario where liquidity risks materializes, the central bank will inject funds to avoid failure. In this context, authors such as Calomiris, Heider, & Hoerova (2014), Freixas & Rochet (2008), Hoerova et al. (2018) and Stein (2013), suggest that liquidity regulation may mitigate this moral hazard behavior and serves to dissuade reliance on LOLR by requiring banks to hold sufficient liquidity buffers.

¹ The Liquidity Coverage Ratio (LCR) and the Net Stable Funding Ratio (NSFR). The LCR can be seen as a measure of the ability of the bank to deal with a severe liquidity freeze and it is designed to ensure that banks hold sufficient high-quality liquid assets to endure an adverse funding scenario lasting 30 days, while the NSFR addresses the liquidity mismatched that stem from the significant differences in maturity between the bank's assets and liabilities, the NSRF requirements are designed to guarantee that banks finance themselves with stable funding sources.

The literature also provides evidence regarding the role of supervisory practices focusing on accurate information disclosure. In this context, Barth et al. (2004) using survey data from a sample of 107 countries find that regulatory and supervisory policies that force accurate information disclosure, empower private-sector corporate control of banks and foster incentives for private agents to exert corporate control, work best in promoting bank performance and stability. A number of other studies focusing on the public disclosure of results on specific supervisory exercises, also indicate that supervisory information disclosure conveys valuable information to the market, improves transparency in the banking sector and enhances market discipline and private monitoring (Alves, Mendes, & Silva, 2015; Duro, Heese, & Ormazabal, 2019; Kleymenova & Tomy, 2019; Morgan, Peristiani, & Savino, 2010). Moreover, Delis & Staikouras (2011) find evidence of a negative relationship between disclosure requirements and bank risk, arguing that the policy-making agenda should be reoriented to place more weight on the effective implementation of disclosure requirements and on fostering more transparency. Caprio, Demirguc-Kunt, & Kane (2008), Demirguc-Kunt, Detragiache, & Tressel (2008) also suggest that supervisors should be focusing on increasing transparency and ensuring that risks are fully understood and fairly priced by investors, reinforcing the role of market discipline.

There is a relatively rich body of literature examining the relationship between bank stability and regulatory practices such as the ones discussed thus far. However, in what concerns architectural aspects of the supervision system, such as supervisory independence and discretion, the research is still scarce. In this context, independence measures the extent to which supervisors are insulated, or able to resist pressure and influence from the government, other political forces or from the industry. Barth, Nolle, Phumiwasana, & Yago (2003) argue that independence allows bank supervisors to monitor the financial condition of banks in a strictly professional and consistent fashion, while Čihák (2010) mentions that greater independence from outside pressures means that central banks are less politically constrained when it comes to addressing financial distress, allowing them to act earlier and more decisively before a crisis erupts and giving them wider latitude in managing a systemic crisis. Empirical evidence supporting the importance of central bank independence is provided by Doumpos, Gaganis, & Pasiouras (2015) that show for a

sample of 1700 banks operating in around 90 countries over the 2000-2011 period that central bank independence exercises a positive impact on bank soundness. Moreover, Osma, Mora, & Porcuna-Enguix (2019) show that greater independence of powerful supervisors from the government and from the industry are desirable governance characteristic, with positive impacts on financial transparency. At the country level, Klomp & de Haan (2009) find a significant and robust negative relation between central bank independence and financial instability, while Dincer & Eichengreen (2012) find a negative relationship between supervisor independency and the ratio of nonperforming loans as a percentage of the GDP.

2.5.2. Regulation, Supervision and Bank Competition

A number of studies have documented that the regulatory framework and supervisory practices have the potential to interfere on the competitive landscape in the banking industry.

A group of authors approach the topic by investigating how specific regulatory reforms and deregulatory initiatives affected the competitive conditions on the banking system. In this context, Angelini & Cetorelli (2003) focusing on a sample of Italian banks over the 1983-1997 period report that the deregulation process that culminated with the implementation of the Second Banking Directive in 1993 contributed to a significant increase in bank competition. The authors document a steady decrease in the Lerner Index associated to the implementation of the new directive that removed substantial barriers to foreign entry by allowing European Union banks to branch freely into other European Union countries. Similarly, for a sample of Spanish banks over the 1968-1998 period, Salas & Saurina (2003) report that regulatory changes such as liberalization of interest rates, lifting of legal entry barriers across geographical markets and the removal of investment coefficients, increased competition and eroded the market power of Spanish banks. Gelos & Roldos (2004) examine the evolution of the market structure of a sample of European and Latin American emerging banking systems during the 1990s. During the years in analysis, these countries followed a consolidation trend characterized by a sharp decline in the number of banks. However, based on the estimates for the Panzar and Rosse H-Statistic, the study demonstrates that these markets have not become less competitive. The

authors argue that the introduction of regulatory initiatives designed to lower the barriers to foreign entry had an important role in preventing a decline in competitive pressures associated with the consolidation pattern.

A second group of studies use cross-country data to estimate and measure bank competition across economies seeking to assess to what extent different regulatory restrictions and requirements explain differences in the competitive landscape across countries. In this setting, Claessens & Laeven (2004) estimate the degree of competition in 50 countries' banking industries over the 1994 to 2001 period and report that higher competitiveness scores (measured by the Panzar and Rosse H-statistic) are associated with lower entry and activity restrictions. Using data on 23 emerging economies from 1996 to 2016, Li (2019) confirms that banking systems with lower activity restrictions and lower foreign entry barriers tend to be more competitive.

A number of studies examines the effects of regulation and supervision on the banking system by investigating the association between regulation and factors or outcomes presumably related to competition. In this setting, Ahrend, Arnold, & Murtin (2009) argue that higher net interest margins may be indicative of less competition. Using data from 23 OECD countries from the 1998 to 2006 period, the authors find that more stringent entry and ownership rules are associated with higher net interest margins, and thus lower banking competition. The authors also report that the indicators that capture the stringency of exit and disciplining devices and the strength and independence of the supervisory authority, are associated with lower net interest margins, and thus, enhance competition.² Similarly, Barth et al. (2004) using data on 107 countries, confirm that tighter entry barriers are negatively associated with bank efficiency and associated with higher net interest margins. To the extent that lower efficiency and higher net interest margins are associated with less competitive markets, this result confirms that tighter entry barriers

² Entry rules and ownership structures includes information on the granting procedure and requirements for entry licenses, disclosure of and limitations on the source of funds, limits to engagement in securities, insurance and real estate activities; exit rules and disciplining devices include measures relating to the forced exit of banks, bankruptcy procedures for banks, and the powers of supervisors to override management decisions; strength of the supervisory authority include the budget and number of professional supervisors relative to the size of the sector, frequency of onsite inspections, ability of supervisors to change banks' internal organization and the protection of the supervisory agency from political interference.

tend to limit competition. Demirguc-Kunt, Laeven, & Levine (2003) also confirm the positive association between bank margins and entry regulatory restrictions, moreover, the authors also find that tighter restrictions on bank activities boost net interest margins.

2.6. The impact of Competition on Bank Stability

The literature dedicated to the analysis of the relationship between competitive conditions and stability presents two distinct views: the competition-fragility view and the competition-stability view. Each one makes different predictions about the effect of industry competition conditions on bank risk.

The first strand of literature – the “competition-fragility view” rests on the idea that there is a trade-off between competition and bank stability. Under this hypothesis, competition has a negative effect on bank stability because it erodes banks’ market power and charter values, which in turns creates incentives for excessive risk-taking to compensate for profit erosion. To better understand the underpinnings of this theory it may be helpful to clarify the concept of “charter value” and how it is connected to market power. Berger, Klapper, & Turk-Ariss (2017) define “charter value” as “the ongoing concern or market value of the banks beyond their book values” (p.1) , similarly, Northcott (2004) defines it as “the benefit that accrues to a bank’s owners from its future operations” (p.11) , hence, charter value can be seen as an opportunity cost of going bankrupt, since this accrued value can only be maintained while the bank is in operation. Keeley (1990) argues that banks with higher market power, earn higher rents and consequently have higher “charter values”. To the extent that market power drives returns and future profitability, increases in competition would erode market power and negatively impact “charter value”. The author argues that increased competition and deregulation during the 1980s in the U.S. caused losses in banks’ charter values, which in turn encouraged banks to pursue riskier strategies. To support this hypothesis, the author presents empirical evidence that confirms that banks with higher market power (measured by the market-to-book asset ratio) hold more capital relative to assets and present lower default risk. Yielding similar conclusions, Marcus (1984) builds a one-period model to show that as market power and charter value declines, banks tend to adopt “risk-taking strategies”, concluding that deregulation and policies aimed at easing industry entry, cause charters to devalue

and hold the potential to increase the incidence of insolvencies. Further support to this proposition includes the works of authors such as Suarez (1994), Hellmann, Murdock, & Stiglitz (2000) and Repullo (2004).

Allen & Gale (2000, 2004), Besanko & Thakor (2004) and Boot, Greenbaum, & Thakor (1993) argue that another channel through which competition and eroded market power can affect stability is by diminishing the informational rents originated by “relationship banking”, which consist in repeated bilateral credit transactions between bank and borrowers. In a course of this regular relationship, banks acquire private information on their borrowers, and although this information comes at a cost, it provides informational rents for the bank, which in turn provides an incentive for the bank to keep monitoring and screening their borrowers. A more competitive setting has a negative impact in relationship banking, banks earn fewer informational rents from their screening and monitoring activities, reducing the incentives perform such task. This tendency has the consequence of diminishing the quality of the bank’s loan portfolio, exposing the bank to increased credit risk. Marquez (2002) supports this idea by arguing that an increase in the number of banks in the banking system has the consequence of dispersing borrower-specific information. As each bank becomes informed about a smaller pool of borrowers, the bank’s ability to properly screen borrowers is reduced and the number of low-quality borrowers that are granted access to credit increases. The body of empirical evidence supporting the “competition-fragility view” includes the works of authors such as Demsetz, Saidenberg, & Strahan (1997), that found for a sample of U.S. banks, that banks with higher market power (and higher franchise value) hold more capital and take on less portfolio risk; Turk-Ariss (2010) using bank data from 60 developing economies found that an increase in the degree of market power led to lower probability of bank default and enhanced profit efficiency; for a sample of Spanish banks, Jiménez et al. (2013) found a negative relationship between loan market power and bank risk; Berger et al. (2009) also found that banks with a higher degree of market power also have less overall risk exposure, although a positive relationship between market power and loan portfolio risk was also documented. More recently, using a bank data from 25 developed countries between 2007 and 2015, Danisman & Demirel (2019) found that higher bank market power decreases the risky behavior of banks, confirming that the competition-fragility view holds. Their conclusions hold for various measures of bank risk-taking, including risk dimensions such as default risk, operational risk, leverage risk, portfolio risk, credit risk and liquidity risk.

A relatively more recent strand of literature offers a different assessment on the relationship between competition and bank stability. This newer paradigm is commonly referred to as the “competition-stability” view. As the name suggests, this new paradigm rests on the idea that a banking structure characterized by the existence of fewer larger institutions with higher levels of market power may actually result in higher bank risk and in financial fragility. The “risk-shifting paradigm” is one of the most frequently hypotheses explored under the “competition-stability” view and helps to clarify some of the channels through which competition may affect bank risk. Stiglitz & Weiss (1981) set up the moral hazard and adverse selection “environment”, under which higher interest rates that arise as a result of lower competition may increase the average “riskiness” of banks’ loan portfolio in two ways: first, higher interest rates would increase the average “riskiness” of bank borrowers because individuals willing to pay higher rates may on average be the “worse risks” while “safer borrowers” would be discouraged to borrow - an adverse selection problem-, and second, higher interest rates would change the behavior of the borrowers, inducing them to undertake riskier projects (with lower probability of success but higher payoffs when successful) - a moral hazard problem. Thus, higher interest rates caused by lower competition would ultimately lead to decreased asset quality with a growing volume of nonperforming loans, undermining bank stability and enhancing fragility. Similarly, Boyd & De Nicoló (2005) present a model where banks use increasing market power both in the loan and deposit markets to charge higher loan interest rates. In a moral hazard environment, when faced with increasing funding costs, borrowers choose riskier projects to compensate for the higher loan rates, additionally, these higher loan rates would also make loan repayment harder, this is called the “risk-shifting effect”. The authors conclude that the effects of competition on loan rates and on borrower behavior result in a monotonic negative relationship between competition and bank risk.

A noteworthy study by Martinez-Miera & Repullo (2010) introduce an additional layer of ambiguity and complexity to this relationship. These authors extend the Boyd & De Nicoló (2005) model while also working under the “moral hazard environment” previously described, in which higher interest rates increase the average “riskiness” of banks’ loan portfolio. Thus, lower interest rates arising from increased competition, should lead to lower default probabilities and hence, safer banks - the previously described “risk-shifting” effect. However, the authors also bring attention to the fact that lower interest rates also have the effect of reducing interest payments from performing loans. This effect

is described as the “margin effect”; under this hypothesis greater bank competition reduces interest payments on non-defaulting loans, which would in turn decrease revenues and increase bank risk. Thus, in addition to the “risk-shifting effect” proposed by Boyd & De Nicoló (2005), Martínez-Miera & Repullo (2010) identify a second effect inherent to increased competition and lower rates – the “margin effect”- that goes in the opposite direction. The combination of these two effects produces a nonlinear relationship between competition and bank risk: the “risk-shifting effect” is observed to dominate in monopolistic markets, such that further entry reduces bank risk, and the “margin effect” dominates in competitive markets, such that further entry increases bank risk. Thus, the authors conclude that the probability of bank failure is lowest in markets with moderate levels of competition and highest in either very competitive or very monopolistic markets.

In addition to the “risk-shifting effect”, supporters of the “competition stability” view uncover another channel through which higher levels of market power may adversely affect bank stability: “too-big” or “too-important” to fail policies. Proponents of this paradigm suggest that policymakers are more concerned about bank failures when the banking market structure is characterized by the existence of fewer and larger institutions. In the event of a failure of a large bank, the stability of whole financial system would be threatened, thus, concerns about contagion resulting from the failure of large banks leads policymakers to set up a “safety-net” that prevents large institutions from failing. The fact that there is implicit guarantee of survival generates moral hazard problems, distorting banks’ risk taking incentives, which ultimately leads to instability and bank fragility (Kane, 2000; Mishkin, 1999, 2006). These results imply that there is a positive relationship between competition and stability and that policies that aim at enhancing market competition may increase stability. Additional empirical evidence supporting the “competition-stability” is provided by Schaeck, Cihak, & Wolfe (2009) and Uhde & Heimeshoff (2009) that concluded that more competitive banking systems are less prone to experience a systemic crisis; Levy Yeyati & Micco (2007) found for a large sample of Latin American commercial banks a negative relationship between competition and bank risk; Anginer et al. (2014) using an international sample of traded banks during the 1997 to 2009 period found a robust negative relationship between competition and systemic risk; with respect to risk-taking behavior, the authors find that greater competition encourages banks to take on more diversified risks, reducing the exposure to shocks;

3. Data and Methodology

3.1. Methodology

In the present study we are interested in uncovering the effects produced by the establishment of the SSM in terms of competition and individual risk levels for the Eurozone banking industry. Additionally, building on the literature on bank risk and competition, we are also interest in investigating how market power affects bank risk.

To empirically address our research questions, we follow a structural model suggested by Keeley (1990). The empirical model is specified as a system of simultaneous equations that can be represented by:

$$(3.1) \quad MP_{ijt} = \alpha_0 + \beta_1(Treated_{ij} * Post_{it}) + \sum_{j=1}^J \beta_j X_{ijt}^j + \sum_{m=1}^M \beta_m X_{j,t}^m + \sum_{n=1}^N \beta_n X_{j,t}^n + \varepsilon_{1\ i,j,t}$$

$$(3.2) \quad BS_{ijt} = \psi_0 + \gamma_1(Treated_{ij} * Post_{it}) + \gamma_2 MP + \sum_{j=1}^J \gamma_j X_{ijt}^j + \sum_{m=1}^M \gamma_m X_{j,t}^m + \sum_{n=1}^N \gamma_n X_{j,t}^n + \varepsilon_{2\ i,j,t}$$

where the subscripts i, j and t denote individual banks, countries and time horizon, $\varepsilon_{i,j,t}$ denotes the error term, α_0 and ψ_0 represent the intercept or constant terms; MP_{ijt} represents bank-specific market power measured by the Lerner Index; BS_{ijt} denotes bank stability, proxied by the Z-Score; $Treated_{ij}$ is a dummy variable that takes the value of one if the bank i , in country j is operating under direct supervision of the SSM and takes the value of zero otherwise. $Post_{it}$ is a dummy variable that is equal to one for observations in the years following the establishment of the SSM, and is equal to zero otherwise. Because the SSM only became fully operation in November 2014, we consider the 2011-2014 period as the pre-implementation period, and 2015-2018 as the post implementation period. $X_{ijt}^j, X_{j,t}^m$ and $X_{j,t}^n$ represent vectors of bank specific controls, industry-specific controls and country-specific variables, respectively.

Equations (3.3) and (3.4) present the extended version of the model, a detailed description of the included variables is provided on Table 3.2 of section 3.3.

$$(3.3) \quad MP_{ijt} = \alpha_0 + \beta_1(Treated_{ij} * Post_{it}) + \beta_2LOGTATA + \beta_3DIV + \beta_4CI \\ + \beta_5EA + \beta_6HHI + \beta_7Banking + \beta_8GDP + \varepsilon_{1ij,t}$$

$$(3.4) \quad BS_{ijt} = \psi_0 + \gamma_1(Treated_{ij} * Post_{it}) + \gamma_2MP + \gamma_3LOGTA + \gamma_4DIV \\ + \gamma_5EA + \gamma_6ROAA + \gamma_7HHI + \gamma_8GDP + \varepsilon_{2ij,t}$$

In order to evaluate the impact of the implementation of the SSM on the risk levels and market power of eurozone banks, we employ the Difference-in-Differences (DiD) approach. More specifically, we follow the methodology recently employed by Avignone, Altunbas, Polizzi, & Reghezza (2021) and Fiordelisi et al. (2017), that also focus on the impact produced by the establishment of the SSM. Under the DiD approach, we use panel data to compare the effects of the SSM on the Z-Score and on the Lerner Index for our treatment group, with a control group of non-Eurozone EU banks that did not experience a change in supervisor. To correctly apply the DiD methodology, our data must fulfill the parallel trend assumption, that requires both bank groups (Eurozone banks and non-Eurozone EU banks) to meet a parallel trend in the evolution of the outcome variables prior to the establishment of the SSM. Accordingly, changes in the dependent variables over time should be the same in both treatment and control groups in the absence of intervention. Following Avignone et al. (2021), Fiordelisi et al. (2017), we plot the evolution of our dependent variables into a graph to show that the Z-Score and the Lerner Index in both the treated and the control groups, have a similar trend in the pre-implementation period. These results can be found in Appendix B.

Moreover, our model consists of a system of simultaneous equations where market power and bank stability are specified as endogenous. MP_{ijt} is a dependent variable of equation (3.3) and a right-hand side explanatory variable in equation (3.4). Applying estimation via Ordinary Least Squares in this setting of simultaneous equations, would produce biased and inconsistent results, a problem commonly referred to as “simultaneous equation bias” (Gujarati, Porter, & Ridge, 2010; Wooldridge, 2012). To address the endogeneity of both market power and bank risk we estimate our model using the three-

stage least squares (3SLS) technique, a methodology frequently used when working under a simultaneous equations framework (e.g. Amidu & Wolfe, 2013; Bougatef & Mgdmi, 2016; Fernandes, Farinha, Martins, & Mateus, 2017; Fu, Lin, & Molyneux, 2015; Saadaoui, 2014). Under 3SLS, all dependent variables are explicitly taken to be endogenous to the system and are treated as correlated with the disturbances in the system's equations, all other variables are treated as exogenous, uncorrelated with the disturbances, and are taken as instruments for the endogenous variables. The 3SLS technique was introduced by Zellner & Theil (1962) and it is a method of estimation that combines system equation, known as seemingly unrelated regression (SUR), with two-stage least squares estimation (2SLS). The 2SLS regression technique estimates the coefficients of each structural equation separately, while 3SLS estimates all coefficients simultaneously. These estimates are produced from a three-step process: in a first step, it develops instrumented values for all endogenous variables; in a second step, it obtains a consistent estimate of the covariance matrix of the disturbances; and as the last step, it performs a Generalized-Least-Squares-type estimation taking the covariance matrix estimated in the second step, and the instrumented values in place of the right-hand-side endogenous variables. Because 3SLS takes into account the cross-equation correlations, it produces asymptotically more efficient parameter estimates than 2SLS (Zellner & Theil, 1962; Amemiya, 1977; Amidu & Wolfe, 2013; Greene, 2018; Shim, 2013). Under 3SLS, it is assumed that each equation of the system is at least just-identified. In order to satisfy the order condition of identification, in a model of m simultaneous equations, each equation must exclude at least $m-1$ variables (endogenous as well as exogenous to the model) (Gujarati et al., 2010). Since our model has two equations, in order to satisfy the order condition, each equation must exclude at least one variable. It can be verified that our model satisfies this condition.

As a robustness test, we will also re-estimate our model employing the 2SLS estimation method. Moreover, to access the reliability of our baseline model, we will add to our model a set of country-specific institutional variables to control for differences on the institutional environment.

3.2. Sample and Data Sources

We collect annual data on bank's financial statements compiled from the BankFocus database provided by Bureau Van Dijk – Moody's Analytics. Information regarding industry-specific variables, macroeconomic controls and governance indicators were extracted from Eurostat and from the World Bank database.

Our final sample consists of 125 banks from both Eurozone and EU non-Eurozone countries and the period under analysis spans from 2011 to 2018.

In our sample, Eurozone banks consist of significant banks that are included in ECB's annual lists of directly supervised entities for the years under analysis. The sample of non-Eurozone EU banks consist of banks from European Union countries that did not experience a change in banking supervision because their home jurisdiction is not part of the eurozone. Moreover, to obtain a homogeneous dataset and to allow comparison between the two groups, we only include non-Eurozone EU banks with the same specialization of Eurozone banks. Additionally, to obtain a balanced panel, we excluded all banks with missing information on any year on all the variables included in the analysis.

The result is a balanced panel containing data for banks from 15 Eurozone countries and 9 non-Eurozone EU countries. For the 8 years considered we have 384 Eurozone bank-year observations and 616 non-Eurozone EU bank-year observations.

3.3. Construction of Variables

3.3.1. Dependent Variables

3.3.1.1. Market Power

Following recent studies (Căpraru, Ihnatov, & Pintilie, 2018; Cruz-García, De Guevara, & Maudos, 2017; Maudos & Vives, 2019; Okolelova & Bikker, 2019), we employ the Lerner Index at the individual bank-level as the proxy of market power. The Lerner Index represents the mark-up of price over marginal costs expressed as a percentage of price and it is calculated as:

$$(3.5) \quad \textit{Lerner Index} = \frac{P - MC}{P}$$

Where P is the price of total assets (proxied by the ratio of total revenues to total assets), and MC is the marginal costs of total assets calculated from the estimation of a translogarithmic costs function, where the total costs depend on the prices of three inputs (labour, physical capital and deposits), on the bank's volume of production (total assets) and on technical change (proxied by a trend). Following the De Guevara & Maudos (2007) approach, we specify the costs function as:

$$\begin{aligned}
(3.6) \quad \ln(TC_i) = & \alpha_0 + \alpha_1 \ln TA_i + \frac{1}{2} \alpha_2 (\ln TA_i)^2 + \sum_{j=1}^3 \beta_j \ln W_{ji} \\
& + \frac{1}{2} \sum_{j=1}^3 \sum_{k=1}^3 \beta_{jk} \ln W_{ji} \ln W_{ki} + \frac{1}{2} \sum_{j=1}^3 \gamma_j \ln TA_i \ln W_{ji} + \mu_1 Trend \\
& + \mu_2 \frac{1}{2} Trend^2 + \mu_3 Trend \ln TA_i \sum_{j=1}^3 \lambda_j Trend \ln W_{ji} + \ln u_i
\end{aligned}$$

where TC_i is the bank's total costs including financial and operating costs. TA_i is the bank's total assets, which, and as mentioned before are used as a proxy variable for banking output. The $TREND$ variable is introduced to reflect the effect of technical change, which shifts the cost function over time. The input prices (W) are defined as follows:

Price of labour (w_1) =	Personnel costs divided by total assets
Price of physical capital (w_2) =	Other administrative and operating divided by fixed assets
Price of funds (w_3) =	Interest expenses divided by total deposits

In the estimation of the costs function, fixed effects are introduced to capture the effect of possible unobserved variables specific to each bank. The estimated coefficients of the cost function are then used to derive the marginal cost (MC) that will then be used to calculate the Lerner Index:

$$(3.7) \quad MC_i = \frac{TC}{TA} (\hat{\alpha}_1 + \hat{\alpha}_2 \ln TA_i + \frac{1}{2} \sum_{j=1}^3 \hat{\gamma}_j \ln W_{ji} + \mu_3 Trend)$$

As previously mentioned, the Lerner Index provides a direct measure of the degree of market power and in should be interpreted as follows: an index with higher (lower) values indicates higher (lower) pricing power and less (more) competitive market conditions.

3.3.1.2. Bank Risk

In our study, we will be employing the Z-Score as the measure of bank risk. The Z-score measures the number of standard deviations that a bank's profit must fall to drive the bank into insolvency (Amidu & Wolfe, 2013; Beck, 2008). Therefore, it should be interpreted as an inverse measure of the probability of insolvency³. The index is calculated as:

$$(3.8) \quad Z - Score = \frac{(ROA + CAR)}{\sigma (ROA)}$$

where *ROA* stands for returns on assets and it is calculated as net income divided by total assets, *CAR* represents the equity capital to assets ratio and $\sigma(ROA)$ represents the standard deviation of return on assets. Following Cihak & Hesse (2007) we use standard deviation estimates $\sigma (ROA)$ that are calculated over the full period, and combine these with current period *t* values of *ROA* and *CAR*. Following Baselga-Pascual, Trujillo-Ponce, & Cardone-Riportella (2015), Delis & Staikouras (2011), Laeven & Levine (2008) and other, we take the natural logarithm of the Z-score itself to avoid skewness on the original metric.

3.3.2. Explanatory Variables

Following the literature, we include in our analysis a set of explanatory variables that are likely to influence and determine the risk levels and the market power of European banks. According to previous studies, these factors fall in three main categories. The first group of controls includes variables that are specific to each bank and that are in many cases direct results of managerial decisions. The second group includes determinants that relate bank risk and market power to industry-specific variables. The last group of determinants includes country-specific conditions, such as the characteristics of its institutional system as well as the surrounding macroeconomic environment under which banks operate.

³ A more detailed description of the interpretation of the Z-Score is included in subsection 2.2.

3.3.2.1. Bank Specific Variables

We control for differences in *Bank Size* by including total assets as an explanatory variable for both market power and bank stability. *Bank Size* is expected to positively impact market power as larger banks are probably able to set higher margins or have access to a cheaper source of funds due to scale economies, informational asymmetries, and moral hazard issues, moreover, larger banks may be able to impound the otherwise effective role of institutions in enhancing competition (Delis, 2012; Mirzaei & Moore, 2014). In what concerns the impact of *Size* on bank risk, the provisions are less clear. On one hand, larger banks may be more stable than smaller ones because of enhanced diversification opportunities, greater economies of scale and scope and managerial efficiency and capacity. On the other hand, there is also the theory that larger banks may be riskier due to moral hazard problems associated with too-big-to-fail entities (Agoraki et al., 2011; Baselga-Pascual et al., 2015; Nguyen et al., 2012; Saurina Salas et al., 2011).

We include the ratio of non-interest operating income to total operating revenues as a proxy for *Income Diversification*. This ratio is expected to have a positive impact on bank market power, in fact there are studies indicating that diversifying into activities that provide non-interest income (such as fees, commissions and trading income) seem to be an effective way of minimizing direct competition and increasing market power (Valverde & Fernández, 2007; Maudos & Nagore, 2005; Okolelova & Bikker, 2019). When considering the impact of revenue diversification on bank risk, there seems to be a common expectation, rooted in portfolio theory, that diversification enhances stability, suggesting that diversifying across different activities should result in a less volatile stream of revenues and lower risk (Diamond, 1984; Köhler, 2014; Baselga-Pascual et al., 2015). However, there is also an important stream of literature with conflicting predictions, as various studies report that diversification into alternative sources of revenue is actually detrimental for bank stability (DeYoung & Roland, 2001; Mercieca, Schaeck, & Wolfe, 2007; Stiroh & Rumble, 2006; Clark, Dick, Hirtle, Stiroh, & Williams, 2007; De Jonghe, 2010).

We include the Equity-to-Assets ratio to control for differences in *Capitalization* across banks. *Capitalization* is expected to be positively related to market power, as better capitalized banks may have access to cheaper sources of funding, and thus enjoy higher margins (Delis,

2012; Maudos & Nagore, 2005; Mirzaei & Moore, 2014). Moreover, previous studies seem to indicate that there is a negative relationship between *Capitalization* and bank risk. Lower capital and higher leverage seem to be associated with higher incentives for risk-taking and lower quality portfolios (Baselga-Pascual et al., 2015; Berger & DeYoung, 1997; Poghosyan & Čihák, 2011).

We include the Cost-to-Income Ratio to account for differences in *Efficiency*. The ratio is frequently used in the literature as an inverse proxy for bank's operating efficiency. Following previous studies, we expect a positive relationship between *Efficiency* and market power, as more efficient banks (those with lower cost-to-income ratios) presumably enjoy higher margins as a consequence of their lower marginal costs (De Guevara & Maudos, 2007; De Guevara et al., 2005).

We include *Return-on-Assets* as our measure of profitability, to control for differences in performance. Profitability is expected to have an inverse relationship with bank risk, as the literature documents that more profitable banks tend to be more stable and experience less distress (Baselga-Pascual et al., 2015; Köhler, 2014; Poghosyan & Čihák, 2011).

3.3.2.2. Industry Specific Variables

We include the *Hirschman Herfindahl Index* (HHI) in terms of total assets calculated for each country as our proxy for industry concentration. In the past, concentration was frequently used as a measure of competition, but more recent studies recognize that they are not adequate to directly infer about competitive behavior, alternatively, concentration may be viewed as a determinant of competition (Bikker & Haaf, 2004). Contrary to what was previously assumed in earlier studies, the link between bank concentration and competition is not clear and the empirical evidence directly investigating the relationship is limited. Bikker & Haaf (2004) find that higher levels of concentration result in a lower level of competition by generating a few large (cartel) banks that are likely to restrict overall competition in the industry. Similarly, for a sample of South Asian economies Khan, Kutan, Ahmad, & Gee (2017) found that these countries followed a consolidation pattern in the post-crisis period and that this significant increase in consolidation resulted in a decrease on the level of bank competition. Using cross-country data, Maudos & Nagore (2005) also found a positive

relationship between concentration and bank market power. Holding opposing conclusions, Claessens & Laeven (2004) find that more concentrated banking systems exhibit higher degrees of competition. Other authors such as Northcott (2004) argue that competition and concentration may coexist, while Delis (2012) proposes that in countries with strong institutions and robust competition policies, high concentration might not be associated with anticompetitive conduct. In what concerns the relationship between concentration and bank risk the predictions are also mixed. Proponents of the concentration-stability view argue that concentration enhances bank stability by at least two channels: first, monopolistic banks may enjoy higher profits allowing them to build ‘capital buffers’ and second, in concentrated systems with fewer banks supervision and monitoring may be for effective, reducing the likelihood of banking crisis (Allen & Gale, 2000; Beck et al., 2006; Keeley, 1990). The opposing view- the concentration-fragility argument- suggests that concentration in the banking systems is detrimental for bank stability potentially due to “too-big-to-fail” policies that induce moral hazard and distort risk-taking incentives (Boyd & De Nicoló, 2005). In conclusion, we cannot predict the sign of the impact of concentration on bank risk and on market power.

3.3.2.3. Country Specific Variables

We control for the effect of economic growth by including in our study the annual real *GDP growth* rate of each country. As suggested by previous studies, we expect a positive relationship between economic growth and both bank stability and market power (Baselga-Pascual et al., 2015; Claessens & Laeven, 2004; Maudos & Nagore, 2005; Poghosyan & Čihák, 2011). We control for differences related to the size and development of the domestic banking sector, by including the variable *Banking*, calculated as the ratio of total assets of the banking system to GDP. Previous studies found that banks in well-developed banking markets face higher competition, according to these results we expect a negative relationship between the variable *Banking* and bank market power (De Guevara et al., 2005; Maudos & Nagore, 2005).

3.3.2.4. Institutional Variables

We also include in our analysis the set of World Governance Indexes provided by (Kaufmann, Kraay, & Mastruzzi, 2011) through the World Bank Database. The World

Governance Indexes measure six dimensions of governance: *Voice and Accountability*, *Political Stability and Absence of Violence/Terrorism*, *Government Effectiveness*, *Regulatory Quality*, *Rule of Law*, and *Control of Corruption*. These indicators are included in our analysis to control for effects that different country-specific institutional characteristics may have on bank risk.

3.3.2.5. Other Variables

In our analysis, the effects that the introduction of SSM potentially had on market power and bank risk are captured by the dummy variable *SSM*, that results from the interaction of the variables *Post* and *Treated*, defined in Section 3.1.

Table 3.1 - Variables Definitions

Variables	Definition	Notation	Source
Lerner Index Calculation Inputs			
Total Costs	The sum of interest expenses, personnel expense and other administration and operating expenses	TC	Bank Focus
Price of Labour	Unit price of labour, measured by the ratio of personnel costs to total assets	W1	Bank Focus
Price of Physical Capital	Unit price of physical capital, measured by the sum of other administrative and operating expenses (except personnel expenses) divided by total fixed assets	W2	Bank Focus
Price of Funds	Unit price of funds, measured by the ratio of interest expenses to total deposits	W3	Bank Focus
Price of Assets	Ratio of total revenues divided by total assets	P	Bank Focus
Marginal Cost	Bank's marginal costs as estimated by equation (3.7)	MC	Own calculations
Z-Score Calculation Inputs			
Return on Average Assets	Net income divided by total assets (%)	ROAA	Bank Focus
Std. Dev. Return on Av. Assets	Standard deviation of the return on average assets over the full period of the sample	$\sigma(\text{ROAA})$	Own calculations
Capitalization	Equity-to-Assets ratio defined as the book value of equity divided by total assets	EA	Bank Focus

Table 3.2 - Variables Definitions (continuation)

Variables	Definition	Notation	Source
Bank-Specific			
Size	Natural logarithm of total asset	LOGTA	Bank Focus
Income Diversification	Ratio of Non-Interest Income to Operating Revenues	DIV	Bank Focus
Efficiency	Cost-to-Income ratio defined as total operating expenses divided by operating revenues	CI	Bank Focus
Capitalization	Equity-to-Assets ratio defined as the book value of equity divided by total assets	EA	Bank Focus
Return on Average Assets	Net income divided by total assets (%)	ROAA	Bank Focus
Industry-Specific			
Herfindahl–Hirschman index	Industry concentration calculated as the sum of the squares of all credit institutions' market shares within a country in terms of total assets	HHI	World Bank
Country-Specific			
Economic growth	Annual real GDP growth rate (%)	GDP	Eurostat
Banking Industry Assets to GDP	Total assets held by deposit money banks as a share of GDP	BANKING	World Bank
Other variables			
SSM	Dummy variable that results from the interaction between the variables <i>Treated</i> and <i>Post</i> ; takes the value of 1 if the observation corresponds to a Eurozone bank in the post implementation period of the SSM, and takes the value of 0 otherwise;	SSM	

Table 3.3 - Variables Definitions (continuation)

Variables	Definition	Source
Institutional Variables		
Voice and Accountability	Indicator that captures the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media. The index ranges from -2.5 (weak) to 2.5 (strong) governance performance.	Kaufmann et al. (2011); World Bank
Political Stability and Absence of Violence/Terrorism	Indicator that captures the likelihood of political instability and/or politically-motivated violence, including terrorism. The index ranges from -2.5 (weak) to 2.5 (strong) governance performance.	Kaufmann et al. (2011); World Bank
Government Effectiveness	Indicator that captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. The index ranges from -2.5 (weak) to 2.5 (strong) governance performance.	Kaufmann et al. (2011); World Bank
Regulatory Quality	Indicator that captures perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development. The index ranges from -2.5 (weak) to 2.5 (strong) governance performance.	Kaufmann et al. (2011); World Bank
Rule of Law	Indicator that captures the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence. The index ranges from -2.5 (weak) to 2.5 (strong) governance performance.	Kaufmann et al. (2011); World Bank
Control of Corruption	Indicator that captures the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests. The index ranges from -2.5 (weak) to 2.5 (strong) governance performance.	Kaufmann et al. (2011); World Bank

3.4. Descriptive Statistics

Table 3.4 and Table 3.5 convey the descriptive statistics for the dependent variables and controls used in our study. By looking at the mean values for the dependent variables we observe that on average Eurozone banks exhibit higher Z-scores, and thus lower risk when compared to non-Eurozone European banks. Eurozone banks also show higher dispersion of values for the same variable. On average, non-eurozone EU banks present slightly higher values for the Lerner Index, indicating that eurozone banks may face more stringent competitive conditions. However, this difference in the mean values is not too pronounced: on average, Eurozone banks price their products at a value that is around 33% above marginal costs while non-Eurozone EU banks price their products at around 35% above marginal costs. In what concerns the differences in size of the banks in our sample, Eurozone banks are on average larger than non-Eurozone banks in terms of total assets (EUR 242 479m vs EUR 176 636m, for Eurozone and non-Eurozone groups, respectively). Conversely, Eurozone banks are on average less capitalized than non-Eurozone banks (Equity-to-Assets ratio of 7.43% for Eurozone banks and 10.22% for non-Eurozone banks), however, non-Eurozone banks show higher dispersion of values. Average Efficiency (measured by the Cost-to-Income ratio) does not differ substantially for the two groups. Similarly, in what concerns business models, both groups exhibit similar values for Income Diversification, indicating that on average both groups derive a similar fraction of their revenues from non-interest income (around 45% for Eurozone banks vs. 41% for non-Eurozone EU banks). The mean values for ROAA indicate that, on average, non-Eurozone banks exhibit higher profitability than Eurozone banks (ROAA of 0.38% for Eurozone banks vs 0.72% for non-Eurozone EU banks). The mean values for the Herfindahl–Hirschman index are identical for the two groups, indicating that there are no evident differences in terms of banking industry concentration between the economies in each sample. Similarly, values for average economic growth and average financial markets development do not show substantial differences between the two groups. The mean values for the ratio of Banking Industry Assets to GDP indicate that on average banks in the non-Eurozone EU group face a larger, more developed banking sector. In what concerns the values for the Institutional Variables included in the World Governance Indexes, both groups exhibit similar values.

Table 3.4 - Descriptive statistics of variables for Eurozone and non-Eurozone banks

Variables	Mean		Median		Std. Dev.		Max.		Min.		Observations	
	Non-Eurozone	Eurozone	Non-Eurozone	Eurozone	Non-Eurozone	Eurozone	Non-Eurozone	Eurozone	Non-Eurozone	Eurozone	Non-Eurozone	Eurozone
Dependent Variables												
Z-Score	40.339	52.864	30.838	32.697	38.052	69.885	210.508	353.808	.905	0.1170	616	384
Lerner Index	0.348	0.326	0.357	0.331	0.132	0.128	0.740	0.663	0	0	616	384
Price Total Assets	0.052	0.042	0.047	0.037	0.033	0.016	0.245	0.131	0.004	0.014	616	384
Marginal Cost	0.034	0.028	0.029	0.025	0.024	0.013	0.196	0.114	0.002	0.008	616	384
Total Costs (m EUR)	3579.335	7 260.355	411.248	2 101.984	8199.597	1 1319.3	50215.86	55 363	25.379	61.3	616	384
Price of Labour	0.010	0.008	0.009	0.007	0.007	0.004	0.056	0.025	0.001	0.001	616	384
Price of Physical Capital	3.860	2.360	1.601	1.568	9.625	3.493	100.116	31.696	0.114	0.283	616	384
Price of Funds	0.023	0.308	0.014	0.018	0.039	3.936	0.628	63.327	0.001	0.001	616	384
Explanatory Variables												
Bank-specific												
Total Assets (m EUR)	176 636.3	242 479	10 622.54	78 887	404 550.5	377 197	225 3095	2 164 103	788.453	2 494	616	384
Income Diversification	0.412	0.452	0.385	0.435	0.201	0.195	1.209	0.978	0.022	0.043	616	384
Efficiency	0.629	0.658	0.616	0.643	0.190	0.175	1.540	1.826	0.052	0.255	616	384
Capitalization	10.216	7.434	8.935	6.640	6.154	3.381	48.39	21.750	1.21	1.640	616	384

Table 3.5 - Descriptive statistics of variables for Eurozone and non-Eurozone bank (continuation)

	Mean		Median		Std. Dev		Max.		Min.		Observations	
	Non-Eurozone	Eurozone	Non-Eurozone	Eurozone	Non-Eurozone	Eurozone	Non-Eurozone	Eurozone	Non-Eurozone	Eurozone	Non-Eurozone	Eurozone
Return on Average Assets	0.716	0.380	0.655	0.314	1.104	0.720	13.016	3.072	-4.301	-2.814	616	384
Industry-specific												
HHI	0.078	0.078	0.074	0.058	0.031	0.060	0.155	0.270	0.035	0.025	616	384
Country-specific												
Economic growth	2.224	2.083	2.1	1.90	1.408	2.747	7.1	25.200	-2.2	-6.600	616	384
Banking Industry Assets to GDP	120.305	107.245	132.478	104.267	47.149	33.197	199.445	194.339	35.205	18.006	616	384
Institutional Controls												
Voice and Accountability	1.2	1.2	1.3	1.2	0.4	0.2	1.7	1.7	0.3	0.7	616	384
Rule of Law	1.4	1.4	1.7	1.4	0.6	0.4	2.1	2.0	-0.1	0.3	616	384
Regulatory Quality	1.4	1.3	1.7	1.3	0.5	0.4	1.9	2.1	0.4	0.6	616	384
Control of Corruption	1.4	1.3	1.7	1.4	0.8	0.6	2.4	2.2	-0.3	0	616	384
Government Effectiveness	1.3	1.4	1.5	1.4	0.5	0.4	2.1	1.9	-0.3	0.4	616	384
Political Stability and Absence of Violence	0.7	0.7	0.7	0.7	0.3	0.4	1.2	1.4	0	-0.1	616	384

4. Empirical Results

As a first step in our empirical analysis, we will be performing a univariate analysis testing for the differences between the means and medians of our dependent variables and their bank-specific determinates. The results are provided in table 4.1.

In **section 4.2** we provide the results for our regression analysis.

4.1. Univariate Analysis

In order to observe potential asymmetries between eurozone banks and non-eurozone banks, both before and after the introduction of the SSM, we resort to Welch t-tests with unequal variances and non-parametric Wilcoxon/Mann-Whitney tests. We perform Welch t-tests to test for differences in means, and Wilcoxon/Mann-Whitney tests to test for differences in medians of our dependent variables and other bank-specific controls. The results are reported in **Table 4.1**.

The results for the Mean Analysis on panel A indicate that Eurozone banks are safer, as they present higher Z-scores when compared to the non-Eurozone EU banks. These results are common to both the Pre-SSM and Post-SSM periods. Contrarily, the results of the Median Analysis in Panel B, seem to indicate that there are no significant differences between the risk levels of Eurozone banks and non-Eurozone banks in neither subperiod. The results for both the Mean and Median Analysis indicate that on the Post-SSM period, Eurozone banks exhibit significantly lower levels of Market Power when compared to their non-Eurozone peers. While the median test suggests that this difference was already significant, albeit less pronounced, in the pre-SSM period, the mean t-test suggest that on the pre-SSM period, equality between the two groups cannot be rejected.

Based on the median tests, Eurozone banks appear to be larger in both sub-periods, while the mean t-test reports no significant differences in terms of average size on the pre-SSM period. Conversely, both sets of tests indicate that non-Eurozone EU banks exhibit higher values for capitalization and profitability ratios when compared to the Eurozone banks group. Both tests indicate that in the post-SSM period, non-Eurozone EU banks are significantly more cost-efficient when compared to their Eurozone peers. Regarding income diversification, the results for both sets of tests indicate that Eurozone banks derive a higher share of their income from non-interest sources.

Table 4.1 - Comparison between Eurozone banks and non-Eurozone EU banks

Variables	Panel A: Mean Analysis				Panel B: Median Analysis			
	Pre-SSM		Post-SSM		Pre-SSM		Post-SSM	
	Non-Eurozone	Eurozone	Non-Eurozone	Eurozone	Non-Eurozone	Eurozone	Non-Eurozone	Eurozone
Z-Score	38.44	52.17	42.24	57.84	29.57	30.77	33.60	33.60
	(-2.40)**		(-2.60)***		(-0.55)		(-1.04)	
Lerner Index	0.33	0.32	0.36	0.33	0.34	0.32	0.39	0.34
	(1.54)		(2.07)**		(1.78)*		(2.56)**	
Total Assets (m EUR)	184 918	245 852	168 354	239 106	9 468	90 746	11 475	74 185
	(-1.64)		(-2.07)**		(-8.06)***		(-7.83)***	
Diversification	0.42	0.45	0.41	0.46	0.39	0.43	0.38	0.43
	(-1.79)*		(-2.60)***		(-2.24)**		(-2.77)***	
Efficiency	0.63	0.65	0.63	0.67	0.61	0.62	0.62	0.66
	(-1.25)		(-2.20)**		(-1.22)		(-2.68)***	
Capitalization	9.76	6.99	10.67	7.88	8.22	6.26	9.46	6.98
	(6.62)***		(6.46)***		(6.06)***		(5.76)***	
Return on Av. Assets	0.56	0.27	0.87	0.49	0.59	0.24	0.79	0.43
	(3.47)***		(4.95)***		(5.23)***		(5.33)***	

Panel A shows the mean values of each variable per group and per period. Panel B reposts the median values of each variable per group and per period. The "Pre-SSM" sub-period corresponds to the observations between 2011 and 2014; The "Post-SSM" sub-period corresponds to the observations between 2015 and 2018. Figures in brackets correspond to the t and χ^2 statistics for the differences in mean and median tests. ***, **, * represent statistical significance at 1%, 5% and 10%, respectively, using a two-tailed test.

4.2. Multivariate Analysis

Table 4.2 reports the three-stage least squares regression results of equations (3.3) and (3.4). Column (1) present the regression results for the equation where bank insolvency risk (Z-Score) is the dependent variable. Column (2) reports the estimated coefficients for the equation with the Lerner Index as the dependent variable. The result for the Wald t-tests rejects the null hypothesis of joint insignificance of the explanatory variables in our model.

Table 4.2 – Main regression results

	Column (1) Log Z-Score	Column (2) Lerner Index
Variables		
SSM	0.0848** (0.0340)	-0.0136* (0.0072)
LERNER INDEX	0.9830*** (0.1751)	
LOGTA	0.0933*** (0.0185)	0.0262*** (0.0037)
DIV	-0.2846*** (0.0649)	0.1097*** (0.0139)
EA	0.0054* (0.0029)	0.0006 (0.0006)
ROAA	0.0789*** (0.0170)	
CI		-0.4914*** (0.0158)
HHI	-2.1055*** (0.3571)	0.6042*** (0.0676)
GDP	-0.0101 (0.0066)	0.0073*** (0.0014)
BANKING		-0.0001* (0.0001)
Observations	1000	1000
Adj. R. squared	0.1199	0.5849
Wald test (p-value)	$\chi^2 = 218.4783^{***}$ ($p=0.0000$)	$\chi^2 = 1428.542^{***}$ ($p=0.0000$)

The table shows the iterative 3SLS regression results. The dependent variable for Column (1) is bank insolvency risk, measured by the Z-Score (log); the dependent variable in Column (2) is bank market power, measured by the Lerner Index. The remaining explanatory variables are as described in section 3. A constant is included but not reported. Standard errors are reported in brackets and below the respective coefficient estimates. ***, **, and * denote statistical significance at the 1%, 5% and 10% levels, respectively. Multicollinearity tests are presented in Table 9.1 and Table 9.2 of Appendix A.

The regression results presented in Column (1) report a positive and statistically significant (at the 1% level) relationship between size and bank stability. The positive sign of *LOGTA* is in line with the results of previous studies, suggesting that larger banks may be safer due to greater diversification, opportunities for economies of scale and scope and higher managerial capacity (Agoraki et al., 2011; Baselga-Pascual et al., 2015; Salas & Saurina, 2002). We also find a strong inverse relationship between profitability and bank risk. The positive sign for the coefficient of *ROAA* is in line with the literature, suggesting that more profitable banks suffer less distress (Baselga-Pascual et al., 2015; Köhler, 2014; Poghosyan & Čihak, 2011). In line with previous studies, capitalization is also positive and significantly (at the 10% level) related to bank stability. As suggested by Berger & DeYoung (1997) and Poghosyan & Čihak (2011), higher capital ratios seem to mitigate risk-taking incentives. Contrarily, we find that income diversification is positive and significantly (at the 1% level) related to bank risk. The negative coefficient of *DIV* is in line with the findings of Clark et al. (2007), De Jonghe (2010), DeYoung & Roland (2001), Mercieca et al. (2007), Stiroh & Rumble (2006), suggesting that alternative sources of income are associated with higher risks. In line with Alves & Tavares (2017), European Systemic Risk Board (2014), and Köhler (2015), we find no significant relationship between economic growth and bank risk.

Our results show that the coefficient for the *LERNER INDEX* is positive and statistically significant (at the 1% level), suggesting that market power is positively related to bank stability. These findings are in line with those obtained by Agoraki et al. (2011), Danisman & Demirel (2019), Fu et al. (2015), Jiménez et al. (2013) and Turk Ariss (2010), indicating that decreases in market power caused by intensified competition in the banking sector would increase risk-taking incentives and negatively impact the stability of European banks. The coefficient of *HHI*, our proxy for banking industry concentration is negative and significant at the 1% level, indicating that in more concentrated banking systems, banks are more likely to exhibit higher probabilities of default. This finding confirms the results obtained by Boyd, Nicolo, & Jalal (2009), De Nicoló, Jalal, & Boyd (2006), Fu et al. (2015), and Uhde & Heimeshoff (2009). The negative sign of the *HHI* coefficient and the positive sign of the *LERNER INDEX* suggest that higher concentration and lower market power can simultaneously lead to bank fragility. This result is in line with the findings of other studies that also employ both concentration and competition measures stability in the same model as determinants of bank stability (Fu et al., 2015; Kasman & Kasman, 2015; Saif-Alyousfi, Saha, & Rus, 2018). Moreover, as suggested by (Berger, Klapper, & Turk-Ariss, 2009b), our results also indicate that concentration and competition can coexist and could

simultaneously induce stability or fragility. Our findings also support the idea that concentration proxies, such as the Herfindahl–Hirschman index, are insufficient measures of bank competition (Claessens & Laeven, 2004; Leon, 2014).

The coefficient for the *SSM* dummy variable is positive and statistically significant, indicating that operating under the introduction of the Single Supervisory Mechanism has a significant stability enhancing effect. Our results indicate that the SSM fulfilled the goal of increasing the resilience of banks in the eurozone area. The value of +0.0848 for this coefficient indicates that, on average, operating under the scope of the SSM raises the Z-score levels by 8.8%⁴, implying a decrease of equal magnitude in the probability of bank default.

The literature on supervision and bank risk, and previous empirical research on the impact of the SSM on the banking sector, may help to explain our results and clarify channels through which the SSM positively impacts bank stability. First, the transference of supervisory powers from national authorities to the ECB, a supranational institution, constitutes an increase in supervisory independence (Bischof, Rudolf, & Elfers, 2020; Loipersberger, 2018). In this regard, supervisory independence implies insulation from pressures of individual governments or other national political forces. In this context, our results align with those of previous studies that document a positive relationship between greater independence of supervisory bodies and bank stability (Dincer & Eichengreen, 2012; Doumpos et al., 2015; Klomp & de Haan, 2009; Poghosyan & Čihák, 2011). Moreover, these results are consistent with the idea that the SSM improved bank stability by increasing the standards of supervision and supervisory scrutiny (Loipersberger, 2018). In fact, some authors find evidence supporting the idea that banks anticipated and perceive the ECB to be a stricter regulator, when compared to the prior national supervisory authorities (Abad, García-Olalla, & Robles, 2020; Fiordelisi et al., 2017; Loipersberger, 2018). Furthermore, our results are in line with those of other studies showing that centralized supervision tends to be more effective in reducing bank risk, when compared to decentralized banking supervision. In this context, Agarwal, Lucca, Seru, & Trebbi (2014), focusing on the U.S. dual supervisory mechanism report that central supervisors do have a tendency to exhibit a stricter supervisory style. The authors report that state-level authorities and federal supervisors implement identical rules inconsistently, in the sense that federal regulators are

⁴ Taking in consideration the log transformation of our dependent variable, we interpret the coefficient of *SSM* as the relative change of *ZSCORE* per unit absolute change of the *SSM* dummy variable. As so, we obtain the value of 8.8% by computing $(e^{0.0848}-1)*100\%$.

systematically tougher, downgrading supervisory ratings almost twice as frequently as do state supervisors. A recent study by Avignone, Altunbas, Polizzi, & Reghezza (2021) offer similar conclusions: focusing on a sample of 746 European banks over the 2011-2018 period, the authors find that the establishment of the SSM significantly reduced the credit risk exposure of SSM supervised financial institutions compared to nationally supervised banks. The authors argue that these results indicate that centralized banking supervision, and the current supervisory system, tend to be more effective than decentralized supervision in mitigating bank risk. And third, supervisory information disclosure initiatives, such as the publication of the results of Comprehensive Assessment carried out by the ECB in the run-up to the implementation of the SSM, may also contribute to improve the stability of eurozone banks by increasing the transparency in the banking system and reinforcing the role of market discipline (Barth, Caprio, & Levine, 2004; Bischof et al., 2020; Carboni, Fiordelisi, Ricci, & Lopes, 2017; Delis & Staikouras, 2011).

Column (2) reports the regression results for equation (3.1), with the Lerner Index of market power, as the dependent variable. As expected, the coefficient of $LOGTA$ is positive and significantly related to the Lerner Index. This result is in line with previous studies (Delis, 2012; Maudos & Nagore, 2005; Mirzaei & Moore, 2014), suggesting that larger banks may be able to set higher margins or have access to a cheaper source of funds. The coefficient of CI is negative and significantly related to market power. The Cost-to-Income ratio is an inverse proxy for cost efficiency: higher (lower) levels for the ratio denote lower (higher) cost-efficiency. As expected, we find that greater efficiency enables banks to enjoy greater market power, indicating that banks with better management of their inputs have lower marginal costs, and use their greater cost-efficiency as a barrier to entry (De Guevara & Maudos, 2007; De Guevara et al., 2005). The coefficient for DIV is positive and significantly (at the 1% level) related to market power. In line with Valverde & Fernández (2007), Maudos & Nagore (2005), and Okolelova & Bikker (2019) we find that it is likely that competition is more intense in the traditional task of intermediation (taking deposits and granting loans) than in other less traditional banking activities (those that generate non-interest income). We do not find a significant relationship between capitalization and market power.

The positive and significant coefficient of HHI indicates that market concentration positively affects market power. This result is consistent with previous studies that found that concentrated banking systems are more likely to exhibit lower degrees of competition

(Bikker & Haaf, 2004; Khan et al., 2017; Maudos & Nagore, 2005). We also find a positive correlation between economic growth and the Lerner Index. The positive and significant sign of the *GDP* coefficient, which denotes the real rate of growth of GDP, indicates that in times of economic expansion, banks may enjoy greater relative margins (De Guevara et al., 2005). The negative coefficient of *BANKING*, our proxy for the size and development of the domestic banking sector, indicates that it is likely that in well-developed banking systems banks face more intensive competitive conditions. This result is also consistent with the conclusions of previous studies (De Guevara et al., 2005; Maudos & Nagore, 2005).

The negative coefficient of the *SSM* dummy variable suggests that the introduction of SSM significantly reduced the extent of market power of banks operating under the uniform supervisory framework. More specifically we find that, on average, operating under the scope of the SSM results in a market power index reduction of around 0.0136 percentage points. This result is consistent with previous findings of Okolelova & Bikker (2019). The aforementioned authors also find, on the basis of Lerner Index and Boone indicator estimates, a significant decrease on the extent of market power of banks subject to direct ECB supervision in five EU economies. In sum, we find evidence of a significant increase in competition associated to the commencement of the SSM. The empirical evidence on the competitive implication of the SSM is still very scarce. However, it is frequently hypothesized that the regulatory harmonization introduced by the single supervisory framework created a level playing field and mitigated the frictions that deterred banks from conducting cross-border business. By reducing the compliance costs and by making regulatory practices and standards more consistent across member states, the single rulebook creates more opportunities for banks to compete across various jurisdictions, exposing domestic banking markets to open foreign competition and cross-border contestation (Constâncio, 2014a; Hakkarainen, 2017, 2018; Maudos & Vives, 2019; Okolelova & Bikker, 2019). While more data is necessary to confirm this hypothesis, namely on the evolution of eurozone cross-border banking, our results, to some extent, support this premise.

5. Robustness Tests

In this section we include a set of additional robustness tests. First, following Amidu & Wolfe (2013), Bougatef & Mgadmi (2016), Fernandes et al. (2017), we test the robustness of our results by re-estimating our main equation **(3.2)** (the *Z-Score* equation), using the two-stage least squares (2SLS) estimation method. And second, we add to our baseline model a set of country-specific institutional variables to control for the effects of the institutional environment on bank stability.

5.1. Two-stage least squares estimation

The estimation results of equation **(3.2)** using the 2SLS estimation method are presented in **Table 5.1**. Both the Z-Score and the Lerner Index are still treated as endogenous, and the exogenous variables of our baseline model are taken as instruments for the endogenous variables. The results obtained are similar to those presented in Column (1) of **Table 4.2**, except that the coefficient on *EA* (equity-to-assets ratio) becomes statistically significant at the 5% level, instead of the 10% significance level previously reported. The direction of the sign and the significance of all coefficients remain unchanged, providing evidence of robustness to our results. Moreover, the standard error of 2SLS is larger (and the R^2 smaller) than the standard error produced by the 3SLS estimation procedure performed in **section 4.2**, indicating that 3SLS estimation does in fact yield more precise and consistent estimates than 2SLS.

Re-estimating equation **(3.2)** using 2SLS also allows us to perform several diagnosis tests. We use two tests of overidentifying restrictions - the Sargan χ^2 test, and the Basman χ^2 test - to test if our instruments are correlated with the error term. Under the null hypothesis, our instruments are valid in the sense that they are uncorrelated with the structural error term. Based on the values for both tests reported in **Table 5.1** we do not reject the null hypothesis of validity of our instruments.

Additionally, we also report the values for the Wu-Hausman F-test and for the Durbin test. These statistics are used to test if the variables that we take as endogenous could instead be treated as exogenous. For both tests, under the null hypothesis, the Lerner Index (that we treat as endogenous) is an exogenous variable. As reported in **Table 5.1**, both test statistics are highly significant, therefore, we reject the null hypothesis of exogeneity and conclude that the Lerner Index is correctly specified as endogenous.

Table 5.1 – Two-stage least squares regression results

	Column (1)
	Log Z-Score
Variables	
SSM	0.0847** (0.0341)
LERNER INDEX	1.0881*** (0.1763)
LOGTA	0.0903*** (0.0186)
DIV	-0.2781*** (0.0651)
EA	0.0072** (0.0030)
ROAA	0.0502*** (0.0175)
HHI	-2.1757*** (0.3585)
GDP	-0.0088 (0.0066)
Observations	1000
Adj. R. squared	0.1136
Wald test (p-value)	193.3885*** ($p=0.0000$)
Sargan test (p-value)	0.5380 ($p=0.4654$)
Basman test (p-value)	0.5380 ($p=0.4654$)
Wu-Hausman F-test (p-value)	26.2938*** ($p=0.0000$)
Durbin test (p-value)	26.2938*** ($p=0.0000$)

The table shows 2SLS regression results. The dependent variable for Column (1) is bank insolvency risk, measured by the Z-Score (log); the Lerner Index is specified as endogenous. The remaining explanatory variables are as described in section 3. A constant is included but not reported. Standard errors are reported in brackets and below the respective coefficient estimates. ***, **, and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

5.2. Three-stage least squares regression with additional institutional controls

We now add to our model a set of country-specific institutional variables to control for the characteristics of the institutional environment that banks operate in. Several authors have shown that aspects related to institutional quality significantly affect bank stability (Barth et al., 2004; Demirguc-Kunt & Detragiache, 1998; Fernandez & Gonzalez, 2005; Klomp & de Haan, 2015). Following the results reported by these authors, we expect a positive association between bank soundness and institutional quality. To capture the institutional quality within a country, we include in our analysis the set of World Governance Indexes provided by Kaufmann et al. (2011). The World Governance Indexes include a set of indices that capture six dimensions of governance and institutional quality: Voice and Accountability, Political Stability and Absence of Violence/Terrorism, Government Effectiveness, Regulatory Quality, Rule of Law, and Control of Corruption. **Table 3.3** provides a detailed description of these variables. To address multicollinearity concerns, these additional variables are included in the regression one at a time. The results are provided in **Table 5.2**.

We find that *Control of Corruption*, *Voice and Accountability*, *Government Effectiveness* and *Political Stability and Absence of Violence* are positively and significantly, at the 1% level, related to bank stability. *Regulatory Quality* and *Rule of Law* are also positively related to bank soundness, at 5% and 10% level, respectively. The positive and significant coefficients for the indices capturing different aspects of a country's institutional environment suggest that higher institutional quality effectively mitigates bank risk. Moreover, the reported results are consistent with our prior results as the sign and significance of all coefficients remain unchanged. This provides additional support to the reliability of our results.

Table 5.2 - Three-stage least squares regression with additional institutional controls

Panel A	Dependent Variable: Log Z-score					
	(1)	(2)	(3)	(4)	(5)	(6)
Variables						
SSM	0.0821** (0.0341)	0.0867** 0.0342	0.0889*** 0.0342	0.0908*** 0.0342	0.0820** 0.0341	0.0888*** 0.0338
LERNER INDEX	1.0396*** (0.1797)	1.0261*** 0.1819	1.0590*** 0.1797	1.0555*** 0.1808	1.0533*** 0.1809	0.9772*** 0.1736
LOGTA	0.0892*** 0.0186	0.0902*** 0.0187	0.0895*** 0.0187	0.0889*** 0.0187	0.0892*** 0.0187	0.1058*** 0.0185
DIV	-0.3023*** 0.0653	-0.3001*** 0.0657	-0.2973*** 0.0654	-0.3063*** 0.0656	-0.3046*** 0.0654	-0.2802*** 0.0644
EA	0.0065** 0.0030	0.0060** 0.0030	0.0060** 0.0030	0.0059** 0.0030	0.0064** 0.0030	0.0070** 0.0029
ROAA	0.0792*** 0.0171	0.0794*** 0.0171	0.0783*** 0.0171	0.0799*** 0.0171	0.0803*** 0.0170	0.0789*** 0.0169
HHI	-2.1274*** 0.3586	-2.0939*** 0.3587	-2.0738*** 0.3590	-2.1048*** 0.3586	-2.1393*** 0.3592	-2.3036*** 0.3609
GDP	-0.0082 0.0066	-0.0084 0.0066	-0.0093 0.0066	-0.0078 0.0066	-0.0064 0.0067	-0.0109 0.0065
Voice and Accountability	0.1244*** 0.0422					
Rule of Law		0.0461* 0.0246				
Regulatory Quality			0.0767** 0.0309			
Control of Corruption				0.0512*** 0.0182		
Government Effectiveness					0.0867*** 0.0282	
Political Stability and Absence of Violence						0.1491*** 0.0386
Observations	1000	1000	1000	1000	1000	1000
Adj. R. squared	0.1233	0.1194	0.1171	0.1203	0.1226	0.1365
Panel B	Dependent Variable: Lerner Index					
SSM	-0.0142* 0.0073	-0.0140* 0.0073	-0.0140* 0.0072	-0.0142* 0.0073	-0.0142** 0.0073	-0.0134* 0.0072
LOGTA	0.0263*** 0.0073	0.0262*** 0.0037	0.0263*** 0.0037	0.0263*** 0.0037	0.0263*** 0.0037	0.0261*** 0.0037

DIV	0.1101***	0.1099***	0.1099***	0.1101***	0.1102***	0.1096***
	0.0139	0.0139	0.0139	0.0139	0.0139	0.0139
EA	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006
	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006
CI	-0.4907***	-0.4910***	-0.4905***	-0.4905***	-0.4906***	-0.4917***
	0.0158	0.0158	0.0158	0.0158	0.0158	0.0158
HHI	0.6073***	0.6062***	0.6068***	0.6075***	0.6078***	0.6033***
	0.0676	0.0676	0.0676	0.0676	0.0676	0.0676
GDP	0.0071***	0.0072***	0.0072***	0.0071***	0.0071***	0.0073***
	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014
BANKING	-0.0001**	-0.0001**	-0.0001**	-0.0001**	-0.0001**	-0.0001
	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Observations	1000	1000	1000	1000	1000	1000
Adj. R. squared	0.5848	0.5848	0.5848	0.5848	0.5848	0.5849

The table shows the iterative 3SLS regression results with additional institutional controls. The dependent variable on Panel A is bank insolvency risk, measured by the Z-Score (log); the dependent variable on Panel B is bank market power, measured by the Lerner Index. The remaining explanatory variables are as described in section 3. A constant is included but not reported. Standard errors are reported in brackets and below the respective coefficient estimates. ***, **, and * denote statistical significance at the 1%, 5% and 10% levels, respectively. Multicollinearity tests are presented in Table 9.3 and Table 9.4 of Appendix A.

6. Conclusion

In 2012, in an effort to revise and improve the standards of European banking supervision and regulation, the European Commission proposed the creation of the European Banking Union, a system based on three pillars: The Single Supervisory Mechanism, the Single Resolution Mechanism and the European Deposit Insurance Scheme. In November 2014, the SSM became the first fully operational pillar of the European Banking Union. At that time banking supervision was, in a great extent, transferred to the European level and the ECB became, in cooperation with the NCA of each country, the ultimate supervisor of eurozone banks. This reform in banking supervision was introduced in the aftermath of the financial crisis, with the ultimate goal of increasing the resilience of banks and enhancing the stability of the financial system.

While the reduction of bank risk was an explicit goal, a potential effect of the SSM in the competitive landscape of the European banking sector was also hypothesized by some authors. In the present study, we contribute to the literature on bank regulation and supervision by testing if the SSM reached one of its seminal goals of increasing the resilience of eurozone banks. At the same time, we investigate and quantify the competitive implications produced by the transition to the current supervisory framework. Building on previous literature, we also analyze the relationship between stability and competition in the European banking sector by incorporating in our model market power as a possible determinant of bank risk levels. Altogether, we dedicate our research efforts to offer some clarification on the intricate relationship between risk, competition and banking supervision.

We employ a difference-in-differences approach to a balanced panel of 125 banks from both Eurozone and EU non-Eurozone countries, over the 2011 to 2018 period. Accounting for the endogeneity and simultaneity in our model, we apply three-stage least squares estimation to system of simultaneous equations. As dependent variables, we use the Z-Score as our proxy for bank stability, and the Lerner Index as our proxy for market power.

Overall, our results indicate that operating under the scope of the SSM has significant stabilizing effects, reducing the risk levels of ECB supervised banks. More specifically, we find that on average, operating under the scope of the SSM raises the Z-Score levels by 8.8%. Additionally, our results indicate that the introduction of the uniform

supervisory framework significantly affected the market power of eurozone banks. We find a significant increase in banking competition among eurozone banks associated to the implementation of the SSM, as reflected by the significant decrease on the mean values of the Lerner Index for Eurozone banks. More specifically, we find that, on average, operating under the direct supervision of the SSM results in a market power reduction of around 0.0136 percentage points.

In what concerns the relationship between competition and bank risk, our results are consistent with the “competition-fragility view”, as we find a negative association between market power and bank risk. Under the “competition-fragility paradigm”, competition has a negative effect on stability because it erodes banks’ market power and creates incentives for excessive risk-taking. In our results, this is reflected by the positive relationship between the Z-Score and the Lerner Index.

Regarding other determinants of bank risk, we find a negative association between bank size, capitalization, profitability and risk. In contrast, our results indicate that banks deriving higher shares of their income from non-interest sources tend to exhibit higher risk levels. We also find banks operating in more concentrated banking systems to be less stable.

In what concerns the bank-specific determinants of bank market power, we find size, cost efficiency and income diversification to be positively related to bank’s margins. Regarding country and industry-specific factors, we find that higher economic growth and industry concentration favor greater market power. Contrarily, we find evidence suggesting that banks operating in more developed banking markets face more intensive competition.

Altogether, we can conclude that the SSM was successful in reaching the goal of increasing the resilience of Eurozone banks. We also find evidence of a significant increase in competition associated to the commencement of the SSM. Moreover, we find competition to be a significant driver of European banks risk levels.

Our paper contributes to the existing literature in several ways. First, we contribute to the literature focusing on the determinants of bank risk and banking competition. We also provide empirical evidence contributing to the long-standing debate on the relationship between competition and bank stability. Moreover, we show how bank supervision may significantly affect bank risk. More specifically, we add to the scarce empirical studies on how changes in banking supervision affect bank behavior, and we also contribute to the research on the effectiveness of centralized vs. decentralized supervision. We also contribute to the literature on how different supervisory setting affect competition

by providing evidence suggesting that supervisory uniformization may significantly affect competitive conditions in the banking industry. Lastly, considering that the SSM is a fairly recent development in the European banking system, our work contributes to the under-researched topic of the effects produced by the implementation of SSM.

Our findings have significant policy implications. Overall our results support the current supervisory structure, indicating that the centralized and uniform supervision model introduced by the SSM was successful in respect to reaching the goal of reducing the risk levels of eurozone financial institutions. However, since our results are consistent with the existence of a trade-off between competition and stability, the reported competition-enhancing effect associated to the establishment of the SSM raises a warning flag. Considering that our findings suggest that banks with greater market power tend to be more stable, further competitive enhancing incentives and the consequent market power deterioration, could have detrimental effects for the risk levels of banks and for the stability of the European banking system as a whole.

7. Limitations of the Study and Future Research

Despite our efforts, we recognize that the present study may still suffer from some limitations. One limitation of this research is related to the reduced sample of Eurozone banks in our study. When we formed our sample, our starting point was the full set of significant entities included in ECB's list of directly supervised institutions. However, due to missing data for some variables, we had to exclude several observations. As a result, our final sample only includes a smaller fraction of the 117 significant institutions directly supervised by the ECB in 2020. Possibly due to the small sample size, the *SSM* estimate, capturing the impact of the SSM on banks' market power, is only statistically significant at the 10% level. Moreover, when choosing the proxies for our dependent variables, as well as for our internal and external determinants, we chose those that we found to be the most well-established and the most popular in the literature. We also took into consideration factors regarding data availability and alignment with our research objectives. However, considering the multitude of alternative measures for each variable and the novelty of some of these indicators, there is no guarantee that we chose the best ones.

Considering that the SSM is a new feature in the European banking sector, and that this study only covers the first four years of its effective operation, further research is still necessary to fully understand the effects of the establishment of the SSM on the medium and long-run. Updating this study to include more data and a longer time range would be useful in addressing this challenge. Moreover, as mentioned in the section where we present the empirical results of our study, the channels through which the supervisory uniformization positively impacted bank competition are not clear. Future research on how the SSM impacted cross-border banking, cross-border expansion and M&A activity across member states, would be helpful to uncover potential channels through which the SSM impacts bank competition and market integration in the European banking sector.

8. References

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9. Appendices

9.1. Appendix A

Table 9.1 – Correlation Matrix for 3SLS regression’s independent variables

Equation (3.1)	SSM	LOGTA	DIV	EA	CI	HHI	GDP	BANKING
SSM	1.0000							
LOGTA	0.2081	1.0000						
DIV	0.0698	0.0979	1.0000					
EA	-0.1142	-0.5242	-0.0911	1.0000				
CI	0.0721	0.1300	0.2310	-0.2565	1.0000			
HHI	0.0330	-0.3441	-0.2033	-0.2565	-0.2905	1.0000		
GDP	0.1918	-0.0895	-0.0537	0.0827	-0.0663	0.0911	1.0000	
BANKING	-0.1909	0.1143	0.0940	-0.1465	0.1612	-0.0204	-0.3283	1.0000

Equation (3.2)	SSM	LERNER INDEX	LOGTA	DIV	EA	ROAA	HHI	GDP
SSM	1.0000							
LERNER INDEX	-0.0092	1.0000						
LOGTA	0.2081	-0.0006	1.0000					
DIV	0.0698	-0.0318	0.0979	1.0000				
EA	-0.1142	0.1630	-0.5242	-0.0911	1.0000			
ROAA	-0.0467	0.4407	-0.2366	0.0079	0.4406	1.0000		
HHI	0.0330	0.3272	-0.3441	-0.2033	0.2435	0.1616	1.0000	
GDP	0.1918	0.1595	-0.0895	-0.0537	0.0827	0.1923	0.0911	1.0000

Table 9.2 – VIF Testing for 3SLS regression

Equation (3.1)		Equation (3.2)	
Variable	Variance Inflation Factors	Variable	Variance Inflation Factors
SSM	1.17	SSM	1.13
LOGTA	1.58	LERNER INDEX	2.03
DIV	1.09	LOGTA	1.74
EA	1.46	DIV	1.06
CI	1.21	EA	1.63
HHI	1.28	ROAA	1.88
GDP	1.16	HHI	1.59
BANKING	1.21	GDP	1.12
Mean VIF	1.27	Mean VIF	1.52

Table 9.3 - Correlation Matrix for 3SLS robustness regression

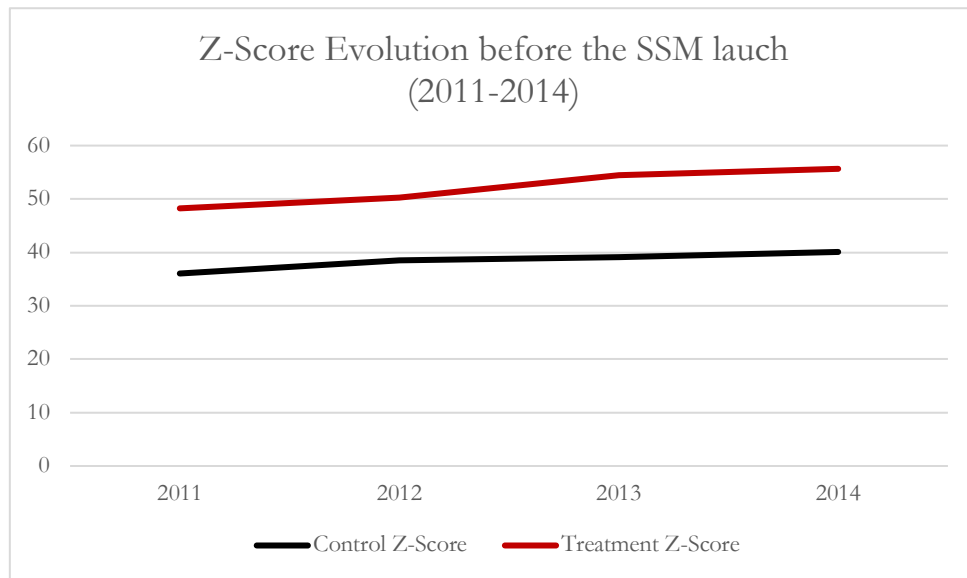
Equation (3.1)	SSM	LOGTA	DIV	EA	CI	HHI	GDP	BANKING
SSM	1.0000							
LOGTA	0.2081	1.0000						
DIV	0.0698	0.0979	1.0000					
EA	-0.1142	-0.5242	-0.0911	1.0000				
CI	0.0721	0.1300	0.2310	-0.2565	1.0000			
HHI	0.0330	-0.3441	-0.2033	-0.2565	-0.2905	1.0000		
GDP	0.1918	-0.0895	-0.0537	0.0827	-0.0663	0.0911	1.0000	
BANKING	-0.1909	0.1143	0.0940	-0.1465	0.1612	-0.0204	-0.3283	1.0000

Equation (3.2)	SSM	LERNER INDEX	LOGTA	DIV	EA	ROAA	HHI	GDP	Voice and Accountability	Rule of Law	Regulatory Quality	Control of Corruption	Government Effectiveness	Political Stability/ no Violence
SSM	1.0000													
LERNER INDEX	-0.0092	1.0000												
LOGTA	0.2081	-0.0006	1.0000											
DIV	0.0698	-0.0318	0.0979	1.0000										
EA	-0.1142	0.1630	-0.5242	-0.0911	1.0000									
ROAA	-0.0467	0.4407	-0.2366	0.0079	0.4406	1.0000								
HHI	0.0330	0.3272	-0.3441	-0.2033	0.2435	0.1616	1.0000							
GDP	0.1918	0.1595	-0.0895	-0.0537	0.0827	0.1923	0.0911	1.0000						
Voice and Accountability	0.0538	-0.2037	0.1844	0.1204	-0.2366	-0.1552	-0.1309	-0.1451	1.0000					
Rule of Law	-0.0097	-0.2429	0.1897	0.1567	-0.2259	-0.1619	-0.1939	-0.2048	0.9357	1.0000				
Regulatory Quality	-0.0208	-0.2071	0.1621	0.1136	-0.1979	-0.1309	-0.2178	-0.1269	0.8815	0.9265	1.0000			
Control of Corruption	-0.0446	-0.2306	0.1541	0.1409	-0.1872	-0.1634	-0.1750	-0.1982	0.9289	0.9265	0.9168	1.0000		
Government Effectiveness	0.0352	-0.2381	0.1746	0.1255	-0.2300	-0.1926	-0.1342	-0.2343	0.9256	0.9564	0.8924	0.9469	1.0000	
Political Stability no Violence	-0.0496	-0.0132	-0.2123	-0.0653	0.0087	0.0132	0.2252	0.0524	0.3263	0.2419	0.1614	0.1736	0.2513	1.0000

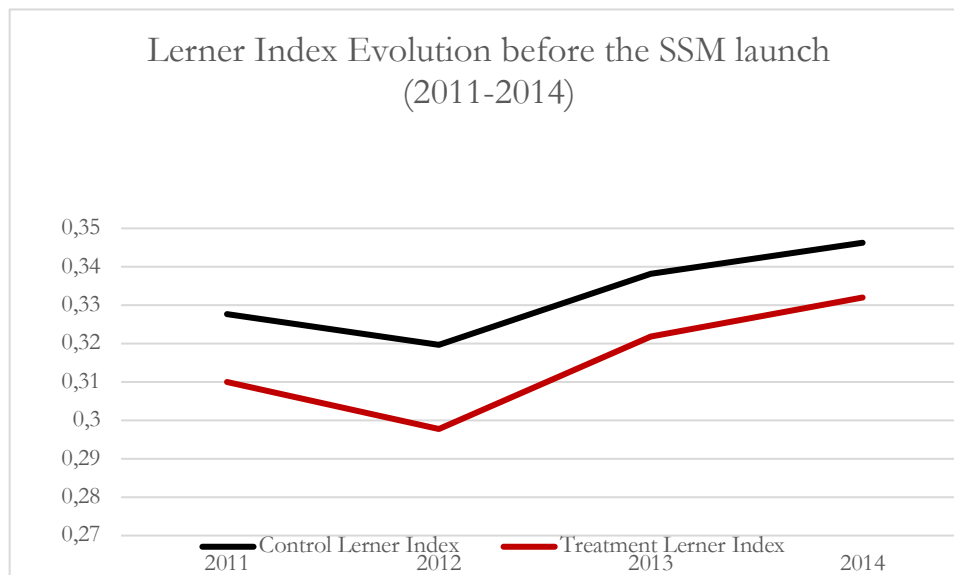
Table 9.4 – VIF Testing for 3SLS robustness regression

Equation (3.2) Variable	Variance Inflation Factors					
	(1)	(2)	(3)	(4)	(5)	(6)
SSM	1.13	1.14	1.14	1.14	1.13	1.14
LERNER INDEX	2.14	2.18	2.12	2.16	2.17	2.04
LOGTA	1.77	1.77	1.76	1.77	1.76	1.78
DIV	1.07	1.08	1.07	1.08	1.07	1.06
EA	1.65	1.65	1.64	1.64	1.65	1.65
ROAA	1.89	1.90	1.89	1.89	1.89	1.88
HHI	1.59	1.59	1.59	1.59	1.60	1.64
GDP	1.13	1.14	1.13	1.14	1.16	1.12
Voice and Accountability	1.16					
Rule of Law		1.22				
Regulatory Quality			1.14			
Control of Corruption				1.18		
Government Effectiveness					1.21	
Political Stability no Violence						1.11
Mean VIF	1.50	1.52	1.50	1.51	1.52	1.49

9.2. Appendix B



Graph 9.1 – Visual Inspection of the parallel trend in the evolution of the Z-Score for the control and treatment groups



Graph 9.2 - Visual Inspection of the parallel trend in the evolution of the Lerner Index for the control and treatment groups