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"Bank profitability and financial stability: an Italian empirical analysis "

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Introduction

The big shocks of the last few years, as the Great Financial Crisis of 2007-09 and the Sovereign Debt Crisis of 2010-12, have highlighted the interconnection between the conditions of the banking system and the macroeconomy.

Therefore, the analysis of the main factors that impact on bank profitability and financial stability has drawn the attention of the decision makers and researchers since the banking sector is of crucial importance for developing a national economy and establishing its financial stability.

When giving a speech on the "*Challenges for bank profitability*" on 1st May 2019, the Vice-President of the ECB Luis de Guindos claimed that "*Bank profitability is important because bank profitability matters for financial stability.*" This sentence is one among many which illustrate the concern of policymakers on bank profitability based on the view that the latter favors financial stability.

Analyzing the banking sector, profitability is an important condition both from a shareholder's and regulator's point of view. From an investor's perspective, profitability is important to generate a return from investments, while from a regulatory point of view it is important to guarantee good solvency ratios even in the case of a risky business environment, which in turn guarantees stability for the banking system and allows to avoid problems in the real economy.

The bank profitability is reflected in the majority of empirical studies by the return on assets (ROA), return on equity (ROE), risk adjusted returns, and the price to book ratio (as a proxy for charter value). A sound and profitable banking sector is better able to withstand negative shocks and contribute to the stability of the financial system.

For this reason, we need also to take into account the role of the financial stability which is captured by both idiosyncratic and systemic risk measures.

Focusing on the literature, the most common measure used for the banks' idiosyncratic risk is the Z-score which is considered as the financial stability of an individual bank. It is inversely related to the probability of a bank's insolvency, i.e., the probability that the value of its assets becomes lower than the value of the debt.

Then, besides idiosyncratic risks, the activities of a financial institution can contribute to systemic risk (i.e., to the overall financial system). A single institution's risk measure does not necessarily reflect systemic risk, which is the risk that the stability of the financial system as a whole is threatened. A measure of systemic risk is the CoVaR (Adrian and Brunnermeier 2011), the conditional value at risk of the financial system conditional on institutions being under

distress. The difference between the CoVaR conditional on the distress of an institution and the CoVaR conditional on the "normal" state of the institution, ΔCoVaR, captures the marginal contribution of a particular institution (in a non-causal sense) to the overall systemic risk.

The existing literature on bank profitability and its impact on financial stability reports mixed evidence. From a theoretical model (TengTeng Xu et al., 2019), it is possible to highlight the analytical relationship between bank profitability and financial stability by exploring the role of non-interest income and bank business models. It is analyzed the importance of the different determinants of banking profitability and financial stability, capturing bank business models and characteristics, structural and cyclical conditions, and policies.

In the low interest rate environment following the global financial crisis, banks diversified by looking for non interest sources of income. Non-interest income is a mixture of heterogeneous components that generate income other than interest income. It comprises fee and commission income that is closely related to market oriented activities such as underwriting and securitization, but also income that is related to traditional banking activities such as payment services fees and commission income arising from the sale of insurances and other products (Kohler 2014). This is consistent with the findings by DeYoung and Torna (2013) who show that it is not non-interest income per se that is decisive for bank stability, but rather the type of non-interest income.

In this context, the objective of the research question is to stress out the impact that bank specific and macroeconomic factors have upon the profitability and the financial stability of the banks that operate in Italy. Firstly, applying a panel regression approach in order to examine the determinants of bank profitability and financial stability, then evaluating the impact that each factor or determinant have upon them.

Focusing on the case of Italy, the profitability of Italian banks has come under scrutiny in the last few years, for at least two reasons. First, in the context of a persistently weak macroeconomic environment, rising credit losses, together with the reduction in the intermediated funds and the contraction of interest rate spreads, have exerted downward pressure on both bank profits and bank capital. Second, because of the Basel III Agreement (which imposes tighter capital requirements on banks) the ability of banks to extend credit to the economy will depend more than ever on their adequate capitalization. The differences in profitability may also be a reflection of their particular business models and its related risks, on both the liability and asset side of the balance sheet.

The main objective of the empirical analysis is to consider a sample of 19 Italian banks, considering a period from 2006 to 2019 in order to capture the full effects of the crisis that characterized this period.

The dependent variables are the bank profitability and financial stability measures, instead the independent variables are divided into internal and external determinants, such as the bank specific and macroeconomic specific factors.

Then we test empirically the expected effect of every determinants in order to show the impact that internal and external determinants factors have on bank profitability and financial stability. The main empirical approach to conduct this type of analysis on bank profitability and financial stability is a panel regression setup that control for business models, bank characteristics, as well as policy variables and cyclical conditions in the economy.

The analysis will be made considering three groups of panel regression estimations: the first group is characterized by the determinants of bank profitability; instead, in the second one are examined determinants of financial stability at individual level through the Z-score measure; finally, in the third one are examined determinants of financial stability at system level using ΔCoVaR measure.

The thesis is structured as follows: Chapter 1 provides a general overview of the bank profitability and financial stability; Chapter 2 presents a focus on the Italian banking system; Chapter 3 gives the most relevant contribution of the academic and empiric literature; finally, Chapter 4 shows our Italian empirical analysis.

1. Bank profitability and financial stability

1.1. The role of bank profitability

The global financial crisis that started in 2007 quickly turned into a global recession and changed the way most financial institutions operate as they had to comply with an economic cycle of lower demand, more difficult financing condition, and stricter regulation.

These structural adjustments in the economy and the reforms of the financial system may have had an important effect on banks' profitability and, consequently, on banks' capacity to survive in the short run. In fact, weak profitability is one of the key challenges currently faced by many banks in the European Union. Since the outbreak of the global financial crisis, the profitability of European banks declined substantially, and has not recovered to its pre-crisis level yet.

In countries facing the sovereign debt crisis banks were hit harder after 2011, as their economies deteriorated, while losses peaked in 2008 in countries where banks were more exposed to the subprime crisis and to toxic assets. In countries where the recession was particularly severe, banks are still paying a high cost of risk in terms of provisioning, and profitability remains weak though improving. Therefore, since the profitability of the banking sector is one of the most important elements of financial system for the future of the economy, it is important to study its determinants in the context of the global financial crisis.

Profitability is a crucial goal for a firm and can be considered the most important one. Making a profit means that a firm is able to generate a stream of revenue that is greater than its operating costs, and in broad sense, it signals the success of the firm within the market.

Over time, several elements contribute to the shape of profitability of a specific business: the level of interest rates, inflation, general economic growth, competition within the sector and so forth. Moreover profitability is usually pro-cyclical; during economic downturns, the level of profits falls sharply, and some firms default, exiting the market for ever.

The banking sector plays a crucial role within the economy of a country, and it is not surprising that its profitability is a strong indicator of the health of a specific economic and financial system. In many ways banks represent a fundamental pillar sustaining modern economies, and they are active both in direct and in indirect finance.

Deterioration of the surrounding environment leads to a worse asset quality and lower revenues for the banking system. The main problem is that banks are at the same time the target and the promoters of the dynamics of the economic cycle. Given that banks represent a transmission channel for transferring purchasing power within the economy, their default can be at the same

time the effect of defaulting firms and the cause of economic downturns; they can transform a crisis started at a microeconomic level into one at macroeconomic level. This is the reason why the health of the banking system is a key issue for policymakers and regulators and, at the same time, it explains the enormous output of prudential regulation over time.

As previously explained, the severe crisis that started in the US in mid-2007 has had intense and long-lasting effects on the banking sector; one of the most important results of this troubled period has been a dramatic fall in bank profitability.

This outcome is particularly dangerous for the financial industry and for the whole economy, in that the resilience of a bank depends on its level of regulatory capital, and its ability to increase this aggregate is strongly linked to the remuneration offered to its shareholders. Moreover, recent prudential regulation has strengthened the importance of self-financing as a measure for reinforcing the level of capital ratio. For this reason, re-establishing a sound level of profitability has become a key point of bankers, regulators and policymakers; in this area, some elements need to be managed and clarified. On the one hand, from a technical point of view, it is necessary to define what we mean by profitability and which indicators we can use to measure it.

Over the years, different ratios have been used to define the profitability level of a specific firm; this has been particularly true for the banking system, which has peculiar features in terms of financial statements and business lines. These ratios can involve measures of profitability, price volatility, risk adjusted performance measures and others linked to financial market data; moreover, attention can be focused on the revenues of a specific business, as in the case of the interest margin. On the other hand, from a strategic and managerial point of view, it is necessary to clarify how the profitability of a specific bank can be enhanced and improved. This involves the ability of a firm to understand and anticipate the changes in the surrounding environment, choosing between the alternatives available at specific times.

The European Central Bank (2010) identifies four main drivers that are required to generate sustainable profitability defined as the capacity to maintain profits over time: earnings, efficiency, risk-taking and leverage, which are discussed below.

1. The ***earnings*** analysis is linked to the asset quality analysis and is an issue which has a high degree of attention since the crisis began. In particular, the composition and the volatility of earnings are important factors that affect the probability of profits to be recurring. For example, if a source of revenues is characterized by high volatility or if it is generated by an extraordinary component, it is very unlikely that the profitability of a bank in a year will be repeated in the following income statements. That is the

reason why analysts investigate bank's sources of income: they want to understand if the performance of a bank is an extraordinary event or if the bank is going to replicate it in the future. Moreover, a persistent high level of profitability should alarm about the possibility of an excess of risk taking by the bank. In order to analyze the composition of profits, analysts look at the main aggregates of the income statement and at their relative contribution in generating the global profitability.

2. ***Efficiency*** is about the ability of a bank to generate profits from a group of assets or from a source of revenues. In fact, producing revenues is not a synonym of producing profits: the main difference is that costs must be deducted from revenues to get profits. It is possible to talk about efficiency even relating costs and revenues, such as for the cost-to-income ratio: in this case the ratio describes the ability of a bank to transform resources into revenues. An important consideration is that the degree of efficiency is strictly connected with the business model of a bank since each business model implies a different use of resources: this means that efficiency comparisons are meaningful only among banks with similar business models.
3. ***Risk-taking*** refers to the amount of risk banks undertake in performing their activities. This impacts the profitability of banks in two ways: on one hand, the more the undertaken risk, the higher can be the profitability in a good scenario case; on the other hand, risk affects profitability due to the adjustments that must be done on earnings because of it (like the provisions associated to the credit risk). In this sense, it is important that the risk appetite of a bank is aligned with its strategy and its business structure not to damage the ability to generate profits in the future. In fact, a bank must find a balance in the trade-off between risk, growth and return to be profitable. The most used credit-risk indicators are the coverage ratio, the non-performing loans ratio and impairment charges as a percentage of total loans.
4. ***Leverage*** is about the use of borrowed capital as a source of funding to increase the bank's assets. The aim is to invest more to generate higher returns on capital, therefore boosting some profitability indicators like ROE: in this sense it can be seen as a multiplier of performance. But, at the same time, the higher is the leverage of the bank and the higher is the solvency risk for the institution, which is the risk not to meet its obligations. As reminded by the European Central Bank (2010), leverage should be seen as a warning indicator: in particular, when its value increases for more subsequent years and when it overcomes a level of 30, the bank is considered "non-sound".

The aim of the European Central Bank (2010) is to point out that to produce a meaningful analysis about the profitability of banks it is not enough to look at their income statements and at ratios made on it, but there is the need to perform a sum of the part analysis, focusing not only to performance depictions but even on profitability drivers.

This new scheme of analysis is a consequence produced by the recent crisis, which has completely changed the way analysts investigate the profitability of banks. Today, the focus is not merely on the short-term performance, but it includes even a complementary analysis on risk, assets quality, capital adequacy and leverage.

The aim is to analyze key business drivers to understand whether the business model adopted by banks is producing a sustainable profitability, which means that banks will be able to maintain their performance in the long term and that they will be able to absorb unexpected losses due to shocks in the future.

The importance of bank profitability can be evaluated at the micro and macro levels of the economy. At the micro level, profit is the essential prerequisite of a competitive banking institution and the cheapest source of funds. The basic aim of a bank's management is to achieve a profit, as the essential requirement for conducting any business. At the macro level, a profitable banking sector is better able to withstand negative shocks and contribute to the stability of the financial system.

1.1.1. Measures of bank profitability

Profitability can be defined as the ability to produce a positive balance between the revenues and costs of an economic entity, being this a whole enterprise or part of it, through the use of financial and non-financial resources. This means, first of all, that the measurement of bank profitability normally consists in a ratio in which the numerator contains items extracted from the income statement, while the denominator comprises items typically linked to assets or liabilities included in the balance sheet. The specific choice of the items that will be included in the calculation determines the wide range of indices available for analysis. However, there are some properties, listed below, that appear particularly desirable when choosing a profitability metric:

- The first characteristic should be consistency with the purpose for which the index was constructed. In particular, the quantities taken into account should effectively represent the analyst's area of interest; appropriate reclassifications in financial statements should make it possible to isolate those items that refer to similar activities performed by the bank, allowing a correct measurement of performance;

- A second and fundamental characteristic should be data reliability: this involves some important considerations on the subject of data quality. This aspect of data is strongly linked to a third virtuous element that should always be sought: data consistency;
- Considering data consistency, the existence of multiple methodologies for calculating the financial statement indices and the evolution over time of accounting principles and supervisory regulations make comparison between banks from different geographical contexts (a typical example is a comparison of European and U.S. banks) or the reconstruction of adequate historical series of data extremely complex.

For this reason, it is clear that the creation and use of bank profitability metrics requires a common framework of accounting rules and homogeneous practices in the calculation of the indices.

Alongside the three properties mentioned above, we would like to draw attention to two further elements in order to increase the effectiveness of profitability measures in explaining the performance of a bank: these are elements that could be defined as "enhancers" of the above properties. The first element is transparency, meaning the possibility of clearly identifying and breaking down determinants of profitability. The second one comprises the replicability of the result; the greater the information content of a given profitability datum, the greater the persistence of profits. This aspect is of fundamental importance in the analysis of bank profitability, being linked to the bank's ability to increase its equity over time, attract new capital and reduce its overall risk.

From these considerations it is clear how complex it is to have effective measures of profitability; each usable metric has strengths and weaknesses that must be taken into account when interpreting the financial performance of a bank. The bank profitability measures commonly used are generally traceable on two main indices. In most cases, the key variables are the return on equity (ROE) and the return on assets (ROA). Moreover, another indicator may be added, that is the net interest margin (NIM).

Over time, volatility measures for these indicators (generally in the form of standard deviation) and risk-return variables have also been established; examples of these latter ratios are the RAROA and RAROE, respectively, obtained by dividing the ROA and ROE by their volatility over time. These are interesting extensions to bank profitability analysis, since, as stated previously, persistence is a fundamental element for the evaluation of the overall performance achieved by a company. Below, all these profitability measures are analyzed in detail, in an attempt to highlight their reporting content, areas of use and critical aspects.

i. Return on Equity (ROE): It is an indicator that is easy to construct and use, its financial significance is extremely simple to understand and it is available for all public companies. For this reason, it is not surprising that in the bank profitability literature, ROE has been used as a dependent variable in most quantitative studies. ROE is generally calculated as the ratio between net income and owners' equity at the end of a certain period of observation. The latter usually tends to coincide with the end of the calendar year, unless the drawing up of financial statements requires different choices. The importance that this indicator has acquired over time derives from the significance that can be attributed to it: the ROE expresses the percentage of remuneration obtained by shareholders through net profits recorded in the company's income statement. This is a fundamental information for the shareholders in that they can compare this result with the profitability offered by other instruments or the stock market as a whole, verifying if the risk-return profile of their investment meets their expectations. This aspect is particularly useful when determining whether the company is creating or destroying value, for example, by comparing its ability to generate a level of profitability sufficient to cover its weighted average cost of capital or, more simply, its expected cost of equity. However, as stated previously, this parameter has numerous weak points which must be taken into consideration. The first is a feature common to almost all financial indices and derives from the possibility of having different ways of calculating a certain parameter. For example, from a financial and interpretative point of view, the index calculated on the average of the owners' capital appears more correct; in fact, if a tangible change in the shareholders' equity occurred during the year, a denominator formed only from the stock at the end of the period risks providing biased results. This feature has a financial significance: using the average of owners' equity enables one to account for the fact that the production of net profits occurred during the year, thanks to certain average capital endowment. Obviously, this assumption presents potential defects too. The average of the balances at the beginning and at the end of the year implies that it is assumed that the change observed in shareholders' equity occurred proportionally throughout the year; if instead it happened near at the beginning or the end, the calculation would provide biased results. Continuing the analysis of the weakness of the ROE, we can see that there is another highly critical aspect of this index, which derives from the information used to construct the indicator: the company's operational sensitivity to financial leverage. This is a delicate problem in the light of the effects that the correlation between the two variables can produce on interpretations of the ROE data provided by a company. Indeed, all else being equal, a company with less

owners' equity will have a higher ROE. Since this index is so widespread and appreciated, this could push managers to choose more leveraged financial structures in order to increase the perception of profitability of their companies. This aspect is well known in the financial and banking field in particular; the international financial crisis that began in 2007 clearly highlighted both the extreme level of leverage with which some financial intermediaries operated, and the risks that this strategy involves. Increased leverage weakens the financial structure of a bank, making it more vulnerable and less resilient to losses. It could be argued that the increase in ROE as leverage increases represent a compensation (through greater profitability) for the greater risk incurred by shareholders; however, in the absence of an adequate perception of this growing risk, the increase in ROE would be seen as the result of better business management. This explains the fact that the prudential regulation has imposed precise and more stringent limits on leverage in the banking sector due to episodes of instability that affected many banks during the crisis.

ii. Return on assets (ROA): it is the second most used performance measure in the banking sector; in the literature it is extremely common to find both measures as dependent variables in econometric estimations or in financial analysts' reports. In particular, ROA is used together with ROE to verify differences in the behavior of covariates when the dependent variable varies, or as an alternative to ROE in empirical model robustness checks. In the financial world, ROA is widely used, thanks to the ease with which it is possible to interpret its results: it permits measurement of the return generated by a company's assets. This is because the indicator is constructed by relating the bank's net income to its total assets. As in the previous case, some indexes are constructed by putting the average of total assets at the beginning and at the end of the observation period in the denominator, rather than the final value obtained from the balance sheet; in these cases, we talk of ROAA, or return on average assets. One of the main limitations of ROA is linked to an accounting aspect of this financial parameter: if a bank has significant amounts of off-balance-sheet activities, the ROA tends to provide biased results, that is, to lose real financial significance.

Summarizing the differences between these performance indicators, it can be affirmed that while ROE focuses on the return generated for shareholders, ROA expresses the result obtained from the use of the company's assets, regardless of the way in which they were financed. From this point of view, the use of ROA is particularly interesting, since it shifts attention on the one hand into the managerial choices behind the

composition of the assets, and on the other into the profitability of the latter. This aspect is linked to some key strategic choices for a bank, such as the identification of its business model and risk appetite.

iii. Net interest margin (NIM): it represents the third and final "classical" measure by which bank profitability is assessed. This indicator explains the capacity of the bank to produce the margin and the return obtained through traditional intermediation activity, that is, borrowing and lending money. More specifically, the indicator is usually constructed dividing net interest income by interest-earning assets; net interest income is, in turn, calculated as the difference between interest income (derived from the bank-lending activity) and interest expenses (paid to those who lend to the bank, such as account holders). For this indicator too, there is a formulation (which is also the most frequent in the literature) which provides for the inclusion in the denominator of the average interest-earning assets as the average of the data collected at the beginning and at the end of the observation period. Compared to the performance indicators mentioned above, NIM stands out for one fundamental reason: it takes into account only the revenues and costs incurred for the traditional activity of commercial banks, ignoring other forms of cost and revenue. This may appear to be an element of weakness in the index, due to the neglect of many entries deriving from the bank's income statement; in fact, this focus on a few, but very significant budget items, allows us to examine the profitability of the bank's core business (at least for commercial banks) in greater depth. The NIM numerator, or net interest income, is one of the main items contributing to the net income of a bank (and therefore also influences the performance of other indices, such as ROE and ROA). NIM has grown in importance in the analysis of bank profitability following the great financial crisis. After 2007, bank credit portfolios began to show signs of sharp deterioration; non-performing loans (NPLs) grew enormously, penalizing banks that operated with riskier customers and with a high share of loans over total assets. Small local banks focusing on traditional borrowing and lending activities have been strongly affected by these dynamics, but large international groups have also experienced critical issues. The monetary authorities' response to the rapid spread of the crisis in the economic system has involved various policies, but an extremely evident aspect has been the general lowering of short term interest rates. In the more developed countries, this has been accompanied by a strong decrease in long term rates, leading to a flattening of the yield curve. These two elements, of micro and macroeconomic nature (the formation of NPLs and the drastic lowering of rates of

return), have an impact on NIM: they are able to influence both the denominator and numerator of the index. The evolution of the net interest margin therefore has the role of showing how banks can adapt their assets and liabilities management following a change in the surrounding economic context, and hence the interest in this performance indicator in turbulent years such as those following 2007. Alongside these undoubted qualities, NIM also naturally has some limitations. As previously stated, the first derives from its nature; focusing only on net interest income, the index neglects other potential important business areas that the bank may decide to enter. A second critical aspect regards the inability of the net interest margin to disentangle the importance of interest income and interest costs in the calculation of the net interest income. An increase in the NIM numerator could, in fact, derive from greater asset profitability of from cheaper funding sources; both situations have specific risk factors. An increase in interest income could signal credit concession to riskier customers, willing to pay higher interest rates against their own risk of insolvency. Likewise, a reduction in the rate of interest on savings could weaken customer loyalty, leading to cash outflows to the benefit of competitors or other uses by customers.

iv. Risk – adjusted measures: over the years, academics and practitioners have created a wide range of risk adjusted return measures, with the aim of providing a clearer view of the link between positive financial performance and risks borne to achieve this result. The literature on the topic has focused on some particularly significant and widespread indicators: RAROE and RAROA (respectively, risk adjusted ROE and ROA). In general, the main risk adjusted return measures are based on well-known risk metrics; of these, the most commonly used is the standard deviation. This statistical measure is largely used in modern finance, thanks to its simplicity of calculation and interpretation. It expresses the degree of volatility of a certain phenomenon, and therefore represents the classic degree of risk of an investment in the collective imagination. Standard deviation underlies two indices widely used in the literature: RAROE and RAROA. They are usually calculated as follows:

$$RAROE = \frac{ROE}{\sigma ROE}$$

$$RAROA = \frac{ROA}{\sigma ROA}$$

where σROE and σROA, respectively, identify the calculated standard deviation for ROE and ROA over the reference period, which requires some clarification. As always occurs when calculating a single-point figure starting from numerical series, it is necessary to first define the period on which the analysis is carried out; this depends simultaneously on the availability of data and the time span of interest. From an interpretative point of view, the measures indicated above have the same characteristics as the metrics from which they derive, that is, ROE and ROA; they do, however, permit the penalizing of subjects with a high dispersion of financial results. When observing RAROE and RAROA data, it is therefore good practice to analyze in detail the profitability and profit volatility data that contributed to the calculation; in this way, a much clearer and more reliable view will be achieved.

1.1.2. Internal and external determinants

In this paragraph, we analyze the factors that explain bank profitability according to causal links widely explored in the literature. There are many variables that have proved capable of explaining the dynamics of income produced by a bank. To try to simplify the analysis and make the contents more usable, it is important to firstly divide the main determinants of bank profitability into internal and external factors.

- Internal determinants of bank profitability: this large group of factors, extensively studied in empirical research that have tested over time their ability to affect the performance of banks, often finding conflicting results.

  One of the most carefully explored factors among the determinants of bank profitability is the size of the bank. It is a factor that has multiple effects on the performance of a bank; from one point of view, it is linked to the possible creation of economies of scale, while, on the other, large size can have specific connotations for some subjects (e.g. the so called “too big to fail” banks (SIFIs)), and condition their behavior and economic results. In the literature, size is a control variable present in almost all empirical work; its importance in discriminating small and large subjects is fundamental, above all, where the size range of the investigated samples is wide.

  The results of empirical estimation models concerning the role of size in influencing bank profitability provide contrasting results. The existence of economies of scale in banking business is not proven incontrovertibly; in general, the indications deriving from data analysis seem to suggest that the advantages linked to the size decrease as the size increases. This result should not be surprising: an increase in size can generate some

beneficial scale effects, but at the same time it generates organizational diseconomies and various forms of inefficiency linked to the great dimension itself. When the negative effects outweigh the positives, an increase in size becomes a negative factor for bank's profitability. However, contrary situations may occur, in which small entities can exploit competitive advantages, generating high and stable levels of profitability.

In this way, it is possible to highlight that the size may often represent a significant element in explaining a pattern of bank profitability; the sign of the link, however, is not certain a priori.

A second internal factor is the business model chosen by the bank. This element radically affects the strategic positioning of the company and its risk-return profile. A lot of research effort concentrated on this aspect in the period immediately following the great international financial crisis; this indirectly demonstrates the importance attributed to the choice of business model in explaining banks' income profile.

The determination of a bank's orientation toward a certain business model can be carried out directly through specific dummies, where the strategic choice made by management is declared, or through variables that tend to capture specific and significant connotations of the bank's activity.

In this way, two variables can be derived from, respectively, the balance sheet and the income statement of an intermediary: the share of loans out of total assets and the non-interest income. The share of the credit portfolio out of a bank's total assets denotes its orientation toward the traditional activity of borrowing and lending money. Then for the second variable, as highlighted previously, an important aggregate that plays a crucial role on the analysis of bank profitability is the non-interest income. It is a mixture of heterogenous components that generate income other than interest income. It comprises fee and commission income that is closely related to market-oriented activities such as underwriting and securitization, but also income arising from the sale of insurance and other products.

Non-interest income also includes the income that banks generate with their trading and market making activities and other operating income. Since non-interest income is usually more volatile than interest income, it is often held to be riskier (Kohler 2014). This is consistent with the findings by DeYoung and Torna (2013) who show that it is not non-interest income per se that is decisive for bank stability, but rather the type of non-interest income. In fact, in addition to the traditional lending and deposit-taking activities, banks perform many other activities like checking and cash management, investment services and securities brokerage. Knowing that concentration of revenues

on a single source of income exposes one to significant risks if an adverse scenario emerges (e.g. a serious economic crisis that makes the recovery of loans granted difficult, due to widespread default among customers), many banks may prefer to diversify revenue sources.

The ability to activate effective revenue diversification processes is linked to a bank's ability to bear the costs related to the implementation of organizational processes, technological investments and the acquisition of skills for personnel assigned to new functions. It is clear that these dynamics require adequate adaption time for the bank; in fact, it does not seem possible to follow diversification strategies over a very short period. The cost to be paid can be high and the volatility generated by new sources of revenue may be greater than the beneficial effect of diversification deriving from the low correlation between the various activities carried out, leading to a loss for the bank. This is the so called "*dark side of revenue diversification*" introduced in a famous article by Stiroh and Rumble (2006).

While on the subject of loans and non-interest income, the role played by possible credit deterioration must be taken into account; this is an aspect that emerged with great emphasis at the outbreak of the international financial crisis.

The variables used in the literature in this regard are varied, and range from the share of non-performing loans out of total loans, troubled loans out of total loans or the level of loan loss provisions inserted by the bank in its income statement. As a rule, all these aspects have provided strong empirical evidence in explaining the dynamics of bank profitability; the expected sign of the coefficients associated with these variables is naturally negative (Foos et al., 2010).

Another crucial aspect that the severe crisis has highlighted is the importance of the bank's regulatory capital level; as previously mentioned, the low level of many intermediaries' equity in the past allowed them to generate extremely high levels of ROE. However, the crash of the crisis evidenced the fragility of intermediaries characterized by excessively high level of leverage, and prudential regulation intervened to limit those speculative strategies.

Financial leverage (or capital ratio) has therefore become particularly important explanatory variables in the field of empirical research. Financially, a lower degree of financial leverage should be accompanied by a lower risk of default for the bank, and therefore its greater resilience even in the face of market turbulence.

Finally, a key variable widely used in the literature is the cost income ratio, calculated as the ratio between operating costs and operating revenues; it is a particularly

informative indicator, since it throws light on whether a bank is able to balance recurring costs and revenues. Although there are entities able to operate with extremely low fixed costs, thanks to their structure (e.g. online banks or banks that operate through tied agent networks), as a rule, banks that carry out traditional activities and manage to reach a low cost income ratio tend to perform better than others.

This is a variable that management itself should monitor with great care, partly in order to conduct effective benchmarking activities as regards competitors. It should be noted in this regard that the importance of the cost income ratio lies in its ability to compare costs and revenues, and not merely provide a representation of the costs incurred. In other words, a limited cost income ratio can be achieved both through a reduction in cost and an increase in revenues; it is the relationship between the two which is really significant. It follows that a policy of mere cost-cutting could prove to be completely mistaken where the reduction in charges leads to customer dissatisfaction with the service received, with consequent lower revenues in the future. The cost income ratio could even be reduced by increasing costs, offset, however, by proportionally higher revenues; it is undoubtedly one of the main indicators for understanding the ability of management to make virtuous choices for the bank's future.

- External determinants of bank profitability: banks are crucial for the functioning of financial markets, but also for the economy as a whole; their nature as asset and risk transformers means they play a leading role in intermediation activities.

  This results in a very close link between the life of a bank and the environment in which it operates; it is therefore normal that there is a very strong relationship between environmental factors and bank profitability.

  In the literature, the external determinants of bank profitability are generally characterized by macroeconomic factors. Of these ones, the elements that appear to be most able to influence bank profitability are the economic cycle, the level of market interest rates and inflation.

  The economic cycle is normally approximated through variations in gross domestic product (GDP); specifically, bank profitability is expected to follow a pro-cyclical trend (Albertazzi and Gambacorta, 2009). GDP growth should therefore stimulate banks' revenues, while the onset of recession leads to a reduction in income. GDP performance tends to summarize all the surrounding economic conditions, and therefore the profit opportunities for companies operating on the market. Interest rate and inflation rate trends are other elements used frequently as control variable for the financial conditions of the economy.

To conclude, it should be clear that defining and measuring bank profitability is particularly complex and involves selecting appropriately from a huge number of financial indices. This implies that the profitability of banks is not only affected by how the banking activities are managed, but it depends even on some macroeconomic factors, which are affected by economic institutions and by the regulator.

At the same time profitability depends even on well identified drivers, which must be carefully analyzed with the business model of the bank to assess whether the return obtained by the financial institution is sustainable, which means that it was generated by recurring components and so that it is replicable in the future.

1.2. The role of financial stability

According to the existing literature on financial stability issues it has become apparent that in recent years the questions related to the maintaining of financial stability have been receiving priority attention from both academics and policy makers around the world.

Clearly the definition of "financial stability" is important for the development of relevant analytical tools and for the design of policy and operational frameworks essential for economic policy implementation.

The financial stability generally refers to the stability of the financial system as a whole, and as a consequence to the financial strength of an individual institution. In fact, the stability of financial institutions and markets represents a prerequisite for a stable financial system, which in this way is intended as a shock absorber. Thereby, in order to assess the financial stability, the relations and networks among financial institutions is equally important.

In particular, the recent financial crisis has painfully disclosed the policy mismatch between the former regulatory framework of banking supervision, namely Basel II, and its intended objective of financial stability.

The existing deficiencies predominantly concern neglected dimensions of systemic risk as well as their corresponding transmission channels. Accordingly, the Basel Committee on Banking Supervision (BCBS) has aimed to approach the mentioned issues with Basel III, the latest version of its global regulatory framework on banking supervision. To fill existing gaps, the framework passed through the indispensable development process towards a broader consideration of dimensions of systemic risk. The Basel III accord reacts to the events of the recent financial turmoil with a combination of revised micro-prudential and macro-prudential regulatory instruments in order to address various newly identified dimensions of systemic risk. But the theoretical and empirical literature was mainly focused on the dimension of individual

bank risk and one main measure of individual soundness was commonly used to analyse the impact of financial mutations and market structure on financial stability: the Z-score.

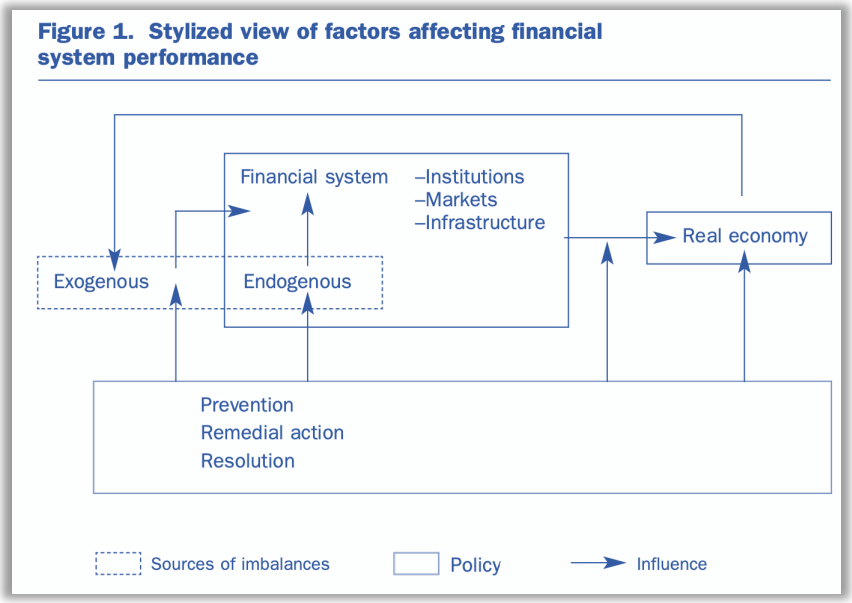
However, the recent financial crisis questioned the exogeneity assumption of banking risks. Thus, the sum of the risks borne by financial institutions does not reflect the risks borne by the entire system. This would be due to common exposures to a single risk factor, the pro-cyclicality of the financial imbalances and the interconnections between financial institutions characterized by their complexity. The latter does not exclusively relate to the importance of their size but also to the sophistication of their instruments, threatening the substitutability of their products.

Prior to the global financial downturns, the regulatory framework in place was only based on a micro-prudential foundation. The crisis highlighted its shortcomings through the pro-cyclicality and the handling of solvency ratios, as well as the lack of macro-prudential dimension. The implementation of a micro-prudential risk assessment based on a general equilibrium and designed to safeguard the financial system as a whole appeared unavoidable to complete the micro-prudential risk assessment based on a partial equilibrium in its conception, and aiming at preventing costly failures of individual financial institutions.

The endogenous nature of risk introduced the need for a macro-prudential approach to bank regulation, giving a key role to banking regulators in the computing and management of global risk, so called systemic risk.

For our purpose, in defining financial stability we are concerned both of an individual bank risk and systemic risk (i.e. to the overall financial system) in order to make a more exhaustive analysis. As indicated in Figure 1, risks and vulnerabilities may develop endogenously, within the financial system, as well as exogenously – for example, in the real economy.

Different kinds of risks require different policy actions. The size and likelihood of endogenous imbalances can typically be influenced by the financial authorities through regulation, supervision, or crisis management. By contrast, external disturbances are harder to control, except through macroeconomic policies subject to long and uncertain time lags. The scope for policy in the event of an external disturbance is limited mostly to reducing the impact on the financial system, for instance, by maintaining the system's ability to absorb shocks and activating back-up systems to protect vital information.



Source: International Monetary Fund, 2005

1.2.1. Measures of financial stability and its determinants

The use of both individual and systemic risk measures must not be viewed as a discrepancy because the two indicators do not share the same dimension.

Developments in financial stability cannot be summarized in a single quantitative indicator. In contrast with price stability for instance, there is as yet no unequivocal unit of measurement for financial stability. This reflects the multifaced nature of financial stability as it relates to both the stability and resilience of financial institutions, and to the smooth functioning of financial markets and settlements systems. Moreover, different factors need to be weighed in terms of their potential ultimate influence on real economic activity.

For a deeper analysis is better to distinguish between systemic and idiosyncratic risk measure, as follows:

I. Systemic risk measure:

According to the European Central Bank (2010)[1], systemic risk can be defined as the risk of financial instability insofar it adversely affects the effective functioning of the financial system, and it significantly impairs the sustainable growth of the economy and social welfare.

[1] Speech by Jean-Claude Trichet, President of the ECB, at the 13th conference of the ECB-CFS Research Network, Frankfurt am Main, 27 September 2010.

Since the outbreak of the global financial crisis in 2007, and the dramatic effects of the Lehman collapse in 2008, systemic risk has become a matter of great concern for policy makers and central bankers. Losses tend to spread across financial institutions, threatening the financial system as a whole.

The spreading of distress gives rise to systemic risk, the risk that the intermediation capacity of the entire financial system is impaired, with potentially adverse consequences for the supply of credit to the real economy.

In systemic financial events, spillovers across institutions can arise from direct contractual links and heightened counterparty credit risk, or can occur indirectly through price effects and liquidity spirals.

The most common measure of risk used by financial institutions is the value at risk (VaR), but it focuses only on the risk of an institution in isolation. However, a single institution's risk measure does not necessarily reflect the systemic risk.

First, according to the classification in Brunnermeier, Crocket, Goodhart, Perssaud, and Shin (2009), a systemic risk measure should identify the risk to the system by "individually systemic" institutions, which are so interconnected and large that they can cause negative risk spillover effects on others. Second, risk measures should recognize that risk typically builds up in the background in the form of imbalances and bubbles and materializes only during a crisis.

To emphasize the systemic nature of the risk measure, Adrian and Brunnermeier (2011) add to existing risk measures the prefix "*Co*", which stands for *co*nditional, *co*ntagion, or *co*movement. Focusing primarily on CoVaR, where institutions *i*'s CoVaR relative to the system is defined as the VaR of the whole financial sector conditional on institution *i* being in distress. The difference between the CoVaR conditional on the distress of an institution and the CoVaR conditional on the "normal" state of the institution, $\Delta CoVaR$, captures the marginal contribution of a particular institution to the overall systemic risk.

There are several advantages to the $\Delta CoVaR$ measure. First, while this measure has the ability to highlight the contribution of each institution to overall system risk, traditional risk measures focus on the risk of individual institutions. Another, important advantage of this measure is that it is general enough to study the risk spillovers from institutions across the whole financial network.

Adrian and Brunnermeier (2011) denote by $CoVaR_q^{j|i}$ the VaR of institution j (or of the financial system) conditional on some event $C(X^i)$ of institution i. That is, $CoVaR_q^{j|i}$ is implicitly defined by the q-quantile of the conditional probability distribution:

$$\Pr\left(X^j \leq CoVaR_q^{j|C(X^i)} \middle| C(X^i)\right) = q$$

II. Idiosyncratic risk measures:

In this part, we explain three idiosyncratic risk measures that are commonly used in the empirical research in order to assess the bank financial stability at individual level. There are briefly analyzed, respectively: Z-score, Expected Default Frequency (EDF) and finally the Value at Risk (VaR).

- *Z-score:* in line with the literature (e.g. Stiroh, 2004; Stiroh and Rumble, 2006), one of the main indicators of bank is the Z-score, which is defined as,

$$Z - score = \frac{ROA + CAR}{SDROA}$$

where CAR is equal to the bank's capital asset ratio (i.e. the ratio between equity and total assets) and SDROA is equal to the standard deviation of the ROA. The index is clearly characterized by the numerator, which contains the solvency condition of the bank. Indeed, as a rule, insolvency occurs when the sum of CAR and ROA is null or negative; a high level of capitalization is therefore necessary to counteract negative ROA results. The volatility of ROA, seen in the index denominator, penalizes companies that have shown an unstable pattern of financial results over time.

The Z-score is the inverse of the probability of insolvency, i.e. a higher Z-score indicates that a bank incurs fewer risks and is more stable.

Its widespread use is due to its relative simplicity and the fact that it can be calculated using only accounting information. This wording shows that the Z-score combines in one single indicator the bank profitability, bank capital and return volatility.

From a statistical point of view, the Z-score indicates the critical threshold of standard deviations below which the collapse of bank returns wipes out all equity and led to bank insolvency. From an economic viewpoint, the Z-score measures the probability that a bank becomes insolvent due to a decline in its assets value below its debt value.

- *Expected Default Frequency (EDF)*: it is a credit measure that was developed by Moody's Analytics as part of the KMV model.

EDF measures the probability that a company will default on payments within a given period by failing to honor the interest and principal payments, usually within a period of one year, hence, it provides a forward-looking measure of default.

- *Value at Risk (VaR)*: this has for many years been the standard measure used for risk management.

  VaR is the methodology used to estimate the market risk to which a bank is exposed, and also for determining, the banks' minimum capital required to cover this risk.

  It measures the probable maximum loss registered on a certain position or a positions' portfolio in a given period and for a given confidence interval.

  There are different models to estimate the VaR of a portfolio or return distribution, either parametrically or non-parametrically that are briefly explained below:

  - *Variance-covariance method:* made popular by JP Morgan at the start of the '90s, it is one of the fastest and easiest method to estimate the VaR.

    It relies on the fact that only risk factor of a portfolio is the value of the factors contained in the portfolio itself. It is based on two fundamental assumptions:

    - The distribution of returns of the risk factors is a normal distribution;
    - The movements in the portfolio's value is a linear combination of the movements of the securities that make it up. This implies that the movements in the value of the portfolio are also distributed according to a normal distribution.

    Hence, once estimated the correlation matrix of returns between the securities from the historical series of the risk factors, given the properties of the normal distribution it is easy to obtain the desired percentile of the distribution of the movements of the expected values of the portfolio.
  - *Monte Carlo method*: a simulation technique that, given some assumptions on the distribution of returns and their correlation, forecasts a series of different sets of possible future values of the securities in a portfolio. For each set of values, the portfolio is then re-evaluated and from the vector of expected returns the desired percentile is extracted.
  - *Historical Simulation method*: this approach uses historical data of returns to generate an empirical distribution. It then assumes that the empirical distribution can be used as a prediction for future returns.

It is considered one of the best approaches both because it does not involve any *a priori* hypothesis on the distribution of returns and because the correlation between risk factors is implicitly captured without the need of an *ad hoc* estimation. Almost 85% of large banks in the world were using historical simulation while the remaining part Monte Carlo simulations.

In most empirical research, the commonly dependent variable that is used for the evaluation of financial stability is the Z-score since it is pretty easy to determine through the balance sheet information.
But in order to make a more complete analysis, is crucial to take into account as dependent variable, also the component of systemic risk. As we have already seen, $\Delta CoVaR$ has the ability to capture the financial stability at system level and to assess the risk that the stability of the financial system as a whole is threatened.

As mentioned earlier, financial stability is measured both by idiosyncratic and systemic risks. Now, we summarize the factors that explain financial stability dividing the variables into internal and external variables (as we have already made for the analysis of bank profitability). Key-bank specific variables include bank profitability, asset size, funding risk, income diversification and credit risk.
In addition to these factors, we need to consider also the external determinants, where are considered policy and cyclical variables such as: short term interest rates, government structural balance and GDP growth.

1.3. The interconnections between bank profitability and financial stability: a stylized theoretical model

Building on the research and model made by TengTeng Xu et al., (2019), we analyse the analytical relationship between bank profitability and financial stability. The focus of the model is to capture both retailed-based and market-based non-interest income activities, and, as a consequence, the non-linear impact of NII on banking risks. To keep it tractable and focused, they abstract from modelling a dynamic programming problem, as it is not essential for capturing the stylized relationship among bank profitability, business models and financial stability.

First of all, we need to consider the model set up with a static setting of a representative risk-neutral bank with the following balance sheet structure:

Assets	Liabilities
L	D
$\boldsymbol{N_r}$	E
$\boldsymbol{N_m}$	

In this way, the balance sheet constraint is given by the following equation:

$$L + N_r + N_m = D + E \equiv A,$$

where N_m stands for the assets related to market-based NII activities, such as underwriting, trade commissions, and investment-banking services, and N_r captures retail-based NII activities, such as payment services fees, insurance commissions, lending service fees, and fiduciary income. N_r and N_m are the assets devoted to NII activities at the beginning of the period.[2] *L* stands for loans, *D* deposits, *E* equity, and *A* bank assets. For simplicity, *D*, *L* and *E* are assumed to be exogenous, and that the capital constraint is binding, $E = eA$, where *e* is the reciprocal of the leverage ratio.

[2] For example, if retail-based NII includes payment service fees, then N_r represents the payment network or system's assets (e.g., ATM, software, machinery).

Going on, we need to write the bank's profit function, that is given by:

$$\tilde{\Pi} = (1-x)\tilde{r}_L L + \tilde{r}_m N_m + \tilde{r}_r N_r^{\alpha} L^{1-\alpha} - c_m N_m - c_r N_r - c_f A - r_D D,$$

where tilde "˜ " stands for random variables, and returns are normally distributed. Then, c_m, c_r and c_f are the cost parameters, x denotes the problem loan ratio and the deposit rate r_D can be viewed as funding cost in this model. Particularly important in the model is the Cobb-Douglas production function $N_r^{\alpha} L^{1-\alpha}$ of retail-based NII activities. It ensures homogeneity of degree one with respect to inputs L and N_r, as well as the complementarity between retail-based lending business L, and retail-based NII activities N_r.

After having introduced the bank's profit function, it is possible to consider the bank's objective function that is given by,

$$max_{N_m,N_r}\, E(\tilde{\Pi}) + E$$

subject to the balance constraint $L + Nr + Nm = D + E$. The bank's survival probability is given by $q = Prob(\tilde{\Pi} + E \geq 0)$. Then, it is possible to normalize the bank's objective function by bank asset A and take expectations. In this way, the normalized objective function can be rewritten as,

$$max_{n_m,n_r}\, \mu_\pi + e$$

Subject to $l + n_r + n_m = 1$, where the bank's profit function can be rewritten in this way:

$$\mu_\pi \equiv \frac{E(\tilde{\Pi})}{A} \equiv E(\tilde{\Pi}) = (1-x)r_L l + r_m n_m + r_r n_r^{\alpha} l^{1-\alpha} - c_m n_m - c_r n_r - c_f - r_D(1-e),$$

$$e = \frac{E}{A}, l = \frac{L}{A}, n_m = \frac{N_m}{A}, n_r = \frac{N_r}{A}$$

Pay attention that n_m and n_r capture market-based and retail-based NII intensity (share of NII activities in bank asset, different from income), l is the LTA ratio, and μ_π captures the expected return on asset (ROA).

Now, since we are interested in the relationship between bank profitability and financial stability, for this model two types of risks that are particularly relevant for financial stability

considerations are described. First, we evaluate the default probability of a bank, measured by its overall credit risk or solvency. Second, we are also interested in the tail risks faced by a bank. Based on this stylized theoretical model, it is possible to define the EDF proxy (default probability) and the VaR of individual banks in this way:

- *Expected Default Frequency Proxy (EDF)* is defined as one minus the survival probability of the bank:

$$EDF \equiv 1 - q = Prob(\tilde{\pi} + e < 0)$$

- *Value at Risk (VaR)* is defined as the 95 percentile of equity loss in this model, where higher VaR signifies higher tail risks:

$$Prob(|Loss| \geq VaR) = Prob(-\tilde{\pi} - e \geq VaR) = 0.05.$$

Solving the bank's optimization problem by taking first order conditions with respect to n_m and n_r, subject to its budget constraint, we obtain these results:

$$[n_m]: \quad r_m = c_m + \varphi \quad if\ n_m > 0$$
$$[n_r]: \quad \alpha r_r n_r^{\alpha-1} l^{1-\alpha} = c_r + \varphi \quad if\ n_m > 0$$

where φ is the Lagrange multiplier of $l + n_r + n_m = 1$.

Then, the authors rewrite the first order conditions with subscript * denoting the optimal value of choice variables:

$$If\ l \geq \frac{1}{1+k}: \quad n_r^* = 1 - l, \quad n_m^* = 0 \quad and \quad \frac{n_r^*}{n_m^*} = \infty,$$
$$If\ l < \frac{1}{1+k}: \quad n_r^* = kl, \quad n_m^* = 1 - l - kl \quad and \quad \frac{n_r^*}{n_m^*} = \frac{kl}{1 - l - kl}$$

If $l < \frac{1}{1+k}$,the first order conditions imply an interior solution where the optimal retail-based NII intensity n_r^* is a positive function of the LTA ratio l, reflecting the complementarity between n_r and l. If instead, $l \geq \frac{1}{1+k}$, the first order conditions imply a corner solution where the optimal market-based NII intensity n_m^* is equal to zero.

Based on the model solutions are derived five important propositions that highlights the nexus between bank profitability and financial stability:

- *Proposition 1*: *Bank idiosyncratic risks measured by EDF and VaR are decreasing in the (expected) ROA* μ_π^*.

$$\frac{\partial EDF}{\partial \mu_\pi^*} < 0, \quad \frac{\partial VaR}{\partial \mu_\pi^*} < 0$$

  The economic intuition that explains the negative relationship between idiosyncratic risks and bank profitability is that per-period profit μ_π^* provides a buffer against negative shocks to bank capital. Higher values of μ_π^* means larger buffers and reduced default risk, which lowers idiosyncratic risks.

- *Proposition 2*: *When LTA ratio (l) is below a certain threshold (*$\underline{l}$*), higher NII share (s) will lead to higher VaR and EDF.*

$$\frac{\partial EDF}{\partial s} > 0, \quad \frac{\partial VaR}{\partial s} > 0, \quad if\ l \le \underline{l}$$

  To understand the underlying mechanism, note that bank assets make a portfolio consisting of three sources of return: loans, market-based NII activities, and retail-based NII activities. If *l* is small enough ($l \le \underline{l}$), n_r^*/n_m^* will also be sufficiently low that banks become over-reliant on market-based NII activities. If the bank's portfolio weighs heavily on one source of return (i.e., n_r^*/n_m^* is very small), the overall portfolio risks increase.

- *Proposition 3*: *Expected profits are decreasing in the problem loan ratio x, the operating cost* c_f*, and the funding cost* r_D.

$$\frac{\partial \mu_\pi^*}{\partial x} < 0 \quad \frac{\partial \mu_\pi^*}{\partial c_f} < 0 \quad \frac{\partial \mu_\pi^*}{\partial r_D} < 0.$$

  This proposition is consistent with the accounting relationship in a bank's balance sheet. Intuitively, higher problem loan ratios could led to more provisioning for non-

performing loans (NPLs), which would then weigh on bank profitability. In addition, higher costs either from the operating side or the funding side would reduce bank profits.

1.3.1. Extension of the model with bank charter value

In this part of the analysis, it is made an extension with bank charter value, in order to determine the last two propositions. In addition to the book value of profitability, another common measure of profitability is the price-to-book ratio, which can be interpreted as the charter value of a bank, or a function of all future profits. The baseline model is extended to include the interaction of bank charter value and idiosyncratic risks. For analytical purpose, it is taken into account a bank that has already made the optimal choice on NII activities and then isolate the implication of charter value on banking risks alone. In this extended model, the bank is also subject to a random shock $-zA$ to equity, where z follows a Bernoulli Distribution:

$$z = \begin{cases} \epsilon, & with\ probability\ 1-p \\ 0, & with\ probability\ p \end{cases}$$

An interpretation of shock z is an operational risk shock. The probability that the bank is affected by the random shock z depends on the intensity of its monitoring. The more intense the monitoring activity (high monitoring cost), the lower the likelihood that it will be affected by shocks to equity. The monitoring or risk management cost is given by:

$$C(p) = -\frac{1}{2}bp^2A,$$

where $C(p)$ is a function of asset size A, the probability of the shock p, and a costant b. A banks is therefore incentivized to monitor – in order to reduce the expected equity impact from random shock – as long as the marginal monitoring cost does not exceed the marginal impact on bank equity from the random shock. Finally, consider V the continuation value of bank equity; for simplicity, it is assumed to be exogenous.

Then, the bank's new objective function is given by:

$$max_p \boldsymbol{E}\left(\widetilde{\Pi} + E - zA\right) - \frac{bp^2A}{2} + qV,$$

subject to the balance constraint $L + N_r + N_m = D + E$. As previously done, it is possible to normalize the bank's new objective function by asset A and take expectations. The normalized objective function can be written as follows:

$$max_p \ \mu_\pi^* + e - \epsilon(1-p) - \frac{bp^2}{2} + qev,$$

$v = \frac{V}{E} = Price/Book\ Ratio$ and $e = \frac{E}{A}$ captures the inverse of leverage.

Since the bank is subject to a new equity shock, the bank's survival probability is modified to q', reflecting the Bernoulli Distribution of shock z:

$$q' = Prob(\tilde{\pi} + e - z \geq 0)$$

Bank idiosyncratic risk measures can also be modified to account for the new equity shock:

$$EDF' \equiv 1 - q' = Prob(\tilde{\pi} + e - z < 0)$$
$$Prob(|Loss| \geq VaR) = Prob(-\tilde{\pi} - e + z \geq VaR') = 0.05$$

Then, in order to obtain the optimal shock probability p^* is sufficient to derive the first order condition with respect to p. Remember that p^* is the probability that the equity impact of shock z is zero (or minimum), and a higher p^* is associated with more intense monitoring or higher monitoring costs. A possible interpretation is that increasing price-to-book values or falling leverage incentivizes banks to monitor and to reduce the equity impact of shocks. Based on these considerations, there are derived two final propositions that support the analytical relationships between idiosyncratic risks and bank leverage.

- *Proposition 4: Bank idiosyncratic risks measured by EDF' and VaR' are decreasing in the price-to-book ratio v.*

$$\frac{\partial EDF'}{\partial v} < 0, \quad \frac{\partial VaR'}{\partial v} < 0$$

The intuition for the negative relationship between bank idiosyncratic risks and the price-to-book value, v, is that higher charter value or long-term profits (captured by v) deters risk-taking behavior of banks. A bank is only able to retain its charter value if it

survives at the end of the period. Therefore, the higher v, the higher the incentive for banks to reduce risk-taking and avoid potential bankruptcy.

- *Proposition 5: Bank idiosyncratic risks measured by EDF' and VaR' are decreasing in e (increasing in leverage $\frac{1}{e}$).*

$$\frac{\partial EDF'}{\partial e} < 0, \qquad \frac{\partial VaR'}{\partial e} \leq 0$$

Higher equity-to-asset ratio e implies more "skin in the game" for banks, and thus they will have higher incentives to monitor and reduce risk-taking behaviors to avoid defaults. Then, additionally, higher equity increases the buffer against negative shocks for banks, which reduce bank risks mechanically through accounting relationships in bank balance sheets.

This is the first model that develops a stylized theoretical model that captures bank risks and retail-based and market-based NII activities. The stylized theoretical model establishes the analytical relationship between financial stability and bank profitability, and between financial stability and business models captured by NII activities. These results raise several interesting issues for policy makers and financial stability authorities. First, the results highlight the need for a clear distinction between different types of NII activities; in general, market-based NII activities are riskier than retail-based NII activities. This consideration is very important since in a low interest rate environment, banks tend to diversify into NII activities, but this causes a shift in a bank's risk profile. Following, these results highlight the need to evaluate the sustainability of bank profitability. An over-reliance on leverage and wholesale funding are associated with higher idiosyncratic and contribution to systemic risks and thereby lower financial stability. Policy makers and financial stability authorities should pay more attention to the source and the sustainability of bank profitability in the design and the calibration of macro-prudential stress tests and systemic risk analysis. These findings underscore the importance of the effective and timely implementation of the Basel III framework, the need for well calibrated macro-prudential tools, and to ensure that banks' reliance on wholesale funding and leverage remains prudentially manageable.

2. Italian banking system

2.1. An overview of the Italian banking sector

In this section, after having analysed the role of bank profitability and financial stability, we focus on the Italian banking system and its specifics.

The big shocks of the last few years (the financial crisis of 2007-09, the ensuing Great Recession of 2008-09, the sovereign debt crisis of 2010-12 and the resulting new bout of recession) have highlighted the interplay between the conditions of the banking system and the macroeconomy. The performance of credit institutions, in particular their profitability, directly and heavily depends on macroeconomic developments which are influenced by several other factors unrelated to the banking sector.
In several countries, including Italy, the double recession has resulted in an unprecedented worsening of the quality of bank credit, with a dramatic surge in the stock of bad debts and other non-performing loans (NPLs) and a corresponding fall in bank profits. At the same time, the worsening in financial conditions has contributed to the fall in economic activity during the global financial and sovereign debt crises, both in Italy and elsewhere.

The profitability of Italian banks has come under scrutiny in the last few years, for at least two reasons. First, in the context of a persistently weak macroeconomic environment, rising credit losses, together with the reduction in intermediated funds and the contraction of interest rate spreads, have exerted downward pressure on both bank profits and bank capital; these developments have in turn affected the availability of credit, thus exacerbating and lengthening the real effects of the crisis. Second, because of Basel III Agreement (which imposes tighter capital requirements on banks, to be phased-in fully in 2019) the ability of banks to extend credit to the economy will depend more than ever on their adequate capitalization. Jointly taken, the enduring turbulence in the financial markets and the more stringent Basel III capital requirements imply that bank profitability is bound to become an even more important component of financial stability (BIS, 2012, and, ECB, 2016). A thorough understanding of the determinants of bank profitability in Italy is therefore warranted, especially given today's relatively poor asset quality levels (IMF, 2016).

The weak profitability of Italian banks is by no means a recent phenomenon. Already in the early 1990s, and for the rest of the decade, Italian banks were underperforming their competitors in other major advanced economies. The long-lasting debate on the sources of the Italian bank profitability gap further intensified during the most recent crisis, when their underperformance become particularly pronounced. In 2011, the tensions in the Italian sovereign debt market swiftly spread to National banks, affecting both the cost and availability of funding, especially in wholesale markets (Albertazzi et al., 2014). Not only was the Italian economy hit more heavily by the financial market turbulences caused by the sovereign debt crisis, but because Italian lenders primarily engage in traditional banking activities, they tend to be more negatively affected by macroeconomic slumps (Bonaccorsi di Patti et al., 2016).

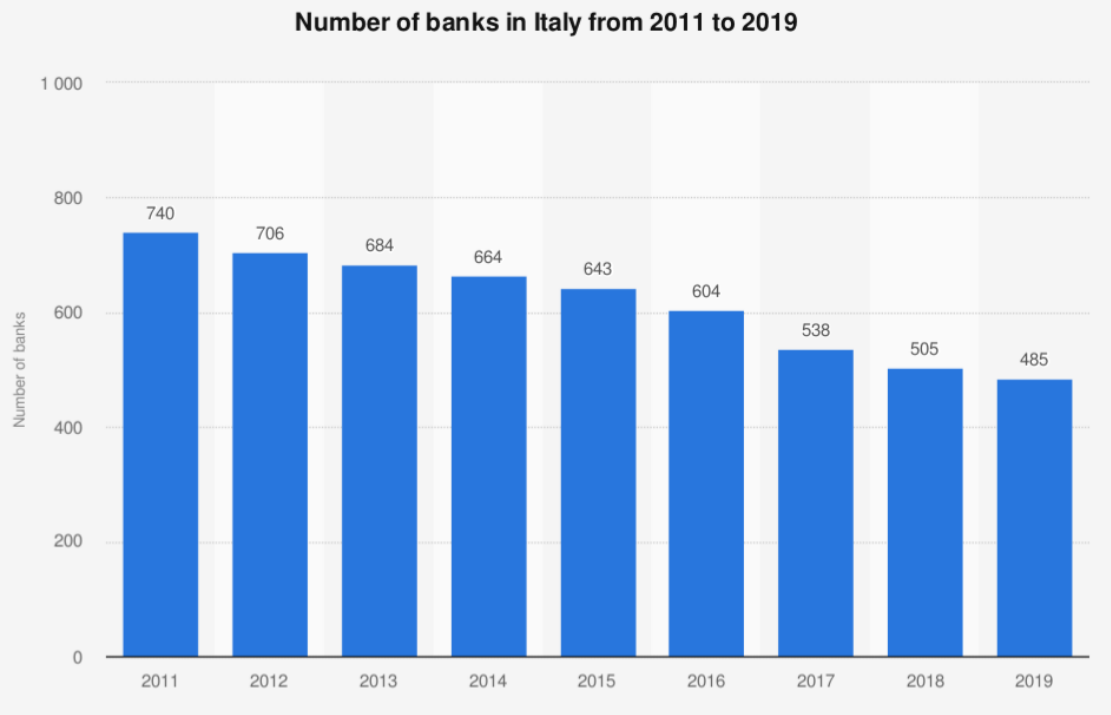
The analysis available in the literature have identified a number of factors that are likely responsible for the low profitability of Italian banks. Some of those factors (such as general macroeconomic conditions or the fiscal regime) are by and large external to the banking sector. Other factors may represent intrinsic weaknesses in the sector itself, as is the case of the relative cost efficiency. The differences in profitability may also be a reflection of their particular business model and its related risks, on both the liability (leverage) and asset side (market risk, credit risk, interest-rate risk) of the balance sheet, as we have highlighted in the previous section.

Since the Nineties many and deep changes have occurred in the Italian banking system. Privatisation, European monetary and Economic Unification, increased international competition and more operational and organizational complexity represent some examples of the most significant factors that have influenced the evolution of the Italian banking system (Chiorazzo et al., 2008). The need to address a different operational scenario – characterized, first of all, by a decreasing capacity of the net interest income to support the whole banking profitability as in the past and by the necessity to diversify the offer in order to satisfy better the more complex financial demand of the customers – has forced Italian banks to modify their strategies and organizational structures. So, they have answered to these changes also by increasing mergers and acquisitions, for the first time considered as a way to enhance profitability, efficiency and the competitive positioning on an international basis. The concentration process approach by banks is in fact connected to the achievement of some advantages, such as economies of scale, especially when referred to the information technology, the possibility to enter in specific market segments where the business-size is a relevant factor

in order to compose an adequate and well diversified portfolio and, at the same time, to manage a global risk.

Moreover, banks have always been the main source of finance for the Italian economy, so grasping the main features, strengths and weaknesses of the banking system is essential to understanding the country's economic prospects, especially given the growing integration of international financial markets. Banks continue to dominate the Italian financial system despite the significant growth of insurance firms and investment funds in recent years. While the banking sector has consolidated recent years, the number of small mutual, cooperative, and regional banks remains relatively high. In January 2019, about 227 of the 266 mutual banks were merged into two new banking groups, which have been classified as SIs; the remaining mutual banks will enter into an institutional protection scheme (IPS). These consolidations reduced the number of banks in the financial system to about 156 (as of June 2019). As we can see, in the Figure 2, during the last decade the number of banks in Italy suffered a great decrease, starting from 740 and arriving to 485.

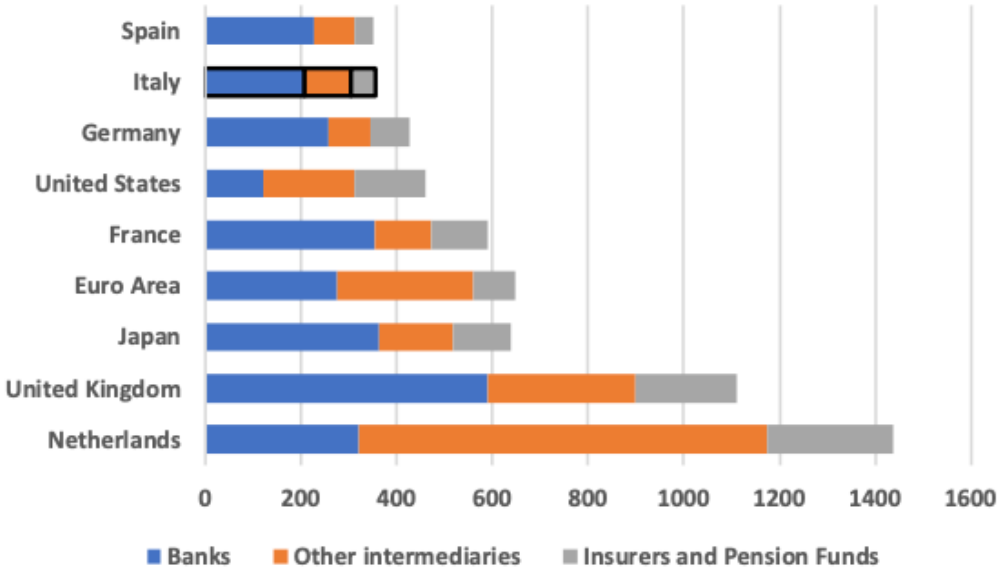
Figure 2: Evolution of banks during the last decade



Source: Bank of Italy, March 2020

The Italian banking system is smaller than those of other European countries. Figure 3 shows that the Italian financial system is large by global standard, but smaller than the euro area average. In this small financial system, the importance of banks in providing finance to firms stands out. Italian banks' marked specialization in lending to small businesses has also influenced the overall evolution of the system. Very often relations between banks and firms are on fiduciary basis that is a serious impediment to the expansion of credit institutions.

Figure 3: Italy – financial system structure (tot. assets of financial institutions in % of GDP)



Source: Financial Stability Board and IMF staff calculation

In fact, the Italian banking system is considered as a bank-oriented system. In a bank-based system, banks are important providers of loans to non-financial companies and they are really strong in collecting household savings.

A bank-oriented system is characterized by:

- Banks are the most important players in the financial sector;
- Savers use banks as their main investment option;
- Firms fund investments with bank debt;
- Strong relationship banking;
- Banks are involved in the governance of other firms;
- Banks have strong influence on other financial companies as stock exchange;
- Insider control system;
- Organized capital markets are not important as a source of funding;
- Banks are mostly universal banks.

Indeed, the Italian economy is mainly characterized by a huge number of small and medium companies which prefer to finance their investments through bank loans.

The financial crisis has brought the long-term profitability of the banking industry to the fore and raised many questions. The crisis has shown the flaws of many business models that banks adopted during the long phase of credit expansion and innovation. Victims can be found both in banks that relied too much on risky trading activities, as well as those whose retail banking model was compatible only with the rosy scenario of eternal growth and limitless availability of liquidity.

The Italian banking system is an interesting case in point: historically, it has focused on the traditional intermediation between households, companies and the public sector (on a smaller scale in the last decades). Italian banks proved to be among the most sound at the onset of the crisis: only a few of them had to ask for state-guaranteed bonds and for small amounts (both in absolute terms and relative to their size). But as the crisis continues the situation has changed.

2.2. An evaluation of different type of Italian banks

Different types of financial intermediaries are evaluated according to the influence of profit-seeking on their business strategies. Specifically, the distinction is made on two types of banks: commercial banks, namely, privately owned banks that provide services both to general public and to private firms; cooperative banks, namely, those with a "per capita" voting mechanism that provide services mainly to cooperative members, households, and small and medium-sized enterprises (SMEs). Moreover, commercial banks are profit-driven. They tend to assume large risks. By contrast, cooperative banks tend to adopt conservative business strategies and stakeholder maximisation policies. In fact, cooperative banks are customer-oriented and are particularly efficient in maintaining long-lasting relationships with their members and customers. These banks are particularly strong in relationship banking, a type of banking which enables banks to make informed decisions in the provision of loans and financial services.

By evaluating different types of banks operating in the Italian market, an attempt is made to outline policy implications for the stability of the National financial system. Stability, as we have already spoken about in the previous section, is defined both as a situation in which financial markets fulfil their allocation function in a satisfactory manner and as the stability of the key institutions. The need to discuss such a topic is derived, for instance, from the argument that in any banking activity, there is a relationship between profitability and liquidity with important implications for financial stability (Stefancic, M., Kathitziotis, N., 2011).

Recalling the previous paragraph, the Italian banking system has undergone a process of restructuring and significant consolidation in the 1990s. Developments have been multifaceted and had influenced different groups of banks and several financial intermediaries.
Competition has increased as a result of the financial integration at the EU level. While cooperative banks had consolidated their position in local markets, commercial banks and some larger popular bank privileged growth strategies on a national level or in the European markets. As a result of the above-mentioned changes, commercial and cooperative banks play an even more important role for the Italian financial system.
The evidence from the credit crisis suggests that many commercial banks were not satisfying these criteria prior to the crisis. Since they are established with the purpose of maximising profits, commercial banks' primary goal is the creation of profits or, more exactly, the maximisation of shareholder value. On the other hand, pre-crisis scholarly research on both Italian and European cooperative banks indicated that cooperative banks are, on average, less

profitable in “normal” periods but also more stable due to higher solvency ratios (Gutierrez, 2008). As a result of their embeddedness in local economic systems, their institutional legacies and mutualistic values, cooperative banks tend to adopt conservative business strategies and stakeholder value maximisation policies in comparison to commercial banks. They are customer-oriented, and particularly efficient at maintaining long-lasting relationships with their members and customers. In other words, these banks are particularly strong at relationship banking, a strategy that enables banks to make informed decisions on the provision of loans and financial services as a result of in-depth knowledge of customers’ business.
Relationship banking generated a number of advantages, such as proximity to customers, which may contribute positively to the quality of these banks’ loans. In Italy, cooperative banks can also rely on a well-developed commercial network with important historical roots and market advantages, which may help to ease their access to information about customers. These characteristics may make cooperative banks less vulnerable to shocks to the system, as was the case in the last credit crisis.

Italian cooperative banks play an important role for the stability of the financial system at the level of regions. They provide credit to individuals and households, as well as capital to SMEs. Italian cooperative credit banks are integrated into a distinct network, which grants them an adequate level of competitiveness. With the implementation of democratic principles of governance, and by relying on traditional yet fully competitive intermediation models, they seem to provide the best alternative to standard commercial banks. For this reason, they can be viewed as complementary to commercial banks.
A distinct feature of Italian cooperative credit banks results from a well-developed retail business, which enables them to adequately address the financial needs of their cooperative members and customers. It comes as no surprise that they show an ability to meet the needs of innovative, small-sized and family-owned enterprises, which are typical of the Italian economy.

Despite some significant developments in financial markets that took place in the last decades as a result of the financial deregulation, the liberalisation of the Italian banking market, and a rise in competition prompted by technological innovation, the cooperative model in banking has preserved its fundamental idiosyncrasies and can be best described as an “originate-to-hold” (OTH) model. Banks and financial institutions applying such intermediation model to their business take in deposits, and provide credit and financial services primarily to cooperative members. They rely primarily on their members and are dependent on the loyalty of retail customers.

Italian cooperative credit banks operate in "market niches", they do not specialise in large, risky financial investments and transactions, and do not operate in the inter-banking markets as much as commercial banks. Cooperative credit banks are well equipped to overcome market failures due to their deep rooting in relationship banking, which enables them to develop tailor-made services and reduce asymmetries on borrowers. Such model is consistent with cooperative goal to maximise stakeholders' value rather than profits.

Although fundamental differences can be observed within the cooperative credit systems across different European countries, a standard governance and business model applies to European cooperative banks, including the Italian cooperative credit banks. The model is conceived in such a way to compete on a regional and national level; it could hardly compete in international markets. By reference to Groeneveld and Sjauw-Koen-Fa (2009), one may argue that the model currently shows features such as:

a) Corporate governance with cooperative ownership;
b) A policy aimed at increasing the wealth of local communities;
c) High level of capitalisation;
d) Stable levels of profits;
e) A rather conservative business strategy based on retail banking;
f) Proximity to customers effectively managed through branch networking.

Cooperative banks are common worldwide, but some governance aspects of Italian cooperatives can be problematic. While there is no single definition of a bank cooperative in Europe, they share some common ownership features, including memberships requirements and voting rights limited to one vote per member regardless of the investment. These limitations on ownership may hamper effective governance once the bank grows beyond a certain size, as well as limit interest from potential outside investors.

There are two categories of bank cooperatives in Italy. The first is the Banche di Credito Cooperativo (BCCs), comprised by small entities that account for 6 percent of the banking system. These cooperatives' main lending activity is to grant credit to their members. Their shares are non-tradable and held only by members, and they allocate three-quarters of their profits to building reserves. The second category is the Banche Popolari (BPs). These entities' assets account for 14 percent of the banking system, can list their shares in the stock exchange. They have to allocate only 10 percent of their profits to reserves.

Cooperatives are considered the major source of credit to local business. Due to their legal status and geographical remit, cooperatives tend to have no exposure to global financial markets and the international economy and focus mainly on servicing borrowers. Italian BPs lend up two-thirds of their funds to small and medium-sized enterprises (SMEs) and have been the main provider of credit to those firms since 2008.

Finally, Table 1 summarises the specifics in terms of organisational structure, governance and business of, on the one hand, Italian cooperative banks; and, on the other hand, commercial banks.

Table 1: Organizational differences between Italian cooperative and commercial banks

	COOPERATIVE BANKS	COMMERCIAL BANKS
Corporate governance	Member ownership	Shareholder ownership
Business strategy	OTH (originate to hold)	OTD (originate to distribute)
Profitability	Consumer surplus maximisation	Short-term maximisation
Line of business	Relationship banking and retail segment	Diversified

Source: own elaboration

2.3. Reactions of Italian banking system to the crises

For a clearer description of the impact of the crisis on the Italian banking system, it is useful to subdivide the period from 2007 to 2011 into two acute phases: the subprime phase of 2007-09, with the turmoil in the financial markets caused by the subprime mortgage crisis, aggravated to dramatic proportions by the failure of Lehman Brothers in September 2008, and the sovereign debt phase from 2010 onward, caused by the sovereign debt crisis affecting first Greece and then the peripheral countries of the European Monetary Union (EMU): Portugal, Ireland, Spain and Italy.

On the eve of the financial crisis, the Italian banking system was still feeling the effects of the period of deep restructuring in the 1990s continued in the first decade of this century with an increase in concentration, generating significant cost reductions. The restructuring had helped to improve the efficiency and competition of the Italian banking industry, and before the beginning of the crisis most of Italian banks' standard performance indicators were broadly in line with those of the other large European countries.

The Italian banking and financial system showed more resilience than other national systems in the first wave of the global financial crisis, the so-called subprime phase (2007–2008), but the impact was much more severe in the second, sovereign debt and redenomination risk phase (2010–2012), and the system continues to show major signs of difficulty in the current phase of deep economic recession (De Bonis, Pozzolo, Stacchini., 2012).

I. The financial crisis of 2007-09 was triggered in the summer of 2007 by the collapse of the subprime mortgage market in the United States and then spread worldwide has a limited impact on the Italian banking system. The virtues of a more traditional business model based on careful assessment of borrowers' creditworthiness, stable funding and strict supervision ensured that no Italian bank failed and that government injections of capital to banks were extremely modest. The lower degree of development of the Italian banking system by comparison with the rest of the Euro area and even more with the British and American systems is connected with Italian banks' traditionally prudent lending policies and the relative unimportance of investment banking, which in hindsight proved to be much riskier that it might have seemed at first.

Prudence has been greatest in lending to households. For mortgage lending, the loan-to-value ratio is low by international standards. At the same time, Italian banks' lesser propensity for financial innovation discouraged such practices as mortgage equity withdrawals, which in some countries were the main driver of mortgage lending. Before 2007 the expansion of lending had sustained the demand for houses in the UK, Ireland, Spain and the United States, sparking a price boom. In Italy, the smaller size of mortgage market attenuated the dependence of demand on credit and limited the impact on real estate prices. When the bubble burst the house price decline was not as sharp in Italy as elsewhere, and the effect on banks' balance sheets was correspondingly less severe.

The relatively modest amount of investment banking in Italy – linked with customers' lack of financial sophistication and the historic competitive disadvantage of Italian with European countries and American banks – was another factor making Italian banks less vulnerable to the crisis, thanks to their lesser exposure to opaque and risky financial assets. In addition, some cases of bond defaults in previous years had made banks more cautious in marketing securities to customers, which attenuated the repercussions of the collapse in the financial markets on the portfolios of households and borrower firms. Finally, supervisory controls on securitizations prevented them from becoming a source of instability (Albertazzi et al., 2011). Special purpose vehicles has no particular problems in Italy, and the conversion of asset-backed securities into potentially risky instruments like CDOs and CDOs-squared was negligible. This helped to keep the overall leverage of the financial system relatively low. And if during the years of financial euphoria this obviously resulted in lower profitability, when the crisis came it limited losses.

Finally, Italian banks' low degree of internationalization ensured less exposure to the worst-hit financial markets. Prudent asset management and less aggressive use of leverage permitted greater prudence in funding as well. As we have seen, the share of banks' fund-raising that comes from retail customers is greater than in the other countries, while interbank liabilities – on which there was a run that brought the collapse of a good number of banks – are more limited.

During the crisis the greater stability of banks' sources of funding eased the impact in Italy of the tensions in the international money markets, thanks in part to the supervisory authorities, who tightened controls on banks' liquidity as far back as 2007. The milder impact of the crisis produced a more moderate deceleration of credit than in other countries. The large banks, with their greater dependence on the international interbank

and bond markets, slowed their lending more sharply. In part, the resulting slack was taken up by smaller banks, which exploited their direct relationships with customers at a time of uncertainty over borrowers' solvency (Panetta and Signoretti, 2010). Credit growth is stronger now in Italy than in the euro-area countries as a group. The repercussions of the financial crisis of 2007-09 on the productive economy could not fail to affect the Italian financial system, but Italian banks weathered the crisis better than those in most countries.

Banking regulations introduced in response to the financial crisis are having profound effects on prudential and accounting rules and on supervision. The new regulations are compressing the size of the banking sector. The Basel III rules raised capital requirements, limited average, and established stringent liquidity requirements. Additional capital requirements are envisaged for systematically important banks. Several countries have introduced measures to separate lending from the financial activities that banks carry out on their own account. Looking ahead, these regulatory changes will make banks less risky, increasing their capital and liquidity and lowering their leverage. However, banks' profitability and the development of the lending market will be under pressure, with potential repercussions on the availability of credit for the real economy.

II. With the sovereign debt crisis, the great government interventions in many countries to salvage the financial system in the 2007-09 crisis put a strain on Italian banks.

At first the debt crisis struck Greece, Ireland and Portugal, euro-area countries with large budget deficits. During that period, Italian banks' relative lack of internationalization appeared to be strength: by comparison with German and French banks, they had much smaller investments in Greece, Ireland and Portugal.

During the summer of 2011 the sovereign debt crisis spread to Italy and threatened even France. Worried that Italian government securities make up some 40 per cent of Italian banks' bond portfolio, the stock markets reacted negatively, with judgments out of line with the long-run performance of Italian banks. Home bias in portfolio composition is a feature of many other banking systems in countries with large public debts, such as Japan and Belgium. For Italian banks, holding the government securities of a euro-area country that are eligible as collateral for central bank refinancing has always been a factor of soundness. But the changed external framework has transformed what seemed to be a strength into a source of vulnerability, even though the pressures on the public

debt are due to external causes and not to massive spending on bank bailouts as in, say, Ireland. The link between banks' balance sheets and the state of the public finances is much looser today than in the past. Any national banking system inevitably depends on the general performance of the country's economy. The consequences of the sovereign debt crisis are hard to foresee but they absolutely cannot be underestimated. A solution is essential not only to prevent the collapse of the financial system in some member countries but to ensure the very survival of the euro area. When the problem is resolved, Italian banks' traditional caution may well prove, once again, to have been a bulwark for the stability of the financial system.

Italy is an especially good case for assessing the effects of the sovereign risk on the banking sector. First, the high level of public debt and the heavy exposure of Italian banks to the public sector suggests that sovereign tensions are likely to have a strong impact on the banking sector. Second, Italy experienced periods of tensions on its sovereign debt market also during the 1990s. Third, while in some European countries the sovereign crisis started out when government borrowing conditions deteriorated following the substantial public interventions to support weak banking sectors, in Italy the initial increase in government borrowing costs was related to the weakness of the public sector itself in the context of a relatively healthy domestic banking sector.

Sovereign risk transmits to banks' funding and lending conditions through number of different channels, reflecting banks' high exposure to domestic sovereign debt, the role of government securities as collateral in secured transactions and the connections between sovereign and banks' credit ratings (Bank for International Settlements, 2011). More precisely, one can identify three main channels through which sovereign tensions may be transmitted to bank funding and credit supply conditions:

- The *balance-sheet channel* operates when a reduction in the value of government bonds held in the portfolios of banks affects their income and possibly capital and thus funding ability, potentially triggering a reduction in credit supply.
- The *liquidity channel* operates when a reduction in the value of sovereign bonds reduces banks' ability to borrow in collateralized interbank transactions. Similarly, a bank's borrowing capacity may be damaged if its rating is downgraded following a reduction in sovereign rating, which are typically a ceiling for domestic borrowers' ratings.

- The *price channel* operates when banks' borrowing cost or loan interest rates increase following a rise in government bond yields, due to arbitrage-type mechanisms as the latter are one of the most important investment opportunities available on the market.

In principle, the intensity of each of these channels is likely to depend on banks' balance-sheet characteristics – such as the level of capitalization, the reliance on (un)stable funding sources, the quality of the loan portfolio – as well as on business models and lending strategies. For example, banks more reliant on wholesale funding are likely to be more severely affected by a dry-up of international capital markets following a sovereign crisis.

For Italian banks, a convenient way to explore the heterogeneity in the transmission of the sovereign tensions is to distinguish between the five largest banking groups and the rest of the system, since these two groups of financial intermediaries differ significantly in terms of balance-sheet characteristic as well as business models and lending strategies.

In general, the largest banks tend to be less capitalized; they tend to fund a larger share of their loans through wholesale financing; and, at the onset of the sovereign debt crisis they had a greater incidence of bad loans. Moreover, while smaller banks' activity relies almost entirely on traditional banking operations, the largest banks gain a greater share of income from non-traditional activities and operations, such as trading and investment banking, insurance and other financial services. In addition, while small banks typically have a local presence, large banks are geographically diversified, with some of them having significant foreign operations. A corollary is that small banks typically rely more on soft information for borrowers' selection and engage relatively more in relationship lending. Given these structural differences, one may expect the transmission of sovereign debt tensions to the banking activity to be stronger for larger banks.

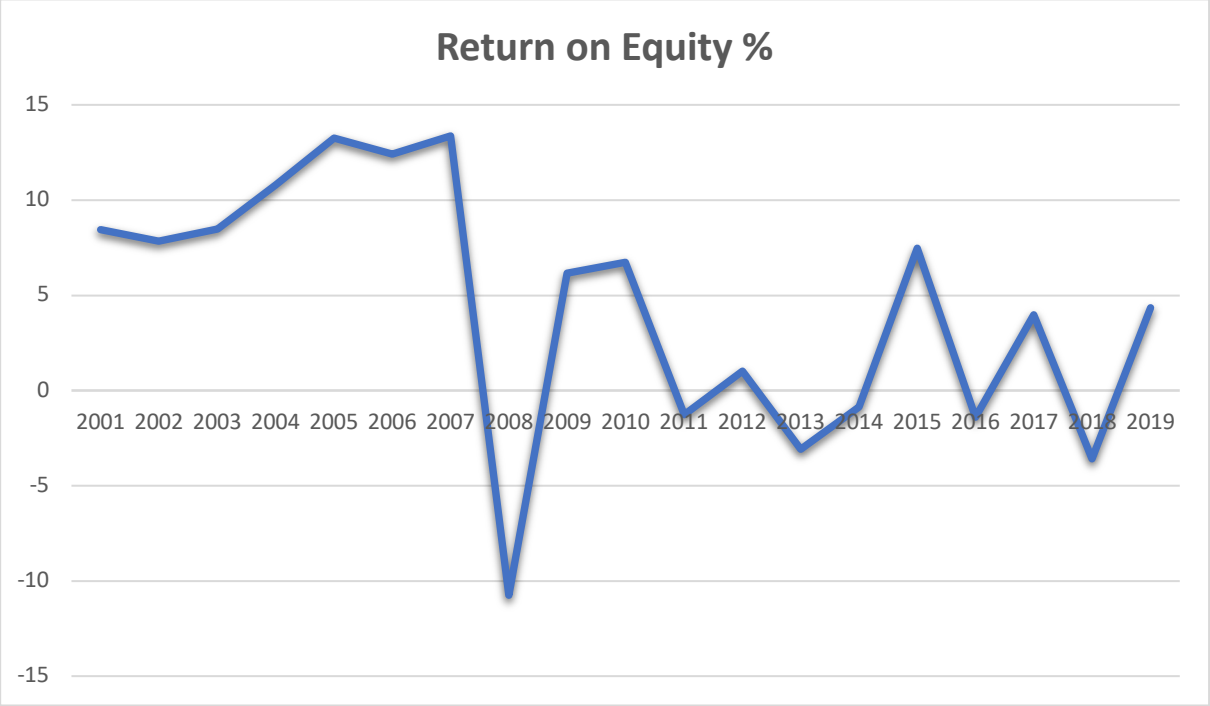
2.4. An analysis of Italian banking system

After having discussed about the overall Italian banking system in the previous paragraphs, now, in order to capture the actual situation of the Italian banking system we will investigate the performance of Italian banks from a quantitative point of view (data obtained from Thomson Reuters and Bankscope).

First of all, we analyze some ratios that summarize the overall profitability of Italian banks in order to make a general idea about their performance.

The first summary indicator of profitability we use to analyze the Italian banking system is ROE, which, as we have already seen in Chapter 1, is the ratio between net income and shareholder's equity of the year. Since ROE is a very popular measure of profitability and it is quite easy to obtain from public information, it allows for fast comparisons between banks and it tells the return an investor gets from his investment. In particular, for a bank it is important to have a ROE bigger than its cost of capital to produce value for shareholders, since the main goal of a firm is to create wealth for its owners. The Figure 4 shows the level of ROE of a sample of Italian banks for the period 2001-2019, taking into account the two last decades, to highlight the most important crisis (Great Financial Crisis and Sovereign Debt Crisis).

Figure 4: ROE (in percentage terms) of Italian banking system

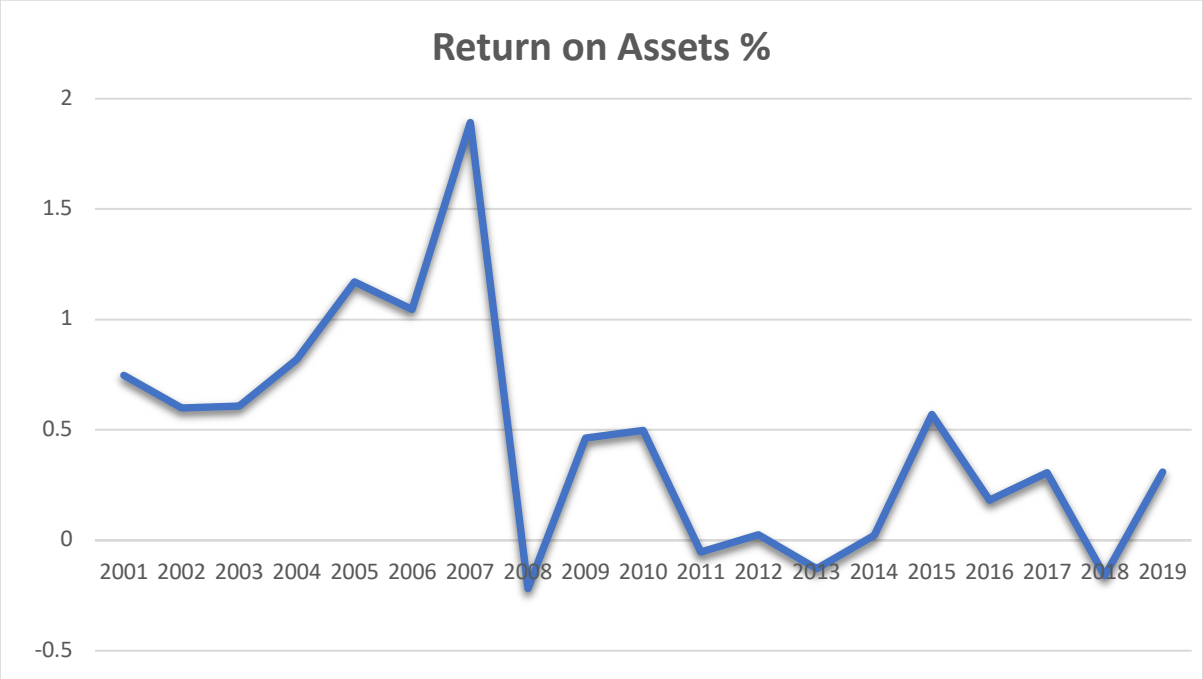


Source: own elaboration on Thomson Reuters and Bankscope database (sample of 19 Italian banks)

As it is possible to figure out from the Figure 4, Italian banks experienced a strong reduction in their profitability during the financial crisis. For what concerns the ROE, it started decreasing immediately after the beginning of the crisis in 2007, reaching a negative value with a great peak up to 10%. Then, it seems to improve after the Great Financial Crisis, even if it was quite low. Another negative peak in 2012 highlighted the Sovereign Debt Crisis, an event that negatively affect the situation of Italian banking system. From these numbers it seems that after the strong reduction in profitability during the last two decades due to the crisis and after the strong negative peaks reached in the recent years, the Italian banking system has started recovering during the last year, moving toward the pre-crisis level profitability.

Then, as we have explained in the first chapter, another indicator we can use to study the Italian bank's profitability is ROA, which is defined as the ratio between the net income and the average value of total assets of the year.

Figure 5: ROA (in percentage terms) of Italian banking system

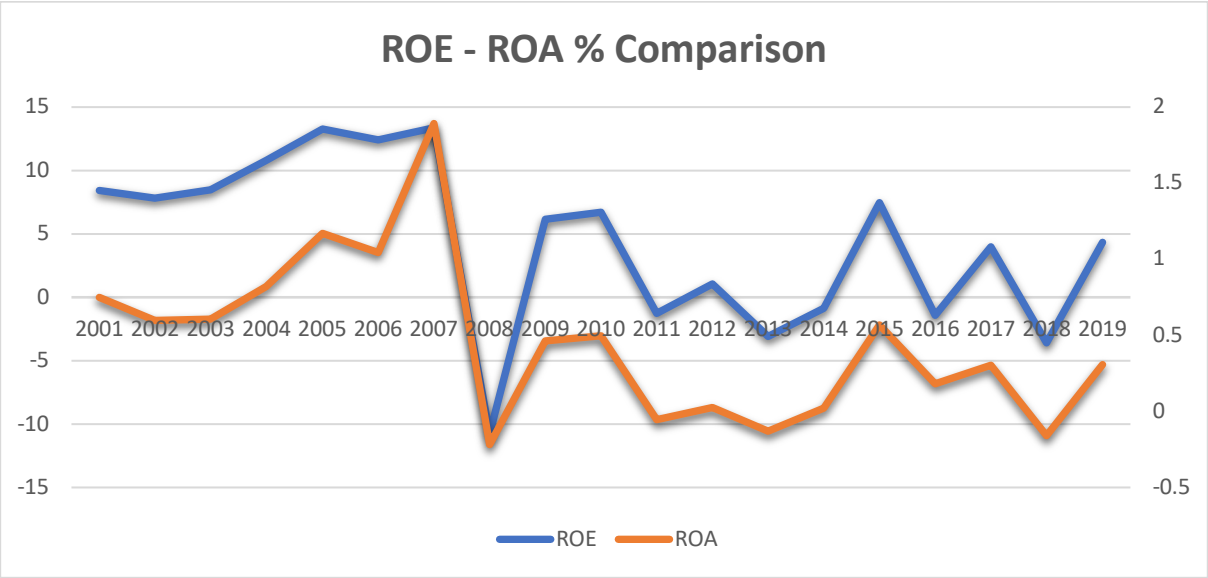


Source: own elaboration on Thomson Reuters and Bankscope database (sample of 19 Italian banks)

Figure 5 shows the level of ROA of Italian banks during the last period. With the Great Financial Crisis, its level strongly decreased until it become negative. This situation happened again with the Sovereign Debt Crisis, even if the collapse is less drastic.

As we can see from these two graphs, given that the numerator is the same, the values of ROA tend to have the same dynamic of the ones of ROE. Moreover, in Figure 6, we can highlight that the financial crisis and the sovereign debt crisis heavily affected the profitability of Italian banks during the last period. In fact, making the comparison, it is possible to evidence the co-movement of the two indices during the Great Financial Crisis.

Figure 6: Comparison between ROA and ROE



Source: own elaboration on Thomson Reuters and Bankscope database (ROA is measured in the right-hand scale)

The next step to deepen the analysis about the profitability of Italian banks during the last years is to make a focus on two most important factors that affect ROA and ROE during the period of the crisis. This analysis is important to study how the crisis hit the different activities performed by banks to identify which are the main problems of Italian bank's profitability today and to understand, how certain factors affect the profitability of the banks and then also the financial stability, as we will discuss in the next chapter with the empirical analysis.

The first factor to analyze is the presence of NPLs. Non-performing loans (NPLs) are exposures to debtors who are no longer able to meet all or part of their contractual obligations because their economic and financial circumstances have deteriorated.
The definitions of NPLs adopted by the Bank of Italy have been harmonized within the Single Supervisory Mechanism (SSM) and meet the European Banking Authority (EBA) standards published in 2013.

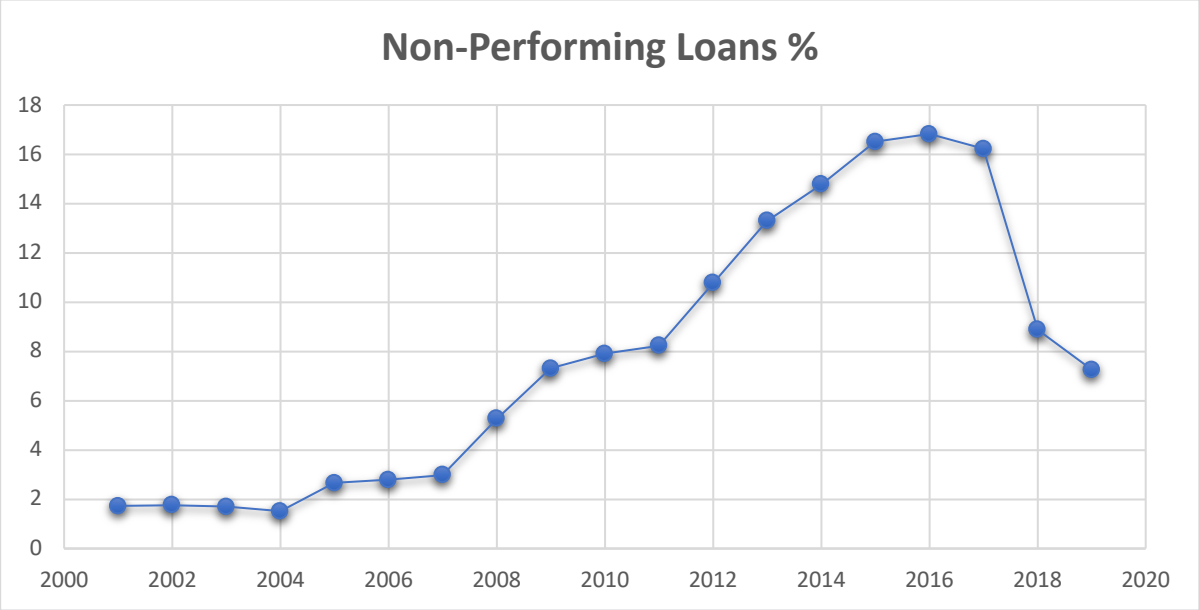
The three subcategories of NPLs are 'bad loans', 'unlikely to pay exposures' and 'overdrawn and/or past due exposures'. More specifically:

- **Bad loans** are exposures to debtors that are insolvent or in substantially similar circumstances.
- **Unlikely-to-pay exposures** (aside from those included among bad loans) are those in respect of which banks believe the debtors are unlikely to meet their contractual obligations in full unless action such as the enforcement of guarantees is taken.
- **Overdrawn and/or past-due exposures** (aside from those classified among bad loans and unlikely-to-pay exposures) are those that are overdrawn and/or past-due by more than 90 days and for above a predefined amount.

The NPLs problem at Italy's banks is largely the result of the prolonged recession that has hit the Italian economy in recent years and of lengthy credit recovery procedures, as it is possible to evidence in Figure 7.

The double-dip recession that struck Italy between 2008 and 2014 severely impaired Italian banks' balance sheet and loan quality. It had two phases. The Italian banking system reacted relatively well to the 2008-09 recession (phase one of the financial crisis), triggered by the collapse of the US subprime mortgage market and the attendant structured products crisis, to which Italy's banks, unlike their European counterparts, were little exposed. However, the deterioration in customers' economic and financial circumstances did lead to a significant increase in the flow of new NPLs. Phase two of the financial crisis began in the second half of 2011 with the Italian sovereign debt crisis. With the new recession, customers' ability to repay debt was further diminished, leading to a fresh rise in the rate of new NPLs.

Figure 7: Evolution of NPLs (NPLs%Tot.loans) in the Italian banking system



Source: own elaboration on Thomson Reuters and Bankscope database

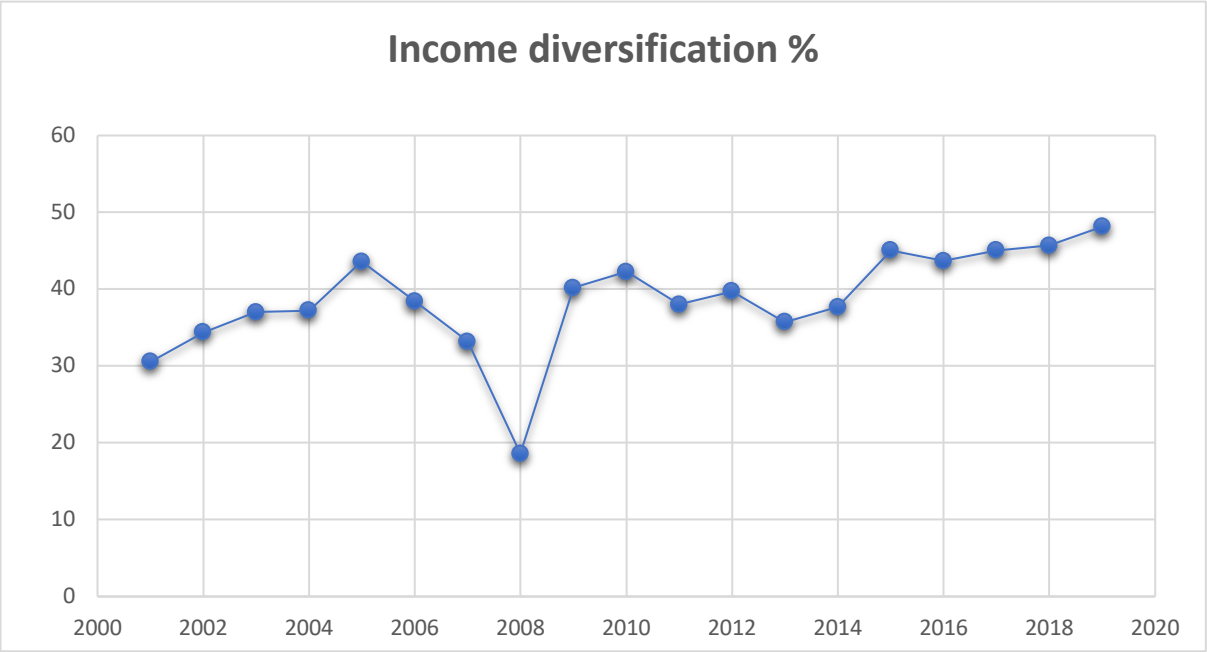
Another factor that is important to analyse, for the bank performance and subsequently for the financial stability, is the income diversification.

This factor is measured as the ratio between non-interest income and total revenues.

After the crisis, changes occurred in the banks' business lines through the enhancement of some traditional retail banking segments such as customer credit and mortgage loans. At the same time, banks developed new services in the area of payment services, insurance and social security, and asset management.

All these changes had a substantial impact on the structure of bank income and composition of bank revenues. Figure 8 depicts this evolution. The non-interest component of operating income increased from approximately 20% (during the crisis) up to 40% the following year.

Figure 8: Evolution of income diversification (in percentage terms) of Italian banking system



Source: own elaboration on Thomson Reuters and Bankscope database

After making this brief analysis, in the Chapter 4 we perform an empirical analysis focusing on the Italian banking system to better understand how certain factors (i.e. internal and external determinants) impact and affect the bank profitability and financial stability.

3. Literature review

It is argued that bank profitability and stability in financial institutions is a growing concern for regulators and bank supervisors. This issue has gained significant attention among researchers, in particular after 2007-2008 financial crisis.

A crucial point to take into account is that a high performing banking system has a greater ability to safeguard financial adversities. Furthermore, financial system stability has a direct relationship with the determinants of bank profitability (Ali, 2015; Borio, 2003; Mörttinen et al., 2005). This ascertains that unexplored profitability determinants should be of interest to academicians, financial market analysis, bank regulators and managers. This justifies the reason why the past literature of bank profitability is flooded with empirical investigations.

The existing literature on bank profitability and its impact on financial stability reports mixed evidence. Considering profitability and risks, some researchers found that higher profitability leads to higher "charter value" (i.e., long-term expected profitability) and therefore less risk-taking by banks (Berger et al., 2009). Others suggest that high profitability could loosen leverage constraints and lead to more risk-taking (Natalya, Ratnovski, and Vlahu, 2015). Furthermore, high profits in good times could be an indicator of systemic tail risk in bad times (Meiselman, Nagel, and Purnanandam, 2018).
In the following two subsections, we make a distinction of the literature between bank profitability and financial stability to better understand the analysis that we will do in the empirical work. Finally, we make a literature review about the econometric methodology implemented and used by researchers.

3.1. Bank profitability literature

Bank performance has been extensively studied in the past. Early work goes back to Short (1979) and Bourke (1989), who were followed by a series of papers which attempted to identify some of the major determinants of bank profitability.

Despite the increased trend toward bank disintermediation observed in many countries, the role of banks remains central in financing economic activity in general and different segments of the market in particular. A sound and profitable banking sector is better able to withstand negative shocks and contribute to the stability of the financial system. Therefore, the determinants of bank performance have attracted the interest of academic research as well as of bank management, financial markets and bank supervisors.

The respective empirical studies have focused their analysis either on cross-country evidence or on the banking system of individual countries.

The studies by Molyneux and Thornton (1992), Demirgüç-Kunt and Huizinga (1999), Staikouras and Wood (2004), Goddard et al., (2004), Athanasoglou et al., (2006), Micco et al., (2007) and Pasiouras and Kosmidou (2007) investigate a panel dataset. Studies by Berger et al., (1987), Berger (1995), Mamatzakis and Remoundos (2003), Naceur and Goaied (2008), Athanasoglou et al., (2008) and Garcia-Herrero et al., (2009) focus their analysis on single countries, as we will made for our analysis focusing on the Italian case.

The empirical results of these above-mentioned studies do vary, which is to be expected, given the differences in their datasets, time periods, investigated environments, and countries. However, it is possible to find some mutual elements that we used to categorize further the determinants of banking profitability.
Usually, bank profitability is measured by the return on average assets, return on average equity and net interest margin, and it is expressed as a function of internal and external determinants. The internal determinants originate from banks accounts (balance sheets and/or profit and loss accounts) and therefore could be termed as bank-specific determinants of profitability.
The external determinants, such as macroeconomic variables, are not related to bank management but reflect the economic and legal environment that affect the operation and performance of banks.

In most studies, variables such as bank size, risk capital ratio and operational efficiency are used as internal determinants of banking profitability (e.g., Bourke, 1989; Demirguc-Kunt and Huzinga, 1999; Goddard et al., 2004; Javaid et al., 2011; Pasiouras and Kosmidou, 2007).
The external determinants of bank profitability, as presented in the literature, include factors such as the inflation rate and GDP growth rate. Most studies (Athanasoglou et al., 2008; Demirguc-Kunt and Huzinga, 1999) have shown a positive relationship between inflation, GDP growth, and bank profitability.

Iannotta (2007) find a positive and significant relationship between the size and the profitability of a bank. This is because larger banks are likely to have a higher degree of product and loan diversification than smaller banks, and because they should benefit from economies of scale. Other authors, such as Berger et al., (1987), provide evidence that costs are reduced only slightly by increasing the size of a bank and that very large banks often encounter scale inefficiencies. Stiroh and Rumble (2006) work attribute a negative relationship of bank size and profitability due to agency costs, other expenses of large firms and the overhead expenses of bureaucratic processes. In sum, our literature analysis suggests that bank size and bank profitability relationship remain inconclusive and requires further investigation.

The solvency risk plays an important role to predict bank profitability (Adusei, 2015). The capital strength of a bank is measured through solvency risk (equity to total asset ratio), while strong bank equity allows a bank to absorb external/internal shocks (Curak et al., 2012). It is a noteworthy point that the bank considers its capital as a safety pillow through which a bank enables to mitigate insolvency risk by maintaining a higher amount of capitalization. In this way, risk-return hypothesis state that such type of a bank observes low profitability. However, well-capitalized banks with creditworthiness enhance the confidence of customer deposits, which results, lower interest rates, interest expenses and external financing. Furthermore, lower risk (greater equity to asset ratio) would increase bank profitability. Hence, bank profitability and solvency risk may have a positive relationship.

Abreu and Mendes (2002), who examined banks in Portugal, Spain, France and Germany, find that the loans-to-assets ratio, as a proxy for risk, has a positive impact on the profitability of a bank. Bourke (1989) and Molyneux and Thornton (1992), among others, find a negative and significant relationship between the level of risk and profitability. This result might reflect that financial institutions that are exposed to high-risk loans also have a higher accumulation of unpaid loans. These loan losses lower the return of the affected banks.

The need for risk management in the banking sector is inherent in the nature of the banking business. Poor asset quality and low levels of liquidity are the two major causes of bank failures. During periods of increased uncertainty, financial institutions may decide to diversify their portfolios and/or raise their liquid holdings in order to reduce their risk. In this respect, risk can be divided into credit and liquidity risk. Molyneux and Thornton (1992), among others, find a negative and significant relationship between the level of liquidity and profitability. In contrast, Bourke (1989) reports an opposite result, while the effect of credit risk on profitability appears clearly negative (Miller and Noulas, 1997). This result may be explained by taking into account the fact that the more financial institutions are exposed to high-risk loans, the higher is the accumulation of unpaid loans, implying that these loan losses have produced lower returns to many commercial banks.

The last group of profitability determinants deals with macroeconomic control variables. The variables normally used are the inflation rate, the long-term interest rate and/or the growth rate of money supply. Revell (1979) introduces the issue of the relationship between bank profitability and inflation. He notes that the effect of inflation on bank profitability depends on whether banks' wages and other operating expenses increase at a faster rate than inflation. The question is how mature an economy is so that future inflation can be accurately forecasted and thus banks can accordingly manage their operating costs. Most studies (e.g. Bourke, 1989; Molyneux and Thornton, 1992) have shown a positive relationship between either inflation or long-term interest rate and profitability.

3.2. Financial stability literature

In this section, we highlight the importance of risk measures for evaluating the financial stability of a single country. A large number of authors focused their attention on the most used measure for quantifying the risk, distinguishing between idiosyncratic and systemic ones.

The theoretical and empirical literature on these issues was flourishing and one main measure of individual soundness was commonly used to analyse the impact of financial mutations and market structure on financial stability: the Z-score developed by Roy (1952).

It is an accounting-based risk measure generally viewed in the banking literature as a measure of bank soundness (see, e.g., Laeven and Levine, 2009; Lepetit and Strobel, 2013; Fu et al., 2014). As we have already discussed in Chapter 1, the Z-score indicator is inversely related to the probability of a bank's insolvency. A higher Z-score implies a lower probability of insolvency and lower risks. It combines in one single indicator the bank profitability, bank capital and return volatility.

After having considered the individual risk of a bank, recent literature proposed a market-based measure to assess the contribution of a single bank to the systemic risk, e.g. the delta conditional value-at-risk ($\Delta CoVaR$). This measure could be useful to control the dynamics of systemic risk as perceived by the market. Several papers have dealt first with the problem of finding a commonly shared definition for systemic risk and then with the issue of developing a methodology for its measurement.
As explained in Chapter 1, systemic risk has been defined as the risk that the intermediation capacity of the financial system is impaired, with potentially adverse consequences for real economy, triggered by the distress or disorderly failure of one, or more, financial institutions.

There are two ways of measuring bank contribution to systemic risk. A first approach, to which we refer to as supervisory approach, relies on firm-specific information on cross-jurisdictional activity, size, interconnectedness, substitutability, and complexity. This approach considers annual accounting and other confidential data provided to regulators by financial institutions and usually not captured by the markets (Gourieroux et al., 2012; Basel Committee on Banking Supervision 2011, 2013, 2018; Greenwood et al., 2015).
A second approach, to which we refer to as market-based approach, relies on publicly available market data, such as stock prices and/or credit default swap (CDS) spreads (see Segoviano

Basurto and Goodhart 2009), which are high frequency and forward-looking data and incorporate early warning signals for systemic crisis.

As observed by Benoit et al., (2017), the data needed for the supervisory approach are disclosed with a lag (e.g. since they are mainly accounting data). Conversely, the market-based approach considers high frequency data and it is more sensitive to changes in systemic risk regimes.

Public authorities look for proper measures of systemic risk that go beyond the different sources of systemic risk implied in the supervisory approach. Being the scope of these authorities to operationally set capital requirements, market-based systemic risk measures must provide stable results to be implemented in practice and they should be sufficiently reliable for a day-to-day use.

A prominent example of this market-based approach is the delta conditional value-at-risk ($\Delta CoVaR$) proposed by Adrian and Brunnermeier (2011): it can be estimated on a high frequency basis, it incorporates early warning signals and it could be considered as a tool to assess if a systemic event occurs. It is considered in the academic literature as the most influential paper on market-based systemic risk measures.

Over the past years, several research papers have discussed and implemented market-based systemic risk measures. Several works discussed if the $\Delta CoVaR$ measure proposed by Adrian and Brunnermeier (2011) is a proper systemic risk measure (e.g. Bernard et al., 2012; Benoit et al., 2017). However, only a few papers estimated the same systemic risk measure through alternative methodologies and compared these estimates.

The $CoVaR$ methodology proposed by Adrian and Brunnermeier (2011) seems to solve the problems outlined in the supervisory approach (difficulty to obtain detailed information on cross-exposures, typically owned by central banks and not publicly available).

In fact, it is based on publicly observable balance sheet and market data. Moreover, that methodology has an advantage over the employment of CDS data in the sense that, under the assumption of market efficiency, the stock market price should reflect all types of risk toward which a financial institution is exposed.

After considering the measures of financial stability most adopted by the literature, now we focus on the determinants that could affect them.

The possible explanation between size-stability relationships can be explained by the agency theory of the firm (Jensen and Meckling, 1976). The agency theory submits that manager's actions and decisions become inordinately skewed toward personal gain. In this sense, the size of a firm is increased because of the managerial empire-building, hence, bad governance

associates with large firms. In this way, this study expects a negative relationship between financial stability and bank size. Similarly, the size-stability relationship is also explained by the stewardship theory. Donaldson and Davis (1991) and Davis et al., (1997) suggest that managers of the firm fairly use the resources of the firm and they are considered as inherently trustworthy employees. But, unlike the agency theory, stewardship theory submits that increase in the size of a firm may enhance its stability. By extraction, this theory posits a positive relationship between financial stability and bank size.

One study of Laeven et al., (2014) analyze the effect of bank size on financial stability. The study reports that smaller banks are less risky than larger banks. In contrast, Kohler (2015) investigates the effect of bank business and stability model using a sample data from European Union (EU) banks. His research indicates that bank size shows a negative and significant effect on stability. Thus, we draw an obvious conclusion that the size-stability relationship is inconclusive and requires further empirical support.

The relationship between bank funding risk and stability receiving a considerable amount of attention among the researchers (Adusei, 2015). In this context, Calomiris and Kahn (1991) suggest that bank wholesale funding reduces risk through efficient utilization of bank resources and capital diversification. Demirguc-Kunt and Huizinga (2010) suggest that bank instability is mainly associated with the larger portion of non-deposit funding. However, Kohler (2015) associate non-deposit funding risk with a different type of banks. This signifies that share of non-deposit funding has a negative impact on stability of retail-oriented banks, while this relationship is positive for investment banks. Moreover, Adusei (2015) report a positive relationship between bank stability and funding risk. Hence, it is important to examine the relationship between these two variables.

A substantial portion of the bank diversification literature focuses on U.S banks with fewer studies on other developed or emerging banking systems. Kohler (2014) studies German banks and finds that retail-oriented institutions become more stable when they increase non-interest income activities. Sanya and Wolfe (2011) analyze a sample of banks from 11 emerging countries between 2000 and 2007 and find that diversification improves profitability and stability. In contrast to the aforementioned literature, a range of other studies arrive at the counter conclusion, namely, that bank diversification increases risks. DeYoung and Roland (2001), for instance, find that banks non-traditional sources of income increases revenue volatility. Similarly, Acharya et al., (2006) link increased non-interest income to poorer performance as diversification reduces bank loan monitoring incentives. Stiroh and Rumble

(2006) investigate the association between bank diversification, risk and profitability for a sample of U.S financial holding companies. They find that non-interest based activities improve profitability but also increase risk. This suggests that it is not diversification of itself but how the diversification process is managed that determines whether there will be performance or/and risk benefits forthcoming.

Credit risk plays an important role in the financial stability. Imbierowicz and Rauch (2014) analyze the relationship between liquidity and credit risks, and their impact on the soundness of 4300 US commercial banks over the period 1998-2010, including 254 failures banks during the crisis. The results show that credit and liquidity risks jointly influence the banks' default probability.

3.3. Econometric methodology literature

Panel data analysis was adopted for conducting the econometric modelling. The term panel refers to the pooling of observations of separate units (countries, banks, groups of people etc..) on the same set of variables over several time periods (Baltagi, 2001).
Prior to describing the model, it is important to stipulate the reasons why panel data analysis can be beneficial, as well as distinguishing between the models used in panel data analysis. Among the main advantages of panel data, compared to other types of data, is that the approach allows the testing and adjustment of the assumptions that are implicit in cross-sectional analysis. A number of econometricians state that the use of panel data analysis can be very beneficial in a number of ways, including:

- Panel data suggest that individual countries, banks, etc., are heterogeneous;
- Panel data give more information, more variability, less collinearity among other variables, more degrees of freedom and more efficiency;
- Panel data can capture and measure effects that are not detectable in cross-section time series analysis.

Following the work made by Sufian et al., (2008) about the Philippines, the authors in order to test the relationship between bank profitability, bank specific and macroeconomic determinants, they estimate a linear regression model in the following form:

$$y_{jt} = \delta_j + \alpha' X_{ijt} + \beta' X_{et} + \varepsilon_{jt},$$

where j refers to an individual financial institution; t refers to year; y_{jt} refers to the return on assets (ROA) and is the observation of financial institution j in a particular year t; X_i represents the internal factors (determinants) of a financial institution; X_e represents the external factors (determinants) of a financial institution; ε_{jt} is a normally distributed random variable disturbance term. They apply the least square method to a fixed effects (FE) model, where the standard errors are calculated by using White's (1980) transformation to control for cross-section heteroscedasticity. The opportunity to use a fixed effects model rather than a random effects model has been tested with the Hausman test. To check for the robustness of the results, they also reported results from the random effects model.

The same analysis is conducted by Roman et al., (2013), regarding the Romanian case. They analyzed a sample of 15 commercial banks that operate in Romania and that hold together 78.10% of the total bank assets. Moreover, they have selected only commercial banks that have available information between 2003 and 2011. The paper uses panel due to the advantage that it has: it helps to study the behavior of each bank over time and across space (Baltagi, 2001). A multiple linear regression model was issued to determine the relative importance of each explanatory variable in affecting the performance of bank.

The general linear regression model is:

$$Y_{it} = c + \beta_i X_{it} + \mu_{it}$$

where Y_{it} stands for the dependent variable observed for i-th bank at time t; X is the independent variable (including the internal and external determinants); β is the coefficient for explanatory variables; i=2….N; c is a constant term; μ represent the error term of the model.

Menicucci and Paolucci (2015) have investigated the relationship between bank-specific characteristics and profitability in European banking sector to find the role of internal factors in achieving high profitability. A regression analysis is built on an unbalanced panel data set comprising 175 observations of 35 top European banks over the period 2009-2013. To test the relationship between bank profitability and bank-specific determinants described before, they use a linear regression model. The feedback from the literature on bank profitability reveals that the functional linear form of analysis is the proper one. A linear model is used to analyze the cross-section time series data and a simple linear equation is estimated using pooled sample of European banks in the period 2009-2013. Hence, the basic estimation strategy is to pool the observations across banks and apply the regression analysis on the pooled sample. They select panel data because they allow to measure respectively individual variability and dynamic change of the cross-section units over time.

To examine the profits' determinants of European banks, they estimate a linear regression model in the following form:

$$y_{jt} = \delta_t + \alpha'_{it} X_{ijt} + \varepsilon_{jt}$$

where j refers to an individual bank; t refers to year; y_{jt} refers to the profitability of bank j at time t and it is the observation of bank j in a particular year t; X_i represents the internal factors (determinants) of a bank's profitability; ε_{jt} is a normally distributed random variable disturbance term (error term). Extending the above equation to reflect the variables considered in the study, the regression model is formulated as follows:

$$y_{jt} = \delta_0 + \alpha_1 SIZE_{jt} + \alpha_2 CAP_{jt} + \alpha_3 LOAN_{jt} + \alpha_4 DEP_{jt} + \alpha_5 LLP_{jt} + \varepsilon_{jt},$$

where y_{jt} is the profitability of bank j at time t. Three indicators, namely, ROA, ROE and NIM represent three alternative performance measures for bank j during the period t. Hence, three models are alternatively tested in the analysis, and each one includes a different measure of profitability (dependent variable).

Another work developed by Merin (2016), is focused on a single country, specifically considering private commercial banks that operate in Ethiopia.

The researcher collected financial data from the annual reports of the sampled banks for the period of 2004-2011. Besides to financial data, macroeconomic data were gathered from National bank of Ethiopia.

The analysis used panel model to analyze the collected data. As we have already discussed, panel model is a combination of cross sectional and time series observations. For this study, fixed effect model is selected. It is one panel model which control for unobserved heterogeneity among cross sectional units. The following equation indicates the general model of the study:

$$\Pi_{it} = c + \sum_{m=1} \beta_m X_{it}^m + \sum_{k=1} \beta_k X_{it}^k + \varepsilon_{it},$$

where Π_{it} is the dependent variable and is observation on profitability measures of ROA, for bank i at time t, and c is the constant term. $\sum_{m=1} \beta_m X_{it}^m$ is a vector of m^{th} bank specific variables. While the second set of independent variables $\sum_{k=1} \beta_k X_{it}^k$ is the vector of k^{th} external variables and ε_{it} is the error term.

In the work made by Ali and Puah (2018), they examine the internal determinants of bank profitability and stability in Pakistan banking sector. The methodology that is used is a panel regression analysis built on a balanced panel data using 24 commercial banks over the sample period of 2007-2015. The authors performed a separate analysis of bank profitability and stability. Both models used a comprehensive set of bank internal determinants.

Based on the past empirical studies, they develop their panel data models to examine the impact of bank internal variable on its profitability and stability:

$$ROE = \alpha + \beta_1 BSIZE + \beta_2 LRISK + \beta_3 CRISK + \beta_4 FRISK + \beta_5 BSTAB + FC(DUMM) + \varepsilon \quad (1)$$

$$BSTAB = \alpha + \beta_1 BSIZE + \beta_2 LRISK + \beta_3 CRISK + \beta_4 FRISK + \beta_5 ROA + FC(DUMM) + \varepsilon \quad (2)$$

According to equations (1) and (2), BSTAB shows bank stability, whereas ROE and ROA represent profitability; BSIZE is bank size; FRISK denotes fund risk; LRISK indicates liquidity risk; CRISK highlights credit risk and FC(DUMM) is used as a dummy variable for financial crisis. They use independent variables in t-1 while dependent variable in time t. This implies that our independent variables are lagged variables to mitigate the potential problem of endogeneity (Adusei, 2015; Hannan and Prager, 2009).

Now, in this following part, we consider some works that are made using the dynamic panel regression. The Arellano-Bover/Blundell-Bond system estimator is an extension of the Arellano-Bond estimator that accommodates large autoregressive parameters and a large ratio of the variance of the panel – level effect to the variance of idiosyncratic error. The Arellano-Bover/Blundell-Bond system estimator is designed for datasets with many panels and few periods, which is the case of the following mentioned analyses.

Considering the analysis made by Athanasoglou et al., 2008, they use an unbalanced panel of Greek commercial banks since it contains banks entering or leaving the market during the sample period (e.g. due to mergers). Unbalanced panels are more likely to be the norm in studies of a specific country's bank profitability. The following model forms the basis of their estimation:

$$\Pi_{it} = c + \delta \Pi_{i,t-1} + \sum_{j=1}^{J} \beta_j X_{it}^j + \sum_{l=1}^{L} \beta_l X_{it}^l + \sum_{m=1}^{M} \beta_m X_{it}^m + \varepsilon_{it}$$

In static relationships the literature usually applies least squares methods on fixed effects (FE) or random effects (RE) models. However, in dynamic relationships these methods produce biased (especially as the time dimension T gets smaller) and inconsistent estimates (see Baltagi, 2001). Following Arellano and Bond (1991), they suggest that consistency and efficiency gains can be obtained by using all available lagged values of the dependent variable plus lagged values of the exogenous regressors as instruments. Yet, the Arellano and Bond estimator has been criticized when applied to panels with very small T, the argument being that under such conditions this estimator is inefficient if the instruments used are weak (Arellano and Bover, 1995). However, in this study T=17, which is larger enough to avoid such problems.

Consequently, they will proceed with the estimation of their model using GMM estimator in the Arellano and Bond paradigm.

Focusing again on a specific country, we refer to Dietrich and Wanzenried (2010) work, where they make evidence from Switzerland. To empirically investigate the effects of internal and external factors on bank profitability, they follow Athanasoglou et al., (2008) and Garcia-Herrero et al., (2009) and use a linear model given by:

$$\mathrm{PERF}_{it} = c + \delta \mathrm{PERF}_{i,t-1} + \sum_{j=1}^{J} \beta_j X_{it}^{j} + \sum_{l=1}^{L} \beta_l X_{it}^{l} + \varepsilon_{it}$$

PERF_{it} is profitability of bank *i* at time t, with *i*=1,…,N, t=1,…,T, c is a constant term, X_{it}'s are the bank-specific and market specific explanatory variables as outlined above, and ε_{it} is the disturbance term. As made before, they specify a dynamic panel model by including a lagged dependent variable among the regressors, i.e. $\mathrm{PERF}_{i,t-1}$ is the one-period lagged profitability and δ the speed of adjustment to equilibrium. A value of δ between 0 and 1 implies persistence of profits, but they will eventually return to their normal level. A value close to 0 indicates an industry that is fairly competitive, while a value close to 1 implies a less competitive structure. Given the dynamic nature of the model, least squares estimation methods produce biased and inconsistent estimates (see Baltagi, 2001). Therefore, they use again the techniques for dynamic panel estimation that are able to deal with the biases and inconsistencies of their estimates. Following Garcia-Herrero et al., (2009), they address these problems by employing the generalized method of moments (GMM) following Arellano and Bover (1995), also known as system GMM estimator. This methodology accounts for endogeneity. The system GMM estimator uses lagged values of the dependent variable in level and in differences as instruments, as well as lagged values of other regressors which could potentially suffer from endogeneity.

As previously stated, these analyses are designed for datasets with many panels and few periods, which is not our case, for this reason we do not implement this dynamic panel regression.

4. Italian empirical analysis

4.1. Data source and research methodology

To investigate the determinants of Italian banks' profitability and financial stability, we collect a sample data of 19 Italian banks, which includes commercial and cooperative ones.
Because of data constraints, our panel data is unbalanced and covers a sample period of 2006-2019. Considering this time period, it is possible to shed light on the two most important crisis that affected the Italian banking system: the Great Financial Crisis and the Sovereign Debt Crisis.
The data has been examined by applying a panel data multiple regression.
As in many prior studies, we have adopted a descriptive analysis to explore the combined effect of internal and external determinants on the bank profitability and financial stability of the selected banks.
In the following paragraphs, first, information regarding dataset, sample selection, dependent and independent variables is given. Then, the models of the study including the mentioned variables are developed.
The bank-level financial statements are derived from the Bankscope Database and Thomson Reuters Datastream.
Bankscope database supplies annual financial information for banks in 180 countries all over the world and thus it is considered the most comprehensive database for research in banking.
There is a major benefit to use this data source; the information at the bank level is highlighted in standardized formats, after adjusting for differences in accounting and reporting standards across countries. We removed duplicate information, i.e. we focused attention on consolidated data if Bankscope reported both unconsolidated and consolidated.
Daily market data, explained in detailed later on and crucial to compute the systemic risk measure, are extracted from Thomson Reuters Datastream.
The investigation of banks' profitability and financial stability is particularly interesting in the selected period, as the financial system and banks have been exposed to several financial shocks and challenges.
We use both descriptive statistics and econometric tools to analyse the collected data.
A panel regression analysis is built on an unbalanced panel data using 19 commercial banks over the sample period 2006-2019.

We need to perform a separate analysis of bank profitability and financial stability. All the models used a comprehensive set of bank internal determinants and external macroeconomic determinants.

4.1.1. Determinants of bank profitability and variables selection

In this section, we describe both the dependent and independent variables that we select for our analysis on bank profitability. See Table 2 for a summary of the variables described below.
For our empirical analysis, we use as dependent variable the return on assets (ROA) which is defined as the ratio of net income to total assets.
In principle, ROA shows the profits earned per unit of assets and reflects management ability to utilize banks' financial and real investment resources to generate profits.
ROA has emerged as the key ratio for the evaluation of bank profitability and has become the most common measure of it.
In the following pages we make a brief description of the bank specific and macroeconomic profitability determinants.

Bank specific profitability determinants:

- ***Asset size (SIZE)***: one of the most important questions underlying bank policy is which size optimizes bank profitability. In particular, larger-sized banks are able to invest a lot of money in ICT (Information and Communication Technology), so they can build up know-how and technologies for high-quality risk management. Furthermore, a larger size allows the bank to operate more business lines and with a wider range of customers. On the other hand, small-sized banks could benefit both from a greater operating flexibility, i.e., being able of adapting their strategies very quickly to the changing economic environment, and from lower fixed operating costs.

  Generally, the effect of a growing size on profitability has been proved to be positive to a certain extent. However, for banks that become extremely large, the effect of size could be negative due to bureaucratic and other reasons. Hence, the size profitability relationship may be expected to be non-linear. We use banks' total assets (logarithm) in order to capture this possible non-linear relationship.

- ***Funding costs (FC)***: are defined as interest expenses over customers deposits, vary across banks over time. Overall, banks that are able to raise funds more cheaply than others, are expected to be more profitable.
- ***Income diversification of bank (DIV)***: for determining this measure of diversification we consider the following variables: NET (net interest income) and NII (net non-interest income). We take their respective shares in net operating income (NET+NII):

$$NETs = NET/(NET+NII)$$

$$NIIs = NII/(NET+NII)$$

then, following the empirical work of Chiorazzo et al., (2008), we define the measure of income diversiifcation as:

$$DIV = 1 - (NETs^2 + NIIs^2)$$

In order to measure the income diversification level of each bank, we calculate the widely used Herfindahl Hirschman Index (HHI) for all banks. By construction, under the constraint that NET and NII have to assume positive values, such an index varies from 0.0 to 0.5. It is equal to zero when diversification reaches its minimum and equal to 0.5 when there is complete diversification. Positive values of this variable indicate that income diversification improves bank profitability.

The decline in interest margins during the last decade has changed the traditional role of banks and forced them to search for new sources of revenue. In this context, Elsas et al., (2010) find that, initially, commercial banks typically increase diversification by moving into fee-based businesses. Then, they expand their business into trading activities or by underwriting insurance contracts. For this reason, the effect of diversification of income on bank profitability is not clear. Recently, both Chiorazzo et al., (2008) and Elsas et al., (2010) conclude that revenue diversification enhances bank profitability via higher margins from non-interest businesses. In particular, focusing on our Italian case, we expect a positive relationship between bank profitability and income diversification.

- ***Capital adequacy (EA)***: in line with previous research from, among others, Athanasoglou et al., (2008) and Iannotta et al., (2007), the ratio of equity to assets is used as a measure of capital strength. Following Dietrich and Wanzenried (2014), they use this simple measure of common equity to total assets instead of measuring a risk-based bank's capital strength as suggested in the Basel II and Basel III framework. Models with risk-weighted assets (RWA) are problematic as they rely heavily on banks' internal models about the risk levels of individual loans, with many parameters calibrated, making it almost impossible to compare banks. Moreover, data on RWA are not available for many banks and over time. Anticipating the net impact of changes in this ratio is complex: for example, banks with

higher capital-to-asset ratios are considered relatively safer and less risky compared to institutions with lower capital ratios. In line with the conventional risk-return hypothesis, we expect banks with lower capital ratios to have higher returns in comparison to better-capitalized financial institutions. In contrast, highly capitalized banks are safer and remain profitable even during economically difficult times. Furthermore, a lower risk increases a bank's creditworthiness and reduces its funding costs. In addition, banks with higher equity-to-asset ratios normally have a reduced need for external funding, which has again a positive effect on their profitability. Given that we have anticipated effects pointing in opposite directions, the impact of a bank's capitalization on its profitability cannot be anticipated theoretically.

- ***Credit risk (CRISK)***: the ratio of impaired loans over total gross loans is a measure of a bank's credit quality. Theory suggests that increased exposure to credit risk is normally associated with decreased firm profitability and, hence, we expect a negative relationship between ROA and this ratio. Banks would, therefore, improve profitability by improving screening and monitoring credit risk and such policies involve the forecasting of future levels of risk. A higher ratio indicates a lower credit quality and, therefore, a lower profitability. Thus, we expect a negative effect from the loan loss provisions relative to total loans on bank profitability.
- ***Deposit share (DEPOSIT)***: this ratio is a variable measuring the amount of deposits held by a bank proportional to its size. Deposits are banks' primary sources of funds that they can invest to generate income. Therefore, a positive correlation between the bank profitability (especially measured by ROA) and deposits ratio is expected (Davydenko, 2010).

Macroeconomic profitability determinants:

There is a considerable evidence showing that country-level macroeconomic and financial structure variables have a significant impact on bank performance.
In addition to the bank-specific variables described above, the analysis includes a set of macroeconomic characteristics that we expect to have an impact on bank profitability.
To measure the relationship between economic and market conditions and bank profitability, we need to consider two determinants:

- ***Gross domestic product (GDP)***: bad economic conditions can worsen the quality of the loan portfolio, generating credit losses and increasing the provisions banks need to hold,

thus reducing bank profitability. In contrast, an improvement in economic conditions, in addition to improve the solvency of borrowers increases demand for credit by households and firms, with positive effects on the profitability of banks (Athanasoglou et al., 2008). At the same time, following Albertazzi and Gambacorta (2009) conclude that the pro-cyclical nature of bank profits derives from the effects that the economic cycle exerts on the net interest income (through lending activity) and loan loss provisions (via credit quality). For this reason, we can expect a positive relationship between economic growth and bank profitability.

- ***Inflation rate (INF)***: another important macroeconomic condition which may affect both the costs and revenues of banks is the inflation rate. The effect of inflation rate on bank profitability depends on whether wages and other operating expenses increase at a faster rate than the inflation. Most studies (e.g. Bourke, 1989; Molyneux and Thornton, 1992) have found a positive relationship between inflation and profitability. However, if inflation is not anticipated and banks do not adjust their interest rates correctly, there is a possibility that costs may increase faster than revenues and hence affect bank profitability adversely. Accordingly, the overall effect is theoretically undetermined.

Table 2: Summary of variable selection about bank profitability – ROA

DEPENDENT VARIABLE	DESCRIPTION
ROA	Net income/Total assets

INDIPENDENT VARIABLES	DESCRIPTION	EXPECTED EFFECT
ASSET SIZE (SIZE)	Natural logarithm of total assets	+/-
FUNDING COSTS (FC)	Interest expenses/Customer deposits	_
INCOME DIVERSIFICATION (DIV)	$1-(NETs^2 + NIIs^2)$	+
CAPITAL ADEQUACY (EA)	Total equity/Total assets	+/-
CREDIT RISK (CRISK)	Impaired loans/Gross loans	_
DEPOSIT SHARE (DEPOSIT)	Customer deposits/total assets	+
GROSS DOMESTIC PRODUCT (GDP)	Annual real GDP growth rate	+
INFLATION RATE (INF)	Annual inflation rate	+/-

Source: own elaboration

4.1.2. Determinants of financial stability and variables selection – Z-score

In this section, we describe both the dependent and independent variables that we selected for our analysis on financial stability. See Table 3 for a summary of the variables described below. Consistent with past studies, we measure the financial stability distinguishing between idiosyncratic and systemic risk. The former is calculated using Z-score as a measure of bank stability (Adusei, 2015; Stiroh, 2004; Demirguc-Kunt and Huzinga, 2010). The latter, as we have explained in the literature review section, is measured by $\Delta CoVaR$ (Adrian and Brunnermeier, 2011).

In this paragraph we focus on the determinants of financial stability at individual level.

The dependent variable used is Z-score that as previously explained proxies the bank stability at individual level.

Bank specific and macroeconomic financial stability determinants:

- ***Bank profitability (ROA)***: as stated by lots of empirical works, between bank profitability and bank stability there is a positive relationship. Since Z-score is a proxy of bank stability, higher bank profitability leads necessarily to higher bank stability.

- ***Asset size (SIZE)***: it is assessed as the natural log of total assets; the size-stability relationship is inconclusive and requires further empirical support.

- ***Funding risk (FRISK)***: the funding risk is denoted by Z-score and is calculated through the sum of the deposit-to-total asset ratio and the equity-to-total asset ratio, which is further divided by the standard deviation of the deposit-to-total asset ratio. The relationship is ambiguous, so we need to examine if it positive or negative.

- ***Income diversification (DIV)***: as we have highlighted in the literature section, the relationship between income diversification and financial stability is uncertain. But, focusing on our Italian case, we can expect a negative relationship since higher returns obtained from income diversification leads higher volatility which characterized non-interest income.

- ***Credit risk (CRISK)***: following the previous section with the analysis on bank profitability, also the relationship between credit risk and financial stability at individual level is negative.

- ***Capital adequacy (EA)***: for this variable we expect a positive sign since higher is the equity-to-asset ratio, the less leveraged the company is.

- ***Loans share (LOAN)***: this ratio is obtained dividing net loans to total assets; in this case, we expect a negative relationship since the higher the ratio is, the riskier a bank may be to higher defaults.

- ***Gross domestic product (GDP)***: the relationship that we expect is clearly positive since higher GDP growth rate affects positively the bank stability of an individual institution.

- ***Inflation rate (INF)***: for this variable we expect a negative relationship, since we want to maintain the price stability that is required by Bank of Italy.

Table 3: Summary of variable selection about financial stability – Z-score

DEPENDENT VARIABLE	DESCRIPTION
Z-SCORE	(CAR + ROA)/σROA

INDIPENDENT VARIABLES	DESCRIPTION	EXPECTED EFFECT
BANK PROFITABILITY (ROA)	Net income/Total assets	+
ASSET SIZE (SIZE)	Natural logarithm of total assets	+/-
FUNDING RISK (FRISK)	$\left(\frac{DEP}{TA}+\frac{E}{TA}\right)/\sigma\,(DEP/TA)$	+/-
INCOME DIVERSIFICATION (DIV)	1-(NETs^2 + NIIs^2)	_
CREDIT RISK (CRISK)	Impaired loans/Gross loans	_
CAPITAL ADEQUACY (EA)	Total equity/Total assets	+
LOANS SHARE (LOAN)	Net loans/Total assets	_
GROSS DOMESTIC PRODUCT (GDP)	Annual real GDP growth rate	+
INFLATION (INF)	Annual inflation rate	_

Source: own elaboration

4.1.3. Determinants of financial stability and variables selection – $\Delta CoVaR$

In this paragraph, we make a brief analysis about the dependent and independent variables that are used in the last panel regression (Table 4).
Since we want to give a more comprehensive understanding about the financial stability, we consider also the systemic risk, in particular how a financial institution contributes to the systemic risk.
Our dependent variable is $\Delta CoVaR$, that is a measure of systemic risk, very used in the literature. We obtain this measure implementing a code on MATLAB.

Bank specific and macroeconomic financial stability determinants:

- ***Bank stability (Z-SCORE)***: clearly, the relationship that we expect between systemic risk and bank stability is negative. If the systemic risk increases, this situation leads to a decrease in Z-score since higher values of Z-score indicates greater banking stability.

- ***Bank profitability (ROA)***: profitability should exhibit a negative relationship with a bank's systemic risk because profitability shields a bank from defaulting. In fact, profitability proxies the financial institutions' ability to generate profits efficiently throughout the business cycle.

- ***Asset size (SIZE)***: for this variable we expect a positive relationship since large size implies greater systemic risk importance.

- ***Credit risk (CRISK)***: obviously, the relationship that there is between credit risk and systemic risk is positive since an increase in the credit risk (i.e. increasing impaired loans) indicates an increase in systemic risk. In particular, a bank characterized by lots of impaired loans gives a great contribution to the systemic risk.

- ***Income diversification (DIV)***: in this case, the relationship that we expect is positive, since an increase in the income diversification level and in the non-traditional activities (i.e. which usually are riskier and more volatile) have a directly impact on the level of systemic risk.

- ***Value at Risk (VaR)***: the VaR of a bank, i.e. idiosyncratic risk of a bank, contributes positively to the systemic risk. Since when there is an increase in the idiosyncratic risk this generates as a consequence an increase in the systemic risk, contributing to get worse the financial situation and position of a bank.

- ***Capital adequacy (EA)***: the sign that we expect is negative due to the fact that the systemic risk is lower for bank that are well-capitalized i.e. higher equity to asset ratios.

- ***Gross Domestic product (GDP)***: obviously, the sign that we want to obtain is negative since an increase in the GDP growth rate decrease the systemic risk.

Table 4: Summary of variable selection about financial stability – $\Delta CoVaR$

DEPENDENT VARIABLE	DESCRIPTION
$\boldsymbol{\Delta CoVaR}$	MATLAB code

INDIPENDENT VARIABLES	DESCRIPTION	EXPECTED EFFECT
Z-SCORE	(CAR + ROA)/σROA	_
BANK PROFITABILITY (ROA)	Net income/Total assets	_
ASSET SIZE (SIZE)	Natural logarithm of total assets	+
CREDIT RISK (CRISK)	Impaired loans/Gross loans	+
INCOME DIVERSIFICATION (DIV)	1-(NETs^2 + NIIs^2)	+
VALUE AT RISK (VaR)	MATLAB code	+
CAPITAL ADEQUACY (EA)	Total equity/Total assets	_
GROSS DOMESTIC PRODUCT (GDP)	Annual real GDP growth rate	_

Source: own elaboration

4.1.4. Empirical models

Based on the past empirical studies, we develop our panel data models to examine the impact of bank internal variables and macroeconomic variables on its profitability and stability.

To test the relationship between bank profitability and bank-specific determinants and macroeconomic determinants described before, we use a linear regression model. The feedback from the literature on bank profitability and financial stability reveals that the functional linear form of analysis is the proper one.

Therefore, a multivariate analysis is carried out to verify the hypothesis of this study and panel regression techniques are used to investigate the internal and external determinants. We select panel data because they allow to measure respectively individual variability and dynamic change of the cross-section units over time.

To examine the determinants (i.e. internal and external) of bank profitability and financial stability of Italian banks, we estimate a linear regression model of the following form:

$$y_{it} = c + \beta_m X_{it}^m + \beta_k X_{it}^k + \mu_{it} \qquad (1)$$

where *i* refers to an individual bank; *t* refers to year; y_{it} refers to the profitability of the bank for the first part of the analysis and then to the financial stability for the second and third one; X_{it}^m represents the internal determinants (bank-specific variables) and X_{it}^k stands for the external variables (macroeconomic variables); μ_{it} is a normally distributed random variable disturbance term (error term).

Extending equation (1) to reflect the variables considered in the studies, the regression models are formulated in the following way:

$$\begin{aligned} ROA_{it} = c + {} & \beta_1 SIZE_{it} + \beta_2 FC\_L1_{it-1} + \beta_3 DIV_{it} + \beta_4 EA_{it} + \beta_5 CRISK\_L1_{it-1} \\ & + \beta_6 DEPOSIT_{it} + \beta_7 GDP_{it} + \beta_8 INF_{it} \\ & + \mu_{it} \end{aligned} \qquad (2)$$

$$\begin{aligned} Z - SCORE_{it} = {} & c + \beta_1 ROA_{it} + \beta_2 SIZE_{it} + \beta_3 FRISK\_L1_{it-1} + \beta_4 DIV\_L1_{it-1} \\ & + \beta_5 CRISK_{it} + \beta_6 EA_{it} + \beta_7 LOAN_{it} + \beta_8 GDP_{it} + \beta_9 INF_{it} \\ & + \mu_{it} \end{aligned} \qquad (3)$$

$$\Delta CoVaR_{it} = \beta_1 ZSCORE_{it} + \beta_2 ROA_{it} + \beta_3 SIZE_{it} + \beta_4 CRISK_{it} + \beta_5 DIV_{it} + \beta_6 VaR_{it} + \beta_7 EA_{it} + \beta_8 GDP\_L1_{it-1} + \mu_{it} \quad (4)$$

For the first regression model, y_{it} is the profitability of bank *i* at time *t*. We can consider two indicators, namely, ROE and ROA, represent two alternative performance measures for the bank *i* during the period *t.* For our analysis, we make all the evaluation on the estimates through the return on assets (ROA), following the majority of the literature.

Then, for the second regression model, y_{it} stands for the financial stability at individual level. We analyze the bank stability through the Z-score measure, which captures the individual dimension.

Finally, in the last regression, y_{it} represents the systemic risk, measured by $\Delta CoVaR$, which captures the contribution of an individual institution to the systemic risk.

To make a more comprehensive analysis, these three models are evaluated and tested separately. The software used for our empirical analysis are STATA and MATLAB.

4.2. Bank profitability analysis

4.2.1. Descriptive statistics

The data are collected in annual frequency and they are provided by consolidated annual reports of each bank, where it is possible; in addition, we collected data from Bankscope and Thomson Reuters DataStream, over the time window going from 2006 to 2019. The choice of the period is strictly related to the crisis that affect the Italian banking system during that years.

Before carrying out the empirical analysis, a summary of descriptive statistics is presented and the correlation matrix between variables is checked in the following tables (Table 5 and Table 6); in details the number of observations varies since our panel dataset is unbalanced.

Table 5: Descriptive statistics – bank profitability analysis

VARIABLE	Obs	Mean	Std. Dev.	Min.	Max.
ROA	265	.3187452	1.831504	-12.26301	18.25786
SIZE	265	17.13726	1.847532	12.80833	20.75781
FC_L1	253	4.730832	12.72606	-.4465006	162.0623
DIV	234	.4462044	.0771719	.1162139	.499999983

EA	265	8.443781	5.05377	1.249937	47.23644
CRISK_L1	251	10.32112	9.57889	.05	60.07
DEPOSIT	258	46.351	16.53837	4.17096	86.95955
GDP	266	-.0381429	1.998181	-5.28	1.791
INF	266	1.415714	1.06074	-.09	3.35

Source: own elaboration

The average value of ROA (in percentage terms) is a sign that banks suffered in terms of profitability during the financial distress reaching negative values; whereas the variable CRISK_L1, that captures the ratio between impaired loans and gross loans, is equal to 10,32%, with maximum level of 60.07%, a percentage that suggests quite high levels of impaired assets.

Table 6: Correlation matrix of explanatory variables – bank profitability analysis

	SIZE	FC_L1	DIV	EA	CRISK_L1	DEPOSIT	GDP	INF
SIZE	1.0000							
FC_L1	-0.1071	1.0000						
DIV	0.5296	0.0538	1.0000					
EA	-0.3996	0.0787	-0.3073	1.0000				
CRISK_L1	-0.0067	-0.1727	-0.0214	-0.1600	1.0000			
DEPOSIT	-0.1551	-0.3577	0.0572	-0.1365	0.3284	1.0000		
GDP	-0.0474	-0.2954	-0.0831	0.1123	0.1913	0.0784	1.0000	
INF	-0.0383	0.0697	-0.1293	-0.0239	-0.3962	-0.2419	-0.1259	1.0000

Source: own elaboration

This table provides information on the degree of correlation between the explanatory variables used in the multivariate regression analysis.

The matrix shows that in general the correlation between the bank-specific variables is not strong suggesting that multicollinearity problems are either not severe or non-existent.

Kennedy (2008) points out that multicollinearity is a problem when the correlation is above 0.80, which is not the case here.

Even if the Pearson's correlation coefficient provides an easy way to detect the presence and the severity of multicollinearity, it is not widely recommended for quantification of it because of its possible misleading results when, for instance, there is not much historic data or it cannot distinguish dependent from explanatory variables.

To overcome such drawbacks and verify the presence of the abovementioned problems we run a test to verify the goodness of our variables and we compute the VIF (variance inflation factor) of each predictor, with the help of the software STATA.
The VIF may be calculated for each predictor by doing a linear regression of that predictor on all the other predictors, and then obtaining R^2 from that regression. The VIF is just:

$$VIF = \frac{1}{(1 - R^2)}$$

This index measures how much variance of an estimated regression coefficient increases because of collinearity, with respect to the absence of correlation: relatively low VIF size that we have obtained demonstrates that we can continue with our analysis and exclude the presence of high magnitude multicollinearity.
According to the rule of thumb, a VIF of 5 or above is considered enough to ascertain the presence of multicollinearity problems.

Table 7: Variance Inflation Factor – bank profitability analysis

VARIABLE	VIF	1/VIF
SIZE	1.76	0.566648
DIV	1.55	0.646893
DEPOSIT	1.47	0.681598
CRISK_L1	1.37	0.730878
FC_L1	1.36	0.737339
EA	1.34	0.746831
INF	1.27	0.785429
GDP	1.16	0.859635
MEAN VIF	**1.41**	

Source: own elaboration

As we can highlight from the Table 7, in our case values do not exceed 1.76, leaving out the possibility of potential biased estimator due to such problematic.

4.2.2. Regression analysis

To study the aforementioned phenomenon, the baseline regression equation is the following:

$$ROA_{it} = c + \beta_1 SIZE_{it} + \beta_2 FC\_L1_{it-1} + \beta_3 DIV_{it} + \beta_4 EA_{it} + \beta_5 CRISK\_L1_{it-1} + \beta_6 DEPOSIT_{it} + \beta_7 GDP_{it} + \beta_8 INF_{it} + \mu_{it}$$

where the error term μ_{it} can be intended as the sum of two components: $\mu_{it} = a_i + u_{it}$.
The error term captures all the unobserved aspects of the dependent variable that are not explained by the regressors introduced in the model. As it can be easily noticed, the term a_i does not have *t* subscript, meaning that it captures time-constant factors and it is referred to as fixed effects or unobserved heterogeneity, because it remains constant over time and only changes at cross-sectional level, among banks. The term u_{it}, instead, is often called idiosyncratic error or time-varying error because it captures unobserved factors that change over time.

The objective of the research question is to stress out the impact that bank specific and macroeconomic factors have upon the profitability of the banks that operate in Italy.
To study this analysis, we apply a panel regression approach in order to examine the determinants of bank profitability, evaluating the impact that each factor or determinant have upon them.
The data of our sample have been taken in the form of unbalanced panel data, in which there are some missing observations due to the availability of data, collected on yearly frequency.
In the next pages, we firstly infer the coefficients using the pooled OLS method, the Fixed Effect and the Random Effect models: the comparison of these three sets of estimates is helpful in detecting the characteristics of potential bias. The results are summarized in Table 8, that compares three estimation techniques used.[3]

Table 8: Summary of coefficient estimates and related significance level – bank profitability analysis

	POOLED OLS	FIXED EFFECTS	RANDOM EFFECTS
SIZE	-.0140968	1.000397 ***	.0648934
FC_L1	-.0005259	-.0002902	-.0008419

[3] ***; **; * indicate 1%, 5%, 10% significance level respectively

DIV	3.111712 **	1.732998	1.976782
EA	.1247363 ***	.2163711 ***	.1526333 ***
CRISK_L1	-.0877585 ***	-.068696 ***	-.0831504 ***
DEPOSIT	.007974	-.0125668	.0083144
GDP	.113963 ***	.1041061 ***	.1024404 ***
INF	-.1482265 *	-.1440038 *	-.1440878 *
CONSTANT	-1.163936	-18.23972	-2.309202
OBSERVATIONS	221	221	221
R-SQUARED	0.4286	0.4556	0.4201

Source: own elaboration

The first column of Table 8 reports the pooled Ordinary Least Square estimates, the simplest method of estimation employed in a panel data analysis.

The pooled OLS technique gave us the hoped results, confirming most of the expected relationships. The goodness of the model is also confirmed by the R-squared and adjusted R-squared coefficients which stand to an acceptable level of 0.4286 and 0.4071, demonstrating that most of the variance of return on assets (ROA) is explained by the independent variables.

According to pooled OLS estimates, the statistically significant variables are income diversification (DIV), capital adequacy (EA), credit risk (CRISK_L1) and gross domestic product (GDP) that are significant at 1% and 5% significance level, as their p-values are lower than 0.01 and 0.05; indeed, their t-statistic absolute values are higher than 2.58 and/or 1.96 and lower than -2.58 and/or -1.96, further confirming the results. Finally, also the inflation (INF) is statistically significant at 10% significance level.

Although it is useful to compute pooled estimates because they provide a helpful guideline for further and more complex investigations, this technique is based on assumptions that rarely hold, thus it is generally agreed that the likelihood of valid results is quite small, as they do not take into account the serial correlation in the composite errors and they are biased given that the unobserved effects are left entirely in the error term.

In the second column of the Table 8 we have introduced and analysed the fixed effect model, which helps to eliminate the unobserved heterogeneity or time-invariant component, a_i, in the model because it contains these unobservable error correlated with X_{it}.
In other words, it is designed to study causes of changes within the bank, eliminating characteristics that are constant for each unit.
The implementation of the fixed effect model implies some assumption to be taken into account:

- $Cov(u_{it}, u_{is}|X_i, a_i) = 0$, that rules out the possibility the idiosyncratic errors could be correlated with each value of explanatory variables;
- $Cov(a_i; X_{it}) \neq 0$, meaning that the unobserved heterogeneity is correlated with X_{it}.

In this regard, the Fixed Effect model removes such errors through a fixed effect transformation which subtracts the average of the variable within each cross-sectional observation and sweeps away a_i, then gets a pooled OLS unbiased estimator, also called within estimator (i.e. it differs from the between estimator because the latter is obtained using the time averages for each variable and then carry out a cross-sectional regression (Wooldridge, 2012)).
As it is possible to notice from the Table 8 (second column), the return on assets of banks is well explained by the predictor variables, in fact according to R-squared within coefficient, it is equal to 45.56%.
The Fixed Effects model yields consistent variables: the statistically significant regressors are asset size (SIZE), capital adequacy (EA), credit risk (CRISK_L1), gross domestic product (GDP) and inflation (INF).
According to the Table 8, all coefficients are different from zero highlighting the significance of the model, however the same result can be obtained through a joint F-test on regressors, which is useful to assess if all the coefficients are jointly different from zero under the alternative hypothesis. The outcome provided by the table obtained from STATA is the following:

$$F(8,195) = 20.40 \qquad Prob > F = 0.0000$$

thus, it indicates the significance of the model estimates.

Unlike the Fixed Effects model, by estimating the same regression using the Random Effects model it is possible to investigate time-invariant components embedded in the dependent variable.

Finally, for this reason, in the third column we implement the Random Effects model. In this model the correlation assumption between the fixed effects and the control variables, cornerstone of the previously analysed model, does not hold anymore, since the unobserved heterogeneity follows a random walk and it is now considered a random variable where $Cov(a_i; X_{it}) = 0$. More in details, the random effects transformation subtracts a fraction of time average from the corresponding variable, and not the entire average as occurs in FE model; this fraction hinges on errors variance and the number of time periods considered. In this case, the unobserved effects are partially left in the error term, as similarly done in pooled OLS. Nonetheless, the pooled OLS estimator still remains a biased estimator, unable to predict the relationship between dependent and independent variables, due to autoregressive serial correlation issues; a generalized least squares estimator, also called random effect estimator better features such relationships to deal with this problem.
As we can notice from the Table 8 (third column), the information provided is quite consistent with the results borne by the previous model. The R-squared is high enough, equals to 42.01%. The statistically significant variables are capital adequacy (EA), credit risk (CRISK_L1), gross domestic product (GDP) and inflation (INF).

After this quick synthesis of the main results provided by each estimation technique, it is now crucial to figure out which one of the panel data methods used in the previous analysis has the greatest goodness of fit, able to draw a suitable picture of the effects of certain determinants on bank profitability.
To do this, we need to run a series of tests to identify the most appropriate inferences like the Hausman test that establishes the best model between Fixed Effects and Random Effects models and the Breusch-Pagan test which compares pooled OLS with Random Effects model.

1. ***HAUSMAN TEST***: In 1978, Jerry A. Hausman has been the first to propose a test computing the statistically significant differences in estimated coefficients of both the fixed and random effects models.

   The Hausman test remains a fundamental and powerful tool to evaluate which one of the implemented models is the most fitting one. The Fixed Effect model assumes that influence of independent variables on the dependent one is the same for all units in the panel, whereas the Random Effect model is built around the assumption that individual effect is a random variable.

   The null hypothesis states that the preferred model is the Random Effects versus the alternative which is the Fixed Effects. In other words:

$$H_0: Cov(a_i; X_{it}) = 0$$
$$H_1: Cov(a_i; X_{it}) \neq 0$$

Essentially, if the Hausman test leads us to reject the null hypothesis, it means that RE and FE estimates are sufficiently close and their differences are negligible, thus the model with the greatest goodness is the Fixed Effects. Conversely, if we fail to reject the null hypothesis, the RE is deemed to be the most suitable.

The Table 9 shows the results:

Table 9: Hausman test – bank profitability analysis

	Coefficients (b) fe	(B) re	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
SIZE	1.000397	.0648934	.9355035	.2243799
FC_L1	-.0002902	-.0008419	.0005517	.
DIV	1.732998	1.976782	-.2437834	.3605942
EA	.2163711	.1526333	.0637377	.011497
CRISK_L1	-.068696	-.0831504	.0144543	.0030526
DEPOSIT	-.0125668	.0083144	-.0208812	.0074934
GDP	.1041061	.1024404	.0016657	.
INF	-.1440038	-.1440878	.000084	.0127354

b = consistent under Ho and Ha; obtained from xtreg
B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(8) = (b-B)'[(V_b-V_B)^(-1)](b-B)
= 35.75
Prob>chi2 = 0.0000
(V_b-V_B is not positive definite)

Source: own elaboration

According to the results, we got a p-value equal to 0.0000, which indicates that we have to reject the null hypothesis and conclude that the Fixed Effects model is, indeed, appropriate for our analysis.

2. ***BREUSCH AND PAGAN TEST:*** To make sure that we can completely exclude pooled OLS estimates from our analysis, we decided to perform another test, the Breusch and Pagan Lagrangian multiplier test.

   This type of test was developed to check for heteroskedasticity in a linear regression model. The evidence in favour of heteroskedasticity, in facts, detects that the assumption over the constant variance of errors does not hold.

We have run the Breusch and Pagan Lagrangian multiplier test to determine if to use the pooled OLS or the random effects model. In the LM test the null hypothesis supports the goodness of pooled OLS technique and assumes variances across entities to be equal to zero, Var(u)=0. In other words, there are no significant differences across units and, as a result, the panel effect appears to be negligible, without the need to carry out a panel data analysis.

The test outcome is the following one:

Table 10: Breusch and Pagan test – bank profitability analysis

Breusch and Pagan Lagrangian multiplier test for random effects

ROA[BANKNUM,t] = Xb + u[BANKNUM] + e[BANKNUM,t]

Estimated results:

	Var	sd = sqrt(Var)
ROA	2.046142	1.430434
e	.9245627	.9615418
u	.1450883	.3809046

Test: Var(u) = 0

chibar2(01) = 27.13

Prob > chibar2 = 0.0000

Source: own elaboration

According to the results showed in Table 10, which bears p-value equal to 0.0000, we are led to reject the null hypothesis, confirming the presence of a panel effect that makes the Random Effect model the most suitable between the two involved in the test.

The final outcome of our analysis about the bank profitability have led us to conclude that the Fixed Effects model is the most fitting and appropriate to capture the main issues we wanted to investigate. In light of this analysis, it is necessary to attribute an economic meaning to the obtained coefficients.

This study uses return on assets (ROA) to proxy bank profitability. Then, we proceed our profitability model using Fixed Effects (FE) model.

The results for each independent variable, and their economic implications, according to the Fixed Effects model, are reported below:

- $SIZE_{it}$: as we have already seen, generally the effect of a growing size on profitability has been proved to be positive to a certain extent. In fact, the estimated coefficient is positive, the estimate is statistically significant at 1% significance level. The positive sign describes

a situation in which increasing bank size can increase profitability by allowing banks to realize economies of scale. Moreover, larger banks are likely to have a higher degree of product and loan diversification than smaller ones.

- FC_L1_{it-1}: as highlighted from the literature review, there is a negative relationship between funding costs and bank profitability.
  For our analysis we implement the lagged value of funding cost to explain better how the costs accumulated over time could affect the performance of a financial institution.
  Banks have to pay interests on their deposits. These funding costs, which we define as interest expenses over customer deposits, vary across banks and over time. Overall, what we initially expected is confirmed, banks that are able to raise funds more cheaply than others are considered more profitable.
  In the Italian banking system, it is worth noting that since 2009, the ratio of interest expenses to customer deposit declined, one the one hand because the banks failed to attract sufficient liquidity to depositors, on the other hand as a result of the central bank's monetary policy, reflected in progressively lowering the monetary policy rate.

- DIV_{it}: the empirical results reflect a positive statistically insignificant relationship. As confirmed in the work by Chiorazzo, Milani and Salvini (2008), income diversification increases returns. As highlighted in Chapter 2, lots of changes occurred in the banks' business lines that had a substantial impact on the structure of bank income and composition. The shift toward non-interest revenues is undisputedly recognized as one of the most important factors behind the recovery of Italian banks' profitability.

- EA_{it}: the coefficient of the ratio of total equity to total asset is positive and statistically significant, expressing a direct relationship with the bank's profitability. As outlined above, the capital adequacy ratio is a measure of bank risk and may have an a priori ambiguous effect on bank profitability, given that there are opposite effects at work. In our case, the negative risk effect seems to be over-compensated by the positive safety aspect.
  Better capitalized banks are safer compared to those with lower capital ratios and may face lower costs of funding due to lower prospective bankruptcy costs. Moreover, banks with higher equity-to-asset ratio normally have a reduced need for external funding, which has again a positive effect on bank profitability.

- $CRISK\_L1_{it-1}$: as it is clearly intuitive, the empirical results confirm our expectations; the coefficient is negative and statistically significant at 1% significance level. As made for the funding cost variable, only for these two variables we consider the lagged value since it is more significant understand how the effects of accumulated impaired loans over the years affect the bank profitability of a financial institution.

  This shows that banks with a high credit risk present more reduced profitability levels. The deep and prolonged recession that has hit the Italian economy and lengthy credit recovery procedures have contributed to the high volume of impaired loans in the Italian banking system.

  The level of NPL ratios varies widely across the Euro area, but it remains at rather elevated levels in the majority of countries that were most affected by the financial crisis and this may have constrained credit origination in these countries. The Italian banking system appears to be the one most affected by the phenomenon of NPLs. The share of gross NPLs for the main Italian banking groups was 16.8%, compared with a European average of 5.8% (Bank of Italy, 2015).

- $DEPOSIT_{it}$: this variable has an insignificant and negative impact on bank profitability. This result does not respect our expectations, but we will see later on after implementing some robustness tests that this variable becomes positive as we want.

- GDP_{it}: this variable is an important determinant of the bank profitability, the coefficient is positive and statistically significant, which means that banks profits in this country usually increase in prosperous economic times. International crisis, deteriorating domestic and international economic environment, declining growth have, naturally, a significant negative impact on the profitability of Italian banks. During and after the Great Financial Crises and Sovereign Debt Crises, the GDP growth rate suffered a great decline.

- INF_{it}: as mentioned before the effects of the inflation upon the bank's profitability depend on the capacity of the bank management to forecast the inflation. Our findings reflect, in accordance with the theory that at the level of the banks analyzed, the inflation is not anticipated, so the effect of the inflation upon the banking profitability is negative.

4.2.3. Other diagnostic tests

Now, we go further into the analysis and perform some diagnostic tests to better determine the significance of the Fixed Effects model.

- ***WOOLDRIDGE TEST FOR AUTOCORRELATION:*** To check on serial correlation, namely the correlation between an error and the lagged version of itself in our panel dataset that can cause less efficient estimates, we run the Wooldridge test for autocorrelation in panel data, under the null hypothesis H_0: no first-order autocorrelation, and the results are the following:

$$F(1, 16) = 0.597$$
$$Prob > F = 0.4511$$

  With these results we have to accept the null hypothesis (i.e. H_0: no first-order autocorrelation). Then, to make a more complete analysis, we think it would be better to further investigate the goodness of Fixed Effects model.

- ***MODIFIED WALD TEST:*** We have already performed the Breusch-Pagan test to check on whether the error term variance was constant or not and we ended up with rejecting the null hypothesis, thus identifying a non-constant variance. To be more sure about the outcome, we performed the Modified Wald test for group-wise heteroskedasticity in fixed effect regression model and since the p-value is smaller than 0.05 we reject the null hypothesis ($H_0: \sigma_i^2 = \sigma^2$ for all i) and confirm the heteroskedasticity presence.

The previous diagnostic tests have brought heteroskedasticity issues that cannot be ignored. In fact, in this case, the Fixed Effects model yields some shortcoming that could make the coefficient estimates not consistent.

To bypass such problems, many authors proposed different approaches, like the Feasible Generalized Least Square (FGLS) methods by Parks-Kmenta, or the Panel-Corrected Standard Errors (PCSE) by Beck and Katz, with the final aim of ensuring valid statistical inference.

The characteristics of our dataset have taken us to exclude the first approach since it is typically unfeasible for panels where the cross-sectional dimension N is larger than the time dimension T. It is for this reason that we rely on the regression with Panel-Corrected Standard Errors (PCSE) method which well performs with small panels. This technique is useful when we need to solve this shortcoming of heteroskedasticity (imposing no autocorrelation resulted from the

Wooldridge test), getting consistent and unbiased estimators[4]. The results are summarized in the following Table 11:

Table 11: PCSE estimates using STATA 15 – bank profitability analysis

SIZE	.0140968
FC_L1	-.0005259
DIV	3.111712 *
EA	.1247363 ***
CRISK_L1	-.0877585 ***
DEPOSIT	.007974
GDP	.113963 ***
INF	-.1482265 *
Constant	-1.163936
Observations	221

Source: own elaboration

The results, computed using the PCSE method, are similar to previously discussed findings. The most significant variables are the income diversification (DIV), the capital adequacy (EA), the credit risk (CRISK_L1), the gross domestic product (GDP) and the inflation (INF). All of them are significant at 1%, 5% and 10% significance level.

In conclusion, the new modified model moderately changes the initial findings despite it does not introduce prominent differences. The most significant change concerns the sign of deposits that becomes positive as we initially expected. This is expected, since banks normally should strive to attract more deposits as a source of funds.

[4] We have also performed the robust standard errors (through "*vce robust command*") in order to solve the heteroskedasticity problem, the results obtained are quite similar to these ones.

4.3. Financial stability analysis – Z-score

4.3.1. Descriptive statistics

As we have highlighted in the previous Chapters, in this part we explain the role of financial stability focusing on the individual institution level.

Next, in the following section, since we want to make a more comprehensive analysis about financial stability, we will evidence also the role of systemic risk, i.e. how a single institution contributes to the risk at the system level.

Following the empirical analysis made before, we report the summary statistics of both dependent and independent variables used in our model. This shows observations, mean, standard deviation, minimum and maximum of our sample data.

In this analysis our dependent variable is the Z-score than stands for a proxy of bank stability at individual level.

Table 12: Descriptive statistics – financial stability analysis Z-score

VARIABLE	Obs	Mean	Std. Dev.	Min.	Max.
Z-SCORE	265	14.24606	10.14261	-2.184338	41.34451
ROA	265	.3187452	1.831504	-12.26301	18.25786
SIZE	265	17.13726	1.847532	12.80833	20.75781
FRISK_L1	257	8.02434	3.810505	.4051578	16.8284
DIV_L1	233	.4459775	.0772598	.1162139	.499999983
CRISK	252	10.31262	9.560741	.05	60.07
EA	265	8.443781	5.05377	1.249937	47.23644
LOAN	258	61.93601	19.1941	9.025341	96.74909
GDP	266	-.0381429	1.998181	-5.28	1.791
INF	266	1.415714	1.06074	-.09	3.35

Source: own elaboration

After showing the descriptive statistics in the Table 12, it is useful to provide information on the degree of correlation between the independent variables that are implemented in the multivariate regression analysis.

Table 13: Correlation matrix of the explanatory variables – financial stability analysis Z-score

	ROA	SIZE	FRISK_L1	DIV_L1	CRISK	EA	LOAN	GDP	INF
ROA	1.0000								
SIZE	-0.0459	1.0000							
FRISK_L1	-0.0707	0.3670	1.0000						
DIV_L1	0.1767	0.5099	0.1986	1.0000					
CRISK	-0.4129	0.0242	0.0262	0.0804	1.0000				
EA	0.3062	-0.3192	-0.2725	-0.0881	-0.0348	1.0000			
LOAN	0.0643	0.2137	0.2524	0.3719	0.0876	0.0480	1.0000		
GDP	0.0470	-0.0263	0.0953	0.1490	0.0543	0.1058	-0.0128	1.0000	
INF	0.0501	-0.0457	-0.0730	-0.0310	-0.3772	-0.0966	0.0319	-0.1414	1.0000

Source: own elaboration

From the results obtained in the Table 13, we can show that there is no evidence of multicollinearity since the problem arises when the correlation is above 0.80.

To confirm our empirical results, we run a test to verify the goodness of our variables and we compute the VIF (variance inflation factor) of each predictor, through the software STATA.

As we have previously stated, a VIF of 5 or above is considered enough to demonstrate the existence of multicollinearity problems.

Table 14: Variance Inflation Factor – financial stability analysis Z-score

VARIABLE	VIF	1/VIF
DIV_L1	1.69	0.590639
SIZE	1.66	0.603967
CRISK	1.51	0.662215
ROA	1.48	0.675856
EA	1.35	0.743093
FRISK_L1	1.30	0.771712
LOAN	1.27	0.787559
INF	1.24	0.803414
GDP	1.09	0.914891
MEAN VIF	**1.40**	

Source: own elaboration

From the Table 14, it is possible to shed light on the fact that our values do not exceed 1.69, so we can conclude that there is no possibility of potential biased estimator due to such problematic.

4.3.2. Regression analysis

Our regression equation is structured in the following way:

$$Z - SCORE_{it} = c + \beta_1 ROA_{it} + \beta_2 SIZE_{it} + \beta_3 FRISK\_L1_{it-1} + \beta_4 DIV\_L1_{it-1} + \beta_5 CRISK_{it} + \beta_6 EA_{it} + \beta_7 LOAN_{it} + \beta_8 GDP_{it} + \beta_9 INF_{it} + \mu_{it}$$

The main aim of this second analysis is to point out the impact that certain bank specific determinants and macroeconomic factors have upon the financial stability, at individual bank level.

Going through the analysis made for bank profitability, we apply again a panel regression approach in order to analyse the determinants of financial stability.

Also in this panel regression, the data have been taken in form of unbalanced panel data, collected on yearly frequency.

In the following part, we first determine the coefficients using the pooled OLS method, then the fixed effect and random effect models. The results are indicated in the Table 15, that compares these three different estimation techniques.

Table 15: Summary of coefficient estimates and related significance level – financial stability analysis Z-score

	POOLED OLS	FIXED EFFECTS	RANDOM EFFECTS
ROA	1.098797 **	.4813439 ***	.4551451 ***
SIZE	-1.029335 **	-1.640393 ***	-1.168151 ***
FRISK_L1	1.007919 ***	-.0488639	-.0157907
DIV_L1	9.225031	-6.498623 ***	-6.05039 **
CRISK	-.2459098 ***	-.0223453	-.0227772
EA	.1439354	1.114401 ***	1.08837 ***
LOAN	.1997827	-.0619965	-.0497664

	***	***	***
GDP	-.2010813	.0354153	.0378335
INF	-1.07364 *	-.1571879	-.150225
CONSTANT	9.998074	42.21372	31.46367
OBSERVATIONS	224	224	224
R-SQUARED	0.3453	0.6375	0.6345

Source: own elaboration

As we have already seen, the first column reports the pooled OLS estimates, that it the simplest method estimation used in a panel data analysis.

The results obtained with this technique confirm some of the expected relationships. According to this method, the statistically significant variables at 1% significance level are funding risk (FRISK_L1), credit risk (CRISK) and loans share (LOAN), instead return on assets (ROA) and assets size (SIZE) are significant at 5% significance level, finally the inflation (INF) is significant at 10% significance level. In fact, their p-values are lower than 0.01, 0.05 and 0.1 respectively; moreover, their t-statistic absolute values are higher than 2.58, 1.96 and 1.65 or lower than -2.58, -1.96 and -1.65 confirming our estimates.

In the second column of the Table 15 we have considered the fixed effect model. As it is possible to show from the Table above, the Z-score that represents bank stability is explained very well by the predictor variables. In fact, R-squared within coefficient is equal to 63.75%.

In this analysis, the statistically significant regressors at 1% significance level are return on assets (ROA), assets size (SIZE), income diversification (DIV_L1), capital adequacy (EA) and loans share (LOAN).

All the coefficients analysed are different from zero emphasizing the significance of the model, anyway the same result can be achieved through a joint F-test on regressors. The outcome given by STATA is the following:

$$F(9,197) = 38.49. \qquad Prob > F = 0.0000$$

which shows the significance of the model estimates.

Finally, in the third column it is possible to implement the Random Effects model through which it is possible to investigate time-invariant components embedded in the dependent

variables. Analysing the Table 15 (third column), the information provided is quite similar with the results borne by the previous model. As it can be easily noticed, the Z-score is again well explained by the predictor variables, as 63.45% of total sample variation is caught by the model, according to the R-squared coefficient.

The statistically significant variables are the same obtained from the fixed effects: return on assets (ROA), asset size (SIZE), income diversification (DIV_L1), capital adequacy (EA) and loans share (LOAN).

After making this brief analysis of the main results obtained from each technique, we have to make the same tests used in the *bank profitability analysis*.

We need to make some tests in order to identify the most appropriate inferences like the Hausman test that determines the best model between Fixed Effects and Random Effects models and then the Breusch-Pagan test which compares pooled OLS with Random Effects model.

1. **HAUSMAN TEST:** The null hypothesis states that the preferred model is Random Effects versus the alternative which is the Fixed Effects.

   If the Hausman test leads us to reject the null hypothesis, we have to choose the Fixed Effects models, on the contrary if we fail to reject the null, the RE is deemed to be the most suitable.

Table 16: Hausman test – financial stability analysis Z-score

	Coefficients (b) fe	(B) re	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
ROA	.4813439	.4551451	.0261988	.
SIZE	-1.640393	-1.168151	-.4722413	.0971742
FRISK_L1	-.0488639	-.0157907	-.0330732	.
DIV_L1	-6.498623	-6.05039	-.4482326	.
CRISK	-.0223453	-.0227772	.0004319	.
EA	1.114401	1.08837	.0260305	.
LOAN	-.0619965	-.0497664	-.0122301	.
GDP	.0354153	.0378335	-.0024182	.
INF	-.1571879	-.150225	-.0069628	.

b = consistent under Ho and Ha; obtained from xtreg
B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(9) = (b-B)'[(V_b-V_B)^(-1)](b-B)
= 23.06
Prob>chi2 = 0.0061
(V_b-V_B is not positive definite)

Source: own elaboration

Also in this case, looking Table 16, since our p-value is lower than 0.05 we have to reject the null hypothesis and for this reason the Fixed Effects model is the most suitable for our analysis.

2. **BREUSCH-PAGAN TEST:** again in this case, in order to make sure that we can completely exclude pooled OLS estimates from our analysis, we decided to perform the Breusch-Pagan Lagrangian Multiplier test. We have to run this test to determine if to use the pooled OLS or the random effects model. The null supports the goodness of the pooled OLS method. The result is the following:

Table 17: Breusch and Pagan test – financial stability analysis Z-score

Breusch and Pagan Lagrangian multiplier test for random effects

ZSCORE[BANKNUM,t] = Xb + u[BANKNUM] + e[BANKNUM,t]

Estimated results:

	Var	sd = sqrt(Var)
ZSCORE	113.4354	10.65061
e	2.812808	1.677143
u	72.72904	8.528132

Test: Var(u) = 0

chibar2(01) = 906.03

Prob > chibar2 = 0.0000

Source: own elaboration

According to the results showed in the Table 17, with p-value equal to 0.0000, we have to reject the null hypothesis, confirming in this way the presence of a panel effect that makes the Random Effect model the most suitable between the two considered in the test.

Concluding, we can say that our analysis about financial stability at individual level have driven us to choose the Fixed Effects model as the most fitting and appropriate to capture the main issues we wanted to investigate. This study uses Z-score to proxy bank stability at individual level. Then, we continue our analysis using Fixed Effect (FE) model.
The economic implications of each variable are explained below:

- ROA_{it}: as expected, we found a positive relationship between bank profitability and stability. As the financial stability of a bank increases, this reflects a positive movement into its bank profitability. This is understandable because, all things being equal, increasing profits would mean more funds for the bank to meet contingencies. High profitability has

been linked to high stability in the banking industry because if profits do not flow out to shareholders as dividends, they become part of equity capital which strengthen the capital base of the banks leading to an improvement in bank stability.

This relationship is clearly intuitive and significant at 1% significance level, highlighting the importance and interconnection that there is between bank profitability and financial stability, which is one of the main goals of this analysis.

- $SIZE_{it}$: for what concerned this variable, past literature is limited to determine the size-stability relationship. Some studies report a negative relationship between them; on the other hand, others found a positive effect of bank size on stability. According to Table 15 (second column), our analysis suggests that bank size has a negative and significant impact on stability, which is supported by the assumptions of agency theory (bank size has an adverse effect on stability).

- $FRISK\_L1_{it-1}$: our estimates indicate a negative and insignificant relationship between funding risk and stability, that does not respect our expectations. This result will change after running the diagnostic tests.

  In order to develop a more significant model, we need to lag this variable and capture its importance in the previous years.

- DIV_L1_{it-1}: also for this variable, we have used its lagged value, since it explains better its impact on financial stability. As expected, we obtain a negative and significant coefficient of income diversification.

  This is coherent with the results obtained in the first analysis, since higher income diversification leads higher bank profitability and returns but at the same time increase the volatility of the returns, reducing in this way the bank stability at individual level. This is the classical trade-off analysed in economy between risk and return.

- $CRISK_{it}$: as it is clearly intuitive, the negative relationship confirms what we initially expected. Credit risk plays an important role in the financial stability and in the bank's default probability. An increase in the impaired loans leads to a deterioration of the individual bank stability.

- EA_{it}: this ratio is mainly used to assess a company's financial leverage. The higher the equity-to-asset ratio, the less leveraged the company is, meaning that a larger percentage of

its assets are owned by the company and its investors. The result shows a positive a significant coefficient at 1% significance level, confirming what we expect.

- $LOAN_{it}$: the result of this coefficient follows what we expect, it is negative and statistically significant at 1% significance level. In fact, the higher the ratio, the riskier a bank may be to higher defaults.

- GDP_{it}: this sign is aligned with our expectation, the relationship is insignificant but positive. Clearly, an increase in the GDP growth rate leads to an increase in the bank stability, these two variables are necessarily directly proportional.

- INF_{it}: the result shows a negative and insignificant relationship between bank stability at individual level and inflation rate.

4.3.3. Other diagnostic tests

As previously done, we go further in the analysis and perform some diagnostic tests to better estimate the significance of the Fixed Effects model, which is the most appropriate in our analysis.

- **WOOLDRIDGE TEST FOR AUTOCORRELATION:** To check on serial correlation, we run Wooldridge test for autocorrelation in panel data, under the null hypothesis H_0: no first-order autocorrelation, and the results are the following:

$$F(1,17) = 24.345$$
$$Prob > F = 0.0001$$

With these results we have to reject the null hypothesis. As a consequence, we think it would be better to further investigate the goodness of Fixed Effects model, in order to be sure that serial correlation does not produce considerably different estimates change.

- **MODIFIED WALD TEST:** As previously done, in order to check for heteroskedasticity, we need to implement the modified Wald test for group-wise heteroskedasticity in Fixed

Effects regression model. The resulting p-value is 0.0000 which reject the null hypothesis since is lower than 0.05 and confirms the presence of heteroskedasticity problem.

The previous diagnostic tests have brought autocorrelation and heteroskedasticity issued that cannot be erroneously ignored. In order to correct these shortcomings of the Fixed Effects model, we implement the Prais-Winsten regression (PCSE) which well performs with small panels. This technique is useful when a certain degree of correlation and heteroskedasticity is ascertained. The results are summarized in the following Table 18:

Table 18: PCSE estimates using STATA 15 – financial stability analysis Z-score

ROA	.6544147 ***
SIZE	.9906104 ***
FRISK_L1	.4648449 ***
DIV_L1	-5.804933 *
CRISK	-.0858363 **
EA	.9368385 ***
LOAN	-.036074 *
GDP	.0069796
INF	-.2494671
Constant	-14.75088
Observations	224

Source: own elaboration

Also in this case, we can highlight that the results obtained using the PCSE method are quite similar to what we have obtained in the previous analysis.

The R-squared equal to 66.24% shows a high degree of variability explained by the model.

The most significant variables are return on assets (ROA), assets size (SIZE), funding risk (FRISK_L1), income diversification (DIV_L1), credit risk (CRISK), capital adequacy (EA) and loans share (LOAN).

The most important change concerns the sign of funding risk, which now is corrected with our initial expectation.
The coefficient of funding risk (FRISK_L1) is become significant but no longer negative, confirming our expectations. The positive relationship submits that customer deposits are efficiently mobilized by the banks in Italy to attain higher stability. The implication is that a bank that shows consistency in its effective deposit mobilization strategy is more likely to be stable than its counterparts.

Concluding, the new modified model moderately changes the initial findings despite it does not introduce some significant differences wrt the previous analysis.

4.4. Financial stability analysis – $\Delta CoVaR$

4.4.1. $\Delta CoVaR$ estimation

Before concluding our empirical research with the last multivariate regression model focusing on the financial stability at system level, we need to determine our systemic measure $\Delta CoVaR$.

Many studies have been carried out by several researchers trying to measure the transmittable effect of a single firm distress situation to the system and to understand if these measures could have predicted the financial crisis and ex-post if they could have been useful to policymakers to implement the regulations.
The definition of Systemic Risk, takes into account not only the risk associated to a single firm, but also the risk of the whole economy; Billio et al., (2012) gives a definition for systemic risk, which is "any set of circumstances that threatens the stability of or public confidence in the financial system".

Value-at-Risk measures the risk level of an individual institution and does not reflect the risk of the financial system as a whole. For this reason it cannot be used for systemic risk analysis. Adrian and Brunnermeier (2011) define the CoVaR as systemic risk measure.
These researchers determine CoVaR to avoid the problems caused by the VaR and attempt to catch the single firm contribution to the risk of the financial sector. In the definition of the CoVaR "*Co*" stands for the conditional and sounds like covariance because it is a conditional VaR and has different characteristics in common with covariance. In particular, as VaR is commensurate to variance, CoVaR is proportional to covariance.
VaR can be described as the probability of a return to be less than a fixed q quantile of the distribution, that is:

$$\Pr\left(X_i \leq VaR_i^q\right) = q,$$

where X_i is the return of the i^{th} asset and $1 - q$ is the significance level of the VaR.

Following Adrian and Brunnermeier (2011), we define with $A_t^i = MC_t^i L_t^i$ the market value of the total assets of bank *i* at time *t*, where MC_t^i is the bank's market capitalization and L_t^i the bank's asset-to-equity ratio (the leverage ratio).
We define the growth rate of market valued total assets of bank *i* using data available in the market, in this way:

$$X_t^i = \frac{Assets_t^i - Assets_{t-1}^i}{Assets_{t-1}^i}$$

Subscript "sys" denotes the entire financial system, i.e. the set of all the banks in our sample. Note that the Italian banking system is well represented by the set of listed banks that includes most existing banks. The growth rate of market valued total assets of the financial system X_t^{sys} is computed as the average market valued asset returns weighted by lagged market valued total assets.

CoVaR can be defined as the probability that the return of an institution *j* is less than the *q* quantile of the distribution conditioned on an event, *C*, which involves the return of another institution *i*. Note that the institution *j* can also represent the whole system, as in our case.
The CoVaR can be written as:

$$\Pr\left(X^j \leq CoVaR_q^{j|C(X^i)} \middle| C(X^i)\right) = q$$

where X^j is the return of j^{th} institution, X^i is the return of i^{th} institution and q is the significance level that the researcher fixed.
Note that q represents the conditional probability that X^j is less than CoVaR.
It does not depend on the strategy of the management of the i^{th} company. The CoVaR is an endogenous risk measure, because it is based on the risk that other institutions take. Since the CoVaR is a conditioned measure of the return distribution, it identifies terminal values of the tail more extreme than the unconditional tail values found with VaR.
Considering two institutions *i* and *j*, through CoVaR we can measure the spillover effect on the institution *j* caused by an event *C* that involves the institution *i*. This outcome could be caused by interconnections among institutions, like contractual links or due to the fact that these companies have the same stockholders control or the same market target. Note that higher is the CoVaR, more is the effect of the institution *i* on the institution *j*.
Evidently it cannot be a symmetric measure, because it is different conditioning an institution to *i* instead to *j*, hence is:

$$CoVaR_q^{\left(j|C(X^i)\right)} \neq CoVaR_q^{\left(i|C(X^j)\right)}.$$

If we suppose that *j* is the whole financial system and that the return of the financial institution *i* could be distressed, through CoVaR we will estimate the effect on the whole system of a crunch situation of the individual firm. On the other hand, if we suppose that *i* is the whole system and *j* is the single institution we will obtain the effect on the return of an individual

institution caused by a financial system crunch, allowing to sort by the riskiness contribution each institution.

$\Delta CoVaR$ is obtained by difference between the CoVaR of an institution *j* when the *i* one is distressed and the CoVaR of the institution *j* evaluated when the institution *i* is on a median situation, that is:

$$\Delta CoVaR_q^{(j|i)} = CoVaR_q^{\left(j\middle|X^i\right)=VaR_q^i} - CoVaR_q^{\left(j\middle|X^i\right)=Median^i}$$

$\Delta CoVaR$ represents the increase in the VaR of each institution *j*, when there is a crunch in *i* respect to a median situation, *i* and *j* could be either individual companies or *j* could be the whole financial system.

To evaluate CoVaR we will use a quantile approach, instead of other method like time-varying second moments, because it is simple and efficient to analyze empirical data, we consider that:

$$\widehat{X_q^{(system|\imath)}} = \widehat{\alpha_q^i} + \widehat{\beta_q^i} X^i$$

where $X_q^{(system|i)}$ are the expected values of the system of a quantile regression conditioned to the institution *i*.

Through the definition of VaR we can obtain, if the CoVaR is constant over time:

$$\left(VaR_q^{system}\middle|X^i\right) = \widehat{X_q^{(system|\imath)}}$$

$$CoVaR_q^{\left(system\middle|X^i = VaR_q^i\right)} \coloneqq \left(\widehat{VaR_q^{system}}\middle|VaR_q^i\right) = \widehat{\alpha_q^i} + \widehat{\beta_q^i} VaR_q^i$$

$$\Delta CoVaR_q^{(system|i)} = \widehat{\beta_q^i}(VaR_q^i - VaR_{50\%}^i)$$

If CoVaR is not constant over time, we have to be able to catch its variation introducing externalities that can explain the variability.

Up to now, it is presented a methodology for estimating $\Delta CoVaR$ that is constant over time. To capture time-variation in the joint distribution of X^{system} and X^i, we estimate $VaRs$ and $\Delta CoVaRs$ as a function of state variables, allowing in this way to model the evolution of the joint distributions over time. Indicating time-varying $CoVaR_{q,t}^i$ and $VaR_{q,t}^i$ with a subscript *t,* and estimate the time variation conditional on a vector of lagged state variables M_{t-1}.

Conditional estimates are function of state variables, allowing for time-variation in the risk estimates. In order to compute the conditional estimates, we separately regress asset return for each bank *i* and for the system on a number of state variables included in the matrix *M* for the 1% quantile. State variables proxy the state of the economy.

Following Adrian and Brunnermeier (2011), they estimate the following quantile regressions on weekly data (in our code we implement daily data since the code on MATLAB required that type of frequency data):

$$X_t^i = \alpha_q^i + \gamma_q^i M_{t-1} + \varepsilon_{q,t}^i,$$

$$X_t^{system|i} = \alpha_q^{system|i} + \gamma_q^{system|i} M_{t-1} + \beta_q^{system|i} X_t^i + \varepsilon_{q,t}^{system|i}$$

The predicted values from the quantile regressions correspond to the VaR and the CoVaR of bank *i* as follows:

$$VaR_{q,t}^i = \hat{\alpha}_q^i + \hat{\gamma}_q^i M_{t-1},$$

$$CoVaR_{q,t}^i = \hat{\alpha}_q^{system|i} + \hat{\gamma}_q^{system|i} M_{t-1} + \hat{\beta}_q^{system|i} VaR_{q,t}^i.$$

Finally, we compute $\Delta CoVaR_{q,t}^i = CoVaR_{q,t}^i - CoVaR_{50,t}^i$

$$= \hat{\beta}_q^{system|i}\left(VaR_{q,t}^i - VaR_{50,t}^i\right).$$

To assess $\Delta CoVaR$ we have firstly to estimate CoVaR. We choose quantile[5] regression estimation for CoVaR, despite of conditional volatility models such as GARCH, because these lasts require several assumptions on return distribution and are difficult to estimate.
Adrian and Brunnermeier have tested both methods, reached to the conclusion that the results of two methods are similar and hence we could consider the quantile approach as a robust method to estimate CoVaR.
Considering that $\Delta CoVaR$ is the difference between CoVaR determined in a distress situation and the median one, we first evaluate CoVaR of the institution in the median and distress situation using the quantile regression.

For this empirical work, we have used the software MATLAB, adapting the code of Tommaso Belluzzo that is available online and creating an appropriate dataset for our purpose.
Bank of Italy has identified UniCredit, Intesa Sanpaolo and Banco BPM banking groups as other systematically important institutions (O-SIIs) authorized to operate in Italy in 2019.

Before starting with the empirical analysis, in this part we provide a description of the data implemented in the evaluation of $\Delta CoVaR$. We obtained from Thomson Reuters Datastream

[5] Bassett and Koenker (1978) are the first to derive statistical properties of quantile regressions.

some important factors, using a daily frequency (excluding assets and equity data), from 2006 through 2019:

a. Market capitalizations: focusing on the Italian case, we consider MV of all Italian banks taken into account in our sample;
b. Returns of Italian banks considered in our sample;
c. Book value of assets and book value of equity with yearly frequency;
d. Then, similarly to Adrian and Brunnermeier (2011), a set of state variables (or factors) are considered to estimate the $\Delta CoVaR$ of Italian banks through the quantile regression method:
    - EBF EURIBOR 3M DELAYED stands for the change in the 2-year Italian government bond yields to which we refer to as short term yield;
    - the market return, that is the FTSE MIB (Euro Stoxx) Index return, to which we refer to as market returns;
    - the equity volatility, that is the implied volatility index on the Euro Stoxx 50, to which we refer to as equity volatility;
    - IBOXX Corporate Index includes corporate bonds issued by European corporations. We use this index since we could not find a similar specialized on the Italian corporate bond market.
    - The short-term EuriborOIS spread, that is the difference between the 3-month Euribor rate and 3-month overnight indexed swap (OIS) rate.

The choice of these state variables is made analyzing the literature review about this topic, mainly focusing on the empirical works made by Borri et al.[6], (2013) and Bianchi and Sorrentino (2019).

[6] We have also tried to consider the VDAX as new volatility index in the stock market and we have obtained quite similar results. We have used a German state variable due to the lack of the Italian state variable. This is a reasonable assumption due to the spillover effect of Germany on the rest of Europe, in particularly of Italy.

Figure 9: Delta CoVaR Time Series, 2006-2019 (respectively UniCredit, Intesa Sanpaolo and Banco BPM)

Source: own elaboration using MATLAB

Moreover, UniCredit and Intesa Sanpaolo are also considered global systematically important banks (GSIBs), as highlighted in the Figure 9.

Interpreting these figures we read the $\Delta CoVaR$ measure as a positive values, in reality the sign of $\Delta CoVaR$ measure is clearly negative, but the researcher that have created the code changes the sign into a positive one only for a better and easy understanding.

4.4.2. Descriptive statistics

In this final section, we complete our analysis of financial stability considering also the contribution of an individual financial institution at the system level.

We start our third empirical analysis with a summary statistics of the main dependent and independent variables.

We estimate our dependent variable with $\Delta CoVaR$, that measures the systemic risk of our sample of Italian banks over the time span from 2006 to 2019.

The following Table 19 summarizes the descriptive statistics of our variables.

Table 19: Descriptive statistics – financial stability analysis $\Delta CoVaR$

VARIABLE	Obs.	Mean	Std. Dev.	Min.	Max.
DeltaCoVaR	265	-.0123734	.0059614	-.0336638	-.0011002
ZSCORE	265	14.24606	10.14261	-2.184338	41.34451
ROA	265	.3187452	1.831504	-12.26301	18.25786
SIZE	265	17.13726	1.847532	12.80833	20.75781
CRISK	252	10.31262	9.560741	.05	60.07
DIV	236	.442423	.0870914	.1162139	.499999983
VaR	265	-.0364114	.0129425	-.1128995	-.0132177
EA	265	8.443781	5.05377	1.249937	47.23644
GDP_L1	265	-.0394189	2.001853	-5.28	1.791

Source: own elaboration

As previously made for all the analysis, it is helpful to evaluate the correlation level between sets of variables. It can be done with a correlation matrix that uses the Pearson coefficient.

Table 20: Correlation matrix of the explanatory variables – financial stability analysis $\Delta CoVaR$

	ZSCORE	ROA	SIZE	CRISK	DIV	VaR	EA	GDP
ZSCORE	1.0000							
ROA	0.2520	1.0000						
SIZE	0.0558	-0.0456	1.0000					
CRISK	-0.2135	-0.4151	0.0298	1.0000				
DIV	0.1906	0.1054	0.5098	0.0526	1.0000			
VaR	0.3161	0.4192	-0.3381	-0.4051	-0.1793	1.0000		
EA	0.0095	0.3076	-0.3601	-0.0559	-0.1786	0.2454	1.0000	
GDP_L1	0.0146	0.0175	-0.0128	-0.0704	-0.0623	-0.1133	0.0644	1.0000

Source: own elaboration

The Table 20 illustrates that there are some cases of strong, but not perfect, positive or negative correlation that might create multicollinearity issues and might produce biased estimators with

large standard errors. Even if the Pearson's correlation coefficient provides an easy way to detect the presence and the severity of multicollinearity, we need also to run a test to verify the goodness of our variables and we compute the VIF of each predictor, always with the software STATA.

Table 21: Variance Inflation Factor – financial stability analysis $\Delta CoVaR$

VARIABLE	VIF	1/VIF
SIZE	1.72	0.579873
VaR	1.63	0.612725
CRISK	1.55	0.646113
ROA	1.47	0.680868
DIV	1.38	0.723645
EA	1.29	0.773749
ZSCORE	1.22	0.819441
GDP_L1	1.06	0.940203
Mean VIF	**1.42**	

Source: own elaboration

As we can see in the Table 21, values do not exceed 1.72, leaving out the possibility of potential biased estimators due to such problematic.

4.4.3. Regression analysis

To study the aforementioned phenomenon, the baseline multivariate regression equation is the following one:

$$\Delta CoVaR_{it} = \beta_1 ZSCORE_{it} + \beta_2 ROA_{it} + \beta_3 SIZE_{it} + \beta_4 CRISK_{it} + \beta_5 DIV_{it} + \beta_6 VaR_{it} + \beta_7 EA_{it} + \beta_8 GDP\_L1_{it-1} + \mu_{it}$$

We implement a panel regression analysis in which the individual bank *i*'s contribution to systemic risk in year *t* is regressed on the independent variables.
After making the same analysis performed previously: pooled OLS, Fixed and Random Effects models, then Hausman and Breusch-Pagan test, we carry out a number of robustness tests to

better infer the most fitting model able to describe how certain determinants affect the financial stability at system level through the $\Delta CoVaR$.

The Hausman test accepts the null hypothesis, so the Random Effects model is the most suitable, then the Breusch-Pagan test confirmed that Random Effects is better than pooled OLS method. Finally, we need to control for autocorrelation and heteroskedasticity problems, obtaining that there is no autocorrelation but heteroskedasticity problem.

For this reason, as previously performed, we employ a PCSEs (Panel Corrected Standard Errors) regression that help us to correct and performs better estimates, correcting for heteroskedasticity problem.

The Table 22 shows the final estimates of our panel regression:

Table 22: PCSE estimates using STATA 15 – financial stability analysis $\Delta CoVaR$

ZSCORE	-.0001265 ***
ROA	-.0004328 **
SIZE	.0016632 ***
CRISK	.0001643 ***
DIV	.0004842
VaR	.2710592 ***
EA	-.0000831
GDP_L1	-.0000165
Constant	.0269911
Observations	225
R-squared	0.6688

Source: own elaboration

As we can highlight from these results, the most important variables are significant at 1% and 5% significance level such as: bank stability (ZSCORE), bank profitability (ROA), asset size (SIZE), credit risk (CRISK) and Value at Risk (VaR).

In addition, the high R-squared equal to 66.88% shows a high degree of variability explained by the model.

The results for each independent variable, and their economic implications, according to the PCSE regression, are reported below.

- $ZSCORE_{it}$: as it is clearly intuitive, the relationship between the systemic risk and the variable that is used as proxy for financial stability at individual level is significant at 1% significance level and negative. This confirmed what we expect, as financial stability of a bank increases, its contribution to systemic risk decreases.

- ROA_{it}: the coefficient is clearly negative and significant at 5% significance level, showing that a high operating profit margin can reduce systemic risk since it shields banks from defaulting. Empirical results reveal that profitability (ROA) is negatively associated with banks' contribution to systemic risk. As firm's current book profitability improves, their contribution to systemic risk tend to decline.

  One intuitive explanation for this finding is that, as banks' profitability increases, they engage in less-risk taking at the individual bank level, and thereby reducing their systemic risk contribution.

- $SIZE_{it}$: the impact of size on systemic risk is increasing and the result obtained confirmed our expectation. We have a positive and significant result at 1% significance level.

  Larger size implies greater systemic importance, that the contribution to system-wide risk increases more than proportionately with relative size, and that a positive relationship between size and systemic importance is a robust result.

- $CRISK_{it}$: as explained above, the credit risk is the ratio between impaired loans and gross loans. The coefficient obtained from this analysis is obviously positive and significant at 1% significance level.

  The growth of credit and the easy access to financing observed before the subprime crisis could have increased substantially the role of this variable as a significant determinant of bank's contribution to systemic risk.

  A great increase in the impaired loans could leads to a subsequent increase in the systemic risk, since banks have collected lots of deteriorated loans that make them more exposed to systemic risk. In this way, an increase in the credit risk reduces the financial stability measured at system level.

- DIV_{it}: the result shows that non-traditional activities (i.e. trading and securitization, investment banks, brokerage or advisory activities) has a positive contribution to systemic risk. Our results followed DeYoung and Roland (2001), they find that banks non-traditional sources of income increase revenue volatility and consequently increase the systemic risk, reducing the financial stability at system level.

- VaR_{it}: on the most important variable to analyse in relation with the systemic risk is the Value at Risk (i.e. idiosyncratic risk of an individual financial institution). As expected the VaR of a bank contributes positively to the systemic risk at 1% significance level.
  As VaR increases, the financial stability at system level increases as well, more than proportionally. Riskier banks contribute more to systemic risk.

- EA_{it}: the relationship obtained between capital adequacy and systemic risk is negative, demonstrating that the systemic risk is lower for the banks with high capital adequacy ratios. This result supports the hypothesis that a well-capitalized bank finds it costlier to take on high risk, and it underscores that high capital adequacy indicates a capital buffer against the profitability of a bank's failure.

- GDP_L1_{it-1}: for this variable we consider its lagged value, the intuition behind this assumption is that an increase in the economic growth of Italy contributes to decrease its systemic risk. Economic activity and financial stability typically exhibit a positive relationship. In the event of an economic downturn, borrowers may fail to meet loan repayment obligation that can ultimately lead to a systemic failure of the banks. Moreover, economic growth improves the quality of the loan portfolio, decreasing the ratio of non-performing loans to total loans, which leads to a lower systemic risk.

Conclusion

After the theoretical introduction regarding bank profitability and financial stability, we have made an overview about the Italian Banking System, since our empirical analysis is focused on the Italian case. Finally, after presenting the literature review about them, we proceeded with the core of our work: analyzing the impact of certain internal and external determinants that affect bank profitability and financial stability.

It is generally agreed that a strong and healthy financial system is a prerequisite for the sustainable economic growth of a given country. In order to survive negative shocks and maintain a good financial stability, it is important to identify the determinants that mostly influence the overall performance and profitability of banks.

For that matter, the analysis made specifies the empirical framework to investigate the effect of bank specific and macroeconomic variables upon bank profitability and financial stability of Italian banks for the following period 2006-2019.

For the financial stability analysis, in order to make a more complete overview, we have considered the idiosyncratic and systemic dimension, since the risk related to the entire system cannot be considered at the individual level due to its endogenous nature.

The individual dimension is assessed with the Z-score measure, which stands for bank stability. Then, we estimate the contribution to systemic risk of Italian banks using $\Delta CoVaR$ which is a market-based measure to assess the contribution of a single bank to the systemic risk. This measure could be useful to control the dynamics of the systemic risk as perceived by the market. $\Delta CoVaR$ measures the contribution of bank i to the financial system VaR when bank i is in a state of distress. We define "system" as the set of all Italian banks considered in our sample. We find that the information contained in $\Delta CoVaR$ is different from that contained in VaR. Therefore, regulators should take it into account in order to monitor the systemic risk posed by banks. Finally, we conclude that $\Delta CoVaR$ is a very useful policy tool for regulators that can estimate which factors are more relevant in terms of contribution to systemic risk. Moreover, since our conditional measure of systemic risk is time varying and affected by market-based risk factors, macro prudential regulation and banking should also look at information provided by financial markets.

The econometric analysis, introduced and deepened in Chapter 4, provided an interesting insight into the determinants that affect bank profitability and then financial stability.

For each analysis implemented, we obtained the pooled OLS estimates, to have a general picture of relationships we wanted to characterize; then we proceeded with the performance of

the models usually used for a panel data analysis; Fixed Effects and Random Effects models. At the end, after the performance of some important robustness tests, we considered appropriate to take the Fixed Effect model for the first two analysis and the Random Effect for the last one. Despite this, diagnostic tests arose some issued connected to heteroskedasticity and autocorrelation between errors, producing potentially biased estimates; to overcome these problems, a Panel Corrected Standard Errors (PCSE) model was used and generally it delivered results consistent with what we obtained in the previous analysis.

Then, after conducting three separate analysis for respectively, bank profitability, financial stability at individual level and financial stability at system level, we wanted to investigate the relationship between bank profitability and financial stability.

The empirical results that we have obtained confirm the findings highlighted in the literature review. First, profitability (ROA) is positively associated to bank stability measured by Z-score and negatively associated to contribution to the systemic risk measured by $\Delta CoVaR$. As bank's current book profitability improves, their contribution to systemic risk tend to decline. One possible explanation of this result is that, as banks' profitability increases, they engage in less risk-taking activities at the individual level, increasing the bank stability, and thereby reducing their systemic risk contribution. Then, as expected, high funding costs are associated with lower profitability, which follows directly from the accounting relationship of bank profits and losses. Second, a high value of income diversification tends to be associated with higher bank profitability, lower bank stability and higher contribution to systemic risk. In particular, over the last two decades, banks have diversified their operations all around the world including Italy. From our results, we found that income diversification increases the bank profitability of the Italian banks. Income diversification is creating pool of modern banking revenue sources along with the traditional banking activities for sound financial performance of the banks. Income diversification in banking sector refers to increasing shares of fees, net trading profits, exchange incomes, commission and charges, and other non-interest income within net operating income of a bank. An important source of diversification for the banks is considered as non-interest incomes. Depending on the results of our ROA model, we can imply that Italian banks benefit from diversifying their activities beyond the traditional lending activities. But at the same time, this benefit leads to more idiosyncratic and systemic risk that is naturally embedded into the non-interest income activities.

Third, as highlighted in each analysis, the credit risk variable, that is the ratio of impaired loans to gross loans, decreases bank profitability and bank stability of Italian banks, and clearly increases their systemic risk. As we have noticed in Chapter 2, the double-dip recession that has hit Italy between 2008 and 2014 severely impaired Italian banks' balance sheet and loan

quality. Consequently, in order to increase their profitability, banks should be careful with the quality of the loans they grant.

Finally, consistent with the literature, a more favorable macroeconomic environment is associated with higher profitability and bank stability, and lower systemic risk, as we have obtained from our results.

All things considered in our analysis are coherent with the literature review analyzed, as far as our models try to explain in a simplified way a more complex phenomenon, which is the relationship between bank profitability and financial stability.

In particular, this analysis is considered a more complete analysis about the Italian Banking System, since does not take into account only bank profitability or financial stability, but both of them, showing that bank profitability matters for financial stability.

In the end, we can conclude that the main aim of our analysis has been met, leading interesting insights and findings of Italian Banking System.

Appendix 1: List of Tables

Appendix 2: List of Figures

Appendix 3: List of Italian banks in our sample

NAME	TICKER	mCap
UniCredit SPA	I:UCG	18,533
Intesa Sanpaolo	I:ISP	30,313
Monte dei Paschi di Siena	I:BMPS	44,802
Unione di Banche Italiane	I:UBI	3,479
Mediobanca	I:MB	5,836
BPER Banca SPA	I:BPE	1,118
Banca Mediolanum SPA	I:BMED	4,644
Credito Emiliano SPA	I:CE	1,436
Banca Popolare di Sondrio	I:BPSO	841,484
Credito Valtellinese	I:CVAL	388,629
Banca Carige SPA	I:CRG	82,899
Banca di Desio e della Brianza	I:BDB	257,400
Banca Ifis SPA	I:IF	480,264
Banco di Sardegna	I:BSRP	57,156
Banca Profilo SPA	I:PRO	135,193
Banca Intermobiliare	I:BIM	65,459
Banca Generali	I:BANC	2,998
Banca Finnat EuroAmerica	I:BFE	84,188
Banco BPM SPA	I:BP	1,983

For each bank, the market capitalization (mCap) is also reported in million Euro. (Data obtained from Bankscope)

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