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**"THE RELATIONSHIP BETWEEN THE EUROPEAN CENTRAL BANK
TRANSPARENCY AND THE EUROZONE SYSTEMIC RISK LEVEL: AN
EMPIRICAL ANALYSIS"**

RELATORE:

CH.MA PROF.SSA Baldan Cinzia


LAUREANDA: Montresor Arianna

MATRICOLA N. 2007721

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INTRODUCTION

The concept of globalization refers to a process involving societies, cultures and economies worldwide. It entails the emergence of an international network among people, institutions, activities, goods and services, capital, ideas, and news, which are highly interconnected and interdependent among each other, in their social, economic, political, informational and technological dimensions. It is a phenomenon, which has been developing over years, starting from the nineteenth century, ending up to permeate, in a positive or negative way, businesses, exchanges, people's lives and thoughts all over the world.

Globalization is reflected in trade development among countries, with the consequent integration of national activities into a global economic system. Thanks to cheaper and faster transports and through an increase in the income level, resulting from an economic growth, goods and services are easily exchanged. Firms have strengthened their relationships in networks of production and distribution, which, in turn, have increased the productivity and the competitiveness worldwide. The management of economic activities has assumed a global dimension today. Moreover, capital flows travel from one state to another, allowing, investors to fund profitable opportunities and to diversify their risks, and recipient countries to finance projects, boosting the economic growth further. In fact, globalization has favored the opening of domestic financial markets to foreigners and the information circulation, through which cross-border projects can be better evaluated. Among capital flows, worker's remittances represent all, or part, of the emigrants' wages, which are sent to relatives, in the home country, usually a developing one, in order to support their consumption and investment and, as a consequence, the catching up process. Indeed, another consequence of globalization is related to the movement of people, who leave their home country to work abroad, in order to find better employment opportunities and to increase their living standards. As a consequence, knowledge, skills and ideas are spread worldwide. Furthermore, students have the possibility to receive an international education, by attending foreign universities for a given semester and, therefore, to learn a new language. Finally, people movements also involve the development of the international tourism, which, in turn, contributes to the growth of this economic sector. Last but not least, globalization also concerns the spread of knowledge and technology, which offer to emerging countries opportunities of growth. Indeed, new production methods, management techniques, export markets or economic policies could accelerate the domestic innovation capacity and productivity. The flows of ideas among countries have been enhanced by the advent of Internet, which enables a quick communication of news, discoveries, problems solutions, as well as a real-time exchange of views. The online world has modified people's

perception of the space-time dimension, resulting in interlinkages intensification and a deeply interconnected world.

However, the flip side of the coin points out how the globalization has widened inequalities among different countries and how it has enhanced the competition or the pollution levels. In addition, it has facilitated the spread of diseases, shocks and crises.

Among these drawbacks, the rise of a global systemic risk should be considered and deeply investigated. Indeed, the notion traces its origins exactly in the highly interconnected and tightly integrated real and financial markets and it entails the quick and rapid spillovers of a given shock into different branches of the industry, generating, as a consequence, worldwide financial and real sector crises. Therefore, systemic risk is a very complex and multifaceted concept, which involves simultaneously economic sectors, financial markets, people and companies all over the world.

This dissertation aims to define and analyze the notion of systemic risk in all its aspects and characteristics. The focus will be on financial sector exposures and shocks, with a particular attention for the banking field. The author is willing to study risk determinants, such as banks' features and activities or financial markets' structures, in order to accurately understand how they contribute, alone or together, to rise the systemic risk level.

More to the point, the core of the dissertation lies in the analysis of a peculiar variable, Central Bank transparency, which has been less investigated in the literature and for which results seem still inconclusive. Indeed, the final hope is to give a small contribution to the set of studies regarding this topic and, at the same time, to rise curiosity and interest about it, in order to incentive further researches.

The first chapter will present a detailed systemic risk definition, together with some of the several measures that have been introduced, over time, to compute it. Afterwards, the most important determinants, as bank size, capital, leverage, interconnectedness level and financial market structure, will be described, together with the explanation of their contribution to the systemic risk level increase or decrease. In the end the development of regulations, enacted to control and reduce the level of systemic risk, will be investigated.

The second chapter focuses, instead, on the Central Bank transparency only. More to the point, after defining the concept, the several tools, which are implemented by Central Banks to communicate with market participants and the general public, will be described. Subsequently, the analysis of positive and negative effects of an increased transparency level on systemic risk

will follow. Finally, the last two sections will be dedicated to Central Banks' transparency standards and to the review of the literature concerning the impact of Central Bank transparency on the systemic risk level. Besides, in this chapter several examples and focus regarding the European Central Bank will be provided.

The third and last chapter proposes an empirical analysis, of the effect that a given European Central Bank's transparency level exerts on the Eurozone systemic risk. A multiple linear regression is implemented, in order to analyze the direction of the relationship between the Z-score, that is the adopted systemic risk measure, and four explanatory variables, which are, of course, an index representing the ECB transparency, and three macroeconomic controls, as the Eurozone's GDP growth and inflation level and the ratio between the Euro-system total assets and GDP. More precisely, the adopted transparency index was published, in 2019, by Dincer, Eichengreen and Geraats on the book "The Oxford Handbook of the Economics of Central Banking" and it originally referred to the monetary policy only. The author of this thesis will modify its structure by adding a transparency dimension regarding the supervisory role of the ECB, in order to implement a more comprehensive index.

Therefore, the contribution of this dissertation is twofold. First of all, to the knowledge of the author, this is the first time that an ECB transparency index, involving both its monetary and supervisory roles, has been implemented in an empirical study. The second contribution, instead, is to be found in the regression results, which enrich the literature regarding this topic.

Chapter 1

THE SYSTEMIC RISK CONCEPT

1.1 Definition of systemic risk

During the last decades, the financial system has been put to the test by different severe crises, among which the Great Financial Crisis, the European Sovereign Debt Crisis and the recent Covid-19 pandemic. They are, naturally, of different nature: the first one originated in the real sector, when house prices started to drop and borrowers had difficulties in paying back their mortgage to banks, causing losses and volatility in the financial system. The second one was related to the violation of euro's fiscal rule by Greece, which determined the suspect of fiscal irresponsibility of the other GIPSI countries and the following increase in the spread between their ten years government bonds interest rate and the yield of the German bund¹. The third one derived from containment measures, due to a worldwide health emergency, which harmed the real economy and threatened the financial sector soundness².

Nevertheless, all these crises suggest that financial markets are highly interconnected and integrated among each other and that there are interlinkages between financial and real economy stability. Indeed, in the current globalized world, shocks and vulnerabilities in a sector can effortlessly and quickly spill over into another one, through different channels, such as a similar business model or market structure³.

Consequently, the understanding of the systemic risk meaning has become more and more important during years, in order to study the origins of financial and real sector crises, elaborate solutions and enforce new regulations and provisions⁴.

Prior to defining systemic risk, it is important to highlight the first two dimensions of the concept; the horizontal, which deals with shocks affecting financial sector only, and the vertical, that considers also the impact of an event on the real economy⁵. In particular, the dissertation will analyze the first dimension, with a focus on the banking sector.

¹ Philip R. Lane, «The European Sovereign Debt Crisis», *Journal of Economic Perspectives* 26, n. 3 (September 2012): 49–68, <https://doi.org/10.1257/jep.26.3.49>.

² Scott Ellis, Satish Sharma, e Janusz Brzeszczyński, «Systemic Risk Measures and Regulatory Challenges», *Journal of Financial Stability*, 2021, <https://doi.org/10.1016/j.jfs.2021.100960>.

³ Xin Huang, Hao Zhou, e Haibin Zhu, «Assessing the Systemic Risk of a Heterogeneous Portfolio of Banks during the Recent Financial Crisis», *Journal of Financial Stability*, The Financial Crisis of 2008, Credit Markets and Effects on Developed and Emerging Economies, 8, n. 3 (1st September 2012): 193–205, <https://doi.org/10.1016/j.jfs.2011.10.004>.

⁴ Ellis, Sharma, e Brzeszczyński, «Systemic Risk Measures and Regulatory Challenges», 2021.

⁵ Olivier de Bandt e Philipp Hartmann, «Systemic Risk: A Survey» (European Central banks, 2000), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=258430.

With regard to the delineation of the systemic risk significance, difficulties arise since there are a lot of facets to consider. Indeed, the first challenge to face, regarding systemic risk, is its definition. Even if there is an extended literature about this risk type, the concept has never been evenly defined. Three main notions can be highlighted. According to the first one, systemic risk could be defined as a big shock or macro shock, that negatively affects the banking, financial and economic systems in a simultaneous way. The second definition focuses on the domino effect produced by an adverse event, which generates a chain of losses that involves different institutions over time. Lastly, the third one is based on the indirect spread of an initial exogenous external shock across organizations with similar risk exposures⁶.

From these definitions, it is possible to identify a macro and a micro dimension of systemic risk. The distinction lies in the risk the financial system is exposed to. For the first one an aggregate risk is considered, such as the growth in correlated exposures, while the second one is related to the risk resulting from an individual institution failure or, more in general, an initial adverse event. Of course, macro and micro risks are strictly related since, for example, the impact of the individual risk of a bank's default and its consequences are boosted by accumulated imbalances in the financial system. The interrelations of the macro and micro dimension emphasize the complexity of the systemic risk definition⁷.

Moreover, it is possible to distinguish the systemic event in a narrow or broad sense. The first identification is associated with the concept of idiosyncratic shock, which is the one that, initially, threatens the stability of a single financial institution, asset or market and, afterwards, it spreads across the entire financial system. For this reason, the notion of narrow event entails the domino effect. On the other hand, systemic risk in a broad sense is related to "simultaneous adverse effects on a large number of institutions or markets as a consequence of severe and widespread (systematic) shocks". Indeed, contrary to idiosyncratic, systemic shocks affect the entire financial system at the same time⁸.

In addition, both in the case of a narrow and a broad event, the shock could be exogenous, which means that it originates outside the financial system, such as the Covid-19 pandemic; or it is caused endogenously by one financial institution, like the case of the Great Financial Crisis, which erupted after the failure of Lehman Brothers⁹.

⁶ George G. Kaufman e Kenneth E. Scott, «What Is Systemic Risk, and Do Bank Regulators Retard or Contribute to It?», *Independent Review* 7, n. 3 (Winter 2003): 371.

⁷ Paweł Smaga, «The Concept of Systemic Risk», SSRN Scholarly Paper (Rochester, NY: Social Science Research Network, 8th August 2014), <https://papers.ssrn.com/abstract=2477928>.

⁸ de Bandt e Hartmann, «Systemic Risk: A Survey», 2000.

⁹ ECB, «The Concept of Systemic Risk», *Financial Stability Review*, 2009, 9.

Another important dimension of the systemic risk concept is related to the propagation of the shock, which can happen through physical exposures or due to information effects. Indeed, defaults or crashes could be the result of a macroeconomic transmission of a given negative event, which influences both the financial and the real sector components, that are subjected to similar risks. Just think of the breakdown of some corporate firms during a downturn period and the consequences in terms of non-performing loans in the balance sheet of banks, which could reduce lending to the economy¹⁰. Moreover, the physical exposure in the interbank market allows banks to share risks and to lend each other, to face liquidity needs, but if interbank market contracts are not honored, due to an adverse event, contagion bank failures could occur¹¹.

Regarding the second channel of transmission, costly and asymmetric information could lead to the rise of some expectations, which could generate systemic events. This is the case of bank runs, which verify when an adverse event occurs and depositors decide to withdraw their money as they fear that their bank would turn insolvent. Consequently, the bank is actually induced to liquidate its assets to meet withdrawal requests¹². Furthermore, if depositors expect that other depositors are going to pull back their money too, they will withdraw from other banks, which will also fail¹³. Basically “a run on an individual bank can trigger runs on other banks, precipitating a bank panic”¹⁴. In other words, the result of a systemic event could be in the form of a self-fulfilling panic, even if ex ante banks are healthy¹⁵.

The heterogeneity of systemic risk definitions also lies in its different determinants. Indeed, systemic risk could arise from excessive risky activities taken up by a group of banks, the collapse of confidence, information asymmetries, correlated exposures of financial institutions, liquidity provisions, mispricing of assets, sovereign default, procyclicality and so on. Moreover, risks, that before the Great Financial Crisis were treated separately, such as liquidity risk, credit risk and operational risk, are now considered as an aggregated source of systemic risk¹⁶. Some of the most important causes will be later analyzed in the third paragraph of this chapter.

After having highlighted different aspects of the meaning of systemic risk, it is relevant to focus on the essence of the concept, which is hold in the cross-sectional and time-series dimensions.

¹⁰ de Bandt e Hartmann, «Systemic Risk: A Survey», 2000.

¹¹ ECB, «The Concept of Systemic Risk», 2009.

¹² Filippo Occhino, «Debt-overhang banking crises: Detecting and preventing systemic risk», *Journal of Financial Stability*, 2016, <https://www.sciencedirect.com/science/article/pii/S1572308915001448>.

¹³ de Bandt e Hartmann, «Systemic Risk: A Survey», 2000.

¹⁴ Occhino, «Debt-overhang banking crises: Detecting and preventing systemic risk», 2016.

¹⁵ de Bandt e Hartmann, «Systemic Risk: A Survey», 2000.

¹⁶ Smaga, «The Concept of Systemic Risk», 2014.

The cross-sectional dimension refers to the correlation of different risk types and the allocation of systemic risk sources at a given point in time¹⁷. In fact, the core of this first aspect is the interconnectedness among institutions and agents, which is the primary source of spillover effects. On the other hand, time-series dimension entails the progressive increase of systemic risk or market volatility over time. Again, there is a strong correlation between the two dimensions. For instance, systematically important financial institutions, resulting from the rise of the financial system concentration level (cross-sectional dimension), will implement a moral hazard behavior, taking more and more risks over time (time dimension), since they know they can rely on the government bail-out in case of distress. Indeed, they are also called “too big to fail” institutions, which means that the State will never let them break down because they would otherwise entail too severe consequences for the financial and the real system. Another example could be banks’ excessive lending, which raises their risk position (time dimension), resulting in a dangerous exposure in a given market segment (cross-sectional dimension)¹⁸.

To sum up, the concept of systemic risk is built around two pillars: a shock and its propagation. The process starts with an adverse event, that can be macro or micro, idiosyncratic or systemic, exogenous or endogenous. Then, the shock is transmitted through exposures toward other institutions, confidence/behavioral factors and similarities in assets and liabilities, in the business model, in risk management techniques or in the applied diversification methods.

1.2 Measures of systemic risk

The wide range of systemic risk definitions is reflected in the huge number of measures that have been developed over time to compute it. This is not necessary a drawback. Indeed, institutions are free to choose the model they prefer to gain a competitive advantage and, in case of a distressed situation, they can analyze the problem by taking different points of view; hence, they avoid reacting in a similar way, causing further complications¹⁹.

From the regulator point of view, it is important that systemic risk indicators have determined features so that they can be easily used to prevent or reduce the negative effects of a possible adverse event. First of all, they should detect well in advance the build-up of the risk and highlight the warning indicators of an upcoming crisis. Moreover, it should be possible to run an ex-post analysis of these indicators to better understand the development of the crisis and the effectiveness of the set of policies. In the second place, measures should be smoothly implementable to allow policymakers to compute them in case of necessity. At last, the

¹⁷ Ellis, Sharma, e Brzeszczyński, «Systemic Risk Measures and Regulatory Challenges», 2021.

¹⁸ Smaga, «The Concept of Systemic Risk», 2014.

¹⁹ Ellis, Sharma, e Brzeszczyński, «Systemic Risk Measures and Regulatory Challenges», 2021.

possibility of frequent updates is relevant, since authorities can increase the accuracy in performance measuring and timeliness in strategy adoption²⁰.

The models used nowadays to measure systemic risk can be classified into five different categories: early warning and credit default swap indexes, capital, liquidity, contagion and network. Hereafter each of them is described together with one of the models used in practice.

1.2.1 Early warning systems (EWS) and credit default (CDS) indexes

These indexes are used in practice as warning tools. In particular, early warning systems are also useful to assess the level of systemic risk in a given sector or market, in such a way policymakers understand whether their decisions have been effective. In addition, according to EWS literature, these indexes suggest that a fast growth in real estate, price-to-income, credit-to-GDP ratio or debt service costs is the clue for an imminent financial crisis. Nevertheless, EWS also present some drawbacks such as the obtainment of different empirical results, depending on the dataset that has been used and the definition of financial crisis that has been considered.

On the other hand, CDS premia reflect the probability of default of a given institution assessed by market participants²¹. The buyer of these instruments, by paying a premium, is willing to obtain an insurance against the default or the deterioration of the credit quality of the underlying entity, which is the bond or the credit issuer²². Of course, higher is the likelihood of delinquency and higher will be the premia that the buyer will have to pay to get the insurance²³. The most important advantage of CDS premia lies in the better evidence of a financial institution distressed situation that it provides with respect to equity prices, which could be non-zero even after the failure on debt payments. Though, it is important to remember that CDS premia can be used as systemic risk indicators only for those institutions that trade them and, since premia depend also on investors' sentiment, they can sometimes reveal wrong signals due to panics or irrational expectations²⁴.

An example of indicator could be the Distress Insurance Premium (DIP), which was introduced by Huang, Zhou and Zhu in 2009. To estimate it, they considered “a hypothetical debt portfolio

²⁰ . Antonio Di Cesare e Anna Rogantini Picco, «Bank of Italy - No. 458 - A Survey of Systemic Risk Indicators», October 2018, <https://www.bancaditalia.it/pubblicazioni/qef/2018-0458/https%3A%2F%2Fwww.bancaditalia.it%2Fpubblicazioni%2Fqef%2F2018-0458%2Findex.html%3Fcom.dotmarketing.htmlpage.language%3D1>

²¹ Ellis, Sharma, e Brzeszczyński, «Systemic Risk Measures and Regulatory Challenges», 2021.

²² Luca Amadei et al., «Credit Default Swaps: Contract Characteristics and Interrelations with the Bond Market», *SSRN Electronic Journal*, 2011, <https://doi.org/10.2139/ssrn.1905416>.

²³ Jan Ericsson, Kris Jacobs, e Rodolfo Oviedo, «The Determinants of Credit Default Swap Premia», *The Journal of Financial and Quantitative Analysis* 44, n. 1 (2009): 109–32.

²⁴ Ellis, Sharma, e Brzeszczyński, «Systemic Risk Measures and Regulatory Challenges», 2021.

that consists of the liabilities (deposits, debts, and others) of all banks. The DIP is the theoretical insurance premium against any loss of that portfolio above a certain threshold over the following 12 weeks. It is calculated as the risk-neutral expectation of credit losses that equal or exceed a minimum share of the total liabilities of the sector”. It is computed using the individual bank’s probability of default, that is approximated by CDS spread, and the correlation of asset returns, which are inferred from equity returns co-movements. Hence, it is possible to understand that the increase in DIP depends on a higher probability of default and a stronger exposure to common risk factors. Furthermore, this index is forward-looking and easily updatable as CDS spread and equity prices can be retrieved in real time.

1.2.2 Capital measures of systemic risk

Capital measures of systemic risk are useful to detect institutions that are exposed to risks and, therefore, that could be negatively affected by shocks. Nevertheless, the large amount of data and the thorough computing that are needed can rise difficulties in deriving such indicators. The information employed to compute them is mainly represented by proxies and dummies coming from accounting data, but not all financial institutions are able to elaborate them, since they present different operational capabilities. In addition, as these indexes imply the use of balance sheet items, divergences in the accounting standards, applied by different countries, lead to diverse valuation of systemic risk.

One of the most important capital measures of systemic risk is the ΔCoVaR , which was elaborated by Adrian and Brunnermeier, in 2016. It is computed as the “difference between the CoVaR, conditional on the distress of an institution and the CoVaR, conditional on the median state of that institution”. In particular, the Conditional Value at Risk is defined as the VaR of the financial system conditional on an institution being in troubles and it measures the systemic shock originated by one single organization towards the entire financial system. Consequently, the ΔCoVaR reports the effect of the potential losses of the whole financial system, when an individual institution turns into a distressed situation²⁵.

1.2.3 Liquidity measures of systemic risk

After the Great Financial Crisis, it became clear that liquidity risk is a predictor of bank failure. Over years different liquidity risk measures have been developed to try to lower financial institution weaknesses. Indeed, the majority of them aims at reducing unstable exposures related to short term refinancing and maturity mismatch between assets and liabilities, in order to increase then liquidity holdings and make the system more resilient.

²⁵ Di Cesare e Rogantini Picco, «Bank of Italy - No. 458 - A Survey of Systemic Risk Indicators», 2018.

In 2014, Jobst elaborated a risk adjusted measure of stable fundings, that is called Systemic Risk-adjusted Liquidity. The Net Stable Funding ratio, which is a regulatory minimum requirement, that will be later addressed in the fourth paragraph of this chapter, is converted into a stochastic measure to compute potential liquidity shortfalls. In particular, it is the ratio of the available stable fundings and the required stable funding for a given institutions. When the numerator is lower than the denominator, the likelihood of liquidity shortages rises. “In this way, the probability of falling below the lower boundary of this structural ratio translates into a risk-adjusted analog of stable funding”²⁶. What’s more, since the Net Stable Funding ratio is based on some variable market data, which associate institutions to changes in market prices, a joint distribution of expected losses can be then computed, in order to understand when banks’ fundings are below the identified threshold, established by the required stable funding, at the same time²⁷.

1.2.4 Contagion Measures of Systemic Risk

Financial institution interlinkages are a catalyst for financial shocks diffusion. For example, after the collapse of an institution, similar assets portfolios could be subjected to devaluations due to fire sales. In fact, the disposal of assets at lower prices reduces their value even more and, consequently, other organizations, with a similar exposure, are obliged to devalue too. Hence, a spiral of selling and prices contraction is triggered and, thus, the probability of failure of interconnected institutions increases²⁸. Contagion measures are mostly based on the idea that greater are the interdependences and greater is the systemic risk.

One of them, introduced by Nicoló and Kwast in 2002, employs equity return correlations to analyze the interdependences among several institutions. More to the point, they affirmed that the correlations increase is a signal of more powerful connections in the financial system and, therefore, a single shock is more likely to become systemic. Furthermore, in 2013, Patro, Qi and Sun evidenced, in a similar study, the simple, robust, forward-looking and timely nature of daily equity return correlation. However, even if equity returns reflect market participants’ opinion of a given institution, doubts arise with respect to their ability to capture interactions among different financial organizations since this could be private information²⁹. Another possible contagion measure is the one introduced by Tonzer, in 2015, who analyzes cross-

²⁶ Andreas Jobst, «Measuring Systemic Risk-Adjusted Liquidity (SRL)—A Model Approach», *Journal of Banking & Finance* 45 (1st August 2014): 270–87, <https://doi.org/10.1016/j.jbankfin.2014.04.013>.

²⁷ Andreas A. Jobst, «Measuring Systemic Risk-Adjusted Liquidity», *A Guide to IMF Stress Testing* (International Monetary Fund, 2012), <https://www.elibrary.imf.org/view/books/071/20952-9781484368589-en/ch027.xml>.

²⁸ Fabio Caccioli et al., «Stability Analysis of Financial Contagion Due to Overlapping Portfolios», *Journal of Banking & Finance* 46 (1st September 2014): 233–45, <https://doi.org/10.1016/j.jbankfin.2014.05.021>.

²⁹ Ellis, Sharma, e Brzezyczyński, «Systemic Risk Measures and Regulatory Challenges», 2021.

border assets and liabilities positions across banks. Results reveal that credit and funding risks are minimized, when domestic banks are linked to more stable foreign institutions; on the other hand, financial stability at home could be threatened by relations with less stable foreign banks³⁰.

1.2.5 Network measures of systemic risk

Network measures are useful to understand whether a financial institution failure or, more in general, endogenous or exogenous shocks are the determinants of other organizations' distress through contagion. The advantage of these indicators is the ability of considering different types of information simultaneously, such as balance sheet data or factors related to the interactions within the interbank market. Nonetheless, these indicators could generate some biases due to similar underlying assumptions. In addition, models could be useless since it could be difficult to get access to the needed data. For example, information regarding bilateral exposures in the interbank market, mainly for over-the-counter bilateral agreements, is not always available.

In 2015, Poledna, Molina-Barboa, Martinez-Jaramillo, Van der Leij and Thurner identified four network layers, which are deposits and loans, security cross-holdings, derivatives (swaps, forwards, options, and repo transactions) and foreign exchange transactions, and computed their daily contribution to systemic risk. Results reveal that, focusing on just one layer network, the systemic risk is underestimated by up 90%. Furthermore, they pointed out that the exposures related to the cross-holding of securities and to foreign exchange transactions assume a systemic importance in the financial sector³¹. Moreover, the systemic risk measure, resulting from the combined exposure network, is higher than the one deriving from the sum of each single layer contribution. These findings suggest how the spillovers of a given shock are spread across institutions through these network layers³².

1.3 Determinants of systemic risk

After the Great Financial Crisis, the literature regarding bank systemic risk has been enlarged by different studies, with the aim to investigate the determinants of such crisis. Over years, a huge number of factors regarding banks' features and activities or financial markets' structures have been deeply analyzed to better understand how they contribute, alone and together, to rise

³⁰ Lena Tonzer, «Cross-Border Interbank Networks, Banking Risk and Contagion», *Journal of Financial Stability*, last access: 1st April 2022, <https://doi.org/10.1016/j.jfs.2015.02.002>.

³¹ Ellis, Sharma, e Brzeszczyński, «Systemic Risk Measures and Regulatory Challenges», 2021.

³² Sebastian Poledna et al., «The Multi-Layer Network Nature of Systemic Risk and Its Implications for the Costs of Financial Crises», *Journal of Financial Stability* 20 (1st October 2015): 70–81, <https://doi.org/10.1016/j.jfs.2015.08.001>.

systemic risk. Findings are relevant mainly for regulators, who enforced new provisions and requirements to try to guarantee financial stability.

In this section, the most important systemic risk determinants and their interactions are defined; while the following one focuses more on the development of the various regulatory frameworks.

1.3.1 Bank size

Bank size is one of the most critical factors that enhance the level of systemic risk. Over the last decades, as a result of the markets' global integration, banks have significantly grown in their dimensions, through the extension of their local and regional business models worldwide. The increase in the number of cross-border transactions, which are managed and executed by few financial institutions, emphasizes the high concentration of the today banking sector and the great quantity of interlinkages inside it. This phenomenon is associated to the concept of systemically important financial institutions (SIFIs), which entails banks whose stability and soundness are vital to guarantee the smooth functioning of the financial system and the real sector. Indeed, their failure would impose severe losses on other financial institutions and generate spillover effects in the real economy³³.

Consequently, understanding the concept of banks' size is crucial as they provide lots of financial services to the economy sectors and most of the customers prefer to interact with larger financial institutions, which offer a broad range of solutions and a large-scale financing. Moreover, in case of distress, large banks can generate negative repercussions not only on financial markets but also on the entire economic welfare of the society.

Nowadays bank size can be measured by different indicators such as market capitalization, total assets, total revenues, equity capital and risk weighted assets. Each of them is peculiar and it is characterized by some advantages and disadvantages.

Market capitalization is defined as “the number of all shares outstanding of a listed company times the stock price”; hence it measures the current “real” value coming from investors' beliefs, rather than from accounting rules, on a daily basis. What's more, since it is not influenced by measurement rules or business models, it is easily comparable. On the contrary, market capitalization is retrievable only for listed banks and, therefore, it cannot be used to measure bank size of newcomers, savings banks and cooperative banks, which are pretty

³³ Zlatuse Komarkova, Vaclav Hausenblas, e Jan Frait, «How To Identify Systemically Important Financial Institutions», *Occasional Publications - Chapters in Edited Volumes*, 2012, 100–111.

common in Europe. Additionally, market cap is subject to investors irrational exuberance, who could drive stock prices above or below their fair value.

In order to measure bank size, academics and regulators mainly use the total assets indicator, that reports the gross nominal volume of a bank's activities, like loan granting or securities holdings, and it is usually derived from consolidated financial statements, which banks publish on a regular basis. This means that total assets value can be effortlessly obtained both for listed and unlisted banks. Furthermore, the value of total assets, at least the most traditional ones, depends on accounting methods, which imply observable prices and volumes, rather than models or standardized approaches, that are, instead, used to estimate risk weighted assets. For example, a loan is usually booked at its face value; while the determination of the associated risk requires some assumptions. Though, total assets do not distinguish risky exposures such as structured credit products, which are the result of the securitization process, or high-yield bonds, from low-risk positions as loan-to-value retail mortgages or sovereign bonds. Consequently, a different asset nature is hidden behind this indicator. Moreover, balance sheet data show the current best assets estimate but they do not provide a reliable measure to predict the future value of a given position. As a consequence, banks need to compute the probability that a given loan amount is not paid back entirely by a customer or that it is not repaid on time, the loss given default and the recovery rates, in order to determine, also considering the collateral value, the necessary provisions. As all these valuations are based on subjective assessments and theoretical assumptions, getting the future asset value is challenging.

With regard to total revenues, it refers to the difference between the gross revenues and the interest expenses and it expresses how much customers are willing to pay in order to receive a given service from the bank. For sure, one of the most important advantages of this bank size indicator is related to its ability of reflecting banks' core business, which has a more stable trend over time with respect to market-based measures like market capitalization, that is, instead, highly volatile, especially during crises. Moreover, revenues are composed by claims that have been already realized, there is no place for expectations and a forward-looking perspective. In addition, accounting data, based on complex valuation models, assumptions and estimations, are also avoided. On the other hand, revenues could be bumped up by activities that are not related to the bank's core business, like large holdings in non-bank financial subsidiaries as insurance companies.

Another possible indicator of bank size is the equity capital, which is defined as "the sum of capital raised from a bank's owners and of profits retained from its operations over the entire lifetime of the business". In other words, it is the book value of a bank's equity, differently from

the market value of equity, known as market cap. As it is easily retrievable from a financial statement, equity capital can be used both for listed and unlisted banks. Besides, this indicator, different way from total assets, does not depend on the bank's business model and the various assumptions and hypothesis taken to record a given financial instrument. For this reason, equity capital is pretty stable over time and it grants a neutral view of the size, notwithstanding whether the bank has generated no, little or a lot of profit. Nevertheless, total equity can change depending on the applied accounting rule. It is the case of some losses that are directly deducted from the capital in the balance sheet.

Finally, risk weighted assets (RWA) are the last important proxy for bank size³⁴. They are computed by classifying bank's exposures in different asset classes, to which different weights are assigned, depending on whether the standardized or the internal rating-based approach is used.³⁵ "The overall amount of RWA provides a useful indication of the extent of a bank's business, i.e. of its size". For sure, as they assign a weight to the nominal value of a given asset, they are able to normalize the various activities, which are then comparable. This is a relevant improvement with respect to total assets, that sum together different exposures. However, RWA are an artificial figure because they are based on models, assumptions and calculations, which have been introduced by policymakers and supervisors. As a consequence, they could be arbitrary, "politicised" and subject to different adjustments³⁶.

After having analyzed the different ways of measuring bank size, it is relevant to investigate why large banks could be dangerous and how they contribute to the increase of systemic risk. Nowadays, large banks present peculiar characteristics such as lower capital ratios, less stable funding, more exposure to risky market-based activities³⁷ and a more complex organization. Since large size allows for a reduction of risks, thank to more diversification opportunities, banks with a substantial dimension are prone to keep a lower capital and to rely on less-stable fundings³⁸, such as wholesale market fundings, which are supplied on a rollover basis³⁹, and, consequently, they are vulnerable to market liquidity shocks⁴⁰. Furthermore, as large banks are

³⁴ Jan Schildbach, «Large or Small? How to Measure Bank Size», 2017, 24.

³⁵ Francesco Cannata, Simone Casellina, e Gregorio Guidi, «Inside the Labyrinth of Basel Risk-Weighted Assets: How Not to Get Lost», 2012, <http://www.ssrn.com/abstract=2159725>.

³⁶ Schildbach, «Large or Small? How to Measure Bank Size», 2017.

³⁷ Luc Laeven, Lev Ratnovski, e Hui Tong, «Bank Size, Capital, and Systemic Risk: Some International Evidence», *Journal of Banking & Finance*, Bank Capital, 69 (1st August 2016): S25–34, <https://doi.org/10.1016/j.jbankfin.2015.06.022>.

³⁸ Luc Laeven, Lev Ratnovski, e Hui Tong, «Bank Size and Systemic Risk», 2014, 34.

³⁹ Rocco Huang e Lev Ratnovski, «The Dark Side of Bank Wholesale Funding», *Journal of Financial Intermediation* 20, n. 2 (1st April 2011): 248–63, <https://doi.org/10.1016/j.jfi.2010.06.003>.

⁴⁰ Jihad Dagher e Kazim Kazimov, «Banks' Liability Structure and Mortgage Lending during the Financial Crisis», *Journal of Financial Economics* 116, n. 3 (1 giugno 2015): 565–82, <https://doi.org/10.1016/j.jfineco.2015.02.001>.

able to cover significant fixed costs and to reach economies of scale, they enjoy a competitive advantage, with respect to small ones, in market-based activities, like market making, holding of securitized debt and provision of several financial services such as advisory or hedging. In turn, market-based activities induce banks to increase their leverage and their amount of unstable fundings; for instance, securities are the typical collateral of repurchase agreements⁴¹. Finally, the concept of complexity focuses on the banking sector's globalization, which entails the consolidation and the conglomeration of financial services, through the acquisition of affiliates all over the world. Indeed, complexity does not refer only to the huge number of activities provided by a financial institution; but, also, to the organizational dimension of a bank, which can be structured through various affiliates across different countries. Foreign banks are estimated to represent more or less one third of the banks in a given State⁴².

Over years, several theories regarding the contribution to systemic risk of bank size and the related characteristics have been developed. The most common one is the too big to fail hypothesis, according to which large banks never collapse, since the government would intervene to bail them out, using taxpayers' money, in order to avoid the generation of distress in the financial system. Consequently, banks are encouraged to implement a moral hazard behavior, consisting in taking risky and unsafe activities⁴³.

A lot of academics analyzed the effect of size on individual and systemic bank risk. For example, Laeven, Ratnovski and Tong reported, in 2014, in the paper "Bank size and Systemic risk" that bank size, measured as the log of total assets, increases individual bank risk. The following analysis, described in the same paper, takes the SRISK as measure of systemic risk and reveals that bank's dimension is still significant but it is even more informative when it is associated with less capital, fewer deposits and an increasing number of market-based activities undertaken by an institution⁴⁴. What's more, the same authors, in another paper titled "Bank size, capital and systemic risk: Some international evidence", published in 2015, confirmed the previous results by running an OLS regression of ΔCoVaR on a set of bank characteristics. Again, size is positively associated with systemic risk and its interaction with capital, represented by Tier 1, is negative and significant which means that the probability of financial distress is lower for well-capitalized large banks, since, as it will be explained later, they rely on greater buffers⁴⁵. The positive effect on systemic risk was also demonstrated in 2014 by

⁴¹ Laeven, Ratnovski, e Tong, «Bank Size and Systemic Risk», 2014.

⁴² Nicola Cetorelli e Linda S Goldberg, «Measures of Global Bank Complexity», 2014, 20.

⁴³ Laeven, Ratnovski, e Tong, «Bank Size, Capital, and Systemic Risk», 2016.

⁴⁴ Laeven, Ratnovski, e Tong, «Bank Size and Systemic Risk», 2014.

⁴⁵ Laeven, Ratnovski, e Tong, «Bank Size, Capital, and Systemic Risk», 2016.

Calluzzo and Dong, who measured bank size, not only with the assets value, but also using market values⁴⁶. Furthermore, size plays an important role in spreading an initial shock. The study conducted by Paltalidis, Gounopoulos, Kizys and Koutelidakis, in 2015, focused on how a systemic shock, coming from a national banking system in the sovereign credit risk channel, triggers financial contagion across all the European banks. The number of banks defaults due to the shock and the number of banks whose default led other banks to failure are reported. In particular, findings show that the spread of a given shock also depends on the size of the bank that collapses first⁴⁷.

Nevertheless, according to what has been explained, bank excessive size seems to be only a negative feature, which increases systemic risk and that, for this reason, should be better regulated and limited. Actually, large banks offer a wider range of financial services, as explained before, and allow to reach efficiency gains thanks to economies of scale. Consequently, a trade off arises between benefits and costs, in terms of increased risk level, that are generated by large banks⁴⁸.

1.3.2 Bank capital

Bank capital is another relevant factor, which could affect the level of financial stability in the banking system. Several measures of capital have been proposed by Basel III, which was enforced in 2010 to improve Basel I and II, through the introduction of macroprudential tools and standards to mitigate systemic risk⁴⁹. Regulatory provisions are later analyzed in the following paragraph, while, in this section, only the different ratios are taken into account as methods to compute bank capital.

In particular, it is calculated by relating Tier 1, Tier 2 and the sum of them, to risk weighted assets and off-balance sheet exposures⁵⁰, such as those associated with futures or swaps⁵¹. In particular, Tier 1 is the going concern capital of a bank, which means it is the required capital to remain solvent, while running the various activities. It is divided into Common Equity Tier 1 capital and Additional Tier 1. The former is considered as the highest quality regulatory

⁴⁶ Paul Calluzzo e Gang Nathan Dong, «Has the Financial System Become Safer after the Crisis? The Changing Nature of Financial Institution Risk», *Journal of Banking & Finance* 53 (1st April 2015): 233–48, <https://doi.org/10.1016/j.jbankfin.2014.10.009>.

⁴⁷ Nikos Paltalidis et al., «Transmission Channels of Systemic Risk and Contagion in the European Financial Network», *Journal of Banking & Finance*, 2015, <https://doi.org/10.1016/j.jbankfin.2015.03.021>.

⁴⁸ Laeven, Ratnovski, e Tong, «Bank Size, Capital, and Systemic Risk», 2016.

⁴⁹ Peter King e Heath Tarbert, «Basel III: An Overview», *Banking & Financial Services* 30 (2011).

⁵⁰ Deniz Anginer e Asli Demirgüç-Kunt, «Bank Capital and Systemic Stability», SSRN Scholarly Paper (Rochester, NY: Social Science Research Network, 1st June 2014), <https://papers.ssrn.com/abstract=2459698>.

⁵¹ ECB, «Annual Accounts of the ECB 2021», 2021.

capital⁵² and it is principally composed by common stocks and their surpluses deriving from share premia, retained earnings, other comprehensive income, minority interest on common stocks of consolidated subsidiaries and certain regulatory adjustments. The latter, instead, consists of preferred stocks, some paid-in capital, that do not satisfy the standards of Common Equity Tier 1⁵³, other minority instruments and regulatory adjustments.

On the contrary, Tier 2 capital is a gone-concern capital since it is used to pay back depositors and other creditors in case of insolvency⁵⁴. It is formed by preferred stocks with no perpetual features and instruments that are subordinated to depositors, unsecured by the bank and that fail to enter Tier 1 capital⁵⁵.

Some studies about bank capital implemented different versions of these ratios considering, for example, as denominator, total assets, rather than risk weighted assets. Moreover, the common equity ratio, which relates common equity to total assets and the tangible common equity ratio, that excludes intangible assets, as goodwill, are often computed to better focus on the highest quality level of capital.

Lots of researches about the relation between systemic risk and bank capital have been conducted, especially after the Great Financial Crisis, to better grasp what are the capital requirements that must be fulfilled to ensure a more stable financial system.

First of all, a given amount of capital is important to enhance banks' capability to respect its obligations, as deposits withdrawals, notwithstanding unexpected losses in its assets value. Hence, a higher capitalization implies a higher survival probability. Besides, financial stability can be reached thanks to "skin in the game" incentives of bank's owners and executives. In fact, higher is the skin, that is the money involved, the stake in a bank's shares, higher the implemented risk management standards and lower the risk-taking behavior. For instance, borrowers screening and banks' monitoring activities are improved when the capitalization has increased⁵⁶. Consequently, as an indirect effect, the value of loan portfolios is less risky and, therefore, of a higher quality⁵⁷.

⁵² BIS, «Definition of Capital in Basel III - Executive Summary», 27th June 2019, https://www.bis.org/fsi/fsisummaries/defcap_b3.htm.

⁵³ King e Tarbert, «Basel III: An Overview», 2011.

⁵⁴ BIS, «Definition of Capital in Basel III - Executive Summary», 2019.

⁵⁵ King e Tarbert, «Basel III: An Overview», 2011.

⁵⁶ Anginer e Demirgüç-Kunt «Bank Capital and Systemic Stability», 2014.

⁵⁷ Hamid Mehran e Anjan V. Thakor, «Bank Capital and Value in the Cross Section», SSRN Scholarly Paper (Rochester, NY: Social Science Research Network, 1st September 2009), <https://papers.ssrn.com/abstract=1473171>.

As far as empirical results are concerned, Deniz Anginer and Asli Demirguc-Kun published, in 2014, the paper “Bank Capital and Systemic Stability”, in which they investigated the impact of several variables, like bank size or bank liquidity, on Covar. Findings highlight a significant and negative relationship between total regulatory capital ratio and systemic risk. To be more precise, financial instability is mainly reduced by Tier 1 capital, while Tier 2 capital causes a destabilizing effect, probably due to its components, such as unsecured and subordinated instruments. Similar results are obtained also when considering non-risk weighted assets. Tangible capital and common capital both reduce the level of systemic risk, instead. Moreover, authors found that the effect of capital on systemic risk is much more emphasized during periods of crisis, which is consistent with the study conducted in 2012 by Andrea Beltratti and Rene´ M. Stulz. In the paper “The credit crisis around the globe: Why did some banks perform better?” they underlined the positive correlation of bank’s performance during a crisis with its capital ratios prior the crisis. Indeed, a higher capitalization increases the bank’s flexibility in facing the distressed situation. In 2016, Luc Laeven, Lev Ratnovski and Hui Tong came to the same conclusions. The paper “Bank size, capital and systemic risk: some international evidence” reports that bank capital, measured by Tier 1 ratio, significantly reduces systemic risk, identified by the ΔCoVaR . Besides, according to the research, well capitalized banks record higher stock returns, which means they have a lower standalone risk.

Considering then the interaction between bank capital and size, the study of Deniz Anginer and Asli Demirguc-Kun (2014) evidenced a greater efficiency of capital in reducing systemic risk for large banks. Indeed, as said before, these banks incur in riskier activities and, consequently, they gain a lot of benefits from a higher capital level, which enhances their ability to absorb losses. These findings were also confirmed by Luc Laeven, Lev Ratnovski and Hui Tong (2016), who reported, as before anticipated, a significant interaction between Tier 1 and bank assets, which implicates that a given amount of capital is particularly important for large financial institutions, as it offsets the high level of risk they undertake.

1.3.3 Bank leverage

Bank leverage is another factor that influences the level of systemic risk and that has been also deeply analyzed in the literature. It refers to the funding of a business’ assets through borrowing rather than equity. Higher is the debt for each unit of equity and higher is the leverage⁵⁸.

After the Great Financial Crisis, it became clear that there had been an excessive increase in the amount of debt raised by banks, which had led to a process of deleveraging and, as a result, to

⁵⁸ Stefan Ingves, «Banking on Leverage», 26 febbraio 2014, <https://www.bis.org/speeches/sp140226.htm>.

a reduction of credit availability in the real economy and to losses due to activities sell off. Consequently, among the several measures introduced by Basel III, the leverage ratio is one of particular relevance. It is defined as the percentage ratio of capital measure over exposure measure. More to the point, Tier 1, under the risk-based framework, is adopted as capital indicator, while the exposure measure includes both on balance sheet and off-balance sheet activities⁵⁹. For the former, the assets' accounting value is applied, with the exception of derivatives and securities financing transactions (SFT). Indeed, they present different accounting standards, depending on the jurisdiction, and, therefore, in order to ensure a level playing field, Basel III requires a specific treatment⁶⁰. The exposure coming from derivatives contracts lies in the underlying instrument and in the counterparty credit risk and it is computed as the sum of the current exposure, which is the replacement cost of the contract, and the potential future exposure. With reference to SFT, instead, the calculation depends on whether the bank is acting on its own account, as principal, or, on the contrary, on behalf of its clients, as agent. In the first case, the exposure measure is defined as the sum of gross SFT assets, such as gross receivables, and an indicator for counterparty credit risk. On the other hand, in the second case, a bank could decide to just include the second component. Finally, the exposure measure related to off-balance sheet items is determined by multiplying the notional amount by the credit conversion factor established by Basel II standardized approach for credit risk, subject to a floor of 10%⁶¹.

Leverage ratio entails different benefits, as its simplicity. In fact, it is easy to derive and monitor; it does not need high costs or specific requirements to be computed and it can be employed notwithstanding the capital adequacy regime in a given jurisdiction. Moreover, a minimum leverage ratio allows to reduce the incentives of banks to structure products so that they entail low capital requirements, resulting in high exposures concentrations⁶². The ratio also presents some drawbacks; for example, it is risk insensitive since it is a no risk-based measure, which means it considers assets with the same nominal value, but a different risk level, equally⁶³. What's more, leverage ratio is mainly computed using balance sheet items and, therefore, it is not able to capture financial innovation, which has changed the financial system structure over years. Indeed, new credit risk transfer instruments have been introduced and the mismatch

⁵⁹ BIS, «Basel III Leverage Ratio Framework - Executive Summary», 25th October 2017, https://www.bis.org/fsi/fsisummaries/b3_lrf.htm.

⁶⁰ European Central Bank., «The Leverage Ratio, Risk-Taking and Bank Stability.» (LU: Publications Office, 2017), <https://data.europa.eu/doi/10.2866/8728>.

⁶¹ BIS, «Basel III Leverage Ratio Framework - Executive Summary», 2017.

⁶² Katia D'Hulster, «The Leverage Ratio - A New Binding limit on Banks» (World Bank, 2009).

⁶³ European Central Bank., «The Leverage Ratio, Risk-Taking and Bank Stability», 2017.

between assets and liabilities has been enhanced due to the access to wholesale markets and the use of off-balance sheets vehicles. All these aspects are captured by two other leverage measures, instead.

In fact, it is important to mention two additional indicators, which are the economic and the embedded leverage. The first one investigates how changes in the value of a given position are higher than the amount of money banks paid for it. A typical example are loan guarantees, which are linked to a probable future contingent commitment, even if they do not appear on the balance sheet. The second one refers to a position, held by a financial institution, on an instrument which is itself leveraged, such as a bank's minority investment in an equity fund, that is financed through loans⁶⁴.

Banks are characterized by a higher level of leverage with respect to other industry sectors. For instance, large listed non-financial companies report a 50% leverage ratio, which means they finance their activity half with debt and half with equity. On the contrary, banks' business is supported for the 95% by indebtedness and for the 5% by own funds.

A given level of leverage for banks could be optimal since debt is cheaper with respect to equity, thanks to the possibility to deduct interests from taxes. Moreover, financial leverage enhances the positive effect of the operating activities on the return on equity⁶⁵ and it can also be considered as an instrument to discipline managers, who are responsible for choosing investments with a return high enough to cover the interests on the debt they have decided to raise⁶⁶. On the other hand, a too high level of leverage could threaten banks' ability to service their obligations. Especially during periods of distress, revenue fluctuations and assets write downs generate liquidity difficulties for financial institutions, which do not have enough cash flow to pay back their debts⁶⁷. Besides, highly leveraged banks do not only increase their individual risk, but they also contribute to rise systemic risk in the financial system⁶⁸. Indeed, the expansion of the asset side of a bank could lead to a higher level of systemic risk. This result is associated with the procyclical nature of leverage. In fact, contrary to intuition, it rises during periods of booms and it falls during downturns⁶⁹. In practice, during growth times, banks experience an increase in loan demand and, subsequently, they expand their balance sheet by

⁶⁴ D'Hulster, «The Leverage Ratio - A New Binding limit on Banks», 2009.

⁶⁵ Ingves, «Banking on Leverage», 2014.

⁶⁶ Viral V. Acharya e Anjan V. Thakor, «The Dark Side of Liquidity Creation: Leverage and Systemic Risk», *Journal of Financial Intermediation*, Rules for the Lender of Last Resort, 28 (1st October 2016): 4–21, <https://doi.org/10.1016/j.jfi.2016.08.004>.

⁶⁷ Ingves, «Banking on Leverage», 2014.

⁶⁸ Acharya e Thakor, «The Dark Side of Liquidity Creation», 2016.

⁶⁹ D'Hulster, «The Leverage Ratio - A New Binding limit on Banks», 2009.

augmenting the supply of credit but also the amount of cash and securities. The building up of the asset side is mainly financed through debt and, therefore, the leverage raises. This reasoning works the other way round for recession periods⁷⁰. As it is possible to understand, procyclicality increases and complicates the interlinkages among banks and it boosts their excessive lending, which results in imbalances accumulation, leading to an elevated systemic risk level⁷¹. In other words, a higher leverage makes the system more fragile and exposed to inefficient contagion mechanisms. For example, this happens when a liquidation decision is taken by the creditors of a bank, as a consequence of some information related to bank specific risks or to a systematic shock. Of course, all the creditors of a bank are not equally informed, but they update their beliefs by observing other borrowers' liquidation decisions. Wherefore, a contagion effect could rise without the presence of a real adverse systematic or idiosyncratic risk, but simply based on observing the liquidation process of other banks. The result of this contagion effect is ex-post inefficient as it comes from the misinterpretation of a bank-specific shock or a common asset-value shock. To conclude, high leverage, on one hand, allows financial institution to increase their liquidity, but, on the other, it augments the level of systemic risk⁷².

Furthermore, it is interesting to analyze the relationship between leverage and the concept of debt overhang distortion, which implies the risk of a bank's default on its obligations due to an excessive increase of its liabilities. In the case of collapse, benefits coming from new activities are given to creditors. Hence, the bank's marginal return from investments decreases⁷³, as well as its incentives to keep on financing new businesses. In addition, projects with a positive net present value are forgone, since the shareholder's payoff, after debt service, is smaller than the required initial outlay. The negative effect of debt overhang is, of course, enhanced when the leverage is higher⁷⁴. What's more, the distortion generated by a huge amount of debt is at the heart of another contagion mechanisms, which could lead to a systemic crisis. Indeed, the expectations of a poor economic performance generate a reduction in the value of banks' assets and an increase in the risk of default. Consequently, the before explained debt overhang distortion worsens, causing a contraction in lending. As a result, the economy enters into a downturn period and the initial expectations are, then, verified. In conclusion it is possible to

⁷⁰ H. Özlem Dursun-de Neef e Alexander Schandlbauer, «Procyclical Leverage: Evidence from Banks' Lending and Financing Decisions», *Journal of Banking & Finance* 113 (1st April 2020): 105756, <https://doi.org/10.1016/j.jbankfin.2020.105756>.

⁷¹ Smaga, «The Concept of Systemic Risk», 2014.

⁷² Acharya e Thakor, «The Dark Side of Liquidity Creation», 2016.

⁷³ Filippo Occhino e Andrea Pescatori, «Debt Overhang in a Business Cycle Model», *European Economic Review* 73 (1st January 2015): 58–84, <https://doi.org/10.1016/j.euroecorev.2014.11.003>.

⁷⁴ Jie Cai e Zhe Zhang, «Leverage Change, Debt Overhang, and Stock Prices», *Journal of Corporate Finance, Financial Flexibility and Corporate Liquidity*, 17, n. 3 (1st June 2011): 391–402, <https://doi.org/10.1016/j.jcorpfin.2010.12.003>.

affirm that leverage increases systemic risk also indirectly, through the effect of debt overhang. Higher the leverage, higher the distortion and worse the consequences of a pessimistic view⁷⁵.

As before mentioned, an important leverage component, which contributes to the rise of systemic risk, is the one related to bank's off-balance sheet activities. Indeed, financial institutions are also characterized by an implicit degree of leverage, related to securitization and derivative trading activities, which are not accounted in their financial statements. Nevertheless, this part of a bank's business should not be underestimated, since it boosts both idiosyncratic and systemic risk. In fact, banks with off-balance sheet assets, that are willing to deleverage their positions during a crisis, increase the downward pressure on prices and, subsequently, they reduce liquidity and credit supply, generating also negative consequences on the real economy⁷⁶.

With regard to empirical studies, the paper "Debt overhang in a business cycle model", written by Occhino and Pescatori in 2014, reports that when leverage tends to zero, the distortion generated by debt overhang disappears. This result confirms what the theory says about the stronger impact of a substantial debt accumulation on the bank's default risk and its investment activities. In addition, Acharya and V. Thakor investigated, in their study entitled "The dark side of liquidity creation: Leverage and systemic risk" and published in 2016, what is the optimal level and bank's leverage, which has to be able to offset the costs of inefficient liquidation through the benefits coming from manager discipline. They also analyzed the "dependence of a bank's liquidation probability on its own leverage and the other bank's leverage" by demonstrating that when the leverage is high, financial institutions are not able to generate enough cash flows to service the debt and therefore the liquidation probability increases. What's more, if the collapse happens, creditors of other banks assume that a given systemic event is more likely and therefore other financial institutions are liquidated. Finally, Duan et. al published, in 2021, the paper "Bank systemic risk around COVID-19: A cross-country analysis", in which they evidenced a positive relationship between systemic risk, measured by ΔCoVaR , and leverage. Moreover, they showed that the effect of the Covid-19 pandemic on systemic risk has been much more severe on highly leveraged banks.

⁷⁵ Occhino, «Debt-overhang banking crises: Detecting and preventing systemic risk», 2016.

⁷⁶ Nikolaos I. Papanikolaou e Christian C. P. Wolff, «The Role of On- and off-Balance-Sheet Leverage of Banks in the Late 2000s Crisis», *Journal of Financial Stability*, Special Issue: Financial stability, bank risk, and regulation in the light of the crisis, 14 (1st October 2014): 3–22, <https://doi.org/10.1016/j.jfs.2013.12.003>.

1.3.4 Interconnectedness across banks and financial market structure

Another systemic risk determinant, which emerges from the analysis of size, capital and leverage, is the degree of interconnectedness and interdependence among banks. Indeed, since financial institutions develop several interlinkages related to the organizational dimension, the source of funding or the assets exposures, they end up to be more prone to the propagation of a given shock. Essentially, interbank market reveals to be systematically important for banks. Financial connection turns out to be a feature that guarantees the stability under certain conditions, but it ends up to be a source of systemic risk under others. In fact, as long as a small shock is considered, the excess of liquidity of a given bank is used to avoid the collapse of another one. Basically, any potential losses are shared among the different financial institutions. Nonetheless, if the magnitude of a given shock increases, a highly interconnected system becomes more fragile, as the liquidity surplus is not enough to absorb all the losses⁷⁷. In addition, an important source of contagion are bankruptcy costs, which are associated with the default of a given institution and they can be direct, such as legal fees, and indirect, like delay in payments to creditors. The probability of a contagion and the magnitude of the expected losses related to it are positively correlated with the amount of such costs. Furthermore, when banks react to changes in market condition, they could aggravate the impact on an initial shock and generate a spillover effect. This is the case of assets fire sales or credit contraction due to uncertainties regarding the health status of an institution, as it has been explained before. Indeed, another important source of contagion is the loss of confidence in the credit quality of a bank. If its perceived ability to service its obligations reduces, the market value of its liability declines, leading to a decrease in the asset value of other banks⁷⁸.

It is also interesting to analyze how the influence of the several systemic risk indicators depends on the structure of financial markets, which can be market-based and bank-based. The first one is characterized by advanced financial markets and a high level of financial innovation. Consequently, banks perform non-traditional activities, hold similar assets and they are more active in the interbank market, subjecting themselves to common risk exposures. On the contrary, in the second case, stock markets are poorly developed and, therefore, the participation in non-traditional businesses is lower and banks gain more profit from the traditional ones. The effect of size on systemic risk appears to be limited in both the bank-based and market-based financial system. Indeed, for the former it is inverse U-shaped, while it is U-

⁷⁷ Daron Acemoglu, Asuman E. Ozdaglar, e Alireza Tahbaz-Salehi, «Systemic Risk and Stability in Financial Networks», SSRN Scholarly Paper (Rochester, NY: Social Science Research Network, 1st January 2013), <https://doi.org/10.2139/ssrn.2211345>.

⁷⁸ Paul Glasserman e H. Peyton Young, «How Likely Is Contagion in Financial Networks?», *Journal of Banking & Finance* 50 (1st January 2015): 383–99, <https://doi.org/10.1016/j.jbankfin.2014.02.006>.

shaped for the latter. As a result, it is possible to understand that what matters is the risk-taking behavior of too big to fail banks, rather than the dimension itself. As long as no performing loans are concerned, a poor debt quality boosts even more, in market-based financial structure, banks' incentives to diversify their activities, engaging into non-traditional and riskier ones. Differently, the relationship between non-performing loans and systemic risk is negative in the bank-based financial system, probably because banks are more reluctant to take additional risk, given the poor quality of their assets. Instead, return on asset appears to have the same influence on systemic risk, notwithstanding the type of market structure that is considered. In fact, in all systems, more profitable banks are much more prone to execute risky activities⁷⁹.

Of course, systemic risk factors are not only size, capital, leverage, interconnection and financial market structure. The aim of this paragraph was to deeply analyze the most relevant ones; those that always appear in works and researches about the financial sector instability. Nevertheless, by going through them, it has been possible to mention other indicators of systemic risk, such as unstable fundings, procyclicality, organization complexity, substitutability difficulties for defaulted banks, risk aversion, returns volatility of financial institutions and maturity mismatch. Consequently, it is understandable how each indicator does not act alone when affecting financial stability. The complexity of banks interconnections is also reflected in the interrelation among the several factors which threaten the financial system soundness.

1.4 Regulations to reduce systemic risk

This section is devoted to the analysis of the several requirements and provisions, that has been developed over time to try to promote financial stability worldwide. Concerns related to this issue raised already before the Lehman collapse; more precisely in 1974, when the Committee on Banking Regulations and Supervisory Practices was established by the central bank Governors of ten countries, as a consequence of uncertainties in international currency and banking markets. By considering information related to national supervisory arrangements, by boosting the effectiveness of procedures to supervise international banking business and by establishing minimum supervisory standards, the principal objective of the Committee was to empower supervisory understanding and the quality of banking supervision all over the world⁸⁰.

The first important framework, known as Basel I, was released in 1988, with the aim to introduce a minimum capital requirement rule to “increase the safety and soundness of the

⁷⁹ Xiao Qin e Chunyang Zhou, «Financial Structure and Determinants of Systemic Risk Contribution», *Pacific-Basin Finance Journal* 57 (1st October 2019): 101083, <https://doi.org/10.1016/j.pacfin.2018.10.012>.

⁸⁰ BIS, «HISTORY OF THE BASEL COMMITTEE AND ITS MEMBERSHIP», 2001.

international banking system and to set a level playing field for banking regulation”⁸¹. Nevertheless, this provision has been criticized due to its low-risk sensitiveness. Indeed, Basel I involved the use of a rudimentary concept of risk weighted assets, which assigned a weight to each bank existing activities, according to their credit risk. The problem raised since risk weights were rudely calibrated, inducing regulatory arbitrage⁸².

The following version, Basel II, published in 2004, implemented a micro-prudential approach, focusing on the financial soundness of each single bank, with the objective to reduce the default probability⁸³. In order to lower the risk-taking behavior of financial institutions, Basel II was based on three pillars: minimum capital requirements, supervisory review and market discipline.

With reference to the first one, the new framework improved its predecessor by introducing a minimum capital level for banks, based on their assets risk level⁸⁴. In particular, in order to better define the credit risk, banks were enabled to compute risk weights by using the Basel I’s categories and the credit ratings assigned by Standard & Poor’s, Moody’s and Fitch. What’s more, banks could also adopt some internal risk management models⁸⁵. Thanks to this increase in risk sensitivity, financial institutions started to engage less in risky activities⁸⁶.

The second Pillar, instead, guaranteed the effectiveness of the accord by increasing the role of national supervisors, who assumed an audit function. Furthermore, this audit necessity turned out to be negatively related to bank’s financial health, which means that the audit frequency decreases with the improvement of the bank’s soundness.

Finally, the third Pillar was aimed to enhance market discipline, which would have strengthened capital regulation and supervisory efforts, by introducing some disclosures requirements. In particular, the Committee enforced the release of information about banks’ capital structure and its components, the applied accounting policies to evaluate assets and liabilities, the several risk exposures and the risk management strategies, the capital adequacy and any factors affecting it. Thank to this provision, market participants could retrieve key pieces of information and, consequently, assess the stability and the solidity of a given financial institution⁸⁷.

⁸¹ Abel Elizalde, «From Basel I to Basel II: An Analysis of the Three Pillars», *Working Papers*, Working Papers (CEMFI, 2007), https://ideas.repec.org/p/cmfi/wpaper/wp2007_0704.html.

⁸² King e Tarbert, «Basel III: An Overview», 2011.

⁸³ Stefan Schwerter, «Basel III’s ability to mitigate systemic risk», *Journal of Financial Regulation and Compliance* 19, n. 4 (1st January 2011): 337–54, <https://doi.org/10.1108/13581981111182947>.

⁸⁴ Elizalde, «From Basel I to Basel II», 2007.

⁸⁵ King e Tarbert, «Basel III: An Overview», 2011.

⁸⁶ Elizalde, «From Basel I to Basel II», 2007.

⁸⁷ BCBS, «Pillar 3 (Market Discipline)», 2001, 63.

As regard the second and the third Pillars, Basel II was less precise and it rather left more discretion in their implementation to national supervisors⁸⁸.

Nonetheless, the Great Financial Crisis pointed out some drawbacks of the second framework. First of all, it did not adopt a systemic view of the banking sector and it neglected the various interconnections and interdependences among banks. In addition, Basel II subsidized financial institutions that were imposing negative externalities on market participants, since, in a distressed situation, it ensured the government implementation of the bailout procedure. As a consequence, banks were encouraged to become “too big”, “too many” and “too interconnected” and, therefore, they contributed to increase the level of systemic risk. Indeed, as explained in the previous paragraph, size, common risk exposures and interconnection boost the risk level in the financial system⁸⁹. Furthermore, the interlinkages among banks were also developed through the securitization process. Moreover, the adopted capital requirements turned out to be insufficient for many banks, which, by using their internal models, overestimated their capacity to bear risks⁹⁰. The decline of the reputation of rating agencies, which had been too optimistic in their valuations, played also a role in highlighting the limitations of Basel II. Finally, the 2008 crisis revealed that banks had not been able to absorb significant losses due to inadequate capital buffers.

Wherefore, in 2010, the Committee on Banking Regulations and Supervisory Practices, which in the meanwhile had increased the number of its members, reaching twenty states, introduced Basel III. Its implementation should have been completed according to a schedule with end in January 2019, but it has been delayed to January 2023. The most innovative feature of the framework lied in the adoption of macroprudential regulations, in order to reduce the systemic risk level globally⁹¹. These measures did not substitute the micro-prudential ones, but they rather complement them. In fact, provisions focusing on a single bank are useful to reduce risk taking incentives, while macroprudential regulations aim to decrease the exposures to systemic events, in order to avoid collective failures. Hence, both types of measures are relevant to guarantee the financial system stability⁹².

The priority of Basel III is to strengthen the quality, transparency and consistency of bank's capital, to increase the ability of absorbing losses during distressed periods. With regard to

⁸⁸ Elizalde, «From Basel I to Basel II», 2007.

⁸⁹ Schwerter, «Basel III's ability to mitigate systemic risk», 2011.

⁹⁰ DĂNILĂ Oana Miruna, «Impact and Limitations Deriving from Basel II within the Context of the Current Financial Crisis», 2012, *Theoretical and Applied Economics* Volume XIX (s.d.).

⁹¹ King e Tarbert, «Basel III: An Overview», 2011.

⁹² Acharya e Thakor, «The Dark Side of Liquidity Creation», 2016.

capital requirements, Basel III confirms that the level of Total Capital, which is the sum of Tier 1 and Tier 2, must be at least 8% of the bank's risk weighted assets, as it was established by the previous framework. The novelty, instead, lies in the proportion of the different components of regulatory capital. More to the point, Tier 1 capital, which is the one that guarantees the solvency of a bank, must be 75% of the Total Capital, while Tier 2 the 25%. Furthermore, Basel III divides Tier 1 into Common Equity Tier 1 and Additional Tier 1. The former must account for 4,5% of the risk weighted assets and the latter for 6%. In other words, CET1, which is the capital component with the highest quality level, covers more than 50% of a bank's Total Capital⁹³. Thanks to these new requirements, financial institutions, especially the largest ones, are able to absorb losses both on a going concern and a gone concern basis. In addition, in order to enhance the level of consistency, the definition and the application of regulatory adjustments was regulated, by imposing a set of possible deduction and modification according to the capital component⁹⁴. More precisely, as the 2008 crisis pointed out that the majority of credit losses and write downs had been absorbed by CET1, Basel III addressed most of the deductions to this component of regulatory capital. For example, in order to reduce the uncertainty related to intangible assets and the capital advantage that acquisitive banks could enjoy, compared to other financial institutions with the same value of assets and liabilities, the framework enforces the deduction of intangible assets and goodwill from CET1⁹⁵. Furthermore, in order to favor a higher degree of transparency, "the components of regulatory capital must be clearly disclosed and reconciled with the published financial accounts", so that market participants, who receive detailed information about the different capital items, are able to compare capital adequacy among banks⁹⁶.

Basel III also introduces two additional capital buffers, in order to increase the banks' ability to face spells of severe losses. The underlying principle suggests that, during periods of growth, financial institutions should accumulate capital, which is then liquidated during drawdowns.

The Capital Conservation Buffer imposes an additional 2,5% of Total Capital in the form of CET1, which ends up to be 7% of risk weighted assets, as a result. According to Basel III, when a bank falls below this threshold, some reduction of discretionary distributions, involving dividend payments or share buy-backs, must be applied to restore the buffer.

⁹³ King e Tarbert, «Basel III: An Overview», 2011.

⁹⁴ Basel Committee on Banking Supervision, a. c. di, «Strengthening the Resilience of the Banking Sector: Consultative Document» (Bank for Internat. Settlements, 2009).

⁹⁵ RESERVE BANK OF INDIA, «Guidelines on Implementation of Basel III Capital Regulations in India» (RBI Notifications, 2nd May 2012).

⁹⁶ Basel Committee on Banking Supervision, «Strengthening the Resilience of the Banking Sector», 2009.

Since the Great Financial Crisis evidenced the procyclical nature of the financial system, the Countercyclical Buffer is required by Basel III, in order to protect banks against a vicious cycle coming from a huge supply of credit to the economy, which, as a consequence, boosts the systemic risk level. In fact, when an asset bubble, resulting from a rise in lending practice, followed by an increased price level, bursts out, prices go down and loans are not paid back any longer. The subsequent credit contraction leads to a further decrease in prices, while the number of defaults augments. Hence, the buffer is a second pool of capital that must be accumulated during periods of credit growth. In particular, national authorities have the right to activate the Countercyclical Buffer when they assess a too high level of credit availability, with respect to objective measures, such as GDP, which could enhance the systemic risk in the financial system. On the other hand, the buffer is lifted after the reduction of the risk exposure. If banks do not respect the announced buffer, which ranges from 0% to 2,5% of TIER 1, restrictions on discretionary distributions are applied⁹⁷.

These provisions are important especially for large banks, since a higher amount of capital increases the ability to absorb losses and, therefore, it reduces the bank's probability of default, which is a source of individual risk, and the impact of the failure on the financial system, lowering the systemic risk, instead. Moreover, if banks reduce their size, in response to capital buffers, indirect negative externalities, arising from unstable fundings or market-based activities, are weakened⁹⁸. These measures, introduced by Basel III, are validated by the findings of Deniz Anginer and Asli Demirguc-Kun, published in 2014, in the paper "Bank Capital and Systemic Stability" and those of Luc Laeven, Lev Ratnovski and Hui Tong, reported in 2015, in the work "Bank size, capital and systemic risk: some international evidence", which evidence the importance of capital in reducing the systemic risk of large banks, as explained in the previous section.

Always referring to the issue of size, in order to reduce too big to fail subsidies and, consequently, costly bailouts, the European Bank Recovery and Resolution Directive was agreed in 2014 and enacted the following year⁹⁹. In particular, as regard the recovery components, banks are required to develop contingency plans, which embrace several measures and arrangements related to fundings, capital or liquidity, in order to ensure or restore their viability in the case of an idiosyncratic or systemic risk. If such recovery plans fail, the

⁹⁷ King e Tarbert, «Basel III: An Overview», 2011.

⁹⁸ Laeven, Ratnovski, e Tong, «Bank Size and Systemic Risk», 2014.

⁹⁹ Livia Pancotto, Owain ap Gwilym, e Jonathan Williams, «The European Bank Recovery and Resolution Directive: A Market Assessment», *Journal of Financial Stability* 44 (1st October 2019): 100689, <https://doi.org/10.1016/j.jfs.2019.100689>.

resolution procedure is then activated. It is based on the idea that when a given institution can not face a stressful event, its wind down and liquidation must be executed in an orderly manner, in order to avoid threats to the balance of the financial system¹⁰⁰. More precisely the Directive provides four resolution tools, which negatively affect shareholders and creditors. During the bail-in procedure, authorities write down assets and claims against the bank, or convert them into equity. The second tool imposes the sale of shares, assets and liabilities to a specific buyer, while the third one transfers them to a “bridge institution”. According to the last instruments, assets and liabilities are shifted to an asset management vehicle, in order to maximize their value as long as they are disposed or the bank is liquidated¹⁰¹. Thanks to this Directive, the probabilities of a harmful collapse and the connected destabilization of the financial system, due to the subsequent contagion effect, are reduced¹⁰². Moreover, since resolutions methods impose losses on the shareholders and on some of the creditors of a bank, instead of on taxpayers, the moral hazard behavior, which consists in the engagement in risky activities, is then mitigated¹⁰³.

Counterparty credit risk is another important problem addressed by Basel III. Indeed, the 2008 financial crisis pointed out the issue related to “wrong-way risk”, which concerns the positive relationship between the bank’s exposure to a particular counterparty and the deterioration of the creditworthiness of the latter¹⁰⁴. Moreover, financial institutions were much more correlated through their assets with respect to what was reflected in their capital framework, especially due to the securitization process. Consequently, when the crisis erupted, counterparty exposures turned out to be higher than what was expected¹⁰⁵. Besides, the previous framework did not require the capitalization of losses deriving from credit valuation adjustment procedure, which considered the variability in the fair value of a derivative contract, based on the counterparty’s ability to meet its obligation. Capital accumulation was necessary only to face changes in derivatives values after the counterparty’s default¹⁰⁶. Nevertheless, during the crisis, two-thirds of losses came from fair value adjustment, while only one-third from real defaults¹⁰⁷.

¹⁰⁰ Katherine Seal, «Chapter 9: Recovery and Resolution Plans (Living Wills): A Solution to the TITF Problem?», *Building a More Resilient Financial Sector* (International Monetary Fund, 2012), 9, <https://www.elibrary.imf.org/view/books/071/12184-9781616352295-en/ch09.xml>.

¹⁰¹ Deutsche Bank, «Information on bank resolution procedures and creditor participations (bail-ins)», 2019, <https://www.deutsche-bank.de/dam/deutschebank/de/shared/pdf/ser-bankenabwicklung-und-glaeubigerbeteiligung-engl.pdf>.

¹⁰² Katherine Seal, «Chapter 9», 2012, 9.

¹⁰³ Pancotto, ap Gwilym, e Williams, «The European Bank Recovery and Resolution Directive», 2019.

¹⁰⁴ King e Tarbert, «Basel III: An Overview», 2011.

¹⁰⁵ Basel Committee on Banking Supervision, «Strengthening the Resilience of the Banking Sector», 2009.

¹⁰⁶ BCBS, «Review of the Credit Valuation Adjustment Risk Framework», 2015.

¹⁰⁷ Basel Committee on Banking Supervision, «Strengthening the Resilience of the Banking Sector», 2009.

The Committee on Banking Supervision introduced several provisions to reduce counterparty credit risk in asset exposures, securitization procedures and derivatives contracts. First of all, since stress testing for counterparty credit risk were of poor quality, Basel III adds new and more precise requirements such as the use of at least three years of historical data, which are measured on a quarterly basis and must include a period of credit spread increasing. Furthermore, banks are then required to compare the results with a given benchmark. As regard credit value adjustment, instead, Basel III obliges financial institutions to hold capital also against marked-to-market losses, using a “bond equivalent” valuation¹⁰⁸. The idea lies in the possibility of defining the amount of capital for credit value adjustments by considering the market risk capital charge needed for a hypothetical bond¹⁰⁹. In addition, to better manage systemic risk arising from asset correlation among large institutions, the new framework imposes a multiplier of 1,25 to be applied to the exposures towards regulated financial institutions with a given asset value and to those of the unregulated ones, notwithstanding the size. As long as derivatives are concerned, Basel III tries to increase the incentives to use the Central Counterparty, which reduces the counterparty credit risk, through the clearing and the settlement of the various transactions, in the over-the-counter markets. In particular, exposures towards Central Counterparties¹¹⁰, which are compliant with the standards set by The Committee on Payment and Settlement Systems and the Technical Committee of the International Organization of Securities Commissions¹¹¹, enjoy a lower capital charge¹¹².

Furthermore, in order to restrain the buildup of systemic risk, Basel III also imposes a leverage ratio threshold. Indeed, as explained before, deleveraging processes entail spillover effects, that negatively affect the financial system¹¹³. During the 2008 crisis, banks with a high capital ratio, based on their risk weighted assets, accumulated an excessive leverage position. Consequently, Basel III requires banks to hold a leverage ratio, computed as Tier 1 over total exposure, of at least 3%¹¹⁴. The main difference with respect to capital adequacy ratio depends on whether the riskiness of a bank’s activities is considered or not. In fact, capital requirements are based on a well stated principle, according to which each financial institution must have sufficient capital to cover the risk associated with its business, while the leverage ratio does not examine asset risk characteristics, but it rather evaluates how much assets have been financed through

¹⁰⁸ King e Tarbert, «Basel III: An Overview», 2011.

¹⁰⁹ Basel Committee on Banking Supervision, «Strengthening the Resilience of the Banking Sector», 2009.

¹¹⁰ King e Tarbert, «Basel III: An Overview», 2011.

¹¹¹ BCBS, «Capitalisation of bank exposures to central counterparties», 2010.

¹¹² King e Tarbert, «Basel III: An Overview», 2011.

¹¹³ Basel Committee on Banking Supervision, «Strengthening the Resilience of the Banking Sector», 2009.

¹¹⁴ King e Tarbert, «Basel III: An Overview», 2011.

equity¹¹⁵. Nonetheless, it can be seen as a no-risk based capital measure, which integrates Pillar 1 requirements, offering a different perspective to analyze regulatory capital¹¹⁶.

As explained before, leverage could lead to liquidity creation and, therefore, other two relevant ratios are introduced by Basel III: the Liquidity Coverage ratio and the Net Stable Funding ratio. Both aim to improve bank's management of its liquidity, in order to avoid shortages, which would oblige financial institutions to use central bank expensive lending facilities and to reduce their capital.

The Liquidity Coverage ratio, which is a short-term horizon measure, was designed to ensure that banks have enough liquidity to face distressed periods, characterized by a downgrade in their credit rating, the loss of some deposits or unsecured wholesale fundings. In particular, the ratio between high-quality liquid assets over "total net cash outflows over the next 30 calendar days" must be equal to or greater than 100% for a month, which means that a given bank has enough liquid assets, or asset that can be easily converted into cash without a significant loss, to face distressed spells. Highly quality assets are categorized into two groups: Level 1 and Level 2. The former considers assets without particular haircuts, such as cash or central bank reserves; the latter rather includes assets with at least a 15% haircut like some marketable securities, which are not guaranteed by the government or central banks, and corporate bonds not issued by financial institutions. With reference to the denominator, instead, Basel III computes it as the difference between "the total expected cash outflows minus the total expected cash inflows in the stress scenario, up to a cap of 75 percent of expected outflows". In particular, outflows are calculated considering some run off rates, depending on the type of bank's liability. For instance, a 5% run off rate is assigned to government insured or guaranteed deposit since the probability of withdrawal is very low; unsecured fundings coming from other banks, insurance companies or special purpose vehicles require, instead, a 100% run off rate. As regard inflows, Basel III includes only fully performing outstanding exposures, which are not expected to default in the following thirty days.

The Net Stable Funding ratio operates, instead, on a longer period of time, which is one year, and it relates the available amount of stable fundings to the required amount of stable fundings. Again, the ratio must be equal to or greater than 100%, meaning that the bank's sources of funding must be equal to or higher than their required amount¹¹⁷. In other words, banks must hold a given amount of fundings, with respect to their assets and off-balance sheets activities,

¹¹⁵ Ingves, «Banking on Leverage», 2014.

¹¹⁶ European Central Bank., «The Leverage Ratio, Risk-Taking and Bank Stability», 2017.

¹¹⁷ King e Tarbert, «Basel III: An Overview», 2011.

in order to avoid liquidity shortages, as a result of a reduction in their sources of finance¹¹⁸. More to the point, the numerator is composed by regulatory capital and liabilities, as deposits or wholesale fundings. Also, in this case the various sources are weighted according to their degree of stability and the nature of the creditor providing the fundings. On the other hand, the denominator depends on the assets' liquidity risk and on the off-balance sheet exposure. Indeed, a required stable funding factor is computed on the basis of the impossibility of converting an asset into cash through sale or collateral posting for a secured borrowing. For instance, a 0% factor is attributed to cash, while encumbered assets are associated with a 100% factor. The denominator is then calculated by summing the product of these factors and the related asset class value to the product of the amount of off-balance sheet activities and their corresponding factors¹¹⁹.

Basel III is for sure an important milestone in the path to reach financial stability worldwide. It is a strong answer to the Great Financial Crisis and its principal aims are the improvement of previous frameworks, by introducing macroprudential regulations, and the enhancement of the banking supervision, regulation and risk management, to subsequently reduce systemic risk globally.

However, critics to some provisions of Basel III do not lack. First of all, there is a trade off between benefits and costs of capital surcharges. On one hand they increase the soundness and stability of banks; on the other, capital is more costly as source of financing with respect to debt. For example, higher capital requirements could lead to a contraction in lending to the economy, a loss of economies of scale due to the reduction of banks' size and a redistribution of risk in the financial system. In fact, if large banks become smaller and embrace a safer business model, characterized by more capital, stable fundings and a contraction of market-based activities, risk could be undertaken by other entities such as small banks or unregulated financial institutions¹²⁰. Another important drawback of Basel III is related to the absence of a pricing for systemic risk. Calculated systemic risk premia, which include both off-balance sheet and bilateral exposures, to reduce interconnectedness, would be used during systemic events to restore financial stability. As a result, financial institutions are encouraged to operate to reduce systemic risk, in order to save their premia. Besides the non-risk weighted nature of the leverage ratio is assumed to be inappropriate for the competitive financial system in which it is applied. Indeed, critics affirm it incentives banks to satisfy the ratio by selling low-risk activities,

¹¹⁸ BCBS, «Basilea 3 - II Net Stable Funding Ratio», 2014.

¹¹⁹ King e Tarbert, «Basel III: An Overview», 2011.

¹²⁰ Laeven, Ratnovski, e Tong, «Bank Size and Systemic Risk», 2014.

keeping the high-risk ones, rather than increasing equity. Moreover, the Net Stable Funding ratio could rise problems for banks with short-term borrowing and long-term lending. Since the ratio requires to keep more liquidity than they are used to do, these banks have to face decreases in their margins.

Notwithstanding these critics, it is relevant to recognize to Basel III the credit for having pointed out and, subsequently, dampened systemic risk, a crucial risk type, which has been hardly ever contemplated by previous regulations¹²¹.

¹²¹ Schwerter, «Basel III's ability to mitigate systemic risk», 2011.

Chapter 2

THE ROLE OF CENTRAL BANKS' TRANSPARENCY

As mentioned in the previous chapter, the third Pillar of Basel II, enacted in 2004, attributes to market discipline the ability to complement and bolster capital regulation and supervisory efforts and to enhance the level of stability in the financial system, as a result. Consequently, the Basel Committee on Banking Supervision, in order to strengthen market discipline, introduced several disclosure requirements regarding bank capital, risk exposures, risk assessment and management processes. Thanks to this provision, market participants would be able to retrieve key information, to better judge the soundness of financial institutions¹²². Already since that time, the benefits of transparency, on financial system stability, started to be taken into account and to be valued.

In the last two decades, as a consequence of the Great Financial Crisis, the European Sovereign Debt Crisis and the related several subsequent regulations, Central Banks have particularly increased their level of transparency, not only when running monetary policy, but also when safeguarding the financial stability¹²³. Indeed, Central Bank transparency ends up to be an important variable, which, as bank size, capital or leverage, has a peculiar effect on banks' systemic exposures. Nevertheless, the literature regarding the relation between transparency and financial stability is pretty scarce and the few studies and researches about it report inconclusive results¹²⁴. Consequently, the aim of this chapter is to further investigate the meaning of transparency, the implemented tools to ensure a given openness level, the advantages and the disadvantages of an increased Central Bank transparency and the existing legal framework about this topic. Finally, the last section of this chapter provides the literate review. Mostly, the various arguments will be addressed by taking a wide and general perspective, together with some specific references to the European Central Bank, which is the supervisory and monetary policy authority of the Eurozone.

¹²² BCBS, «Pillar 3 (Market Discipline)», 2001.

¹²³ Roman Horváth e Dan Vaško, «Central Bank Transparency and Financial Stability», *Journal of Financial Stability* 22 (1st February 2016): 45–56, <https://doi.org/10.1016/j.jfs.2015.12.003>.

¹²⁴ Alin Marius Andrieş, Simona Nistor, e Nicu Sprincean, «The Impact of Central Bank Transparency on Systemic Risk—Evidence from Central and Eastern Europe», *Research in International Business and Finance* 51 (1st January 2020): 100921, <https://doi.org/10.1016/j.ribaf.2018.06.002>.

2.1 Definition of Central Bank transparency

With regard to the meaning of transparency, as in the case of systemic risk, it is not possible to identify a unique and precise definition. First of all, the concept assumes a different significance, depending on whether the Central Bank is acting as a policy maker, introducing macroeconomic measures, or as a supervisor, guaranteeing the financial system stability.

Considering the first role of the Central Bank, in the paper “Central Bank Transparency”, published in 2002, Petra Geraats specified the concept of transparency by referring to the absence of asymmetric information between monetary policy makers and the economic agents. Furthermore, in a previous study, released in 2001 and entitled “Why adopt transparency? The publication of central bank forecasts”, the author identified five different aspects of transparency significance, depending on the phase of the policymaking process. Political transparency refers to the clarification of Central Bank’s roles and responsibilities, which should be assessed through the degree with which a given policy target has been achieved¹²⁵. The second area, that is the economic transparency, entails the economic information, such as data, models, forecasts, which is used for monetary policy purposes¹²⁶, as well as its disclosure to the public, in order to allow market participants to evaluate Central Bank’s decisions, independently. Procedural transparency is the third aspect of the taxonomy and it focuses on the decision-making process inside the Central Bank. In particular, it includes the publication of transcripts, minutes and voting procedures, that lead to a certain arrangement. The release of information related to the undertaken policy decisions and the reasoning, or the motivation, that guided to them, constitutes the fourth aspect, known as policy transparency. Finally, the operational transparency refers to the disclosure of how policy measures are practically implemented and how the monetary transmission mechanism works. What’s more, the accuracy of past forecasts and some errors in policy or unanticipated economic shocks are taken into account¹²⁷. The definition of Central Bank transparency, given by Secil Yıldırım-Karaman, in the paper entitled “Uncertainty shocks, central bank characteristics and business cycles” and published in 2017, summarizes the previous five aspect of the concept. Indeed, according to the author, Central Bank transparency implies the disclosure of information about decision-making

¹²⁵ Christopher Crowe e Ellen E. Meade, «Central Bank Independence and Transparency: Evolution and Effectiveness», *European Journal of Political Economy*, Does central bank independence still matter?, 24, n. 4 (1st December 2008): 763–77, <https://doi.org/10.1016/j.ejpoleco.2008.06.004>.

¹²⁶ Petra M. Geraats, «Central Bank Transparency», *The Economic Journal* 112, n. 483 (2002): F532–65, <https://doi.org/10.1111/1468-0297.00082>.

¹²⁷ Crowe e Meade, «Central Bank Independence and Transparency», 2008.

procedures, policy decisions and their implementation, policy targets and data regarding economic variables¹²⁸.

Referring to the second role of Central Banks, the concept of transparency entails the degree through which supervisors enact policies to enhance the reliability, timeliness, relevance and comparability of the information released by banks. These ongoing and high-quality disclosures allow authorities to better assess the performance and the risk profile of each bank, as well as the stability and safety of the banking system. More to the point, supervisors elaborate a forward-looking perspective of banks' activities, risks and the related management procedures and they then identify problems or negative trends, at an early stage, for both single financial institutions and the entire banking system. Central Banks are subsequently required to publish their evaluations in annual reports, which not only provide an overview of the financial system stability level and its potential risks, but they also integrate public information, that market participants consider to take their decisions¹²⁹.

2.2 Central Banks' transparency tools

In order to boost their level of transparency, both as monetary policy and supervisory authorities, Central Banks have developed several tools, among which financial stability reports (FSRs), speeches, interviews, press releases, press conferences and the web are of particular importance. The description of the content and the function of such instruments will be provided in this paragraph. Afterwards, a subsection dedicated to the communication tools adopted by the European Central Bank will follow.

FSRs are usually published, on an annual or semi-annual basis, by Central Banks or separate regulatory agencies; while, at a global level, they can also be released by international organizations, as the International Monetary Fund (IMF). Usually, FSRs are analytical stand-alone documents but, sometimes, they could be integrated in another issuance, like the periodic bulletins¹³⁰. Sweden was the first country, in 1997, to disclose a financial stability paper, as a consequence of the financial crisis in the early 1990s. Afterwards, in the 2000s, the publication of FSRs became more common and, nowadays, the majority of Central Banks, in developed countries, produces such document¹³¹. As main objective, FSRs point out the financial industry

¹²⁸ Secil Yıldırım-Karaman, «Uncertainty Shocks, Central Bank Characteristics and Business Cycles», *Economic Systems* 41, n. 3 (1st September 2017): 379–88, <https://doi.org/10.1016/j.ecosys.2016.09.004>.

¹²⁹ BCBS, «Enhancing Bank Transparency», 21st September 1998, <https://www.bis.org/publ/bcbs41.htm>.

¹³⁰ Martin Čihák, «How Do Central Banks Write on Financial Stability?», SSRN Scholarly Paper (Rochester, NY: Social Science Research Network, 1st June 2006), <https://papers.ssrn.com/abstract=920255>.

¹³¹ Horváth e Vaško, «Central Bank Transparency and Financial Stability», 2016.

soundness conditions and the potential sources of systemic risks and vulnerabilities¹³², together with an assessment of the macroeconomic situation of the supervised area¹³³. Over years, their coverage has expanded to several different issues, suggesting the improved ability of Central Banks to collect and analyze data, the expansion of their activities and the associated interest for a wider range of stakeholders and topics. Indeed, nowadays FSRs not only deal with banking system matters, but also with the non-banking financial sector, as pension funds or insurance companies, the real estate, along with households and non-financial firms¹³⁴. The analytical part of these documents concerns quantitative variables such as soundness indicators¹³⁵. In other words, they are macro-prudential indicators that, by also including some micro prudential measures, to be applied to a single institution, assess the stability of the financial system. Examples are the economic growth, the inflation, exchange rates and the balance of payments¹³⁶. Furthermore, results of stress tests are the second quantitative indicator included in FSRs. In particular, after the 2008 crisis, Central Banks are required to perform periodic stress test for the supervised financial institutions, to estimate the degree through which they are able to face potential future shocks¹³⁷. More precisely, both idiosyncratic risks and correlated banks' exposures are investigated by such tests, with the aim to deal with risks threatening the financial system¹³⁸. In Europe, they are carried out by the European Banking Authority (EBA), in cooperation with the European Systemic Risk Board (ESRB), the European Central Bank (ECB) and the European Commission (EC) and they are usually run on two scenarios: the baseline and the adverse one, for which, for instance, a drop in the GDP and in equity prices, or an increase in the short-term risk-free rates, are hypothesized. Results are then disclosed to the public, in order to reduce bank opaqueness and to allow market participants to figure out what are the sound and weak institutions. More to the point, the type of disclosures depends on the conditions that the banking sector is currently facing. For instance, in the case of a distressed situation, when market participants do not trust banks' balance sheet anymore, stress tests tend to provide detailed information, such as portfolio holdings, in order to restore

¹³² Benjamin Born, Michael Ehrmann, e Marcel Fratzscher, «Central Bank Communication on Financial Stability», *The Economic Journal* 124, n. 577 (2014): 701–34, <https://doi.org/10.1111/eoj.12039>.

¹³³ Horváth e Vaško, «Central Bank Transparency and Financial Stability», 2016.

¹³⁴ Sharika Sharifuddin, Kalin Tintchev, e Sònia Muñoz, «Financial Stability Reports: What are They Good for?», *IMF Working Papers* 12 (2nd February 2012), <https://doi.org/10.5089/9781463929923.001>.

¹³⁵ Horváth e Vaško, «Central Bank Transparency and Financial Stability», 2016.

¹³⁶ Paul Louis Ceriel Hilbers et al., «Macroprudential Indicators of Financial System Soundness», *Macroprudential Indicators of Financial System Soundness* (International Monetary Fund, 15th April 2000), <https://www.elibrary.imf.org/view/books/084/04410-9781557758910-en/04410-9781557758910-en-book.xml>.

¹³⁷ Goldstein e Yaron Leitner, «Stress Tests and Information Disclosure», *Journal of Economic Theory* 177 (1st September 2018): 34–69, <https://doi.org/10.1016/j.jet.2018.05.013>.

¹³⁸ Dmitry Orlov, Pavel Zryumov, e Andrzej Skrzypacz, «Design of Macro-Prudential Stress Tests», SSRN Scholarly Paper (Rochester, NY: Social Science Research Network, 5th November 2021), <https://doi.org/10.2139/ssrn.2977016>.

the prior trust level. In addition, it is interesting to point out that financial stability can be improved also when the results of these tests are worse than what was expected. Indeed, after the publication of these outcomes, supervisors are much more incentivized to dispose weak banks to raise new capital. Moreover, the release of bad news fosters the building up of their reputation as independent authorities, which do not engage into regulatory capture. Besides, the reduced discount rate, which is another consequence of negative information disclosure, offsets the decrease in the present value of the future expected earnings, which is a positive signal for investors¹³⁹. Finally, market-based indicators, as financial institutions stock prices, bond and option prices, distance to default or the various ratings, are granted to give a forward-looking feature to these reports¹⁴⁰. In fact, differently from supervised data, these indicators are able to capture the information about publicly traded instruments, that is dispersed among market participants, and, consequently, they are then able to retrieve their expectations for the future. In addition, market-based indicators are easy to obtain thanks to their high frequency, small lags and public availability¹⁴¹. Moreover, in order to further increase the usefulness and the transparency of FSRs, the majority of the data, that has been analyzed, is then shared with the users in a statistical appendix or in a spreadsheet. The decision to provide these data in a separate way, at the end of the report, is justified by the high level of clearness that supervisors are willing to reach. Indeed, a document, with a lot of numerical information inside it, would become too long and confusing, leading to a misunderstanding of the principal messages¹⁴².

Speeches and interviews are other two important instruments, which allow Central Banks to enhance their transparency level towards the public and the financial markets. They are useful to better understand how supervisors assess risks affecting the financial system¹⁴³, which started to be considered as a relevant topic since the Great Financial Crisis. On the contrary, a constant argument, addressed by Central Banks in their speeches, is the monetary policy managing, together with the related variables, as interest rates and inflation. Besides, other significant issues concern the monetary integration and the economic growth, as well as topical arguments, like technological innovation, education or current wars, which gained a particular importance during the last ten years¹⁴⁴. The information is released mainly during seminars and conferences,

¹³⁹ Giovanni Petrella e Andrea Resti, «Supervisors as Information Producers: Do Stress Tests Reduce Bank Opacity?», *Journal of Banking & Finance* 37, n. 12 (1st December 2013): 5406–20, <https://doi.org/10.1016/j.jbankfin.2013.01.005>.

¹⁴⁰ Horváth e Vaško, «Central Bank Transparency and Financial Stability», 2016.

¹⁴¹ Čihák, «How Do Central Banks Write on Financial Stability?», 2006.

¹⁴² Sharifuddin, Tintchev, e Muñoz, «Financial Stability Reports», 2012.

¹⁴³ Paulina Sotomska-Krzysztofik e Olga Szczepanska, «Transparency of Central Banks in Supporting Financial Stability», *Banks and Bank Systems* 1, n. 3 (2006): 13.

¹⁴⁴ Martin Feldkircher, Paul Hofmarcher, e Pierre Siklos, «What's the Message? Interpreting Monetary Policy Through Central Bankers' Speeches», *SUERF*, August 2021.

which are planned by Central Banks or other institutions, as universities or international organizations; speakers vary among the President, the Vice-President or Board Members¹⁴⁵.

Moreover, as just explained, through speeches, supervisors communicate their interpretation of the current economic situation and their intentions concerning the future monetary policy strategy¹⁴⁶. In the last decade, an unconventional monetary policy instrument, known as forward guidance, has been adopted in order to maintain the ability to drive interest rates, even in a situation of zero lower bound¹⁴⁷. Indeed, through this tool, which basically consists of Central Bank's announcements, authorities are able to disclose information related to the future orientation of the monetary policy strategy, to which they anchor, in order to highlight their mandate (Odyssean forward guidance). What's more, the instrument is also adopted to convey Central Bank's expectations about future events and macroeconomic fundamentals, considering the current state of the economy (Delphic forward guidance). More precisely, the aim of forward guidance is to drive public's expectations regarding the instruments of monetary policy, as the policy interest rate, instead of the inflation, which is the target. It is possible to claim that, thanks to the forward guidance, the Central Bank communication has turned into a policy tool itself¹⁴⁸.

With regard to interviews, the President, the Vice-President and Executive Board Members of the Central Bank are asked for explanations or personal opinions about the last implemented monetary policy strategies, the intentions for the future ones, the current economic outlook and topical problems. Interviews are then published on newspapers articles or they are directly released in TV programs. In addition, some social media, as Twitter, give the possibility to organize Q&A sessions, during which the public is free to ask questions to the host, in a real time manner.

Differently from FSRs, that usually follow a predetermined schedule, speeches and interviews are characterized by a higher degree of flexibility¹⁴⁹ and, in particular, their frequency arises during periods of crisis or after a determined shock. Furthermore, they are shorter and much

¹⁴⁵ Sotomska-Krzysztofik e Szczepanska, «Transparency of Central Banks in Supporting Financial Stability», 2006.

¹⁴⁶ Malin Andersson, Hans Dillén, e Peter Sellin, «Monetary Policy Signaling and Movements in the Term Structure of Interest Rates», *Journal of Monetary Economics* 53, n. 8 (1st November 2006): 1815–55, <https://doi.org/10.1016/j.jmoneco.2006.06.002>.

¹⁴⁷ Paul Hubert e Fabien Labondance, «The effect of ECB forward guidance on policy expectations», Sciences Po publications (Sciences Po, October 2016), https://econpapers.repec.org/paper/spowpmain/info_3ahdl_3a2441_2f2g6qj1trtu8q2r79ee4jp49krd.htm.

¹⁴⁸ Peter Praet et al., *Forward Guidance Perspectives from Central Bankers, Scholars and Market Participants* (Centre for Economic Policy Research: Wouter den Haan, 2013).

¹⁴⁹ Born, Ehrmann, e Fratzscher, «Central Bank Communication on Financial Stability», 2014.

more focused on a given issue. Instead, FSRs are more comprehensive, since they cover a wider range of important topics¹⁵⁰. Besides, speeches and interviews could also entail an element of surprise, since supervisors are not obliged to always disclose financial stability statements. Consequently, they insert unanticipated news when they decide to do it¹⁵¹. Indeed, as it will be better explained in the following paragraph, the mere fact that authorities decide to give a speech or an interview generates a relevant signal for financial market participants, who react to it by changing their expectations¹⁵². On the other hand, FSRs and the related information are expected by market participants on the release day¹⁵³. Finally, the last important difference lies in the personal view, conveyed through speeches and interviews, which becomes rather impersonal in FSRs, as they usually must be approved by the entire decision-making body, before the disclosure¹⁵⁴.

Transparency can also be improved through press releases, which are pretty useful during crisis. Indeed, they are fast communication tools and they are able to reduce the asymmetric information problem, as they deliver the same message to all financial market participants¹⁵⁵. Moreover, press conferences, usually take place after a meeting, in order to announce a policy decision and to provide the necessary explanations and clarifications about it. In fact, they include a session dedicated to Q&A, during which the press has the occasion to ask questions, with the aim to solve potential doubts. Usually, press conferences are broadcasted via TV, in order to convey the message to a large number of people¹⁵⁶.

Of course, Internet must be mentioned among the implemented instruments to increase transparency level. Websites allow Central Banks to publish news and documents regarding their daily operations, their goals, their mission and the financial system conditions. Whether or not the Central Bank dedicates a separate page of its website to financial stability, determines the relevance of this issue in its information policy. Furthermore, conducted analysis, newspaper articles and bank authorities' speeches are consultable online. The main advantage of this tool lies, indubitably, in the immediacy of the information transmission and in the

¹⁵⁰ Benjamin Born, Michael Ehrmann, e Marcel Fratzscher, «Communicating About Macro-Prudential Supervision – A New Challenge for Central Banks», *International Finance* 15, n. 2 (2012): 179–203, <https://doi.org/10.1111/j.1468-2362.2012.01301.x>.

¹⁵¹ Born, Ehrmann, e Fratzscher, «Central Bank Communication on Financial Stability», 2014.

¹⁵² Born, Ehrmann, e Fratzscher, «Communicating About Macro-Prudential Supervision – A New Challenge for Central Banks», 2012.

¹⁵³ Born, Ehrmann, e Fratzscher, «Central Bank Communication on Financial Stability», 2014.

¹⁵⁴ Born, Ehrmann, e Fratzscher, «Communicating About Macro-Prudential Supervision – A New Challenge for Central Banks», 2012.

¹⁵⁵ Sotomska-Krzysztofik e Szczepanska, «Transparency of Central Banks in Supporting Financial Stability», 2006.

¹⁵⁶ Alan S Blinder et al., «Central Bank Communication and Monetary Policy: A Survey of Theory and Evidence», March 2008.

possibility to reach simultaneously an unlimited number of people¹⁵⁷. When talking about disclosures through Internet, it is a must to mention social networks, which have turned the communication from passive into active. Indeed, they favor a more direct and immediate connection and discussion with the public. Followers are free to ask questions and to express their opinions, regarding the last Central Bank's announcement or the adopted strategy. Supervisors, on the other hand, can proactively take part in these debates and provide clarifications about the discussed topics, enhancing the transparency level, which allows a further influence of agent's expectations and an increase in Central Bank's reputation, credibility and accountability. More precisely, through social networks, Central Banks convey useful and informative messages, about the future plans, the achieved results and some current important issues. However, the particularity of this communication tool does not lie on the delivered content, which is the same disclosed through the other instruments, but it has to do with how the information is transmitted to the public. In fact, Central Banks provide short and clear messages, which are summarized in the so called "posts" and that can be quickly and easily read by the followers. The advantage of social networks is indeed related to the provision of a fast, free, dynamic, public and two-way communication, which allows Central Bank to reach a higher degree of transparency¹⁵⁸.

2.2.1 European Central Bank's transparency tools

The description of Central Banks' communication tools arouses curiosity regarding the instruments adopted by the European Central Bank (ECB), in order to reach a higher level of clearness. In fact, transparency is obviously one of the core principles on which the ECB's mandate has been built. High priority is given to an open, clear and timely communication with the public, in order to disclose information about the strategy, the policy decisions, the achieved results and the assessment of the current economic situation. According to the ECB's view, transparency favor the public understanding, which leads to a more credible and effective policy¹⁵⁹. For these reasons, over years the ECB has developed several communication tools. The most important and influential ones will be presented in this subsection of the dissertation.

¹⁵⁷ Sotomska-Krzysztofik e Szczepanska, «Transparency of Central Banks in Supporting Financial Stability», 2006.

¹⁵⁸ Goran Bjelobaba, Ana Savic, e Hana Stefanovic, «Analysis of central banks platforms on social networks», *UBT International Conference*, 27th October 2017, 17–21.

¹⁵⁹ ECB, «Transparency», last access: 7th June 2022, <https://www.ecb.europa.eu/ecb/orga/transparency/html/index.en.html>.

One of the most important instruments to convey monetary policy decisions consists of press statements, followed by the press conferences of the ECB President or Vice-President¹⁶⁰. In particular, the initial declaration is extremely relevant, since, in real time, it conveys information about the ECB's assessment of the current status of the monetary policy¹⁶¹. This type of communication takes place during the decision-day, after the monetary policy meeting of the Governing Council, which is the main decision-making body of the ECB¹⁶². It meets every two weeks to discuss several arguments, as the payment system, the financial stability or some legal affairs, while every six weeks it releases its decisions concerning the interest rates¹⁶³. Therefore, this type of communication is prescheduled. In additions, statements and conferences, which are delivered using a determined language and structure¹⁶⁴, are broadcasted on the ECB website, on which their transcript is also published shortly after. This last type of communication tool is also known as webcast and it is mostly implemented to convey monetary policy decisions.¹⁶⁵ Since, before the euro, Central Banks were not used to disclose information after each meeting, the real time transmission of news and updates, introduced by the ECB, increased its importance in financial markets and in the global economy, as well as the immediacy and the transparency of its communication strategy.

During the inter-meeting period, other instruments are implemented, such as the Monthly Bulletin, which is published one week after the press conference and it also contributes to the real time ECB communication policy. More to the point, the Bulletin contains a more detailed clarification about the financing and economic background of the undertaken monetary policy decisions and, four times a year, it also conveys some future projections¹⁶⁶. As regard Bulletins, it is important to mention also the Research Bulletin and the Macroeconomic Bulletin. The former is published on a monthly basis and it provides ECB economists' works about policy, economic and financial topics; the latter aims to increase the transparency level regarding the

¹⁶⁰ Kerstin Bernoth e Geraldine Dany-Knedlik, «The ECB's Communication Strategy: Limits and Challenges After the Financial Crisis», 15th January 2020, <https://policycommons.net/artifacts/1337418/the-ecbs-communication-strategy/1945266/>.

¹⁶¹ Trichet, «Communication, transparency and the ECB's monetary policy», 2005, <https://www.ecb.europa.eu/press/key/date/2005/html/sp050125.en.html>.

¹⁶² Bernoth e Dany-Knedlik, «The ECB's Communication Strategy», 2020.

¹⁶³ ECB, «Governing Council decisions», last access: 7th June 2022, <https://www.ecb.europa.eu/press/govcdec/html/index.it.html>.

¹⁶⁴ Michael Ehrmann e Marcel Fratzscher, «How Should Central Banks Communicate?», *SSRN Electronic Journal*, 2005, <https://doi.org/10.2139/ssrn.850944>.

¹⁶⁵ Bernoth e Dany-Knedlik, «The ECB's Communication Strategy», 2020.

¹⁶⁶ Trichet, «Communication, transparency and the ECB's monetary policy», 2005.

ECB commitment to run and interpret stress tests, as instruments to both understand the soundness of financial institutions and to drive policy decisions¹⁶⁷.

Moreover, the ECB provides several press releases regarding different topics, such as monetary policy, payments and markets, financial stability, banknotes and coins, international and European cooperation and banking supervision. Besides, Euro-system financial statements are published on a weekly basis, together with disclosures regarding monetary developments, security issues, balance of payments, pension funds, insurance corporations, money market or interest rates statistics¹⁶⁸.

Furthermore, the ECB information disclosures are also made through speeches and interviews, released by individual committee members as those of the Governing Council, of the Executive Board or those of the Supervisory Board. Since speeches and interviews are characterized by flexibility in terms of time and content, they ensure a high level of discretionary to the ECB, which is then able to convey, at the preferred time, information about any type of topics¹⁶⁹. In addition, these communication tools highlight the importance of the decentralized nature of the Euro-system. Indeed, national Central Bank Governors, who are members of the Governing Council, transmit, through speeches and interviews, the monetary policy decisions and the current ECB's view of the economic stance to their national public, using their native language. Hence, it is possible to appreciate the ability of these instruments to provide a direct and straightforward message to the public¹⁷⁰.

Of course, the ECB makes use of other several communication tools, among which it is possible to recall Financial Stability Reviews, which are published twice a year and whose aim is the assessment of the potential risks affecting the financial soundness of the euro area¹⁷¹. In order to facilitate the reading and the understanding of the conveyed message, they present the content by combining the technical analysis with infographics¹⁷². What's more, another interesting tool is the ECB Blog, which is provided on a section of the official ECB website. Thanks to this instrument, the public can read articles written by the policy makers about the most recent decisions and the economic outlook of the Eurozone, as well as international trends. Besides, a section devoted to the Supervisory Blog is present on the ECB website, in order to collect all

¹⁶⁷ ECB, «Research & Publications», last access: 4th July 2022, <https://www.ecb.europa.eu/pub/html/index.en.html>.

¹⁶⁸ ECB, «Press releases», last access 20th June 2022, <https://www.ecb.europa.eu/press/pr/html/index.en.html>.

¹⁶⁹ Ehrmann e Fratzscher, «How Should Central Banks Communicate?», 2005.

¹⁷⁰ Trichet, «Communication, transparency and the ECB's monetary policy», 2005.

¹⁷¹ Bernoth e Dany-Knedlik, «The ECB's Communication Strategy», 2020.

¹⁷² Katrin Assenmacher et al., «Clear, Consistent and Engaging: ECB Monetary Policy Communication in a Changing World», 2021, <https://www.ssrn.com/abstract=3928296>.

the posts concerning the supervisory practices and the risks threatening the financial stability¹⁷³. As in the case of FSRs, blog publications are enriched by charts and tables, in order to lighten the reading and to effectively deliver the message¹⁷⁴. Furthermore, as anticipated, webcasts are relevant tools to broadcast via Internet new contents. Beyond conferences, they also transmit the regular meetings of the ECB President and the Executive Board Members with the European Parliament, the ECB Forum and other important events¹⁷⁵. Audio contents only are also offered, thanks to the ECB Podcast, which consists of a periodic series of episodes, that are downloaded by the users on their devices, in order to listen to them when they wish. The host, who conveys her personal opinion, mostly talks about central banking and Eurozone economic facts¹⁷⁶. In addition, the ECB has increased, in recent years, its presence on social networks, since they offer great opportunities for a direct and quick communication and also because they ease the information disclosure to younger generations. Even if the ECB has a profile on Twitter, Instagram, YouTube and LinkedIn, the number of followers is not so high. Hence, there is still space for some improvements¹⁷⁷.

All the several communication tools adopt the English language, in order to guarantee the comprehension of the contents by the greatest possible number of people. Besides, to boost the transparency level, the most relevant topics, as the Euro-system annual consolidated balance sheet and the transcript of press conferences about monetary policy decisions, are presented in more than twenty foreign languages.

2.3 Advantages and disadvantages of an increased Central Banks' transparency level

After having defined Central Bank transparency, along with its communication tools, this section aims to analyze the advantages and the disadvantages of increasing the Central Banks' openness level, when they act both as monetary policy and supervisory authorities, and to identify what are the direct and indirect implications on the degree of systemic risk.

First of all, Central Bank policy ends up to be more predictable, thanks to its precise and straight issuances. As a result, private sector is incentivized to employ public rather than private information and the stemming forecasts are much more accurate. This happens also because transparency can solve private sector's information asymmetries problems, which increase the

¹⁷³ ECB, «The Supervision Blog», last access: 4th July 2022, <https://www.bankingsupervision.europa.eu/press/blog/html/index.en.html>.

¹⁷⁴ ECB, «The ECB Blog», last access: 20th June 2022, <https://www.ecb.europa.eu/press/blog/html/index.en.html>.

¹⁷⁵ ECB, «Podcasts & webcasts», last access: 20th June 2022, <https://www.ecb.europa.eu/press/tvservices/html/index.en.html>.

¹⁷⁶ ECB, «The ECB Podcast», last access: 20th June 2022, <https://www.ecb.europa.eu/press/tvservices/podcast/html/index.en.html>.

¹⁷⁷ Assenmacher et al., «Clear, Consistent and Engaging», 2021.

uncertainties regarding monetary policy decisions. Indeed, facts belonging to the so called “political transparency” could be unclear, like the final Central Bank’s objective. Alternatively, the “economic transparency” could have not been disclosed completely and, consequently, some economic indicators or some analysis, conducted by supervisors, are not known by the private sector. What’s more, the reasoning and the results interpretation, as well as the general workings of the monetary policy could be a source of asymmetric information. By delivering to the public open, clear and timely information, about the decision-making process and the reasons behind it, supervisors convey a transparent message, regarding their mandate and the implemented strategy. Hence, as a consequence, it is possible to understand that an improved level of transparency reduces uncertainties and enables the private sector to formulate more appropriate expectations, about the future Central Bank’s decisions and, thus, to better drive their investment and financing decisions.

Evidences show that the longer-term predictability of monetary policy benefits from a well quantified Central Bank’s objective. This is the case of inflation expectations, for example. As long as supervisors provide a precise definition of price stability and set their inflation target, the agent’s expectations are adjusted in a more precise manner and they end up to be much more anchored to the price stability definition. Furthermore, if the Central Bank also clarifies what are its limits, such as the impossibility to balance short term changes in the inflation rate, which can be due to volatile food or energy prices for example, the expectations’ sensitivity to these types of shocks is weakened. Again, it is possible to comprehend how a high level of transparency improves the predictability of monetary policy and it also prevents the rise of false future forecasts, which could lead to a reduction in the Central Bank’s credibility level¹⁷⁸.

Furthermore, also the forward guidance instrument generates important effects on agent’s expectations, which lead positive consequences on both the financial and the real sector. In particular, as the Central Bank announces its future strategy, regarding the policy interest rate, market participants suddenly adjust their future beliefs. In the case of a declared low interest rate, for example, an expansion in the economic activity is achieved, as a consequence of the reduced short-term interest rate expectations¹⁷⁹, and therefore also the medium and long ones. The latter are of particular importance, since they drive decisions concerning investments and durable consumption and, consequently, they also influence, indirectly, production and employment¹⁸⁰. Better explained, if commercial banks will be able to borrow from the Central

¹⁷⁸ Tobias Sebastian Blattner et al., «The Predictability of Monetary Policy», SSRN Scholarly Paper (Rochester, NY: Social Science Research Network, 1st March 2008), <https://doi.org/10.2139/ssrn.1084925>.

¹⁷⁹ Hubert e Labondance, «The effect of ECB forward guidance on policy expectations», 2016.

¹⁸⁰ ECB, «The ECB’s forward guidance» (ECB Monthly Bulletin, April 2014).

Bank at the announced lower interest rates, they will require lower rates for long-term loans. Consequently, firms and households, who enjoy better financing conditions, enhance the amounts of investments and spending, leading to a subsequent increase in prices. Therefore, this behavior favors the economic development and the inflation sets at levels consistent with price stability¹⁸¹.

An example regarding the Eurozone is that of the 4th of July 2013, when Mario Draghi adopted a new communication strategy using the forward guidance, as an unconventional monetary policy tool. In particular, the words “The Governing Council expects the key interest rates to remain at present or lower levels for an extended period of time” evidenced the ECB’s future commitment, without setting a precise end date¹⁸². As a consequence, the money market curve became flatter, forward rates with over six months maturities fell of five basis points and their sensitivity to economic news and macroeconomic data publications was reduced. What’s more, thanks to the ECB’s forward guidance, the uncertainty about the future short-term interest rates was lowered. Hence, this communication tools enhanced the transparency level of the monetary policy disclosures, favored a higher degree of stability in the money market and strengthened market participant’s expectations, influencing, as a result, their investment and consumption decisions¹⁸³.

Always considering the effect of transparency on the monetary policy predictability, it is important to mention that, what matters is not only the type of information that is disclosed, but also how the message is delivered to the public. In fact, only when supervisors communicate the flow of reasonings, debates and the correlated effects on the decision-making process, in an orderly, open and timely manner, financial markets can easily identify the future direction of monetary policy, thanks also to a better understanding of Central Banks’ mandate and strategies. Besides, both parties would benefit from a clear communication, since financial market participants, which react to information disclosures, reduce their future potential losses, by anticipating the future monetary policy framework, while Central Banks enjoy a higher degree of credibility and accountability. On the contrary, dispersed messages invalidates the objective of the communication, inducing an increase in the uncertainty, a reduction in Central Bank predictability and large financial losses for market participants¹⁸⁴.

¹⁸¹ ECB, «What is forward guidance?», July 2021, https://www.ecb.europa.eu/ecb/educational/explainers/tell-me/html/what-is-forward_guidance.en.html.

¹⁸² Hubert e Labondance, «The effect of ECB forward guidance on policy expectations», 2016.

¹⁸³ ECB, «The ECB’s forward guidance» (ECB Monthly Bulletin, April 2014).

¹⁸⁴ Blattner et al., «The Predictability of Monetary Policy», 2008.

Moreover, transparency affects another important macroeconomic indicator, which is the exchange rate. In particular, a transparent monetary policy is positively associated with flexible exchange rates¹⁸⁵. Information related to the uses of foreign exchange rate, the balance of payments and the eventually objectives, timing, and amount of intervention, which is released through Monthly Bulletins in Europe, enhance the benefits of a flexible exchange rate. For instance, countries are less subjected to currency crises and they enjoy an increased stability in the balance of payments, as the exchange rate moves to restore the equilibrium. Thus, Central Banks are not obliged to keep huge amounts of reserves in foreign currency. Besides, in the case of an exit from a peg regime, transparency in terms of statements released by Central Banks, concerning their commitment to a flexible exchange rate regime and their refrain from intervening in the foreign exchange rate market, facilitates the buildup of agent's confidence and, consequently, it allows the transition to the new regime¹⁸⁶.

As explained in the second section of this chapter, transparency can be achieved also through FSRs, which generate positive effects on financial system stability. Firstly, they allow financial institutions to identify aggregate common exposures and the degree through which they can generate idiosyncratic risks, that could spillover in the economy. This continuous risk monitoring leads, therefore, to an increment in the level of trust towards the financial industry. In addition, thanks to the huge amount of delivered information, FSRs stimulate, among the several users, a debate about financial stability issues. As a result, the spreading of this kind of disclosures increases even more and a broad consensus for the financial system soundness and for the improvement of the financial infrastructure is built. Moreover, by publishing FSRs, the Central Bank is itself encouraged to increase the transparency level. This happens because the analyses and the results reported in these documents are subjected to several critics made by the users, which then assume a disciplinary role. Indeed, supervisors are consequently incentivized to pay much more attention to the quality of their analysis, the reliability of their results and the frequency of the disclosures. For this reason, the transparency level is further improved¹⁸⁷. Besides, Central Bank communication through FSRs affects financial markets. More precisely, optimistic statements foster positive abnormal returns, which means that the actual returns are greater than the expected ones. The research, conducted in 2014 by Benjamin Born, Michael Ehrmann and Marcel Fratzscher and published on the paper "Central Bank Communication on Financial Stability", pointed out that abnormal returns are, on average,

¹⁸⁵ Crowe e Meade, «Central Bank Independence and Transparency», 2008.

¹⁸⁶ Rupa Duttagupta, Gilda Fernandez, e Cem Karacadag, «Moving to a Flexible Exchange Rate: How, When, and How Fast?» (International Monetary Fund, 2005).

¹⁸⁷ Čihák, «How Do Central Banks Write on Financial Stability?», 2006.

0,27% at the day of the issuance and the cumulated abnormal returns reach 1,6% in the long run, which can cover a period of up to 50 trading days, that, said differently, are 10 weeks. As FSRs are released once or twice a year, it is possible to appreciate that the economic effect of these reports is substantial. In addition, the study also highlighted the ability of the relevant information inside FSRs to lower stock market volatility, leading to an increase in price stability.

Speeches and interviews improve stock market conditions too. They are mainly given after a stock market decline, which could happen during a period of crisis, or as a consequence of a given shock, and they are able to reduce the degree of the expected downturn. As regard returns, the long run effect is similar to that of FSRs, while speeches seem to increase stock market volatility, especially the optimistic ones. Nonetheless, differently from FSRs, speeches and interviews have a greater influence during periods of financial distress¹⁸⁸. In fact, during turbulent times, market participants pay extremely attention to every speech, after which they adjust their expectations, towards the Central Bank's predicted direction, in a significant manner, with respect to more stable periods¹⁸⁹.

In Europe, one of the most emblematic examples is, of course, Mario Draghi's speech, on the 26th July 2012, in London¹⁹⁰. At that time European countries were facing the Sovereign Debt Crisis, which erupted after the discovery of a larger than declared fiscal deficit of Greece. Therefore, all the other peripheral nations were blamed on fiscal irresponsibility and consequently the annual spread, between the ten years government bonds of these countries and the German bund, increased, suggesting an increment of their credit risk. In other words, Europe was suffering a deterioration in its financial and economic conditions¹⁹¹. In the occasion of the Olympic Games, in order to support UK international business relations, Mario Draghi was asked to give a speech in front of executives, investors and politicians, at the Global Investment Conference. "Within our mandate, the ECB is ready to do whatever it takes to preserve the euro. And believe me, it will be enough" were the words that, in the following weeks and months, triggered a turnaround of the crisis. Indeed, the spread of the peripheral countries decreased, stock markets inverted their trend upwards, business confidence was restored and the euro area

¹⁸⁸ Born, Ehrmann, e Fratzscher, «Central Bank Communication on Financial Stability», 2014.

¹⁸⁹ Bernd Hayo, Ali M. Kutan, e Matthias Neuenkirch, «Financial Market Reaction to Federal Reserve Communications: Does the Crisis Make a Difference?», 30th January 2012, <https://papers.ssrn.com/abstract=1155481>.

¹⁹⁰ Sebastian Wanke, «Five Years of 'Whatever It Takes': Three Words That Saved the Euro», *KfW Research Economics in Brief*, 2017, 1.

¹⁹¹ Lane, «The European Sovereign Debt Crisis», 2012.

GDP started to rise again. Europe enjoyed recovery and growth thanks to the courage and the determination coming from those words, which powerfully hit the investors' psychology¹⁹².

Nevertheless, transparency also generates some distortions and inefficiencies, especially when it reaches very high levels. For instance, the provision of too much information leads to uncertainties and confusion. In fact, market participants have difficulties in absorbing, interpreting and understanding all the disclosures of the Central Bank and, therefore, they start to perceive a given degree of complexity in the conveyed message and in the monetary policy management, due to information overload.

Moreover, the Central Bank itself could communicate unclear information, such as its inflation forecasts, which are considered by the private sector to adjust its own expectations. If the imperfect messages are correctly received, the public's understanding and the expectations are improved. On the contrary, if the level of uncertainty is particularly high and the content of the disclosure is not well interpreted, the inflation expectations end up to be of poor quality and, therefore, they determine wrong investment or financing decisions. Besides, an improved transparency level does not ensure positive economic outcomes. For example, always considering inflation expectations, psychological factors come into play and they generate some deviations from the rational behavior. The theories of belief perseverance and confirmation bias, belonging to the behavioral economic field, explain such divergences. According to them, the information that is not in line with people's beliefs is usually not considered and, therefore, the rational value of inflation expectations is reached after a long period of time, as agents' thinking is slower updated. In addition, people tend to interpret the received message in a wrong way, so that it is consistent with their prior beliefs. As a consequence, the resulting inflation expectations are, again, of a lower quality level¹⁹³.

Misinterpretation of Central Bank's communication could happen also in the case of forward guidance. Indeed, if the decision, to keep interest rates at low levels, is perceived as a pessimistic view of supervisors regarding the economic situation, market participants would reduce their expectations about the future production and inflation and they would take poor investment and consumption decisions. In addition, this unconventional monetary policy instrument subjects Central Banks to reputational risk, in the case in which the guidance is continuously revised. Deviations from the previous commitment increase also the uncertainty

¹⁹² Wanke, «Five Years of 'Whatever It Takes': Three Words That Saved the Euro», 2017.

¹⁹³ Carin A. B. van der Crujssen, Sylvester C. W. Eijffinger, e Lex H. Hoogduin, «Optimal Central Bank Transparency», *Journal of International Money and Finance* 29, n. 8 (1st December 2010): 1482–1507, <https://doi.org/10.1016/j.jimonfin.2010.06.003>.

among agents, who have difficulties in understanding the final goal of the Central Bank's strategy. Forward guidance could be responsible for rising financial stability risk too. In fact, when market participants are narrowly concentrated on few aspects of the supervisors' announcement, a future adjustment could determine broad market reactions, such as sharp movements in equity prices or sharp depreciation of exchange rates¹⁹⁴.

Information overload produced by Central Banks also creates a negative impact on the exchange rates. More specifically, as already said, huge amounts of disclosures lead to noisy among market participants, who keep on changing their expectations about future monetary policy. The resulting variation in the demand and the supply of foreign currency, because of trade or investment reasons, leads to a highly volatile exchange rate. In other words, a too transparent Central Bank boosts the exchange rate volatility, which implies an increased exchange rate risk¹⁹⁵. As a result, companies and financial institutions engage into a higher probability of collecting losses in terms of, for example, receivables (export contracts), payables (import contracts) and assets or liabilities, requiring foreign currency payment streams¹⁹⁶. Furthermore, erratic exchange rate fluctuations have negative repercussions on the real sector too. In fact, a high volatility could lead to large margin errors in the future cost and income projections and, thus, difficulties arise in consumption and investment planning¹⁹⁷.

What's more, from the perspective of the Central Bank, it is not always convenient to increase transparency level, due to the significant costs in terms of collecting, or producing, interpreting and delivering new information to the public. Examples are the expenditure for data providers, for the analysts, who decide which news are relevant to interpret and evaluate, or for the time that is needed to integrate all the elaborated information¹⁹⁸. Obviously, other important costs, that the Central Bank must take into account, are those related to the publication and the distribution of FSRs¹⁹⁹.

Moreover, these reports are usually very long and, therefore, users could encounter difficulties in receiving the right message, because they only focus on few aspects of a larger situation or

¹⁹⁴ Andrew Filardo e Boris Hofmann, «Forward Guidance at the Zero Lower Bound», *BIS Quarterly Review*, 9th March 2014, https://www.bis.org/publ/qtrpdf/r_qt1403f.htm.

¹⁹⁵ Christoph S. Weber, «The Effect of Central Bank Transparency on Exchange Rate Volatility», *Journal of International Money and Finance* 95 (1st July 2019): 165–81, <https://doi.org/10.1016/j.jimonfin.2019.04.002>.

¹⁹⁶ Michael G. Papaioannou, «Exchange Rate Risk Measurement and Management: Issues and Approaches for Firms», SSRN Scholarly Paper (Rochester, NY: Social Science Research Network, 1st November 2006), <https://papers.ssrn.com/abstract=947372>.

¹⁹⁷ Duttagupta, Fernandez, e Karacadag, «Moving to a Flexible Exchange Rate», 2005.

¹⁹⁸ Crowe e Meade, «Central Bank Independence and Transparency», 2008.

¹⁹⁹ Čihák, «How Do Central Banks Write on Financial Stability?», 2006.

problem and because they tend to mistakenly interpret the massive quantity of information in line with their beliefs²⁰⁰.

As regard the content of FSRs, published stress tests are characterized by some drawbacks and, thus, they turn out to be imperfect. For example, it is not so easy to elaborate correct downturn scenarios. In fact, most of the times, they are not able to represent a concrete unstable financial system, because they are not extreme enough, as they would otherwise generate panic among investors. On the other hand, too simple and soft adverse scenarios make the stress test elementary in the eyes of market participants, which, therefore, do not consider it in a serious manner. Furthermore, if the macroeconomic situation ends up to be worse than expected, according to the downturn scenario, market uncertainties could arise and the supervisor's credibility could be damaged²⁰¹. In addition, since stress tests convey information related to the soundness of each single bank; in the case of some unstable situations, such as temporary liquidity problems, financial institutions are less incentivized to be completely transparent in the data they disclose to the supervisors, because they do not want their competitors and the market in general to be aware about their current conditions. As a result, the effectiveness of stress test is compromised. Lastly, stress test disciplinary role is useful only during normal times, since they maintain at reasonable levels the risks taken by banks. On the contrary, these tests can intensify the effects of the crisis, if they are released during a period of financial instability. This happens due to the coordination problem of public information²⁰², toward which market participants attach a high weight. Consequently, the impact of public disclosures, together with the noisy they carry with them, is extremely large. For this reason, the overreaction of agents exacerbates the damages caused by any noise, and, consequently, it becomes impossible to mitigate a distressed situation²⁰³.

From the analysis of the advantages and disadvantages, it is possible to understand how the transparency issue is pretty complicated, since it includes various types of Central Bank's communication tools, together with the related different aspects and characteristics, and it involves several consequences for the entire system. In fact, it is possible to appreciate how a given transparency level can affect financial system stability directly and indirectly. Indeed, clear and precise communications improve Central Bank's credibility and predictability and market participants' expectations, which better drive their decisions. Moreover, the

²⁰⁰ Van der Cruysen, Eijffinger, e Hoogduin, «Optimal Central Bank Transparency», 2010.

²⁰¹ Petrella e Resti, «Supervisors as Information Producers», 2013.

²⁰² Itay Goldstein e Yaron Leitner, «Stress Tests Disclosure: Theory, Practice, and New Perspectives», 2020.

²⁰³ Stephen Morris e Hyun Song Shin, «Social Value of Public Information», *The American Economic Review* 92, n. 5 (2002): 1521–34.

uncertainties in the system are lowered, the risk of crises is reduced and the stability of macroeconomic variables is enhanced. Consequently, systemic risk is indirectly weakened. The publication of FSRs directly increases the level of financial system soundness, instead. In fact, they facilitate the identification of common or idiosyncratic risks among banks, generate positive abnormal returns and mitigate stock market volatility, leading to a more stable situation.

On the contrary, a too high degree of transparency involves a lot of costs for the supervisors and it also generates complexity and ambiguity in the delivered message, which leads to the consequently poor expectations quality, together with an increase in the risks, such as the exchange rate one. As a result, the financial stability of the system is indirectly threatened. FSRs issuance, on the other hand, could be responsible for boosting, in a straightforward way, the level of uncertainties, since their content is sometimes not so precise or the hypothesis regarding future scenarios turn out to be incorrect. What's more, they could further complicate a distressed situation, due to the above explained coordination problem.

This discussion points out the trade-off faced by Central Banks, when they have to establish the amount of information to disclose and the degree of clearness to adopt²⁰⁴. Therefore, increasing the openness is not always ideal, but, instead, it seems to exist an optimal degree of transparency, which is able to maximize the benefits and minimize the costs. If the transparency level is below a given threshold, then it is suitable to increase it, as it improves the market participants' future forecasts and the stability of the system²⁰⁵. On the other hand, a too high level of transparency is dangerous, because it generates uncertainties and unnecessary market reactions, which, on the contrary, destabilize the system²⁰⁶.

2.4 Transparency legal framework

Once the comparison of the advantages and disadvantages concerning the increase of Central Banks' openness level is concluded, at this point of the chapter, the analysis of transparency moves to its legal aspects. More precisely, in the first subsection of this paragraph some international standards will be presented, while the second one will focus on Eurozone provisions.

²⁰⁴ Blattner et al., «The Predictability of Monetary Policy», 2008.

²⁰⁵ Van der Cruysen, Eijffinger, e Hoogduin, «Optimal Central Bank Transparency», 2010.

²⁰⁶ Blattner et al., «The Predictability of Monetary Policy», 2008.

2.4.1 International transparency standards

From a global view point, Central Banks have increased their importance over years. Especially after the Great Financial Crisis, they have become active actors in the international financial system and, what's more, during the pandemic they have played a crucial role by injecting money into financial markets, with the aim to support commercial banks and other financial institutions. Once the current worldwide significance of Central Banks is understood, it is possible to recognize the need of international standards and best practices, which they should follow, when running their operations and taking their decisions²⁰⁷.

In this subsection, some global standards, regarding the transparency issue, released by international financial institutions, such as the Basel Committee on Banking Supervision and the International Monetary Fund, will be addressed.

The Basel Committee on Banking Supervision published, in 2012, the “Core Principle on Banking Supervision”, in order to provide some minimum, flexible and global standards, to support Central Banks, in their prudential and supervision function. More to the point, the 28th principal concerns disclosure and transparency requirements. It states that supervisors should require banks and banking groups to deliver, on a regular basis, easy to get qualitative and quantitative information, about their risk exposures and the related management strategies, their performance, their financial conditions and their accounting policies. Afterwards, Central Banks, in order to enhance the public knowledge of the banking system and to favor market discipline, should disclose the aggregate information, which has been previously collected and analyzed²⁰⁸.

Furthermore, in 2020, the Executive Board of the International Monetary Fund (IMF) approved the IMF Central Bank Transparency Code (CBT), which is a voluntary code, whose principal aim is to supplement the whole set of governance frameworks, by providing several transparency standards, that Central Banks can apply to the various activities they currently run. In particular, in order to better assess macroeconomic risks and to incentive policy effectiveness, CBT introduces different disclosure requirements for five different pillars: Central Bank Governance, Policies, Operations, Outcome and Official Relations. Obviously, the application of this code is done in accordance with the specific circumstances of each country. Moreover, it can also be used by Central Banks as a sort of benchmark, in order to

²⁰⁷ Daniel Bradlow e Stephen Park, «International Standards and the Role of Central Banks in Global Financial Governance», SSRN Scholarly Paper (Rochester, NY: Social Science Research Network, 14th September 2021), <https://papers.ssrn.com/abstract=3924474>.

²⁰⁸ BCBS, «Core Principles for Effective Banking Supervision», 14th September 2012, <https://www.bis.org/publ/bcbs230.htm>.

appraise the effectiveness of their transparency framework and to eventually introduce new ad hoc dispositions.

With reference to the first pillar, Central Bank Governance, the CBT affirms that Central Banks should disclose “to the public in a manner that is clear and easily accessible” information about the legal framework, its objectives, its functions, its autonomy and the organizational structure. In addition, the undertaken risks exposures, together with the related risk strategy and the accountability framework, should be openly communicated. Central Bank Policies involves, instead, information about the objectives, the decision and the instruments of monetary policy, the policy framework of the foreign exchange policy objectives. The transparency standards, regarding the third pillar, imply the disclosure of the monetary policy instruments and the circumstances in which they are implemented, the convey of information about how macroprudential policies are enforced and how the financial stability assessment has been conducted, covering also the stress test methods. Central Bank Outcome concerns updates about the monetary policy results and the progresses, that has been made in achieving the target. Finally, the last pillar has to do with the communication of the Central Bank’s relationship with the local government, domestic financial agencies, international organizations, other central banks, foreign agencies and governments²⁰⁹.

2.4.2 Transparency concept in the ECB’s legal framework

Since the ECB is a European Union institution, it operates under a determined set of rules, which are divided into primary and secondary European Union laws. The former concerns the Statute and the treaties, while the latter has to do with regulations, directives, opinions, decisions and recommendations. This subsection is going to focus on how the transparency concept has been handled in the European Union primary laws, which establish the objectives and the tasks of the ECB. Afterwards, the ECB’s transparency notion will be analyzed.

To begin, the Treaty on the Function of the European Union (TFEU), at the art. 15(1), states “In order to promote good governance and ensure the participation of civil society, the Union's institutions, bodies, offices and agencies shall conduct their work as openly as possible”. Furthermore, at the third point of the same article, the Treaty points out the right of each Member State citizen to read documents produced by the institutions belonging to the European Union²¹⁰. The Treaty on European Union (TEU) conveys a very similar concept at the art. 11(2),

²⁰⁹ International Monetary Fund Monetary and Capital Markets, «The Central Bank Transparency Code» 2020, n. 038 (30th July 2020), <https://doi.org/10.5089/9781513551814.007.A001>.

²¹⁰ EU, «CONSOLIDATED VERSION OF THE TREATY ON THE FUNCTIONING OF THE EUROPEAN UNION», *Official Journal of the European Union*, 2012.

which recites “The institutions shall maintain an open, transparent and regular dialogue with representative associations and civil society”. Thanks to these provisions, it is possible to appreciate how transparency takes an important role for the correct functioning of the ECB, as well as for the communication with the public. What’s more, according to the first Treaty, European Union institutions must develop their own legislations about the possibility to access their documents. However, as regard the ECB, this obligation is mitigated by the art. 132(2) of the TFEU, which reports “The European Central Bank may decide to publish its decisions, recommendations and opinions”. Hence, the ECB is given a particularly discretionary level regarding the publication of the information produced. This provision is consistent with market participants’ sensitivity to monetary policy or financial stability disclosures, as explained in the previous section. For this reason, it is possible to understand the aim of this unrestricted power: the ECB has to be quite free to decide the amount of information to release, which has to enable it to reach an optimal transparency level, which ensures a balance of the before analyzed advantages and disadvantages.

With reference to the Statue of European System of Central Banks and of the European Central Bank, further dispositions concerning ECB disclosures can be investigated. First of all, the article 10(4) confirms what has just been explained, by underling the confidential nature of the proceedings of the ECB Governing Council’s meetings and the possibility for the latter to decide whether to declare the outcome of its deliberations. Again, it is possible to appreciate the discretionary reserved to the ECB, when taking decisions about its appropriate transparency level²¹¹. Moreover, the article 15 of the Statue presents some reporting commitments for the ECB, such as the publication of quarterly reports about the European System of Central Banks (ESCB) activities, of a weekly ESCB financial statements and of an annual summary about the monetary policy, conducted in the current and previous year²¹².

Moreover, the transparency notion has been provided by the ECB itself on its official website, as part of the Euro-system organizational principles. The concept assumes a crucial importance, as it entails the disclosure, to the general public and the markets, of the ECB’s strategy, assessments of the economic developments, policy decisions and procedures, in an “open, clear and timely manner”. According to what is stated by the ECB, clarity regarding its mandate, the carrying out of its task and the monetary policy limits, enhances the credibility and favor better

²¹¹ Pieter Van Cleynenbreugel, «ECB Decision-Making Within the Banking and Monetary Union: The Principle of Confidentiality on Its Way Out?», *European Papers - A Journal on Law and Integration* 2021 6, n. 3 (28th February 2022): 1437–61, <https://doi.org/10.15166/2499-8249/533>.

²¹² ECB, «ON THE STATUTE OF THE EUROPEAN SYSTEM OF CENTRAL BANKS AND OF THE EUROPEAN CENTRAL BANK» (2011).

anchored expectations. At the same time, a given transparency level is also considered as a self-disciplined tool for the ECB, which incentives policy makers to operate in order to be consistent with their declarations and their forecasts. In the end, public communication and regular disclosures make policy moves more predictable, with the consequent increase in the degree of efficiency and accuracy of market expectations. As a result, policy arrangements are translated into investment and consumption decisions more quickly, thus accelerating economic adjustments²¹³. Furthermore, high-level ECB bodies, as the Governing Council, the Executive Board and the Supervisory Board, follow some guiding principles, when they communicate with the public, private sector, academia, interest groups and the civil society, since they recognize the importance of information transmission for the ECB accountability and governance. First of all, high-level ECB bodies must not take part in events during which, their declarations, that are market-sensitive, are not published on the institution's website, they are not webcasted, or, more in general, they cannot be made available in real time. Besides, the disclosure of relevant information or personal opinions about the current economic and financial outlook, which could be relevant for the future course of monetary or supervisory policy, must not be released in non-public environment, in order to avoid that companies, institutions, or persons would profit thereof. Likewise, during non-public events or bilateral meetings with, for example, bankers or industry representatives, no market-sensitive information must be disclosed. In addition, the schedule of the high-level ECB bodies meetings, with external parties, must be published, in order to foster transparency and accountability. Finally, the quiet period principle requires the members of the Governing Council and the Executive Board to avoid speeches or talks, with media and market participants, during the seven days prior the Governing Council meeting, with the aim to prevent the influence of monetary policy expectations²¹⁴.

2.5 Literature review

The final section of this chapter is devoted to the review of the literature concerning the impact of Central Bank transparency on the systemic risk level. As before anticipated, few studies about this topic have been conducted during the years. Furthermore, the challenge, posed by this argument, does not only concern the degree of scarcity of researches, but also the conflicting results they report. Indeed, as it will be later noticed, it is not possible to drive a

²¹³ ECB, «Transparency», last access: 7th June 2022.

²¹⁴ ECB, «Guiding principles for external communication for high-level officials of the European Central Bank», last access: 22th June 2022, <https://www.ecb.europa.eu/ecb/orga/transparency/html/eb-communications-guidelines.en.html>.

unique conclusion regarding the relationship between the Central Bank transparency and the systemic risk level.

One of the most important research is that of Alin Marius Andrieș, Simona Nistorb and Nicu Sprinceanc, who published the paper “The impact of central bank transparency on systemic risk—Evidence from Central and Eastern Europe”, in 2020. They analyzed the effect of transparency on the individual bank risk and on the contribution of a single bank to systemic risk, considering a sample of 34 banks, located in Central and Eastern Europe, and a time frame going from 2005 to 2012. In particular, as systemic risk measures, they used the change in the Conditional Value at Risk and the SRISK, while the implemented transparency index is the one developed by Dincer and Eichengreen in 2014, who were inspired by the methodology elaborated by Eijffinger and Geraats in 2006 for the monetary policy transparency index. Findings suggest a negative and significant relationship between the Central bank transparency level and the individual risk undertaken by a bank, quantified by the Value at Risk. On the other hand, for both the ΔCoVaR and the SRISK, the increment of information disclosure is positively associated with an increase in banks’ contribution to systemic risk.

In addition, the existence of a non-linear effect of transparency on financial stability, as it has been intuited in the third paragraph, was theorized by Roman Horváth and Dan Vasko, in the study released in 2016, on the paper “Central bank transparency and financial stability”. In particular, through panel regression, they investigated the effect of financial stability transparency index, which has been constructed considering the methodology introduced by Eijffinger and Geraats (2006), on financial instability, identified by the share of non-performing loans. The research outcome evidenced, not only the capacity of financial stability transparency to mitigate the financial stress level and to reduce the share of bad loans, but also its positive square index, which suggests that increasing the transparency level is not always beneficial.

These results are consistent with the part of the literature underlying the existence of an optimal level of transparency, above which the degree of uncertainty and confusion increases, leading to a deterioration in agents’ expectations, to a rise of the asset volatility or to an increment of the costs needed to convey new messages. Thus, the relationship between Central Bank transparency and systemic risk level turns out to be no linear. In this regard the paper “Optimal central bank transparency”, produced in 2010 by Carin A.B. van der Cruisen, Sylvester C.W. Eijffinger and Lex H. Hoogduin, highlights how the information release is favorable, as it improves the quality of private sector’s expectations about the future inflation; but, on the contrary, too much disclosures could worsen the forecasts, since the uncertainty level is

enhanced, due to the perceived complexity of the message and the information overload, which also generates more confusion among market participants.

A similar result is derived by Michael Ehrmann, Sylvester Eijffinger and Marcel Fratzscher, who reported, in 2012, on the paper “The Role of Central Bank Transparency for Guiding Private Sector Forecasts”, that Central Bank communication, regarding the inflation objective, the economic data or the policy models, reduces the disagreement among professional forecasters’ expectations. Nevertheless, once the adopted index, always based on that of Eijffinger and Geraats (2006), is split into different ranges, according to the various degree of transparency, the analysis shows that the lowest levels of openness are associated with a greater reduction in the dispersion among agents’ expectations, while an inferior decline is recorded for the highest transparency levels.

Furthermore, other authors investigated the relationship of Central Bank transparency and private sector expectations. This is the case of Christopher Crowe and Ellen E. Meade, who published, in 2008, on the paper “Central bank independence and transparency: Evolution and effectiveness”, an empirical analysis regarding the influence on a given openness level, measured by an index developed by the writers, on the degree of precision of private sector’s forecasts about the inflation in the following year. Findings reveal that, when the level of transparency is increased, the private sector employs more public rather than private information to adjust its expectations, which are, in addition, more accurate. Nevertheless, Monica Jain and Christopher S. Sutherland evidenced, on the paper “How Do Central Bank Projections and Forward Guidance Influence Private-Sector Forecasts?”, released in 2018, that policy rate projections, disclosed by Central Banks, are not able to mitigate the dispersion of private sector interest rates forecasts, but they rather increase the disagreement. Explanations for these findings concern some errors in the interpretation of Central Banks message, due to macroeconomic uncertainties, a reduced credibility of such projections, as in the past they turned out to be incorrect, or information overload, coming from the heterogeneity of Central Banks communications at the same time. On the other hand, authors found that inflation projections do reduce the dispersion of private sector interest rates forecasts, which considers first the inflation variable to predict the future monetary policy direction, thus. Finally, the effect of forward guidance on private sector expectations was also investigated. Results revealed the ability of this unconventional monetary policy instrument to lower interest rates forecasts disagreement, but they also pointed out its limits in decreasing that of inflation expectations. The reason of such findings, according to the authors, lies in the type of view adopted by different groups. Indeed, even if the conveyed message is the same, divergent

conclusions about the future monetary policy developments can be derived, depending on whether market participants belong to the optimistic forecasters or the pessimistic ones. The former would adjust their macroeconomic expectations upwards, while the latter downwards.

Other studies focus on the relationship of Central Bank transparency with stock market volatility and with returns. With reference to the first relation, Stephanos Papadamou, Moïse Sidiropoulos, Eleftherios Spyromitros pointed out, in 2014, on the paper “Does central bank transparency affect stock market volatility?”, the negative effect of the level of openness on stock market volatility and the consequent enhancement of the degree of financial stability. The Dincer and Eichengreen transparency index, constructed in 2007, was taken into account, while three different variables were implemented to measure stock market volatility: stock prices volatility, GARCH volatility and the beta measure. In all the three cases the direction of the relationship was the same. The research reported in “Central Bank communication on financial stability”, which was conducted by Benjamin Born, Michael Ehrmann and Marcel Fratzscher in 2014, evidenced the impact of FSRs content on financial markets, especially on the market abnormal returns. More to the point, a positive message delivered by FSRs improves stock market sentiment, leading to positive abnormal returns. On the contrary, a pessimistic view generates negative abnormal returns, but in a lower magnitude with respect to the optimistic ones. Therefore, the other important result of this study is related to the scarce power that FSRs have in revealing a warning signal regarding systemic risk.

These results are supported by another analysis conducted in 2006 by Sander Oosterloo, Jakob de Haan and Richard Jong-A-Pin and published on the paper “Financial stability reviews: A first empirical analysis”. Indeed, according to the study, there is no relationship between FSRs transparency and financial stability. The authors explained these findings by stating that the financial system soundness is influenced not only by the release of FSRs, but also by a wide range of different indicators and, therefore, identifying the effect of their publication is challenging. However, it is important to highlight that, when the analysis was carried out, the disclosure of FSRs was a pretty new phenomenon and, consequently, it would have taken more time to significantly affect the financial system stability.

Martin Čihák, Sònia Muñoz, Shakira Teh Sharifuddin, and Kalin Tintchev reported, instead, on the paper “Financial Stability Reports: What are They Good for?”, released in 2012, a “little evidence of a direct relationship between FSR publication and financial stability”. Nevertheless, they highlighted that the release of FSRs by itself is not able to mitigate financial risk. Probably, this result is due to, as the one of the before presented paper, the time frame of the considered sample, during which FSRs publication was a phenomenon at its first stage and its effect on

financial soundness was not visible yet. However, a novelty, introduced by the paper, is related to the improvement of financial soundness, that is generated by the financial stability analysis contained inside the FSRs and by their higher quality level. Indeed, well done FSRs send clear and precise messages to market participants, who better adjust their future expectations. These findings support those of the paper of Benjamin Born, Michael Ehrmann and Marcel Fratzscher (2014), according to which FSRs foster positive abnormal returns.

This literature review allows to understand the scarce development in terms of studies related to systemic risk and Central Bank transparency. Different financial stability indicators, such as ΔCoVaR , SRISK, the share of non-performing loans, inflation persistence level, private sector inflation forecasts or stock prices volatility, as well as various transparency indexes, have been implemented. In particular, the mainly adopted indexes are based on the monetary transparency index, introduced by Eijffinger and Geraats in 2006, to which, during years, several modifications have been applied by different authors as Dincer and Eichengreen. What's more, it is also possible to notice the heterogeneity of the results coming from such studies: a given level of transparency is supposed to reduce the individual bank risk, but to enhance the systemic risk level. Central Bank transparency is also found to lower stock market volatility, leading to a higher financial stability. In addition, different researches point out the existence of an optimal degree of transparency, below which private sector's expectations are more accurate and above which confusion and complexity are generated. Hence, according to some authors, the relationship between systemic risk and Central Bank transparency is no linear. Finally, FSRs have been investigated and the results are discordant too: they do not have a significant impact on systemic risk but, if they are of a high quality, they contribute to increase the financial system stability.

In order to contribute to the existing transparency literature, the next chapter of the dissertation will provide an empirical analysis, to better investigate the kind of relationship that links systemic risk level and Central Bank transparency. In particular, the focus will be on the European Central Bank, whose communication tools and transparency legal framework have just been described, and the Eurozone banking sector. Moreover, to the best of this dissertation's author knowledge, a novelty regarding the transparency index, elaborated by Eijffinger and Geraats in 2006 and further revised by Dincer and Eichengreen and other researchers over years, is introduced. In other words, the monetary policy transparency index, originally composed by five parts, will be integrated by a sixth one, which is aimed at measuring the ECB transparency level, when it operates as supervisory authority. Indeed, the final goal is the buildup of a more complete transparency index, with respect to what is presented in the

literature, to improve the computation of the ECB openness level, by considering both its roles as supervisory and monetary policy authority. The effect of ECB transparency level on the Eurozone systemic risk level will be analyzed by implementing this new derived index.

Chapter 3

EMPIRICAL ANALYSIS

Preface

The third chapter is devoted to an empirical analysis aiming at measuring the impact of a given Central Bank transparency level on the systemic risk. Indeed, since the literature regarding this topic does not provide a unique solution, the final goal is the determination of this relationship's direction, that is to say, whether the impact of a given transparency level has a positive, negative or non-linear effect on systemic risk. In particular, the focus will be adjusted towards the European Central Bank and the banking sector of Eurozone's countries. In this chapter, the adopted model and the implemented variables will be first presented, together with their descriptive statistics and the correlation matrix. Afterwards, the obtained results, with the related interpretations, will be provided.

3.1 Data and methodology

The relationship between the Eurozone's systemic risk level and the ECB transparency index is investigated by running an OLS regression on MATLAB. More to the point, since three additional explanatory variables will be included in the equation, the adopted model will be the Multiple Linear regression.

$$ZSCR = \beta_0 + \beta_1 ECBTI + \beta_2 GDPg + \beta_3 INFL + \beta_4 ESTAGDP$$

Where

ZSCR= Z-score, the systemic risk measure for the Eurozone banking system.

ECBTI= ECB transparency index, which is composed by the monetary policy transparency index elaborated by Dincer, Eichengreen and Geraats in 2019 and a new six dimension added by the author of this dissertation.

GDPg=GDP growth of the Eurozone countries.

INFL= inflation level of the Eurozone countries.

ESTAGDP=Euro-system total assets over the GDP level of Eurozone countries.

3.1.1 Systemic risk measure: Z-score

Z-score, the regression's dependent variable (*ZSCR*), has deeply been implemented in the literature, as a measure of an individual bank's insolvency probability²¹⁵. It is mainly attributed to the study of Edward I. Altman, titled "Financial Ratios, Discriminant Analysis and the Prediction of Corporate Bankruptcy", published in 1968. More to the point, he evidenced the limitations and the possible misleading interpretations in assessing the probability of a firm's bankruptcy when individual financial ratios are adopted. Therefore, he subsequently proposed a combination of several measures into a discriminant function, $Z = v_1x_1 + v_2x_2 + \dots + v_nx_n$, in order to combine variables to predict group membership, which, in this case, consists of bankrupt companies and non-bankrupt ones. The conducted study aimed to classify sixty-six corporations into the two groups, by implementing, in the above function, five out of twenty-two potentially variables. Working Capital/Total Assets, Retained Earnings/Total assets, Earnings before interest and taxes/Total assets, Market value of equity/Book value of total debt and Sales/Total Assets were chosen according to their ability of predicting future bankruptcy. They all were characterized by deteriorating ratios, as the failure probability had increased and the majority of them drastically changed between the third and the second year before bankruptcy. Z-score has been further investigated over years, such as in the studies of Boyd and Graham²¹⁶ and Hannan and Hanweck²¹⁷, where it is defined as the number of standard deviations between the mean of the return on assets and its negative values, which, in turn, would make capital negative, resulting in a bank's insolvency. Mathematically, it is computed by dividing the sum of the ROA and the equity-to-assets ratio by the standard deviation of ROA²¹⁸.

$$Z - score = \frac{ROA + (Equity/Asset)}{\sigma(ROA)}$$

ROA, which stays for return on assets, indicates the effectiveness of converting the invested money into net income. Indeed, even if over years several formulas have been adopted, it is generally computed as net income/total assets. A higher ROA suggests a higher ability of a company or, in this case, of a bank, to transform its assets into profit. Therefore, it can be considered as a proxy of a bank's returns. Furthermore, by taking its standard deviation, which

²¹⁵ Chien-Chiang Lee, Pei-Fen Chen, e Jhih-Hong Zeng, «Bank Income Diversification, Asset Correlation and Systemic Risk», *South African Journal of Economics* 88, n. 1 (2020): 71–89, <https://doi.org/10.1111/saje.12235>.

²¹⁶ John H. Boyd e Stanley L. Graham, «Risk, Regulation, and Bank Holding Company Expansion into Nonbanking», *Quarterly Review* 10, n. Spr (1986): 2–17.

²¹⁷ Timothy H. Hannan e Gerald A. Hanweck, «Bank Insolvency Risk and the Market for Large Certificates of Deposit», *Journal of Money, Credit and Banking* 20, n. 2 (1988): 203–11, <https://doi.org/10.2307/1992111>.

²¹⁸ Xiping Li et al., «Measuring Systemic Risk Contribution: The Leave-One-out z-Score Method», *Finance Research Letters* 36 (1st October 2020): 101316, <https://doi.org/10.1016/j.frl.2019.101316>.

constitutes, in this case, the Z-score denominator, returns' volatility is retrieved, instead. Hence, it represents a measure of a bank's risk.

The equity-to-assets ratio, which identifies the leverage, shows how much equity a bank has, compared to its total assets. The higher is the ratio, the better it is, as it means that the bank finances its activities with less debt and more equity. Thus, it is less risky²¹⁹.

After having analyzed the three Z-score's components, it is possible to understand how this ratio includes, at the same time, profitability, leverage and return volatility in a single value. By relating the bank's capital level to return's volatility, it provides evidence of how much variability in returns can be compensated by capital, without generating the bank's insolvency. Moreover, it is considered as "an inverse proxy for a firm's probability of failure", representing the distance to default of a single bank. Indeed, insolvency probability can be expressed as $ROA < - \text{equity-to-assets ratio}$ and, considering the Roy's Safety-First Criterion, elaborated in 1952, which is adopted to select the best investment portfolio option, that is the one that minimizes the probability of portfolio's returns being lower than a given threshold²²⁰, the inverse of insolvency probability can be computed as $(ROA + (\text{equity/assets})) / \text{sd}(ROA)$, which in literature is known as Z-score²²¹. Therefore, assuming a normal distribution of a bank's returns, the ratio indicates the number of ROA's standard deviations that has to fall before the bank becomes insolvent, that is before capital buffers are exhausted, which, in this case, represents the minimum threshold. In other words, the Z-score reports how many times the sum of a bank's own funds (net income + equity), as a percentage of total assets, is greater than the ROA's standard deviation. For instance, if the numerator is 20% and the denominator is 5%, the Z-score is equal to 4, which means that the incidence of the own funds over total assets is 4 times the ROA's volatility; or the ROA's standard deviation is needed 4 times to get to the numerator. As a consequence, a higher Z-score stays for a more stable bank, a reduced risk level and, therefore, a minimized probability of default ($ROA < - \text{equity-to-assets ratio}$). In fact, if the numerator increases, which means the bank has more equity or retained earnings, the entire ratio rises, suggesting that the financial institution is sounder; hence it is more distant to its failure. On the contrary, an increase of the denominator stays for a higher risk of negative

²¹⁹ Xiping Li, David W. L. Tripe, e Christopher B. Malone, «Measuring Bank Risk: An Exploration of Z-Score», 20th January 2017, <https://papers.ssrn.com/abstract=2823946>.

²²⁰ The Safety-First Criterion assumes that returns are normally distributed and aims at minimizing the left tail of the Gaussian, which represents the probability that returns fall below the acceptable threshold. Higher is the Safety-First ratio $((Re - R_m) / \text{sd}(P))$, with Re expected portfolio's return, R_m minimum required return and $\text{sd}(P)$ portfolio's standard deviation) and higher is the number of standard deviations that is needed to reach the threshold. A. D. Roy, «Safety First and the Holding of Assets», *Econometrica* 20, n. 3 (1952): 431–49, <https://doi.org/10.2307/1907413>.

²²¹ Lee, Chen, e Zeng, «Bank Income Diversification, Asset Correlation and Systemic Risk», 2020.

returns, which would, in turn, deplete capital. Consequently, the ratio decreases, highlighting a higher default's probability²²².

Furthermore, even if the Z-score was born as an idiosyncratic risk measure, it has also been adopted as an aggregate indicator, in order to assess the systemic risk level of the banking sector. More to the point, by taking the weighted average of each individual bank's Z-score, with weights usually represented by each bank's assets, it is possible to retrieve the inverse of the default probability of a country's banking system²²³. As regard the purpose of this dissertation, the dependent variable will represent the distance to insolvency for the Eurozone's banks.

One of the main Z-score's strong points lies in its accounting nature. In fact, data can be easily retrieved from banks' financial statements, both for the listed and the non-listed ones. Thus, it can be computed for a higher number of financial institutions, contrary to market-based measures, as the private, newcomers, savings or cooperative banks. Moreover, accounting data are characterized by a more stable trend over time, differently from market-based measure, which are much more volatile, as they are subject to investors irrational exuberance or market shocks. Consequently, market-based measures are easily driven above or below their fair value and, therefore, they can lead to wrong conclusions. Besides, it is pretty easy to compute and apply. In fact, as accounting data are considered, the Z-score elaboration does not require complex models or standardized approaches, with the consequent related assumptions. Nevertheless, it adopts some hypothesis too, such as the normal distribution of ROA and the insolvency status of a bank associated with a zero level of capital, which is not realistic²²⁴, since banks' capital is constantly monitored and, if the minimum or the additional capital requirements are not respected, supervisors can ask banks to restore their capital or they can even remove their banking license²²⁵. In addition, Z-score is also criticized, as it does not capture the interaction between banks²²⁶. Indeed, since it is firstly an idiosyncratic measure, it considers each single financial institution separately and, therefore, it could disregard the effect that one bank's default would have on the other financial institutions²²⁷. Anyway, its aggregate version, which is the one that will be adopted in this dissertation, is able to evaluate the systemic risk

²²² Li, Tripe, e Malone, «Measuring Bank Risk», 2017.

²²³ Lee, Chen, e Zeng, «Bank Income Diversification, Asset Correlation and Systemic Risk», 2020.

²²⁴ Li, Tripe, e Malone, «Measuring Bank Risk», 2017.

²²⁵ ECB, «Why do banks need to hold capital?», last access: 24th July 2022, https://www.bankingsupervision.europa.eu/about/ssmexplained/html/hold_capital.en.html.

²²⁶ Lee, Chen, e Zeng, «Bank Income Diversification, Asset Correlation and Systemic Risk», 2020.

²²⁷ Martin Čihák et al., «Benchmarking Financial Systems around the World», 2012.

level, by measuring the probability of banks' simultaneous failures²²⁸ and it also allows to analyze the default risk of different groups of institutions²²⁹.

One of Z-score limitations, especially in the case of this thesis, where all the several Eurozone's countries are considered, is represented by the difference in the accounting standards and rules applied in the various states, by each single bank. As a result, the determination of the total assets, equity or net income value will be influenced by subjective assessment and theoretical assumptions and, therefore, it may be difficult to make a comparison among them²³⁰. What's more, accounting data can be easily smoothed out by banks and, consequently, a too positive assessment could be given to their stability level²³¹.

In order to run the OLS regression, Z-score data have been downloaded from the Federal Reserve Bank of st. Louis' official website, which, in turn, is based on the Global Financial Development Database, that provides information concerning different aspects of financial institutions and markets²³². More to the point, Z-scores for banks belonging to the Eurozone are available from 1996 to 2015. For the purpose of the analysis, values from 2000 to 2015 have been considered, since data regarding the main regressor, that is the ECB transparency index, are available only from 1998. Moreover, in order to also investigate the systemic risk level of the most recent years, Z-scores from 2016 to 2020 have been computed by this dissertation's author, following the same procedure adopted by the Federal Reserve Bank of st. Louis. Better explained, annual data for net income, total assets and the equity/total assets ratio of commercial, savings, cooperative, investment banks and real estate & mortgage financial institutions of Eurozone countries have been retrieved, in millions of euros, from Bankfocus. Islamic banks have been excluded from the model, since they apply principles in accordance with the Sharia's Law, which is a body of religious rules belonging to the Islamic tradition. Therefore, they present important differences with respect to conventional banks, as they are not allowed to charge or receive interests on loans, to take part into speculative transactions, involving, for instance, derivatives, and to finance businesses or projects, which have to do with goods or services not accepted by Islamic principles, such as pork or alcohol. In addition, they apply the profit and loss sharing rule, according to which the Islamic bank collects (or deducts) a predetermined percentage of the profits (or losses) of a company, along with the financed capital. As a consequence, the adoption of such principles determines the taking of risks in a

²²⁸ Lee, Chen, e Zeng, «Bank Income Diversification, Asset Correlation and Systemic Risk», 2020.

²²⁹ Čihák et al., «Benchmarking Financial Systems around the World», 2012.

²³⁰ Li, Tripe, e Malone, «Measuring Bank Risk», 2017.

²³¹ Čihák et al., «Benchmarking Financial Systems around the World», 2012.

²³² FRED, «Bank Z-Score for Euro Area», last access: 1st August 2022, <https://fred.stlouisfed.org/series/DDSI01EZA645NWDB>.

different magnitude with respect to traditional banks. It is the case of liquidity risk, which is much more accentuated for Islamic banks, since they have a limited access to money markets, in order to raise funds to face liquidity shortages²³³. Furthermore, even if Islamic financial sector is expanding, the presence in Europe is still marginal and, therefore, for the purpose of this dissertation, it can be neglected²³⁴. What's more, as specified by the Global Financial Development Database, unconsolidated data for each bank, coming from integrated balance sheets, meaning that intra-group transactions are compensated, have been considered, resulting in a sample of 460 Eurozone banks.

The ROA of each bank, for each year from 2016 to 2020, and, afterwards, the annual ROA's standard deviations, have been computed. Then, the single Z-score for each bank, in each year, has been calculated by applying the formula $(ROA + (equity/assets))/sd(ROA)$, implemented also by the Global Financial Development Database. Subsequently, the weight of each single financial institution has been retrieved by taking the ratio of its total assets' value, in a given year, over the sum of all the total assets of all the sample banks, in that particular year. Finally, the weighted average of the Z-score for each single bank, in a given year, has been computed. Results provide the value of the aggregate Z-score for Eurozone banks, over the years 2016-2020, which will complement the Z-scores downloaded from the Fred's official website.

This procedure is characterized by some limits, as the possible different sample of banks that has been considered by Fred to compute the annual Z-scores, due to the fact that, over the years 2000-2020, some banks could have defaulted, others could have been incorporated into groups and others could be of a more recent origin, instead. Besides, another limitation is represented by some divergencies in the definitions of ROA, net income or equity that have been applied. However, during the Z-score computation for the years 2016-2020, the method followed by Fred has been repeated in a peculiar manner, in order to obtain values as similar as possible to those downloaded from the official website. Moreover, the obtained longer historical time series entails a higher number of observations, which, in turn, allow to better analyze the relationship between the Eurozone's systemic risk level and the ECB transparency.

²³³ M. Kabir Hassan, Ashraf Khan, e Andrea Paltrinieri, «Liquidity Risk, Credit Risk and Stability in Islamic and Conventional Banks», *Research in International Business and Finance* 48 (1st April 2019): 17–31, <https://doi.org/10.1016/j.ribaf.2018.10.006>.

²³⁴ Filippo di Mauro et al., «Islamic Finance in Europe», 2013, 74.

3.1.2 Central Bank transparency index

Central Bank transparency index, which is the main regressor of the model, has been intensively implemented in the literature, as a measure of the level of clearness and openness of Central Banks. As explained in the second chapter, the index was introduced in 2006 by Eijffinger and Geraats and, during years, it has been modified by several authors, like Dincer and Eichengreen. The index values, that will be considered in this dissertation, come from an updated version, proposed by Dincer, Eichengreen and Geraats in March 2022, of their previously elaborated transparency index, published on the book “The Oxford Handbook of the Economics of Central Banking”, in 2019.

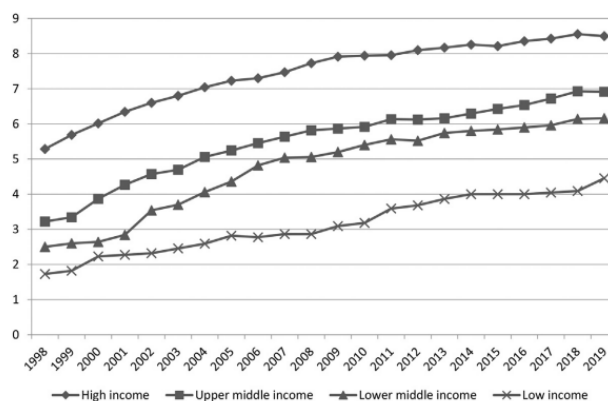
The index deals with the five transparency dimensions of the monetary policy process, that were theorized by Geraats, in 2002, in the paper “Central Bank transparency” and, afterwards, implemented to compute the first transparency index. Political transparency entails communications regarding official objectives, both in qualitative and quantitative terms, as well as prioritizing multiple goals. Economic transparency, instead, concerns the set of economic data and models, that support monetary authorities in making forecasts and in evaluating the efficiency of their decisions. The third dimension, procedural transparency, involves disclosures about the applied strategy, for a given deliberation, and information regarding the monetary policy framework. On the other hand, policy transparency refers to Central Bank communications of their policy decisions, together with the proper reasons. Furthermore, this fourth dimension also considers whether or not Central Banks adopt forward guidance. Finally, operational transparency requires information disclosure concerning obstacles in achieving the established targets and, more generally, problems during the execution of policy decisions.

As regard the structure of the index, each transparency dimension is investigated by three different questions, for which three answers are provided. For each question, the answers are assigned a score of 0, $\frac{1}{2}$ or 1, that will be attributed depending on the degree of openness of each Central Bank. Therefore, each transparency dimension can record a maximum score of 3, for a total of 15 for the overall index, which, in addition, requires information published in English only, since it is the language of international financial markets. The entire formulation of the monetary policy transparency index is available in the appendix of the dissertation.

The last updated version of March 2022 was computed for 112 Central Banks, involving almost 150 countries, from 1998 to 2019. As already said, the transparency index is based on the same framework, presented by the authors in 2019, which is characterized by some modifications with respect to precedent works. For instance, it concentrates on the monetary policy only, as a separate Central Bank function from others, such as the supervision and macroprudential policy

ones. Moreover, the adopted tighter and more demanding criteria, which are a consequence of the Great Financial Crisis, point out the relevance of timely and transparent information to better reduce uncertainties and risks in the system.

Figure 1: Transparency in Monetary Policy by Level of Economic Development (unweighted average)



Source: Authors' calculations.

Note: Unweighted average monetary policy transparency index across central banks grouped by World Bank income classification (for fiscal year 2019). ECCU (Eastern Caribbean Currency Union), CEMAC (Central African Economic and Monetary Community), and WAEMU (West African Economic and Monetary Union) were classified by using GNI in U.S. dollars and population data of each country to compute GNI per capita for the region.

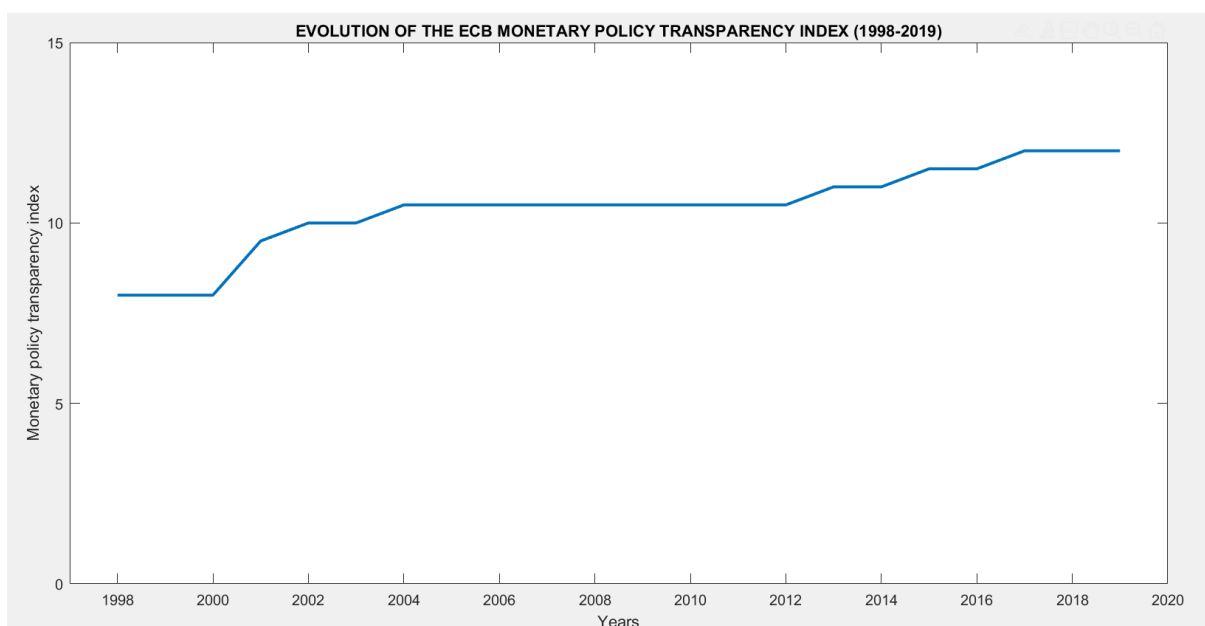
Source: Nergiz Dincer, Barry Eichengreen, e Petra Geraats, «Trends in Monetary Policy Transparency: Further Updates», 2022, *International Journal of Central Banking*

The Figure 1 shows the evolution of transparency in monetary policy, from 1998 to 2019, for high-income, upper-middle-income, lower-middle-income and low-income countries. The classification is based on the one provided by the World Bank for the fiscal year 2019, according to which all the Eurozone countries belong to the high-income class. As it is possible to notice, the transparency level, for all the Central Banks, shows an upward trend over years. This is consistent with the economic development, the increase of the importance of monetary policy authority's role in guiding market expectations and the relevance that transparency has acquired, in particular after the Great Financial Crisis, as a fundamental tool to guarantee the stability of the system. What's more, the positive relationship between monetary policy transparency and the income level could be explained by the society development and, as a consequence, the related degree of complexity of the economic system. Advanced countries, for instance, are characterized by more sophisticated economies, which, in turn, require a higher amount of information regarding macroeconomic data, policy targets, policy decisions or forecasts about future developments. Hence, the considered Central Banks have been able to enhance their transparency level, according to the economic evolution of the countries for which they manage the monetary policy. However, according to authors' results, none of the high-

income countries Central Banks, which enjoy the greatest values for the index, has achieved the highest score of 15, which suggests that there is still room for improvement²³⁵.

Since the empirical analysis, that will follow, concerns the Eurozone systemic risk and the European Central Bank transparency level, the Figure 2 illustrates the evolution of the monetary policy transparency index, computed by Dincer, Eichengreen and Geraats, from 1998 to 2019, for the ECB only, while, in the appendix, the scores attributed to each question by the authors are provided.

Figure 2: Evolution of the ECB monetary policy transparency index (1998-2019)



Source: Author's elaboration with MATLAB

During years, the ECB has increased its transparency level from a total score of 8, in 1998, up to 12, in 2019, for a total increment of 50%. From its birth, the ECB has recorded a pretty high level of openness, which highlights its commitment in communicating policy actions, economic decisions, with the related reasons, to market participants and the general public. More to the point, the main adopted tool was the press conference, which was considered as a timely tool to convey Governing Council's deliberations. Afterwards, the index jumped by two and a half points, in the next five years. Indeed, during the first period of its mandate, in order to comply with the article 127 of the Treaty of the Functioning of the European Union (TFEU), which stated as primary monetary policy objective the maintenance of price stability, the ECB rose its level of transparency, with the aim to acquire credibility among investors and market

²³⁵ Nergiz Dincer, Barry Eichengreen, e Petra Geraats, «Trends in Monetary Policy Transparency: Further Updates», *International Journal of Central Banking* 18, n. 1 (2022): 18.

participants²³⁶. Moreover, after the start of the European Monetary Union (EMU), in 1999, the ECB had to deal with several uncertainties regarding alterations in the monetary policy transmission mechanism, that entails the channels through which policy decisions influence the price and output levels, and the limited amount of harmonized macroeconomic data, that could be implemented to make forecasts about the future economic development, after the introduction of a single common currency. In order to face this unclear environment, a precise monetary policy strategy was needed, not only to assess the economic outlook and the risks to price stability, but also to identify the communication tools to be enforced. The disclosure to the public of internal analyses and decisions enhanced the transparency level and allowed the ECB to face those early challenges²³⁷. Finally, the index improvement is also due some European Parliament disclosure requirements, such as macroeconomic forecasts or econometric models²³⁸. Going further with the analysis of the evolution of the ECB transparency level, it is possible to notice that the index score is equal to 10,5 for a period of time that involves both the Great Financial Crisis and the European Sovereign Debt Crisis. The lack of a transparency upgrade is explained by the degree of financial distress and instability, which characterized these years. Indeed, the ECB had to intervene with conventional and unconventional monetary policy instruments, in order to satisfy the higher liquidity demand and to give credit to households and companies. In addition, right after the crises, the main ECB focus was the identifications of problems in the monetary policy transmission mechanism, together with the investigation of leverage, capital and liquidity situations of Euro Area banks. Therefore, there was little space for transparency improvement. Finally, from 2013 to 2019, the transparency index increases up to 12 points. During this period, in order to boost the inflation growth and to reduce the deflation risk, ECB monetary policy became more complicated and, therefore, a higher degree of openness was needed. Interest rates were lowered to negative values, long term refinancing operations and asset purchase programs were introduced to facilitate credit access and to supply liquidity. As a consequence, monetary policy transparency rose thanks to, for example, the implementation, in 2013 of the forward guidance, to define the future ECB intentions related to interest rates. Furthermore, in 2015, the Monthly Bulletin, which reported an assessment of the economic outlook and monetary developments, started to be released and

²³⁶ Philipp Hartmann e Frank Smets, «The First 20 Years of the European Central Bank: Monetary Policy», *Brookings Papers on Economic Activity*, 2018, 70.

²³⁷ Otmar Issing, «The ECB and the Euro—the First 6 Years: A View from the ECB», *Journal of Policy Modeling*, The Euro, the Dollar and the International Monetary System, 27, n. 4 (1st June 2005): 405–20, <https://doi.org/10.1016/j.jpolmod.2005.04.006>.

²³⁸ Sylvester C. W. Eijffinger e Petra M. Geraats, «How Transparent are Central Banks?», February 2002, <http://socionet.ru/publication.xml?h=repec:cpr:ceprdp:3188>.

an account of each Governing Council's meeting would have been published²³⁹. Of course, as already explained, the index increase was also triggered by the acquired awareness, after the 2008 crisis, of the importance of Central Bank transparency in reducing uncertainties and preventing financial distress.

Considering now the five different transparency dimensions, the political one recorded the highest score, equal to 3, for the entire sample period. This result points out not only the clear ECB communication, since its outset, about its qualitative and quantitative monetary policy objectives, but also the ECB ability to maintain stable, over years, this initial, high, political transparency level. On the contrary, the lowest score was assigned to the procedural transparency, which reached its highest value, of only 1.5, in 2015. This result suggests that, even if the ECB openly disclosed its strategy, and any eventual revision, to better describe its monetary policy framework, as well as its monetary policy strategy statement, through which its principal goal, the appropriate indicator to assess the achievement of it, monetary policy measures to be implemented and the medium-term orientation of the monetary policy strategy are communicated²⁴⁰, lack in procedural transparency was substantial. Indeed, until 2014, the accounts of monetary policy deliberations and meetings were released after more than eight weeks, or they were not disclosed at all. On the other hand, from 2015 onward, such accounts started to be published with a delay of one month with respect to the policy meeting date²⁴¹. Nevertheless, according to how Dincer, Eichengreen and Geraats have structured the index, this is not enough to gain a whole point.

Moreover, for all the sample period, ECB's voting records are not released, or they are released with a substantial lag. This type of disclosure would allow minority members to publicly expose their different view about the monetary policy management and, in addition, it would provide a track record of individual votes, through which the competence of each member could be assessed²⁴². On the other hand, a sense of diversity inside the Committee could be spread among the public, due to the disclosure of the different voting²⁴³. Moreover, in the case of a monetary union, as the Eurozone, central bankers would be induced, by their own governments, to act according to their national interest. Thus, the absence of ECB voting records publication could

²³⁹ Hartmann e Smets, «The First 20 Years of the European Central Bank: Monetary Policy», 2018.

²⁴⁰ ECB, «The ECB's monetary policy strategy statement», last access: 14th July 2022, https://www.ecb.europa.eu/home/search/review/html/ecb.strategyreview_monpol_strategy_statement.en.html.

²⁴¹ ECB, «Monetary policy accounts», last access: 14th July 2022, <https://www.ecb.europa.eu/press/accounts/html/index.en.html>.

²⁴² Hans Gersbach e Volker Hahn, «Should the Individual Voting Records of Central Bankers Be Published?», *Social Choice and Welfare* 30, n. 4 (May 2008): 655–83, <https://doi.org/10.1007/s00355-007-0259-7>.

²⁴³ Alexander Jung, «An International Comparison of Voting by Committees», *SSRN Electronic Journal*, 2011, <https://doi.org/10.2139/ssrn.1932206>.

be justified by the willingness to avoid an outside pressure on the committee members²⁴⁴. Considering, then, the economic transparency, the final score is, on average, pretty high, equal to 2.5. Interesting is the half point attributed, during all the sample period, to the first question of this dimension, regarding the publicly availability of relevant economic data. In fact, the ECB publishes, through the Economic Bulletins and articles, estimates of the Euro Area output gap, but it does not respect the quarterly frequency, which is a necessary requisite to get the whole point²⁴⁵. As regard the policy transparency, the score of 2 dominates for the majority of the considered time period, with an increase up to 3 from 2017 onward. Such improvement is mainly determined by the adoption of the forward guidance, in order to communicate the future direction of the monetary policy. More to the point, from 2014 to 2016, the ECB released qualitative statements and, therefore, a half point has been assigned, which increased up to one, from 2017, thanks to the implementation of a quantitative forward guidance, which entails the disclosure of policy rate's forecasts. In the end, also the operational transparency recorded an average score of 2 over the sample period. The particularity of this fifth dimension lies in the whole point obtained in the first question, which investigates whether or not the Central Bank evaluates its monetary policy performance. Indeed, since 1998, the ECB monitors and communicates the achievement of the 2% inflation target, together with positive or negative deviations from it, which are equally undesirable²⁴⁶. Furthermore, the monetary policy instruments, as asset purchases, long-term refinancing operations, negative interest rates or forward guidance, are kept under control and the ECB is perfectly aware about their benefits and costs²⁴⁷.

3.1.2.1 New computed index

After having analyzed the ECB transparency index results, the aim of this subsection is to propose a new version of the same index, presented by Dincer, Eichengreen and Geraats in 2019, for the ECB.

The index structure will be modified by adding a sixth dimension of transparency, which will involve three additional questions, for the entire, original sample period (1998-2019). The score assigned to this new dimension will be then summed with the transparency index values, published in 2022. The idea comes from the acknowledgement of Dincer, Eichengreen and Geraats, in their paper “Trends in Monetary Policy Transparency: Further Updates”, released

²⁴⁴ Gersbach e Hahn, «Should the Individual Voting Records of Central Bankers Be Published?», 2008.

²⁴⁵ ECB, «Potential output in the post-crisis period», last access: 14th July 2022, https://www.ecb.europa.eu/pub/economic-bulletin/articles/2018/html/ecb.ebart201807_01.en.html.

²⁴⁶ ECB, «Two per cent inflation target», s.d., last access: 14th July 2022.

²⁴⁷ ECB, «Our monetary policy instruments and the strategy review», last access 14th July 2022, <https://www.ecb.europa.eu/home/search/review/html/monetary-policy-instruments.en.html>.

in March 2022, together with the new transparency index results, of the multiple functions performed by Central Banks. Indeed, they not only manage monetary policy, but they also deal with supervisory, micro and macroprudential matters. Since the two roles of monetary and supervisory authority vary in terms of objectives, tasks and activities, the criteria to assess their transparency level would differ as well. Therefore, it seems interesting to modify the until now considered index, by adding a supervisory transparency dimension, in order to obtain a more comprehensive transparency index, which assesses the ECB clearness and openness level in performing its two main tasks. Of course, the new index will contain a subjective component, since the questions and the criteria to assess the ECB's supervisory transparency have been developed by the dissertation's author. Moreover, it is important to highlight that, this is not the first analysis of financial stability transparency in the literature. First, in 2006, on the paper "Transparency of Central Banks in Supporting Financial Stability", Paulina Sotomska-Krzysztofik and Olga Szczepanska proposed a Central Bank transparency index, concerning the financial stability field. What's more, Roman Horváth and Dan Vasko also elaborated and published, in 2016, a financial stability transparency index on the paper "Central bank transparency and financial stability". Nevertheless, to the knowledge of the dissertation's author, this is the first time that a comprehensive index, which considers both monetary and supervisory activities, is elaborated. Obviously, this is not the only possible version; actually, the hope is that many others will be proposed and further investigated in the future, in order to enrich Central Bank transparency literature.

The structure of the new supervisory transparency dimension is the following, while table 1 will provide the score attributed to each new question and the final ECB comprehensive transparency index, from 1998 to 2019.

6.1 Presence of internal bodies devoted to the financial stability/supervisory issue

- Yes – 1
- No - 0

6.2 FSRs coverage

- Macroeconomic environment and its risks, macroeconomic indicators-0,33
- Financial markets and market-based indicators-0,33
- Other information about banking sector, financial non-banking sector and non-financial sector + micro-prudential indicators-0,33

6.3 Other tools to convey information about financial stability/banking supervision

- Speeches/interviews/press releases about financial stability/banking supervision-1/2
- Web page dedicated to financial stability/banking supervision-1/2

Table 1: Computation of the new comprehensive transparency index

Year	Monetary policy transparency index	6.1	6.2	6.3	Total point 6	New comprehensive transparency index
1998	8	0	0	0	0	8
1999	8	0	0	0	0	8
2000	8	0	0	0	0	8
2001	9,5	0	0	0	0	9,5
2002	10	0	0	0	0	10
2003	10	0	0	0	0	10
2004	10,5	0	1	0	1	11,5
2005	10,5	0	1	0	1	11,5
2006	10,5	0	1	0	1	11,5
2007	10,5	0	1	0	1	11,5
2008	10,5	0	1	0	1	11,5
2009	10,5	0	1	0	1	11,5
2010	10,5	0	1	0	1	11,5
2011	10,5	0	1	0	1	11,5
2012	10,5	0	1	0	1	11,5
2013	11	0	1	0	1	12
2014	11	1	1	1	3	14
2015	11,5	1	1	1	3	14,5
2016	11,5	1	1	1	3	14,5
2017	12	1	1	1	3	15
2018	12	1	1	1	3	15
2019	12	1	1	1	3	15

Source: Author's elaboration

From Table 1 it is possible to notice that, as in the case of the monetary policy transparency index structure, each question can record a maximum value of 1, for a total score of 3. Hence, the range of the new comprehensive index goes from 0 to 18 now.

The first question refers to the presence of an internal ECB body, which is in charge of managing supervisory matters. A separate committee would increase its clearness level, as who oversees financial stability issues would be straight identified to the market. In addition, the ECB would be made responsible not only from an operational, but also from a communication point of view. Indeed, among the several duties, there would also be the one related to the release of news regarding supervisory problems, the associated decisions, the assessment of the compliance by supervised entities with the micro-prudential requirements and the degree of Eurozone financial system stability²⁴⁸. Before 2014, the attributed point is zero, as an internal committee devoted to banking supervision did not exist, even if the ECB could perform prudential supervisory tasks. Better explained, according to the article 127(6) of the TFEU, the European Council, through a Council legal act and after consulting the European Parliament and the ECB itself, could mandate the ECB to carry out supervisory activities. Only in 2014,

²⁴⁸ Horváth e Vaško, «Central Bank Transparency and Financial Stability», 2016.

when the Single Supervisory Mechanism (SSM) was implemented, the ECB became responsible to directly supervise all the Eurozone credit institutions. Furthermore, since the Governing Council, which would have been the only constitutional decision-making body regarding financial stability matters, could have encountered difficulties, in terms of decisions efficiency and the correct attention level to be devoted to both the monetary and supervisory ECB activities, the SSM introduced an internal body, the Supervisory Board, which was, and still is, “competent to set and implement the agenda with respect to the ECB’s supervisory activities (i.e. planning, execution and preparation), and it has the exclusive right to initiate the ECB’s supervisory decision-making process”. In fact, it submits to the Governing Council draft decisions, which are then adopted, following the non-objection rule. In other words, the Governing Council can decide to approve or object to them, by giving a monetary policy motivation and without the possibility to change them. This procedure has been adopted to avoid amendments to the TFEU, according to which the ECB has three decision-making bodies: the Governing Council, the Executive Board and the General Council. Thus, supervisory decisions, introduced by the Supervisory Board, are formally adopted by the Governing Council²⁴⁹. Consequently, the score of one is gained from 2014 onward.

With reference to the second question of the new supervisory transparency dimension, the Financial Stability Review coverage is investigated. As highlighted in the second chapter, FSRs provide, by computing and analyzing quantitative indicators, established by the International Monetary Fund, an assessment of the macroeconomic conditions of the supervised area²⁵⁰ and of the soundness of the financial system. Moreover, some adverse trends, that could increase the systemic risk level, are identified²⁵¹. As regard the score, 0,33 is attributed if, in a given year, both the two published FSRs present references to the macroeconomic environment, together with macroeconomic indicators. Examples are economic growth, inflation, spillovers among financial institutions, exchange rates and current account imbalances. On the other hand, the second 0,33 is gained if the ECB has included market-based indicators, such as data about the stock and bond markets, credit default swaps, credit ratings or derivative contracts, in order to investigate the financial market stability. In the end, the presence of information about, not only the banking system, but also the non-banking financial sector, such as insurance companies, pension and hedge funds, and the non-financial sector, like corporates and households, determines the attribution of the third 0,33 score. In particular, micro-prudential

²⁴⁹ Jakub Gren, «The Eurosystem and the Single Supervisory Mechanism: Institutional Continuity Under Constitutional Constraints», *SSRN Electronic Journal*, 2018, <https://doi.org/10.2139/ssrn.3211852>.

²⁵⁰ Horváth e Vaško, «Central Bank Transparency and Financial Stability», 2016.

²⁵¹ Born, Ehrmann, e Fratzscher, «Central Bank Communication on Financial Stability», 2014.

indicators, like return on equity, capital ratios, the presence of non-performing loans, corporate profitability, household indebtedness or interest rate risk are considered. Moreover, the 0,33 score has been assigned, for all the three specifications, also in the case in which the information is conveyed through infographics only. Indeed, as explained in the second chapter, they facilitate the understanding of the message and, as a consequence, they contribute to the transparency of ECB's communication²⁵². The total point of one is associated to the years, during which the ECB has included, in both the two published FSRs, all these information, suggesting a highly transparent communication regarding financial stability. Exception has been made for the year 2004, which collects only the first FSRs to be released. On the contrary, the score of zero has been assigned to the previous years²⁵³. In order to answer the question, all the FSRs published on the official ECB website, from 2004 to 2019, have been investigated²⁵⁴.

Finally, the third question is willing to evaluate the implementation of communication tools, in order to convey information about the financial stability of the system. The first half point is attributed if, in a given year, the ECB has delivered speeches, interviews and press releases about banking supervision matters and, subsequently, the content has been published on its official website. Since a higher number of adopted tools guarantees a major information diffusion and increases the possibility of hearing a news multiple times, it is important that all the three indicated communication instruments have been employed in the same year. In this case, in order to assign the score, an approximation has been used. Indeed, as from 2014, the ECB is responsible for the banking supervision, it has been assumed that, since that year, it releases communications regarding the financial system stability. The information to answer the question has been retrieved from the ECB official website, which provides a list of speeches, interviews and press releases, starting exactly from 2014. Thus, the half point has been attributed from that year. The second half point is assigned if, on the ECB official website, a special section is dedicated to the banking supervision. In fact, as explained in the second chapter, the presence of a separate financial stability part, on the website, points out the relevance of this issue in a Central Bank's information policy. What's more, since, through the website, visitors are able to have quickly access to news and updates regarding the ECB supervisory function, its level of openness is further enhanced²⁵⁵. In order to assign this second

²⁵² Assenmacher et al., «Clear, Consistent and Engaging», 2021.

²⁵³ Dirk Schoenmaker, «The ECB, Financial Supervision, and Financial Stability Management», *The European Central Bank at Ten*, 16th September 2010, 171–93, https://doi.org/10.1007/978-3-642-14237-6_7.

²⁵⁴ ECB, «Financial Stability Review», last access: 19th July 2022, https://www.ecb.europa.eu/pub/financial-stability/fsr/html/all_releases.en.html.

²⁵⁵ Sotomska-Krzysztofik e Szczepanska, «Transparency of Central Banks in Supporting Financial Stability», 2006.

half point, the same approximation explained before has been implemented. It has been assumed that when the ECB acquired the role of supervisory authority, a banking supervision section had been created on its website. Therefore, the second half point is assigned from 2014 too.

Before analyzing the new value of the comprehensive transparency index, it is important to highlight that, one important information is missing from the just presented sixth dimension. It is the case of stress test results. Indeed, as regard the Eurozone, they are not run and published by the ECB only; but they are performed by the European Banking Authority (EBA), in cooperation with the European Systemic Risk Board (ESRB), the ECB and the European Commission (EC). Consequently, as the index specifically refers to the transparency of the Central Bank solely, the author of the dissertation preferred to exclude this information from the new comprehensive index, in order to avoid ambiguities.

Overall, the new supervisory transparency dimension has increased in value over the sample period. During the first years after its outset, the ECB recorded a total score of zero, probably because, even if the contribution to the implementation of supervisory policies, pursued by competent authorities, was among its tasks, it was not much committed to the financial stability issue. Indeed, the ECB was first assigned the monetary policy mandate, while other roles, such as the prudential one, were secondary. Thus, the ECB did not have an internal supervisory committee, it did not disclose FSRs, nor speeches, interviews or press releases and the website did not present a section devoted to the banking supervision²⁵⁶. The transparency level increased from 2004, instead, when the ECB started to publish FSRs, which have always been rich in the amount of the conveyed information. In fact, the score of one has always been attributed from 2004 onward, as all the FSRs provided information and data regarding the macroeconomic environment, the financial market development and the related risks and vulnerabilities, together with micro-prudential indicators for the banking, non-banking financial sector and non-financial sector. The publication of FSRs signals the ECB contribution to the implementation of supervisory policies and to the maintenance of the financial stability system, as disposed by the TFEU²⁵⁷. Moreover, the cooperation between the competent authorities, in charge of banking supervision, as well as their transparency level are boosted²⁵⁸. In the end, from 2014, the sixth dimension of transparency enjoyed the maximum score of 3, which points

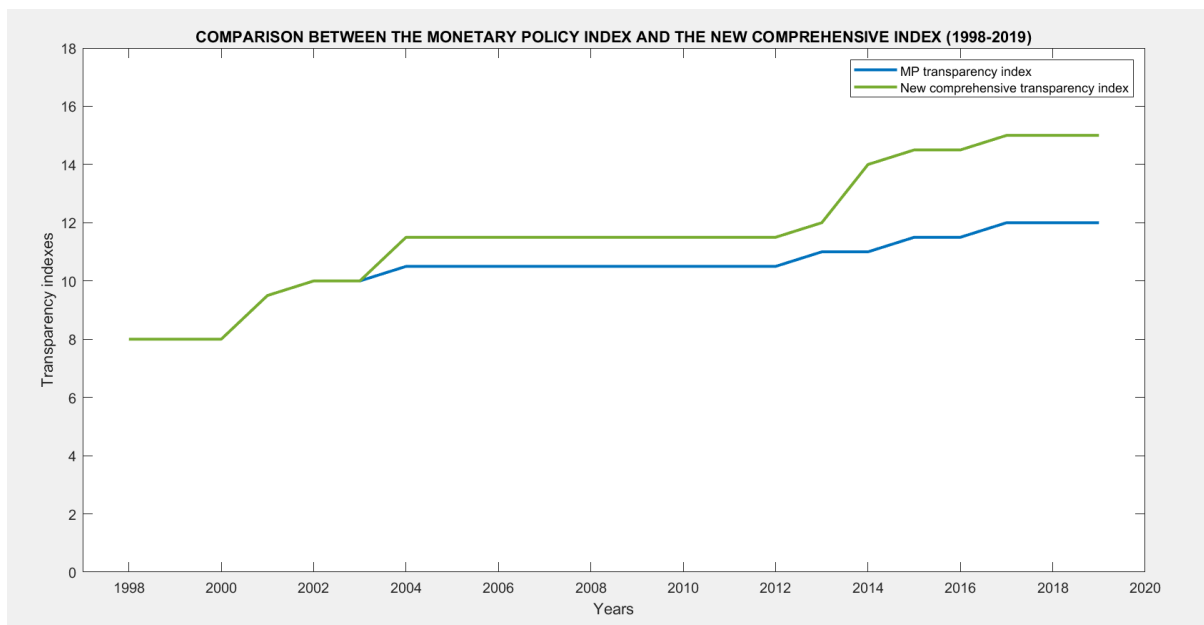
²⁵⁶ Hartmann e Smets, «The First 20 Years of the European Central Bank: Monetary Policy», 2018.

²⁵⁷ ECB, «ESCB Legal Conference», 2018.

²⁵⁸ Sander Oosterloo, Jakob de Haan, e Richard Jong-A-Pin, «Financial Stability Reviews: A First Empirical Analysis», *Journal of Financial Stability* 2, n. 4 (1st March 2007): 337–55, <https://doi.org/10.1016/j.jfs.2006.11.001>.

out the relevance of financial stability in the ECB’s communication policy. Indeed, thanks to the responsibilities, acquired after the SSM implementation, the ECB kept on publishing FSRs and started to convey supervisory information through speeches, interviews, press releases and its website. Furthermore, the Supervisory Board was established as an internal body concerned with the planning, the execution and the communication of the ECB supervisory tasks²⁵⁹.

Figure 3: Comparison between the monetary policy index and the new comprehensive index (1998-2019)



Source: Author’s elaboration with MATLAB

The Figure 3 shows a comparison between the monetary policy transparency index, provided by Dincer, Eichengreen and Geraats in March 2022, and the new comprehensive index, personally computed. Since, during the first years of the sample period, the sixth supervisory transparency dimension records a score of zero, both indexes coincide up to 2003. Basically, the new comprehensive index is composed by the monetary policy dimensions only, because, as explained, financial stability was not an ECB prerogative right after its outset. The small gap between the monetary policy index and the comprehensive one, during the years 2004-2014, is determined by the FSRs publication. In addition, also the new computed index shows a constant evolution during the Great Financial Crisis and the European Sovereign Debt Crisis. Again, the reason could lie in the scarce attention that the ECB was able to dedicate to the transparency issue during that time. Afterwards, from 2014, the gap widens, thanks to the major ECB commitment in banking supervision matters and the awareness, acquired after the 2008 crisis,

²⁵⁹ Gren, «The Eurosystem and the Single Supervisory Mechanism: Institutional Continuity Under Constitutional Constraints», 2018.

of the relevance of financial stability communication, in order to prevent systemic shocks and to guarantee the soundness of financial institutions²⁶⁰.

3.1.3 Macro controls

Other explanatory variables included in the OLS regression are some Eurozone's macroeconomic controls, which could influence the systemic risk level and, therefore, their effect has been considered in a steady state scenario. The aim is to exploit the contribution of other variables to the Z-score under the ceteris paribus condition. Besides, by adding and subtracting these controls, it is possible to observe whether the estimates change or not and to appreciate their level of robustness.

The first macro control concerns the Eurozone's annual GDP growth, which measures the yearly change of the economic output for the Euro Area countries. It indicates how fast an economy is growing and, as a consequence, the population's well-being level. In particular, according to the literature, crises in the banking sector usually occur when the GDP growth is lower; hence, a fall in GDP growth would rise banks' distress probability, which, in turn, would lead to systemic problems²⁶¹. A possible explanation is supplied by Robert A. Jarrow, in the paper "Financial Crises and Economic Growth", published in 2014, according to which, during periods of economic downturn, households and firms could have difficulties in paying back banks' loans. As a result, banks' credit risk increases and higher capital requirements are needed. Consequently, financial institutions with a lower capitalization would contribute to the increment of systemic risk, as they may not have the necessary capital to absorb credit losses. What's more, if the asset value falls, because agents are not able to respect their obligations, banks could encounter difficulties in paying back their debts, which are, in turn, assets for other financial institutions. Subsequently, a spiral of asset devaluations would be created. Such result is confirmed also by another important research, which is the one of Helder Ferreira de Mendonça and Rafael Bernardo da Silva (2018), who provided evidence of a positive relationship between economic growth and financial stability, measured through the ΔCOVAR , in the paper "Effect of banking and macroeconomic variables on systemic risk: An application of ΔCOVAR for an emerging economy". Eurozone's GDP growth annual data, for the years 1999-2019, have been downloaded from the World Bank's official website. Data represent the percentage change in Eurozone GDP, computed on euro currency²⁶².

²⁶⁰ Born, Ehrmann, e Fratzscher, «Central Bank Communication on Financial Stability», 2014.

²⁶¹ Mario Quagliariello, «Does macroeconomy affect bank stability? A review of the empirical evidence», *Journal of Banking Regulation*, 2008, <https://link.springer.com/article/10.1057/jbr.2008.4>.

²⁶² THE WORLD BANK, «GDP growth (annual %)-Euro area», last access: 2nd August 2022, <https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG?locations=XC>.

The second macroeconomic regressor is the Euro Area's annual inflation level, measured by the consumer price index (CPI), which provides the percentage change in the cost of acquiring a given basket of goods and services for an average consumer. Inflation reflects the general, average increase in prices over a prolonged period of time and, simultaneously, the reduction of money's purchasing power. Always referring to the literature, a lower inflation rate usually determines a more stable macroeconomic environment and, as a result, a reduced probability of banking crises²⁶³, or, on the contrary, a high inflation level is associated with a high systemic risk. In fact, higher prices would reduce households and companies purchasing power and, consequently, problems with loans repayment could arise, if wages and income do not grow enough to balance the increase of consumption and investment costs. Again, the increment in banks' credit risk would entail more capital requirements, in order to try to contain the enhanced systemic risk level²⁶⁴. Besides, due to the overall increase of prices, loan demand would diminish, as household would consume less and, at the same time, firms would reduce their investments. Therefore, financial institutions would reduce their lending activity, their revenue would be lower, capital would be allocated in a less efficient manner, financial markets would become less liquid and the probability of fire sales would rise²⁶⁵. Moreover, high inflation increases asymmetric information among borrowers and lenders, since computing the future real returns become more difficult. As a result, expectations turn out to be of poor quality and, therefore, they could trigger over-investments, asset bubbles and excessive credit growth²⁶⁶. Eurozone's annual inflation data, for the years 1999-2019, have been retrieved from the World Bank's official website too. The unit of measure is, again, the yearly percentage change and it is reported on 100 bases²⁶⁷.

Lastly, the third macro-explanatory variable is represented by the ratio between the consolidated Euro-system's assets and the Eurozone's GDP level. More to the point, Euro-system's assets, which comprehend both those held by National Central Banks and those by the ECB, with netted intra-Euro-system claims and liabilities, are normalized by taking as denominator the GDP level. Therefore, the annual size of Euro-system's assets is related to the

²⁶³ Tigran Poghosyan e Martin Čihak, «Determinants of Bank Distress in Europe: Evidence from a New Data Set», *Journal of Financial Services Research*, 2011, <https://link.springer.com/article/10.1007/s10693-011-0103-1>.

²⁶⁴ Benjamin Mosk e Peter Welz, «Financial stability implications of higher than expected inflation», last access: 9th august 2022, https://www.ecb.europa.eu/pub/financial-stability/fsr/focus/2022/html/ecb.fsrbox202205_03~df74747300.en.html.

²⁶⁵ John H. Boyd, Ross Levine, e Bruce D. Smith, «The Impact of Inflation on Financial Sector Performance», *Journal of Monetary Economics* 47, n. 2 (1st April 2001): 221–48, [https://doi.org/10.1016/S0304-3932\(01\)00049-6](https://doi.org/10.1016/S0304-3932(01)00049-6).

²⁶⁶ Otmar Issing, «Monetary and Financial Stability: Is there a Trade-off?» (BIS, 2003).

²⁶⁷ THE WORLD BANK, «Inflation, consumer prices (annual %)-Euro area», last access: 2th August 2022, <https://data.worldbank.org/indicator/FP.CPI.TOTL.ZG?locations=XC>.

Eurozone economic output of the same year, resulting in a percentage value. Hereafter, the expression “ECB total assets” will be adopted to indicate the Euro-system assets toward the Eurozone, as the ECB, which is participated by NCBs, manages monetary policy operations in the secondary market. Therefore, the ratio is assumed to indicate the incidence of ECB’s activities on the Eurozone output level. Over years, the ECB assets side and, consequently, that of the Euro-system, has substantially expanded due to several unconventional monetary policy tools, that have been undertaken, as underlined in the previous subsections, since the Great Financial Crisis, to face liquidity needs and support credit towards households and corporations. Indeed, the ratio grows during time, suggesting a higher incidence of the ECB’s activities over the GDP level, thanks, in fact, to measures such as asset purchase programs or long-term refinancing operations. These provisions, as already explained, have contributed to the increment of the ECB’s assets side during the several crises of the last twenty years, as the most recent Covid-19 Crisis, throughout which the ECB activity has been particularly intensified, resulting in an asset side value of more than 8 million in 2021²⁶⁸. With reference to the literature, the relationship between systemic risk and Central Bank’s balance sheet is negative, suggesting that an increment of the assets side is translated into a lower Eurozone systemic risk. Indeed, the adoption of unconventional monetary policy tools has increased the size of Central Bank’s balance sheet over the last years and, at the same time, these operations have contributed to the systemic risk mitigation, leading to a positive effect on financial stability²⁶⁹. On the other hand, other researches point out how an increase in Central Bank’s assets over GDP is positively associated with a higher systemic risk level²⁷⁰. A possible explanation lies in the higher risks undertaken by financial institutions, which implement a moral hazard behavior, as they rely on the ECB to provide liquidity in case of a distressed situation²⁷¹. With reference to data, total assets value for the Euro-system has been obtained, in millions of euros, from the ECB’s official website²⁷²; while the GDP level, at market prices, for the Eurozone countries has been downloaded from the Eurostat’s official website and it is always expressed in millions of euros. As in the case of the other regressors, the considered data cover the period 1999-2019²⁷³.

²⁶⁸ ECB, «Annual consolidated balance sheet of the Eurosystem», last access: 2nd August 2022, <https://www.ecb.europa.eu/pub/annual/balance/html/index.en.html>.

²⁶⁹ Maelle Vaille, «Central Bank Balance Sheet and Systemic Risk», 2021, 35.

²⁷⁰ Andrieş, Nistor, e Sprincean, «The Impact of Central Bank Transparency on Systemic Risk—Evidence from Central and Eastern Europe», 2020.

²⁷¹ Vaille, «Central Bank Balance Sheet and Systemic Risk», 2021.

²⁷² ECB, «Annual consolidated balance sheet of the Eurosystem», last access: 2nd August 2022, <https://www.ecb.europa.eu/pub/annual/balance/html/index.en.html>.

²⁷³ EUROSTAT, «GDP and main components», last access: 2nd August 2022, <https://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do>.

It is possible to notice a time lag between the historical period considered for the Z-score and the one for the independent variables. In fact, the Z-score's values have been retrieved for the period 2000-2020, while the regressors' data go from 1999 to 2019. This lag is not by chance obviously; it rather has been included in the analysis, in order to avoid potential problems due to reverse causality. This phenomenon deals with a possible inverse relationship between the dependent and the control variables, meaning that the latter are affected by the former, contrary to the original presumption, or it can also be associated with a two-way relationship among the predicted variable and the regressors, as if they all were in a loop. The presence of reverse causality would entail biased estimators due to an endogeneity problem. Actually, in the model presented in this dissertation, there could be some reverse causality episodes. Indeed, it might be that, as a consequence of a higher systemic risk in the banking sector, Central Banks decide to increase their transparency level, in order to better drive investors' expectations or to efficiently manage market's volatility²⁷⁴. Furthermore, an increment of the systemic risk level could generate a rise of low interest rates, which would lead to a fall in the output growth and inflation²⁷⁵. Indeed, several researches evidence a positive relationship between financial stability and macroeconomic variables, GDP and inflation. For instance, high capital ratios are associated with sound financial institutions, which are then able to finance, in a long-term perspective, the real sector, boosting economic growth. What's more, a low non-performing loans level points out a contained credit risk and the consequent banks' ability to keep on lending to the real sector and fostering GDP growth²⁷⁶. In addition, the increase of consumption and investments leads to higher price levels²⁷⁷. Besides, the unconventional monetary policy tools, that has been adopted by Central Banks to face crises, could be implemented to reduce financial turbulence in a given period, which shows a positive influence of financial imbalances on the ECB's asset side size²⁷⁸. By taking the explanatory variables lagged by one year, the possible causality of the Z-score on the regressors is avoided, as they belong to two different time periods and, therefore, they should not be much correlated.

²⁷⁴ Andrieș, Nistor, e Sprincean, «The Impact of Central Bank Transparency on Systemic Risk—Evidence from Central and Eastern Europe», 2020.

²⁷⁵ Alain Ntumba Kabundi e Francisco Nadal De Simone, «Effects on Growth and Inflation of the Unraveling of Systemic Risk in the Euro Area Banking Sector: Lessons from the Financial Crisis», SSRN Scholarly Paper (Rochester, NY, 8th January 2021), <https://doi.org/10.2139/ssrn.3565803>.

²⁷⁶ Lordina P. Manu et al., «Financial Stability and Economic Growth: A Cross-Country Study», *International Journal of Financial Services Management* 5, n. 2 (2011): 121, <https://doi.org/10.1504/IJFSM.2011.041920>.

²⁷⁷ Kabundi e Nadal De Simone, «Effects on Growth and Inflation of the Unraveling of Systemic Risk in the Euro Area Banking Sector», 2021.

²⁷⁸ Vaille, «Central Bank Balance Sheet and Systemic Risk», 2021.

3.2 Empirical results

After having described the adopted variables in details, it is the time to show analysis' empirical results. First of all, descriptive statistics and the correlation matrix will be presented and, afterwards, the estimated OLS coefficients will be interpreted, by controlling also for the heteroskedasticity and the multicollinearity.

3.2.1 Descriptive statistics

Before running the OLS regression, a brief analysis of the descriptive statistics for the dependent and the explanatory variables is presented in the Table 2.

Table 2: Descriptive statistics

Regressand and Regressors	Mean	Median	StDev	Min	Max	Skew	Kurt	Quant25	Quant50	Quant75
{'ZSCR' }	8.4407	10.12	3.277	1.5094	11.09	-1.1704	2.769	7.3358	10.12	10.617
{'ECBTI' }	11.857	11.5	2.1398	8	15	-0.0062435	2.2761	11.125	11.5	14.125
{'GDPg' }	1.4732	1.8345	1.779	-4.5211	3.8642	-1.8692	7.2608	0.87496	1.8345	2.3739
{'INFL' }	1.8884	2.0985	1.0744	0.037514	4.0753	-0.1534	2.4551	1.3411	2.0985	2.5324
{'ESTAGDP' }	0.20664	0.20524	0.11165	0.020044	0.40538	0.438	2.1114	0.11698	0.20524	0.28453

Source: Author's elaboration with MATLAB

During the period 2000-2020, the Z-score recorded an average value of 8.4407 for Eurozone's banks, which means that the ROA's standard deviation was needed more than 8 times to get to the numerator, that is to deplete capital, generating insolvency. What's more, its standard deviation was the highest among that of all the other variables, and it was equal to 3.277, suggesting a great variability in the systemic risk level of Eurozone's banks over years. On the other hand, as regard the main regressor, the ECB's average transparency level was 11.857, for the years 1999-2019, and the maximum recorded score was 15 on a scale of values going from 0 to 18. These findings indicate, as explained in the previous section, that the ECB is not fully transparent yet and, therefore, there is still room for improvement. Nonetheless, considering the minimum value of 8 and the maximum of 15, it is possible to affirm that in 20 years, characterized by financial distress and severe crises, the ECB has been able to almost double its transparency level. With reference to macro controls, instead, during the years 1999-2019, the average GDP growth for Euro Area countries was 1.47%, the average inflation 1.89% and the incidence of ECB total assets on GDP was, on average, slightly greater than 20%. The lowest standard deviation, equal to 0.11165, was recorded by the latter control variable, which implies a reduced volatility around the mean value. Considering, then, the skewness values for all the variables, it is possible to notice that four out of five are characterized by a left-skewed distribution, meaning that, with respect to a gaussian, the distribution is shifted to the right, with tails on the left. Only the ratio of ECB total assets and Eurozone's GDP presents, on the contrary, a right-skewed distribution. In addition, the skewness value for the ECB transparency

index is pretty curious, since it records a value very close to zero, which entails a distribution similar to the normal ones. Besides, the variables' dispositions, with exception of the GDP growth, show a kurtosis value between 2 and 3, suggesting that tails are lighter with respect those of a normal distribution and that there are no outliers. The value of 7.2608, for the GDP growth's kurtosis, implies that highly negative or positive values are most likely to occur. In the end, with reference to quantiles, the most interesting findings are associated with GDP growth and inflation. Indeed, the lowest 25% of observations is positive, which means that only a minority, or even none of the values, is negative, that is, during the sample period 1999-2019, there has been few years, or none, of negative growth or deflation.

3.2.2 Correlation matrix

This subsection aims to investigate the correlation coefficients among all the adopted variables. Findings are shown in the Table 3.

Table 3: Correlation matrix

	ZSCR	ECBTI	GDPg	INFL	ESTAGDP
ZSCR	1.000	-0.8094	-0.1193	0.4543	-0.8149
ECBTI	-0.8094	1.000	-0.0722	-0.5362	0.6741
GDPg	-0.1193	-0.0722	1.000	0.2377	-0.1021
INFL	0.4543	-0.5362	0.2377	1.000	-0.1983
ESTAGDP	-0.8149	0.6741	-0.1021	-0.1983	1.000

Source: Author's elaboration with MATLAB and EXCEL

Concerning the relationship between the Z-score and the regressors, a strong negative correlation, equal to -0.8094, is present between the dependent variable and the ECB transparency index. Consequently, according to this result, an increase in the ECB openness level leads to a reduction in the Z-score, which means a higher systemic risk. Moreover, a stronger negative relationship is the one between the dependent variable and ECB total assets-to-Eurozone GDP ratio. Instead, the ECB transparency index and the GDP growth show a very weak negative relationship. Indeed, the coefficient of -0.0722 indicates that, basically, they are not correlated. More generally, all the regressors, among each other, are not highly correlated, as their coefficients are not close to 1 or -1.

3.2.3 Main findings

After having analyzed the descriptive statistics and the correlations of the OLS variables, now it is the time to show and interpret regression's estimates. The Tables 4-7 are divided into two parts. The first one provides results relative to the model presented above:

$$ZSCR = \beta_0 + \beta_1 ECBTI + \beta_2 GDPg + \beta_3 INFL + \beta_4 ESTAGDP$$

while the second one reports the computation of standard errors robust to heteroskedasticity. Indeed, an important OLS assumption is the one related to the homoskedasticity of the regression's residuals, which must have the same variance, notwithstanding the values of the independent variables, $Var(u)=\sigma^2$. Even if the presence of heteroskedasticity, which implies different variances, does not involve biases or inconsistencies of the OLS estimators, it could generate issues regarding confidence intervals and t-statistics. Recall the formula for the OLS estimator's variance $Var(\widehat{\beta}_j)=\sigma^2/SST_j(1-R_j^2)$; it positively depends on σ^2 . Therefore, without the homoskedasticity assumption, the variance of residuals changes and $Var(\widehat{\beta}_j)$ is biased. As the standard errors are the square root of each OLS estimator's variance, they would not be valid to construct confidence intervals and to run t-tests. In addition, due to the presence of heteroskedasticity, the OLS estimator would not be BLUE (Best Linear Unbiased Estimator), which means that there could be some unbiased estimators, better than the OLS one. Consequently, a robust-heteroskedasticity procedure has been applied, in order to adjust standard errors, with the aim to make them robust to the possible presence of heteroskedasticity. Afterwards, the t-test has been computed to retrieve the new confidence intervals and to verify the significance level of the estimates²⁷⁹.

Table 4: OLS regression coefficients and robust standard errors

```

Linear regression model:
ZSCR ~ 1 + ECBTI

Estimated Coefficients:

```

	Estimate	SE	tStat	pValue
(Intercept)	23.138	2.4843	9.3139	1.633e-08
ECBTI	-1.2395	0.20634	-6.0073	8.842e-06

Number of observations: 21, Error degrees of freedom: 19
Root Mean Squared Error: 1.97
R-squared: 0.655, Adjusted R-Squared: 0.637
F-statistic vs. constant model: 36.1, p-value = 8.84e-06

	Coefficient	SE	tStat	Significance level
Intercept	23,1381	3,5057	6,6001	99% ***
ECBTI	-1,2395	0,3055	4,0573	99% ***

Source: Author's elaboration with MATLAB and EXCEL

²⁷⁹ Jeffrey M. Wooldridge, *Introductory Econometrics A Modern Approach*, fifth edition, 2012.

Table 4 reports the coefficient estimates of the intercept and the ECB transparency index only (*ECBTI*). In particular, with reference to the first part of the table, the ECB transparency level is negatively related to the Z-score with a 99% significance level. Better explained, if the level of ECB transparency increases by one unit, the Z-score reduces of 1.2395 units, meaning that, in order to exhaust banking capital, 1.2395 less ROA's standard deviations are needed. Hence, the probability of insolvency is higher, as well as the systemic risk level. On the contrary, if the ECB transparency level rises by 0.5, the Z-score falls by 0.61975 units. Therefore, the systemic risk level increases, but in a smaller magnitude. In addition, the small p-value provides evidence against the Null Hypothesis (H_0) and stays for a low probability of the t-statistic being as extreme as H_0 would be true, which means, assuming that H_0 is true ($\beta_1=0$), the regressor cannot explain the dependent variable. With reference to the t-statistic, the value of -6.0073 exceeds the critical value with 99% confidence interval, suggesting that *ECBTI* is statistically significant at 99% level. In other words, 99% of the observations fall around the average, only 1% can be found on the tails. The intercept of the model is equal to 23.138 and it indicates the value of the Z-score when all the regressors are equal to zero. In this particular case, it could be interpreted as the starting level of systemic risk, which turns out to be much lower with respect the maximum value (11.09) reported in the second table. As a consequence, without the influence of the explanatory variable, the Eurozone's systemic risk is pretty low; the incidence of the own funds (net income+ equity) over total assets is 23.138 times the ROA's volatility. Controlling for heteroskedasticity, as shown by the second part of Table 4, both the estimated coefficients are statistically significant at 99% level, which confirms the previous outcomes. What's more, the OLS regression explains the 65.5% of the sample variability. Indeed, the R^2 is pretty high and equal to 0.665, meaning that more than half of the Z-score's volatility is captured by the model. As table number 4 only presents the relationship between the dependent variable and one regressor, the R^2 is assumed to further increase by adding more explanatory variables to the model. Precisely because of this reason, among results, the adjusted- R^2 is provided. Indeed, it specifies how a set of regressors is able to explain the variation in the response variable, taking into consideration the number of predictors in the model. More to the point, it decreases if a useless independent variable is added and, conversely, it increases. Therefore, it is interesting to analyze the values it assumes for each of the computed regressions. For the first one, the adjusted- R^2 reports the number of 0.637, which basically confirms the result of the R^2 . Considering the F-statistics, the reported value, equal to 36.1, is pretty high. In fact, the Null Hypothesis ($\beta_1=0$) is rejected with 99% confidence level, meaning again, that *ECBTI*'s coefficient is statistically significant. Actually, the F-statistics provides more comprehensive results with more than one regressor, as it captures whether the entire set of

variables has any correlation with the Z-score, or if they are jointly insignificant and, as a consequence, the entire model should be dropped. Lastly, the p-value for the F-test is consistently small. Indeed, it indicates the probability of observing a value for the F-test as large as 36.1, assuming that the Null Hypothesis is true. In this case, the p-value being small suggests that this probability is very low and, therefore, the H_0 is rejected.

Table 5: OLS regression coefficients and robust standard errors

Linear regression model:
 $ZSCR \sim 1 + ECBTI + GDPg$

Estimated Coefficients:

	Estimate	SE	tStat	pValue
(Intercept)	23.857	2.4895	9.583	1.7133e-08
ECBTI	-1.2593	0.20253	-6.2179	7.2356e-06
GDPg	-0.32913	0.2436	-1.3511	0.1934

Number of observations: 21, Error degrees of freedom: 18
 Root Mean Squared Error: 1.93
 R-squared: 0.687, Adjusted R-Squared: 0.652
 F-statistic vs. constant model: 19.7, p-value = 2.9e-05

	Coefficient	SE	tStat	Significance level
Intercept	23,8571	2,8327	8,4220	99% ***
ECBTI	-1,2593	0,2577	4,8867	99% ***
GDPg	-0,3291	0,1509	2,1809	95% **

Source: Author's elaboration with MATLAB and EXCEL

The Table 5 shows the OLS estimated coefficients for the *ECBTI* and the GDP growth (*GDPg*). Again, considering the first part of the table, the Z-score and the ECB transparency index are characterized by a negative relationship; an improvement in the transparency level by one unit leads to a reduction of the dependent variable by 1.2593 units, which is a greater decrease with respect to the previous model. The coefficient is statistically significant, since the t-statistic of -6.2179 is greater than the critical value at 99% significance level. Hence, there is evidence against the Null Hypothesis ($\beta_1=0$), which means that the partial effect of *ECBTI* on Z-score is relevant. This result is confirmed by the computation of standard errors robust to heteroskedasticity, shown in the second part of Table 5. Of course, the p-value is small, with a significance level of 99% as well. These findings further emphasize a low probability of the H_0 being true. Even the intercept's coefficient is significant at 99% level and it is slightly higher than the one presented in Table 4. As long as the new variable is concerned, the regression results put on a negative relationship between the *GDPg* and the Z-score level. More to the

point, an 1% increase in the GDP generates a reduction of the dependent variable by 0.32913 units, which entails an increase in the systemic risk level. Nevertheless, the coefficient is not statistically significant at 90% level. The p-value equal to 0.1934 points out a high probability of accepting the Null Hypothesis ($\beta_2=0$). R^2 equal to 0.687 suggests that, with the introduction of a new variable, the OLS regression model explains 68.7% of the sample variability, that is to say the explanatory's ability of the model has improved by 2.2%. The value of the adjusted- R^2 , which is 0.652, has increased with respect to the first regression, suggesting that the new predictor variable, the $GDPg$, is useful, that is, it helps explain the variability of the Z-score. Better explained, by adding $GDPg$, the significance of the model increases, which means that fitted values approximate, to a greater extent, the observed dependent variable. Indeed, once standard errors robust to heteroskedasticity are retrieved, as reported in the second part of table 5, the estimated coefficient for $GDPg$ turns out to be significant at 95% level. The F-statistic passes the test at 99% significance level, suggesting that the explanatory variables are jointly statistically significant. Also, in this case the p-value is consistently small and, therefore, the probability of accepting H_0 is low, that is, the estimated coefficients are likely to be different from zero.

Table 6: OLS regression coefficients and robust standard errors

```

Linear regression model:
ZSCR ~ 1 + ECBTI + GDPg + INFL

Estimated Coefficients:

```

	Estimate	SE	tStat	pValue
(Intercept)	22.636	3.5054	6.4575	5.9039e-06
ECBTI	-1.1929	0.24497	-4.8694	0.00014413
GDPg	-0.35975	0.25605	-1.405	0.17803
INFL	0.2535	0.50097	0.50601	0.61935

```

Number of observations: 21, Error degrees of freedom: 17
Root Mean Squared Error: 1.97
R-squared: 0.691, Adjusted R-Squared: 0.637
F-statistic vs. constant model: 12.7, p-value = 0.000133

```

	Coefficient	SE	tStat	Significance level	
Intercept	22,636	3,9962	5,6644	99%	***
ECBTI	-1,1929	0,303	3,9370	99%	***
GDPg	-0,3598	0,1329	2,7073	95%	**
INFL	0,2535	0,5125	0,4946		

Source: Author's elaboration with MATLAB and EXCEL

OLS regression estimated coefficients, with the third new regressor, the Eurozone inflation level (*INFL*), are shown in Table 6. According to the results, an increase of the ECB transparency level by one unit reduces the dependent variable by 1.1929 units, implying that a high degree of transparency is associated with a growth in the Eurozone systemic risk level. The coefficient is statistically significant at 99% level. Indeed, the t-statistic is greater than the critical value, providing evidence against H_0 ($\beta_1=0$) and the p-value is pretty small, suggesting that the probability of accepting H_0 is low. The intercept is statistically significant at 99% level as well, even if lower with respect to the previous results. The estimated coefficients remain significant at 99% level also when considering robust standard errors. The *GDPg* coefficient highlights, as before, a negative relationship with the dependent variable, but it is still statistically not significant at 90% level. Nevertheless, after that robust standard errors are computed, the estimated coefficient results significant at 95% level. The positive inflation coefficient, equal to 0.2535, highlights a positive relationship between the regressor and the Z-score. In particular, a 1% increase in the inflation level generates a growth of the dependent variable by 0.2535 units, which is translated into a reduction in the Eurozone systemic risk level, as 0.2535 more ROA's standard deviations are needed to deplete banking capital. However, the small t-statistic and the high p-value provide evidence, at 90% level, of the statistical insignificance of the inflation's estimated coefficient. By adding the third regressor, the R^2 has risen even more and it is now equal to 0.691. In other words, the model is able to explain almost 70% of the Z-score variability. However, the value for the adjusted- R^2 is now equal to 0.637, which is lower than the one of the previous regression. This result points out that the new variable, *INFL*, is useless to explain the variation of the Z-score. In fact, even in the case of robust standard errors, as shown in the second part of table 6, the estimated coefficient for *INFL* is not statistically significant. Finally, F-statistic is greater than the critical value at 99% significance level. Therefore, H_0 is rejected, which involves that *ECBTI*, *GDPg* and *INFL* coefficients are jointly statistically significant at 99% level and they should not be removed from the model. Being H_0 rejected suggests that at least one estimated coefficient is different from zero. In this case *INFL* is the only variable equal to zero, as it is not statistically significant, even in the presence of robust standard errors. Consistently, the p-value is small and equal to 0.000133. This is further evidence against H_0 .

Table 7: OLS regression coefficients and robust standard errors

Linear regression model:
 $ZSCR \sim 1 + ECBTI + GDPg + INFL + ESTAGDP$

Estimated Coefficients:

	Estimate	SE	tStat	pValue
(Intercept)	16.886	2.7131	6.2241	1.2169e-05
ECBTI	-0.46627	0.2322	-2.0081	0.061828
GDPg	-0.47425	0.17682	-2.6821	0.016362
INFL	0.71813	0.35751	2.0087	0.061753
ESTAGDP	-17.297	3.8302	-4.5161	0.00035167

Number of observations: 21, Error degrees of freedom: 16
 Root Mean Squared Error: 1.35
 R-squared: 0.864, Adjusted R-Squared: 0.83
 F-statistic vs. constant model: 25.5, p-value = 9.06e-07

	Coefficient	SE	tStat	Significance level	
Intercept	16,8862	1,6299	10,3603	99%	***
ECBTI	-0,4663	0,1105	4,2199	99%	***
GDPg	-0,4742	0,1076	4,4071	99%	***
INFL	0,7181	0,2119	3,3889	99%	***
ESTAGDP	-17,2974	3,0338	5,7016	99%	***

Source: Author's elaboration with MATLAB and EXCEL

The Table 7 provides OLS estimated coefficients for the entire model, presented at the beginning of the chapter. The last macro control, which is the ratio between ECB total assets and Eurozone GDP level (*ESTAGDP*) has been now included in the regression. As always, the relationship between ECB transparency level and the Z-score is negative: an improvement of the transparency index by one unit leads to a reduction of the dependent variable by 0.46627 units, which means that the Eurozone systemic risk increases. Nonetheless, considering the first part of Table 7, the coefficient has lost some of its statistical significance. Indeed, the t-statistic is now equal to 2.0081 in absolute value and it is not higher than the critical value, at 95% level, of 2.120. However, it exceeds the threshold of 1.746 for the significance level at 90%. This result is confirmed also by a higher, but still lower than 0.10, p-value, equal to 0.061828. On the contrary, the estimated coefficients for *GDPg* and *INFL* are statistically significant; the former at 95% and the latter at 90% significance level, which entails a probability of 95% and 90% of having the observations falling around their average. What's more, in both cases the Null Hypothesis ($\beta_2=0$ and $\beta_3=0$) is rejected, meaning that their effects on the Z-score are relevant. With reference to the coefficient interpretation, $\beta_2=-0,47425$ provides evidence, at 95% level, of the negative relationship between *GDPg* and Z-score. Better explained, a 1%

increase in the GDP reduces the Z-score by 0.47425 units, resulting in an increase of the systemic risk level. On the other hand, *INFL* coefficient, equal to 0.71813, points out, with a significance level of 90%, the positive relationship between the regressor and the explained variable. The increase of one unit in the inflation generates a reduction of the Eurozone systemic risk level, since the Z-score grows by 0.71813 units. In the first case, the incidence of the own funds over total assets is 0.47425 times less the ROA's volatility, while in the second one, the incidence increases by 0.71813 times. As long as the ratio between ECB total assets and Eurozone GDP level is concerned, the estimated coefficient $\beta_4 = -17.297$ highlights an important result in terms of magnitude. In fact, a 1% increase of the regressor, reduces the Z-score by 17.279 units, which, in turn, suggests a higher systemic risk level. More to the point, 17.297 less ROA's standard deviations are needed to deplete banking capital. Hence, there is a greater probability of insolvency. This coefficient is statistically significant at 99% level, as the t-statistic exceeds the critical value of 2.921. In other words, the effect of *ESTAGDP* on Z-score is relevant, since there is only 1% of probability of getting values on the tails of the distribution. Of course, the p-value records a very low number, equal to 0.00035167, which confirms the significance level of 99%. In the end, the intercept shows the lowest value among the four regressions that have been presented and it is statistically significant at 99% level. With reference to the second part of Table 7, t-statistics all exceeds the critical value with 99% significance level, which suggest that all the estimated coefficients are statistically significant, that is to say 99% of the observations fall around the average. Since the Null Hypotheses are rejected, the ceteris paribus effect of the independent variables on the Z-score is significant. An interesting result concerns the *ECBTI*, *GDPg* and *INFL*, which were characterized by a significance level of, respectively, 90%, 95% and 90% before the robust standard error computation. Now, they have improved it up to 99%, which is translated into a higher probability of rejecting the Null Hypothesis. Indeed, p-values would be smaller, indicating that the probability of accepting H_0 is very low. Therefore, the derived relationship between the regressors and the dependent variable is unlikely to be by chance. After the robust standard error computation, the coefficients of the intercept and the *ESTAGDP* are still significant at 99% level, instead. The R^2 of the regression has remarkably increased, reaching the value of 0.864. Such finding indicates that, thanks to the introduction of several independent variables, the model is now able to explain 86.4% of the Z-score's variability. With respect to the case in which only the *ECBTI* was considered, the explanatory ability has improved by 29.92%. What's more, the adjusted- R^2 has increased a lot, reaching a value of 0.83. Since this indicator tends to add a penalty when a new regressor is added, the huge increase, with respect to the previous model, signals that the *ESTAGDP* is pretty useful for the regression. More to the point,

according to the adjusted- R^2 , which, differently from R^2 , takes into consideration the adopted regressors, this set of predictor variables is able to explain 83% of the Z-score variation. The F-statistic passes the test with 99% significance level, which leads to the rejection of the Null Hypothesis ($\beta_1=0, \beta_2=0, \beta_3=0, \beta_4=0$). As a consequence, *ECBTI*, *GDPg*, *INFL* and *ESTAGDP* are considered to be jointly statistically significant and, therefore, they should not be dropped from the model. The associated p-value is small, suggesting that the probability of accepting the H_0 is very low, that is estimated coefficients are more likely to be different from zero.

To sum up the results, for all the four regressions, the negative relationship between the ECB transparency index and the Z-score indicates that if the ECB decides to adopt a higher degree of openness when running monetary policy, the explained variables reduces and, therefore, the Eurozone systemic risk increases. Indeed, a lower Z-score stays for a lower number of ROA's standard deviation to reach the insolvency situation. In addition, reference has been made to monetary policy only, since, according to the new comprehensive transparency index, presented in the previous section, the ECB reached the maximum score for the banking supervision transparency in 2014. Therefore, an eventual transparency increase concerns the monetary policy only. β_1 estimated coefficients are all significant, but the first three at 99% level, while the latter at 90%. Nonetheless, after controlling for heteroskedasticity, also the fourth regression returns a significant estimated coefficient for *ECBTI*, at 99% level. Besides, coefficients β_2 and β_3 , for, respectively, *GDPg* and *INFL*, are not statistically significant as long as the last independent variable, *ESTAGDP*, is added to the model. Indeed, according to the last regression, the *GDPg* shows a negative relationship with Z-score, which is statistically significant at 95%, while the *INFL* turns out to be positively related to the dependent variable, with a 90% level of significance. However, once robust standard errors are considered, the estimated coefficient for *GDPg* turns out to be significant at 95% level in both the second and third regression. In the last model, presented in Table 7, both *GDPg* and *INFL* are statistically significant at 99%, with robust standard errors. As long as the intercept is concerned, instead, the estimated coefficient is always positive and significant at 99% level, also with robust standard errors. This result suggests that, when all the implemented regressors are set equal to zero, there is always a minimum initial level of systemic risk. Besides, as expected, R^2 increases with the number of explanatory variables added to the model, up to the value of 86.4%. This is consistent also from an algebraic point of view, since, when an additional regressor is inserted in the model, the sum of squared residuals does not increase and, being R^2 computed as $1 -$

SSR/SST^{280} , an increment of this index suggests an improved ability of the model to explain the variability of the dependent variable, which, in turn, means an increase of ESS . Of course, as a high R^2 could be a clue for the presence of multicollinearity among the OLS regressors, afterwards the Variance Inflation Factor (VIF) will be computed. With reference to the adjusted- R^2 , instead, its value increases in the first, second and fourth regressions, when, respectively, $ECBTI$, $GDPg$ and $ESTAGDP$ are added, suggesting that these predictors are useful to explain the variability of the Z-score. Finally, the F-statistics always passes the test with 99% significance level, meaning that for all the four models, the regressors are jointly statistically significant.

3.2.4 Testing for multicollinearity

Before driving the final conclusions, it is important to verify the presence of multicollinearity, in order to better understand, as mentioned, whether the high R^2 actually reports the explicative ability of the model or whether it is simply due to a high correlation among the regressors.

One of the assumptions, according to which OLS estimator is unbiased for the population parameters, is the “no perfect collinearity”, which involves the lack of an exact and linear relationship among the independent variables. In particular, it is important to highlight that the correlation among regressors is allowed, but they simply cannot be perfectly correlated. If the perfect collinearity is present, the OLS regression is not applicable, as the precision of the estimated coefficients would be reduced and the R^2 would be higher without a real reason, that is to say, the model’s explicative ability actually has not increased. In the case of a multiple linear regression, as the one presented in this chapter, the concept of multicollinearity refers to the presence of a high, even if not perfect, correlation among the independent variables. Therefore, this situation does not imply the violation of the “no perfect collinearity” assumption. Nonetheless, a high correlation among the regressors generates an increment of the OLS estimator’s variance, suggesting less precise estimates, larger confidence intervals and less accurate hypothesis tests. What’s more, estimates would highly fluctuate and, consequently, it would be difficult to identify significant variables and to interpret the overall model²⁸¹. As a consequence, the multicollinearity problem has not been defined yet: it does not violate the OLS assumptions, but, at the same time it implicates a too high OLS estimator’s variance. Thus,

²⁸⁰ Wooldridge, 2012.

²⁸¹The OLS estimator Variance is computed as $Var(\widehat{\beta}_j) = \sigma^2/SST_j(1 - R_j^2)$. R_j^2 is the R-squared from the simple regression of x_1 on x_2 . If its value is close to 1, it means that x_2 explains much of the variation in x_1 in the sample. This means that x_1 and x_2 are highly correlated. Therefore, if R_j^2 goes to 1, $Var(\widehat{\beta}_j)$ goes to infinity. See Wooldridge (2012).

what is clear is that, when estimating OLS coefficients, it is preferable to have a low correlation among the independent variables.

In order to test whether the multicollinearity is present in the OLS model and, in the case of an affirmative answer, whether it is a problem or not for the coefficient estimate, the Variance Inflation Factor (VIF) will be computed. Since the formula is $VIF=1/(1 - R_j^2)$, the OLS estimator's variance can be rewritten as $Var(\widehat{\beta}_j)=(\sigma^2/SST_j)*VIF$. An increment in the correlation between two regressors, increases the VIF and, as a consequence, the OLS estimator's variance grows. Basically, the $Var(\widehat{\beta}_j)$ component related with the multicollinearity issue has been isolated in a new statistic for the estimated coefficients. According to the above explanation, a small VIF is preferable, as it means that the correlation among the regressors is low. More to the point, the threshold value, above which the existence of multicollinearity is a problem, is set equal to 10. If VIF is above 10, then R_j^2 is above 0.9, which means that explanatory variables are highly correlated. On the other hand, this statistic presents some limits too. Indeed, the OLS estimator's variance also depends on σ^2 and SST_j , which could increase $Var(\widehat{\beta}_j)$ as well, if the sample size is enlarged, for example²⁸². VIF computation results are shown in Table 8.

Table 8: VIF computation results

	ECBTI	GDPg	INFL	ESTAGDP
VIF	2,7120	1,0871	1,6208	2,0089

Source: Author's elaboration with MATLAB and EXCEL

All the regressors show small values for the VIF , meaning that the correlations among them are pretty low. Consequently, keeping σ^2 and SST_j fixed, the $Var(\widehat{\beta}_j)$ is reduced and OLS estimates are more precise, with tinier confidence intervals. Therefore, the multicollinearity is not a problem in the OLS model and the high R^2 really indicates the ability of the regression to explain the 86.4% of the Z-score's variability. Besides, the VIF 's results are consistent with the correlation coefficients provided by the correlation matrix, shown in table 3. In fact, the greatest explanatory variables' correlations, between $ECBTI-INFL$ and $ECBTI-ESTAGDP$, report values of -0.5362 and 0.6741, and, therefore, they are considered to be moderate, rather than high. All the other correlation coefficients are much lower, which implies that a correlation

²⁸² Wooldridge, 2012.

among the regressors does exist, but it is not high enough to affirm that the multicollinearity generates problems.

3.3 Final results' interpretation

After having considered the presence of multicollinearity and by taking into account the regression presented in Table 7, the aim of this section is to present the final estimated coefficients' interpretation and to compare the obtained results with those provided by the literature. First of all, the intercept, equal to 16.886, indicates the starting level of systemic risk, which is higher than the maximum value of 11.09, recorded by the observed Z-scores. In the case of the model presented above, the intercept points out a lower level of systemic risk, with respect to the observed one, as a higher number of ROA's standard deviation is needed to deplete capital and cause insolvency. Such value stays for a minimum amount of systemic risk, which is always present in the banking system, even when all the regressors are set equal to zero. It could be due to the several interlinkages, developed among banks, related to the organizational dimension, the sources of funding or the assets exposures²⁸³. What's more, other explanations can be found in the greater size of some banks, which are characterized by lower capital ratios, less stable funding and more exposure to risky market-based activities,²⁸⁴ and in the procyclical nature of the leverage, which, in turn, makes the system more fragile and exposed to inefficient contagion mechanisms²⁸⁵.

With reference to the main regressor, instead, the coefficient β_1 evidences a negative relationship between *ECBTI* and the Z-score. Better explained, an increase of the ECB transparency level by one unit leads to a reduction of the dependent variable by 0.46627 units, which, in turn, indicates an increment in the Eurozone systemic risk level. Indeed, in order to exhaust banking capital, 0.46627 less ROA's standard deviations are needed. In other words, the incidence of the own funds on the total assets is 0.46627 times less the ROA's volatility and, consequently, the probability of insolvency is higher. To sum up, according to the provided results, an improvement in the ECB transparency level is not beneficial, as it would threaten the Eurozone's financial stability. Findings are consistent with the part of the literature, according to which the relationship between systemic risk and Central Bank transparency is positive. An example could be the paper "The impact of central bank transparency on systemic risk—Evidence from Central and Eastern Europe", published in 2020, by Alin Marius Andrieș, Simona Nistorb and Nicu Sprinceanc, which reports that, the increment of information

²⁸³ Acemoglu, Ozdaglar, e Tahbaz-Salehi, «Systemic Risk and Stability in Financial Networks», 2013.

²⁸⁴ Laeven, Ratnovski, e Tong, «Bank Size, Capital, and Systemic Risk», 2016.

²⁸⁵ Acharya e Thakor, «The Dark Side of Liquidity Creation», 2016.

disclosure is positively associated with an increase of systemic risk indicators, as the ΔCoVaR and the SRISK. Moreover, regression's results confirm the negative aspects, discussed in the second chapter, of a boost in the Central Banks transparency level. To mention few of them, the information overload could lead to a high exchange rate volatility and, therefore, to a higher exchange rate risk²⁸⁶. In addition, a huge amount of conveyed information could determine difficulties in absorbing, interpreting and understanding the right message and, as a result, market participants' expectations would turn out to be of poor quality, determining wrong investment or financing decisions²⁸⁷. What's more, if the Central Bank keeps on updating the guidance, the uncertainty among agents increases, with the consequent broad and negative market reactions²⁸⁸.

Taking into consideration regression's results, the evolution of the comprehensive transparency index, described in section 3.1.2.1, has negatively affected the Eurozone's financial stability. Indeed, Figure 3 highlights an upward trend of the newly derived index, which, according to the coefficient β_1 , suggests a reduction of the dependent variable. Therefore, it seems reasonable that, according to the last index value of 15, recorded in 2019, there is still room for improvement, but it may not be optimal. In light of these results, it seems that the provisions released by the Treaty on the Function of the European Union (TFEU), presented in the second chapter, are harmful for the financial stability in the Euro Area, since they state that the ECB must operate in an openly manner²⁸⁹. However, it is important to highlight that the direction of the relationship between systemic risk and transparency has not been defined once for all yet and part of the literature regarding this topic support Central Banks clearness as a fundamental tool to weaken financial imbalances. Furthermore, some upgrades in the degree of ECB openness have been necessary and, therefore, unavoidable. Just think about how the acquired supervisory role, which became relevant from 2014, lead to an increment in the degree of transparency, thanks to the introduction of the Supervisory Board or the disclosure of information regarding financial stability through speeches, interviews, press conferences and the official website. What's more, as long as monetary policy is concerned, a high openness level has been implemented since the ECB outset to acquire credibility among investors. Moreover, over the sample years, monetary policy became much more complicated, due to the adoption of unconventional tools and, consequently, a higher transparency degree was needed. As a result, the upward trend of the new comprehensive transparency index is justified by the

²⁸⁶ Weber, «The Effect of Central Bank Transparency on Exchange Rate Volatility», 2019.

²⁸⁷ Van der Cruysen, Eijffinger, e Hoogduin, «Optimal Central Bank Transparency», 2010.

²⁸⁸ Filardo e Hofmann, «Forward Guidance at the Zero Lower Bound», 2014.

²⁸⁹ EU, «CONSOLIDATED VERSION OF THE TREATY ON THE FUNCTIONING OF THE EUROPEAN UNION», 2012.

evolution of the macroeconomic and supervisory environment, which got more complicated during years, requiring a higher level of clearness and information disclosures²⁹⁰. Nevertheless, according to this analysis' results, when the ECB decides to boost its transparency level, beyond the costs of collecting, producing and interpreting new information and those for data providers and analysts, presented in the second chapter, another cost must be now considered: the extent to which an increment of the openness level negatively affects the Eurozone financial stability.

However, by taking a different point of view, the estimated coefficient β_1 suggests a possible solution for a too elevated systemic risk level. Indeed, if the ECB becomes opaquer, the Z-score would increase, meaning that the incidence of the own funds on the ROA's volatility would be higher and, therefore, the insolvency probability would be reduced. Hence, the ECB being less transparent would be translated into a lower systemic risk level. Considering the comprehensive transparency index, presented in this chapter, the ECB could reduce its openness level when acting as supervisory authority, since, during the last sample years, the maximum score of 3 was reached. As long as monetary policy is concerned, instead, the ECB could become opaquer when communicating its inflation target. Indeed, the dimension of political transparency has recorded the maximum value for the entire sample period.

Actually, any transparency dimension, indistinctly, could be reduced, in order to mitigate the Eurozone systemic risk level. In fact, for example, a lower amount of information disclosures reduces the bank's incentives to take riskier activities, which would increment their contribution to the banking systemic risk level²⁹¹. In addition, since banks are linked through common exposures to the same asset class, or simply, through the lending activity among each other, information contagion due to bad news, about one financial institution, could enhance the probability of other banks' defaults, which, in turn, negatively affect financial stability. Therefore, a lower transparency level could prevent the release of such information²⁹².

According to these outcomes, another interesting conclusion can be retrieved. Indeed, in the future, the ECB could be required to, inevitably, increase its transparency level, as already explained, due to some complications in the macroeconomic or supervisory environment²⁹³. For instance, as regard the procedural dimension, where, up to 2019, the lowest score was recorded, the ECB could be asked to disclose how the decisions regarding monetary policy instruments

²⁹⁰ Hartmann e Smets, «The First 20 Years of the European Central Bank: Monetary Policy», 2018.

²⁹¹ Andrieş, Nistor, e Sprincean, «The Impact of Central Bank Transparency on Systemic Risk—Evidence from Central and Eastern Europe», 2020.

²⁹² Toni Ahnert e Co-Pierre Georg, «Information Contagion and Systemic Risk», *Journal of Financial Stability*, Network models, stress testing and other tools for financial stability monitoring and macroprudential policy design and implementation, 35 (1st April 2018): 159–71, <https://doi.org/10.1016/j.jfs.2017.05.009>.

²⁹³ Hartmann e Smets, «The First 20 Years of the European Central Bank: Monetary Policy», 2018.

have been taken. Nevertheless, as already explained in section 3.1.2, the ECB may not be willing to reveal this kind of information, as a sense of diversity inside the Committee would be spread among the public or central bankers would be induced to follow their national interests²⁹⁴. Besides, according to the regression's results, the increment of the ECB transparency index is positively associated with a higher financial instability. Therefore, in order to try to mitigate this last effect, the ECB could increase its degree of openness in the procedural dimension by just 0,5 points, which would mean, according to the index structure presented by Dincer, Eichengreen and Geraats in 2019, communicating voting records within three weeks, or, eight weeks, in the case of an individual person. As a result, the overall explanatory variable would increase by only 0.5 and, therefore, the reduction of the Z-score would be of just 0.233135 units. Consequently, the Eurozone's systemic risk level would be incremented, but with a lower magnitude. This reasoning can be applied to all the different transparency dimensions, where the maximum score has not been reached yet. What's more, this kind of behavior finds support in the TFEU and in the Statute of European System of Central Banks and of the European Central Bank, which recognize, as explained in the second chapter, to the ECB, a given discretion level regarding the publication of the information produced²⁹⁵. Thus, the ECB is free to decide the optimal degree of transparency, according to the extent of financial imbalances present in the system. For example, if the systemic risk is particularly high, disclosures will be then reduced or, if mandatory, information will be released in a smaller magnitude.

On the other hand, regression's outcomes are contrasting the part of the literature supporting the existence of a negative relationship between systemic risk and Central Bank's transparency. In fact, information disclosure results beneficial for inflation expectations, which are more precise, thanks to the reduction of asymmetric information and uncertainties, for exchange rate movements, that favor the equilibrium of the balance of payments and for market's returns, which turn out to be higher than expected. Furthermore, findings are partially in disagreement with researches showing the non-linear nature of the relationship between systemic risk and openness level. Indeed, conforming to them, it is true that a too high transparency level could be the cause of an increment in the systemic risk, but only after the so called "optimal point". In other words, up to a given threshold, Central Bank transparency is actually favorable. On the

²⁹⁴ Gersbach e Hahn, «Should the Individual Voting Records of Central Bankers Be Published?», 2008.

²⁹⁵ ECB, ON THE STATUTE OF THE EUROPEAN SYSTEM OF CENTRAL BANKS AND OF THE EUROPEAN CENTRAL BANK, 2011.

contrary, consistently with regression's results, the relationship between the two variables becomes positive after the optimal level is reached.

Considering now coefficient β_2 , an increase of 1% in the *GDPg* would generate a reduction of Z-score by 0.4742 units, which entails an increment of the Eurozone's systemic risk level. Contrarily, the dependent variable would rise after a GDP fall. This outcome is in disagreement with respect to what is specified in the literature, according to which a higher growth is associated with a lower banks' distress probability and, consequently, with a lower systemic risk. This result, actually, finds feedback in the literature too. Indeed, according to Minsky's "financial instability hypothesis" (2015), during periods of economic growth, both lenders and borrowers tend to take higher risks. Nevertheless, over time, companies encounter difficulties in paying back the principal and the interest of their debt and, as a consequence, they ask for loan restructuring. Thus, a sort of Ponzi scheme is created: firms do not have enough money, even for interest payments and, therefore, they are forced to increase their indebtedness level. Sooner or later credit is not provided any longer, due to banks' lack of trust or general absence of resources in the economy. Hence, borrowers have difficulties in meeting their obligation and financial institutions' credit risk increases. As already anticipated, banks with a low capitalization level would not be able to put aside the required amount of capital, in order to keep on servicing their debt, notwithstanding losses in the assets value. Consequently, they would increment their contribution to the systemic risk level²⁹⁶. Furthermore, as explained in the first chapter, an economic growth would encourage banks to take on riskier activities and to expand their asset side, due to a higher loan demand, resulting in a leverage increase, which, in turn, suggests a rise in banks' borrowing practice and a reduction in their soundness level. What's more, the leverage increment during growth times is due to its procyclical nature, described in the dissertation's first chapter. In practice, during economic booms, banks experience an increase in loan demand and, subsequently, they expand their balance sheet by augmenting the supply of credit, but also the amount of cash and securities. The building up of the asset side is mainly financed through debt and, therefore, the leverage raises²⁹⁷. As a consequence, interlinkages among financial institutions would become much more complicated because of imbalances accumulation. Therefore, the banks' risk of default on their obligation's

²⁹⁶ Sergey Beshenov e Ivan Rozmainsky, «Hyman Minsky's Financial Instability Hypothesis and the Greek Debt Crisis», *Russian Journal of Economics* 1, n. 4 (30th November 2015): 419–38, <https://doi.org/10.1016/j.ruje.2016.02.005>.

²⁹⁷ Dursun-de Neef e Schandlbauer, «Procyclical Leverage», 2020.

increases, as well as their exposure towards inefficient contagion mechanisms, such as asset fire sales²⁹⁸.

Moreover, the *INFL*'s estimated coefficient points out a result inconsistent with the literature too. In fact, the relationship between Z-score and inflation is positive, which means that a lower level of prices determines a reduction of the dependent variable, suggesting an increase in the Eurozone's systemic risk level. Indeed, 0.7181 less ROA's standard deviation would be needed to reduce capital. These findings are justified by the increment of the aggregate demand, which characterizes a low inflation environment and causes the rise of unsustainable bubbles. In addition, this situation is further boosted by the presence of optimistic expectations, as a monetary policy tightening can be avoided. However, financial imbalances appear since the higher demand generates, as a result, an increment in banks' lending practice, resulting in the formation of asset bubbles, which threaten the stability of the system, due to their risk of collapse²⁹⁹. Indeed, according to the first chapter, prices would go down and loans would not be paid back any longer, leading to an overall credit contraction and, therefore, to an increase of the insolvency probability³⁰⁰.

Finally, the ratio between the ECB total assets and the Eurozone's GDP level negatively influences, in a great magnitude, the systemic risk. Indeed, an increase by 1% of the ratio suggests that 17.2974 less ROA's standard deviations are needed to determine an insolvency situation. Differently said, a small increment in the ECB total assets or a tiny reduction in the GDP, produce a notable Eurozone's systemic risk growth. These findings are opposed to the part of the literature according to which a greater Central Bank's assets-to-GDP ratio is beneficial for financial stability. Indeed, the increment in the ECB activities level, in order to face the recent crises, could generate, instead, some financial imbalances. For example, due to a low interest rate environment, banks could be incentivized to soften their credit standards, in order to increase returns. Nevertheless, the resulting increment in loans' riskiness determines the accumulation of dangerous exposures and a higher credit risk level, which, in turn, cause financial system imbalances. What's more, the build-up of credit bubbles, as the Great Financial Crisis reminds, negatively and deeply affects financial stability. Indeed, as anticipated in the previous paragraph, a higher degree of credit availability is associated with an increase in the asset prices, such as real estate, which, in turn, support credit growth. However, bubble bursts reduce collateral values, resulting in the asset impairment. Hence, the borrowing ability of both

²⁹⁸ ECB, «The Concept of Systemic Risk», 2009.

²⁹⁹ Claudio Borio, «Monetary and Financial Stability: Here to Stay?», *Journal of Banking & Finance* 30, n. 12 (1st December 2006): 3407–14, <https://doi.org/10.1016/j.jbankfin.2006.06.004>.

³⁰⁰ King e Tarbert, «Basel III: An Overview», 2011.

lenders and borrowers is undermined³⁰¹. What's more, an expansion of the ECB asset side determines lower risk-free rates, which, successively, lead to a reduction of the considered threshold rate to take investment decisions. As a consequence, corporations undertake projects with little returns and high variances; therefore, banks' exposures towards the real sector become riskier³⁰².

Of course, the just provided explanations focus on the *ceteris paribus* effect of, respectively, *GDPg*, *INFL* and *ESTAGDP* on the Z-score, in order to describe the single relationship between each regressor and the dependent variable. Actually, as the real world is much more complex, all the macroeconomic variables act together, influence each other and, consequently, they contribute together to the increment or the reduction of the systemic risk level.

To conclude, a small reference to the first chapter is necessary, in order to provide further solutions, beyond the reduction of the ECB transparency's degree, for the systemic risk decline in the Eurozone. Indeed, at the beginning of this dissertation, several factors influencing the financial stability have been presented, as bank size, capital, leverage, the interconnectedness level among financial institutions and the financial market structure. Since the possible ways for systemic risk mitigation have been deeply investigated in the first chapter, the aim of this paragraph is just to sum them up, in order to better complete the set of solutions for financial instability, offered by this dissertation. To begin, banks must respect regulatory capital ratios, which are computed by considering their assets risk level, in order to remain sound and to keep on servicing their debts in distressed situations³⁰³. In addition, thanks to capital buffers, large banks are more incentivized to reduce their size and, as a result, they engage less into market-based risky activities and unstable fundings³⁰⁴. What's more, in order to face an idiosyncratic or systemic bank crisis, large financial institutions are required to develop contingency plans, which embrace several measures and arrangements related to fundings, capital or liquidity. With reference to leverage, instead, some ratio thresholds have been introduced, with the aim to reduce the negative effect of procyclicality, which could be the cause of dangerous and inefficient contagion mechanisms³⁰⁵, as the first chapter highlighted. Moreover, to better manage the huge amount of liquidity coming from a high leverage and to avoid shortages, banks

³⁰¹ Banco de España, «The Interaction between Monetary Policy and Financial Stability in the Euro Area», 2017.

³⁰² Gabriel Chodorow-Reich, «Effects of Unconventional Monetary Policy on Financial Institutions», *National Bureau of Economic Research*, June 2014, <https://doi.org/10.3386/w20230>.

³⁰³ Anginer e Demirgüç-Kunt, «Bank Capital and Systemic Stability», 2014.

³⁰⁴ Laeven, Ratnovski, e Tong, «Bank Size and Systemic Risk», 2014.

³⁰⁵ Acharya e Thakor, «The Dark Side of Liquidity Creation», 2016.

are also required to operate according to the Liquidity Coverage ratio and the Net Stable Funding ratio³⁰⁶.

³⁰⁶ King e Tarbert, «Basel III: An Overview», 2011.

CONCLUSIONS

This dissertation deals with the systemic risk concept, as a complex and multifaceted phenomenon, which threatens, at the same time, economic sectors, financial markets, people and companies all over the world. As the first chapter has introduced, the focus is adjusted toward the banking sector and its financial stability. Several indicators, as bank size, capital, leverage, the degree of interconnectedness and financial market structure, have been investigated, in order to assess how and to what extent they affect the banks' systemic risk level.

The second chapter, instead, by drawing the attention to Central Bank's transparency as a systemic risk indicator, introduces the reader to the core of this dissertation. The concept, the communication tools adopted by Central Banks, the advantages and the disadvantages of a given openness level and, afterwards, the transparency standards have been described. Finally, the literature review points out the existence of divergent conclusions regarding the effect of a higher Central Bank's transparency on the systemic risk level. Some researches provide evidence of a positive relationship between the two variables; others suggest, instead, the presence of a negative correlation and a third part of studies stays for a non-linear effect, which is translated into the existence of an optimal transparency level, below which an increment in the degree of openness is beneficial and above which financial stability is undermined.

Considering these outcomes, the third chapter has investigated, through an empirical analysis, the kind of relationship direction that links the ECB transparency index, elaborated and computed by Dincer, Eichengreen and Geraats, in 2019, and whose structure has been modified by this thesis' author, and the Eurozone systemic risk level. Therefore, the contribution of this dissertation to the literature regarding Central Bank's transparency and financial stability is twofold. First of all, to the knowledge of the author, this is the first time that an ECB transparency index, involving both its monetary and supervisory roles, has been implemented in an empirical study.

The obtained new comprehensive index is just one possible modified version of the original one (Dincer, Eichengreen and Geraats, 2019). Indeed, the final hope is to provide a starting point for further transparency indexes development, in order to enrich the literature regarding this topic. The second contribution, instead, lies in the negative relationship, that has been retrieved from the OLS regression model, between the *Z*-score, the systemic risk measure, and the *ECBTI*, which is the updated transparency index for the European Central Bank.

More to the point, the negative relationship between *Z*-score and *ECBTI* is translated into a positive link between the ECB transparency and the Eurozone's systemic risk level. In other

words, an improvement in the degree of openness reduces the dependent variable, which indicates a higher insolvency probability of the banking system. Indeed, as already explained in the second chapter, information overload generates uncertainties among market participants, which would adjust their expectations in a poorly manner, determining wrong investment or financing decisions. What's more, if the Central Bank keeps on updating the guidance, the uncertainty among agents increases, with the consequent broad and negative market reactions. Besides, exchange rate risk could rise. However, the positive upward trend, during the sample years, of the new comprehensive index cannot be avoided, as the ECB's roles of monetary and supervisory authority complicated further and further over time, reflecting the imbalances of the economic environment. Consequently, a higher amount of information disclosures and clearness was needed, which, nonetheless, boosted the Eurozone's systemic risk.

Regression's results provide some possible solutions for periods of a too elevated systemic risk level, actually. Indeed, being opaquer could be beneficial for financial stability. For instance, banks are less incentivized to incur into risky activities, when little information is disclosed. Moreover, a lower transparency level prevents the release of bad news, that could trigger contagion effects among interconnected financial institutions. What's more, when the ECB is required to improve its transparency level, due to some complications in the macroeconomic or supervisory environment, a mitigated increase in the systemic risk level can be obtained, by boosting the degree of openness by less than one unit. In fact, the effect on the Z-score would be lower and, consequently, the reduction of the dependent variable would be attenuated, suggesting a smaller increase in the Eurozone's systemic risk level.

What's more, among the possible solutions to mitigate financial instability, those provided by chapter one is to mention. Examples concern regulatory capital ratios, contingency plans, leverage ratios and liquidity ratios.

The main findings of this dissertation let possible to further comprehend how the systemic risk notion is particularly complex and intricate. In fact, it presents different facets and characteristics, which make an exhaustive analysis more difficult. This thesis has investigated only some of its determinants and has provided some of the possible solutions. Therefore, there is still room for further studies and researches.

What's more, the analysis presented does not solve the issue of literature divergences, but it rather provides several ideas for further analyses. First of all, the new index computation highlights the importance of considering both the ECB's principal roles, those of monetary and supervisory authorities, since the two of them contribute to the enhancement of information

disclosure. Further studies can then be conducted by modifying the index criteria or by computing two different regressions, taking as explanatory variables, for the first one, the monetary policy transparency index and, for the second one, a supervisory transparency index, in order to compare their effects on the Eurozone's systemic risk.

Moreover, future researches could implement, instead of macro controls, some bank controls, like total assets, as a proxy for size, the ratio of equity to total assets, as proxy for leverage, customer deposit to total liabilities, as a proxy for funding structure or ROA, as a proxy for performance, in order to explain and isolate their effect on the systemic risk level. These variables can be considered both at an aggregate level or at an idiosyncratic one, which, in turn, would involve the adoption of panel data. Of course, if the leverage or the ROA are adopted as independent variables, the measure of systemic risk must be changed, as, by keeping the Z-score, some endogeneity problems could rise. Indeed, the ratio between equity and total assets, as well as the ROA, are adopted to compute the dependent variable. Therefore, between the Z-score and some regressors there would be a direct relationship, which would determine trivial results. For example, R^2 would be high due to the presence of a structural dependency of the dependent variable on the independent ones. Besides, other studies could investigate fixed effect models, as country fixed effect or time fixed effect, which capture elements that do not change over time, and consequently cannot be included in an OLS regression, but they rather influence the systemic risk level. In addition, another set of researches could focus on different currency areas, for which the monetary policy transparency index, computed by Dincer, Eichengreen and Geraats (2019), is available, and repeat the same analysis conducted in this dissertation.

Interesting findings could be also retrieved from the comparison of the regression's results. Indeed, a different direction of the relationship between Central Bank's transparency and systemic risk, depending on the type of the adopted monetary or supervisory policies may be pointed out. What's more, even if the obtained estimated coefficients are all significant, a longer transparency time series of other Central Banks may provide more precise results. Instead, in the case of the European Central Bank, the considered historical period necessarily starts from 1998, as it is the year of its outset and, therefore, the number of observations cannot be increased. Finally, the same analysis can be conducted by changing the systemic risk measures, that do not present the same Z-score limits. For instance, equity return correlations, which capture the interactions among banks can be considered. Alternatively, methods that rely on market data, as the ΔCoVaR , can be adopted, in order to avoid drawbacks related to differences in the accounting standards and rules adopted by various countries.

APPENDIX

Monetary policy transparency index structure

The first part of the appendix provides the exact structure of the monetary policy transparency index, elaborated by Dincer, Eichengreen and Geraats, in 2019.

Political transparency

Political transparency refers to monetary policy objectives.

- a) Is there a formal statement of the objective(s) of monetary policy, with an explicit prioritization in case of multiple objectives? No formal objective(s)=0. Multiple objectives without prioritization=1/2. One primary objective or multiple objectives with explicit priority=1.
- b) Is there a quantification of the primary or the main objectives of monetary policy? No=0. Yes, but no for the primary objective or all main objectives=1/2. Yes, for the primary objective or all the main objective=1.
- c) Are there explicit institutional arrangements or contracts for monetary policy between the monetary authorities and the government? No central banks, contracts or other institutional arrangements=0. Central bank without explicit instrument independence or contract=1/2. Central bank with explicit instrument independence for the body responsible for monetary policy or a central bank contract for monetary policy=1.

Economic transparency

Economic transparency focuses on the economic information that is used for monetary policy.

- a) Are the basic economic data relevant for the conduct of the monetary policy publicly available? The focus is on the release of current data for the following variables: (i) money supply growth, short- and long-term interest rates, inflation, GDP growth and unemployment rate; and (ii) a measure of capacity utilization or (central bank's estimate of the) "output gap", and a timely (update of the central bank's) estimate of the "natural" or long run equilibrium interest rate (at least once a year). Quarterly time series not available for all variables ad (i)=0. Quarterly time series available for all variables ad (i)=1/2. Quarterly data available for all variables ad (i) and (ii)=1.
- b) Does the Central Bank disclose the formal macroeconomic model(s) it uses for monetary policy analysis? No=0. Yes=1.

- c) Does the Central Bank regularly publish its own macroeconomic forecasts? No numerical Central Bank forecasts for inflation and output=0. Numerical central banks forecasts for inflation and/or output (gap) published at less than quarterly frequency or only for the short term=1/2. Quarterly numerical central bank forecasts for inflation and output (gap) for the medium term (one to two years ahead), specifying the assumptions about the policy instruments (conditional or unconditional forecasts) =1.

Procedural transparency

Procedural transparency concerns the way monetary policy decisions are made.

- a) Does the Central Bank provide an explicit policy rule or strategy that describes its monetary policy framework? No=0. Yes=1.
- b) Does the Central Bank give a comprehensive account of monetary policy deliberations (or explanations in the case of a single central banker) within a reasonable amount of time? No, or only after a substantial lag (more than eight weeks) =0. Only summary minutes or only comprehensive minutes published with a significant delay (of at least three but no more than eight weeks) =1/2. Yes, comprehensive minutes or explanations, including a discussion of backward- and forward-looking arguments, published within three weeks=1.
- c) Does the Central Bank disclose how each decision on the level of its main monetary operating instruments/target was reached? No voting records, or only released after a substantial lag=0. Only non-attributed voting records released within three weeks, or individual voting records released within eight weeks=1/2. Individual voting records released on the day of the policy announcement, or monetary policy decision made by a single central banker=1.

Policy transparency

Policy transparency means prompt disclosure of monetary policy decisions.

- a) Are decisions about adjustments to the main monetary policy operating instruments/target promptly announced? No, or after a significant lag=0. Yes, at the latest on the day of implementation=1.
- b) Does the Central Bank provide an explanation when it announces monetary policy decisions? No=0. Only when policy decisions change, or only superficially =1/2. Yes, always, and including an assessment of economic prospects=1.

- c) Does the Central Bank disclose an explicit policy inclination after every monetary policy meeting or an explicit indication of the likely timing, direction, size or pace of future monetary policy actions (at least quarterly)? No=0. Only a policy inclination or qualitative forward policy guidance=1/2. Yes, quantitative FG about future policy actions=1.

Operational transparency

Operational transparency concerns the implementation of the central bank's monetary policy actions.

- a) Does the Central Bank evaluate to what extent its main monetary policy operating target (if any) have been achieved? No, or not very often (at less than annual frequency) =0. Yes, but without providing explanations for significant deviations=1/2. Yes, accounting for any significant deviations from its main operating target(s) or (nearly) perfectly achieving them; or the central bank has perfect control over its main monetary policy operating instrument(s)=1.
- b) Does the central bank provide information on (unanticipated) macroeconomic disturbances that affect the monetary policy transmission process? No, or not very often=0. Yes, but only through short-term forecasts or analysis of current macroeconomic developments (at least quarterly) =1/2. Yes, including discussion of its forecast errors (at least annually) =1.
- c) Does the Central Bank provide an evaluation of the monetary policy outcome in light of its macroeconomic objectives? No, or not very often (at less than annual frequency) =0. Yes, but superficially=1/2. Yes, with an explicit account of the contribution of monetary policy in achieving the objectives (at least annually) =1.

Matlab Codes

% CHAPTER 3

% FIGURE 2: EVOLUTION OF THE ECB MONETARY POLICY TRANSPARENCY INDEX (1998-2019)

```
ECBTIMP= readmatrix('dataset.xlsx','Sheet','Foglio2','Range','A1');
index=ECBTIMP(:,2);
years=ECBTIMP(:,1);
plot(years,index,'LineWidth',2);
xlim([1997 2020]);
ylim ([0 15]);
xlabel('Years')
ylabel('Monetary policy transparency index')
title 'EVOLUTION OF THE ECB MONETARY POLICY TRANSPARENCY INDEX (1998-2019)'
```

% FIGURE 3: COMPARISON BETWEEN THE MONETARY POLICY INDEX AND THE NEW COMPREHENSIVE INDEX (1998-2019)

```
ECBTIMP= readmatrix('dataset.xlsx','Sheet','Foglio2','Range','A1');
index=ECBTIMP(:,2);
years=ECBTIMP(:,1);
plot(years,index,'LineWidth',2,'Color',[0 0.4470 0.7410]);
hold on
ECBTIC= readmatrix('dataset.xlsx','Sheet','Foglio3','Range','A1');
indexc=ECBTIC(:,2);
yearsc=ECBTIC(:,1);
plot(yearsc,indexc,'LineWidth',2,'Color',[0.4660 0.6740 0.1880]);
xlim([1997 2020]);
ylim ([0 18]);
legend('MP transparency index', 'New comprehensive transparency index')
xlabel('Years')
ylabel('Transparency indexes')
title 'COMPARISON BETWEEN THE MONETARY POLICY INDEX AND THE NEW COMPREHENSIVE INDEX (1998-2019)'
```

% TABLE 2: DESCRIPTIVE STATISTICS

```
data = readmatrix('dataset.xlsx','Sheet','Foglio1','Range','B2');
m1=mean(data)';
m2=median(data)';
m3=sqrt(var(data)');
m4=min(data)';
m5=max(data)';
m6=skewness(data)';
m7=kurtosis(data)';
m8=quantile(data,[0.25])';
m9=quantile(data,[0.50])';
m10=quantile(data,[0.75])';
```

```
Tab1=table({'ZSCR';'ECBTI';'GDPg';'INFL'; 'ESTAGDP'}, ...
    m1,m2,m3,m4,m5,m6,m7,m8,m9,m10,'VariableNames',{ 'Regressand and Regressors'
'Mean' 'Median' 'StDev' 'Min' 'Max' 'Skew' 'Kurt' 'Quant25' 'Quant50' 'Quant75'});
Tab1
```

% TABLE 3: CORRELATION MATRIX

```
CORR=corr(data)
```

% TABLES 4,5,6,7: REGRESSION'S RESULTS

```
data = readmatrix('dataset.xlsx','Sheet','Foglio1','Range','B2');
ZSCR=data(:,1);
ECBTI=data(:,2);
GDPg=data(:,3);
INFL=data(:,4);
```

```

ESTAGDP=data(:,5);
tb =
table(ZSCR,ECBTI,GDPg,INFL,ESTAGDP,'VariableNames',{'ZSCR','ECBTI','GDPg','INFL','
ESTAGDP'})
lm = fitlm(tb,'ZSCR~ECBTI')
lm1 = fitlm(tb,'ZSCR~ECBTI+GDPg')
lm2 = fitlm(tb,'ZSCR~ECBTI+GDPg+INFL')
lm3 = fitlm(tb,'ZSCR~ECBTI+GDPg+INFL+ESTAGDP')
% TABLE 4,5,6,7: STANDARD ERRORS ROBUST TO HETEROSKEDASTICITY
[EstCov,se,coeff] = hac(lm)
[EstCov,se,coeff] = hac(lm1)
[EstCov,se,coeff] = hac(lm2)
[EstCov,se,coeff] = hac(lm3)

% TABLE 8: VIF COMPUTATION RESULTS
A=[ECBTI GDPg INFL ESTAGDP]
R = corrcoef(A)
VIF = diag(inv(R))'

```

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