# UNIVERSITA' DEGLI STUDI DI PADOVA

**DIPARTIMENTO DI SCIENZE ECONOMICHE ED AZIENDALI "M.FANNO"**

**CORSO DI LAUREA MAGISTRALE IN ECONOMICS AND FINANCE**

**TESI DI LAUREA**

## ANALYSIS AND IMPACT OF STRESS TEST ON EUROPEAN BANKING MARKET

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**MATRICOLA N. 1106402**

**ANNO ACCADEMICO 2015 – 2016**

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*Vorrei dedicare il presente lavoro*
*alla mia famiglia e al mio ragazzo Rocco.*
*Desidero ringraziarli per avermi sempre sostenuta*
*ed essere stati sempre al mio fianco.*

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# INTRODUCTION

The recent financial crisis has shown how the banking system has become an increasingly dynamic and complex field. Since then, the global financial system was hit by deep turmoil and all the major economies have been affected by high volatility of the financial markets. The deterioration in the value of portfolios has impacted on bank balance sheets, due to the consideration of risks previously underestimated.

In this contest, the stress test has become an integral part of macro-prudential regulation; the aim is to create a quantitative tool in the analysis of financial sector stability. Supervisors and Central Banks have the responsibilities to ensure a stable and efficient financial system. In an attempt to restore confidence among investors and depositors, from 2009 to 2016 the Committee of European Banking Supervisors (CEBS), at the beginning, and the European Banking Authority (EBA), from 2011, performed a series of tests of financial soundness on a sample of European banks in order to gauge their capital needs.

The focus of this thesis is on the European stress test and how they are became a key to quantify the resilience and transparency of financial institutions. The resilience is measure in term of capital requirement after the application of the baseline and adverse scenario, it is important to choose plausible scenarios, especially for the extreme shocks. The transparency is another important theme; the banking sector is not entirely transparent due to difficulty in valuing certain assets, especially assets without reference market.

The work wants to verify empirically this objective of transparency, analyzing in detail the stress test of 2014 conducting by EBA and the impact of the exercise on the market; there are six event date, from the announcement to the results, passing from methodology and templates; the EBA wants to publish all results in detail, so that the investors are able to measure the risk and in this way rebuild trust in the banking market, knowing whar are the strong and weak financial institution.

The work is divided into four chapters. The first chapter will declare the utility and importance of stress test; what are the methods to build a stress test, a comparison between the sensitivity and scenario analysis, and the difference between bottom-up and top-down approaches; it will be a list and explanation of all stress test carried out in Europe and a comparison with US stress test.

The second chapter will explain the techniques used to stress the major risks at which banks are exposed, focusing in particular on credit risk, market and liquidity risk. For each risk will

be provided the description and the models used to measure them; for example for the credit risks, there are two different approaches, the Standardize approach and Internal Rating-based approach with a particular focus on a Satellite model called KMV. For the market risk it is explained the Value at Risk (VaR) and a focus on Monte Carlo Simulation as method to measure it. At the end about liquidity risk the model chosen is Liquidity-adjusted Var (L-VaR)

The third chapter will explain in detail the stress test conducted by the EBA during 2014, will describe the baseline and adverse scenario adopted, how the main variables (GDP, unemployment and inflation) change and the related capital requirements. It will illustrate the results published on 26 October 2014 and the restructuring plans approved by the European Central Bank for stressed banks who failed the exercise.

The fourth chapter will describe the empirical analysis that was implemented to study the market reaction to the event of the stress test. It will be initially explained the concept of bank's opacity to test if indeed the banking sector is more opaque than others. For the empirical analysis will be used the event study, widely used in various areas. The work will describe the model in detail and then will be applied to all the event dates. The event study is applied for the total sample of banks and then applied for a determinate geographic area. At the end there is the statistical and economic interpretation of results.

The result obtained will permit to conclude if the stress test of 2014 had a significant impact on the market and if has changed the expectations of investors, in this way the stress test became a tool to increase transparency of banking system.

# CHAPTER I
# MAIN FEATURES AND OBJECTIVES OF EU-WIDE STRESS TEST

The stress test has become the main and very significant tool in the analysis of financial sector stability and an improvement for macro prudential policies. One of the main responsibilities of the supervisory authority is to ensure a stable and efficient financial system. An essential part of the stability and efficiency of financial system depends on prudential regulation and on effective supervision. The recent financial crisis has shown how banks are very vulnerable and how some of large banks were seriously damaged.[1] By the way, the progressive development of stress tests is proving increasingly valuable in monitoring and safeguarding the stability of the financial market (wide access to financial services). It is connected with the lessons learned from the last financial crisis over the past decade and it is used as a complementary tool to traditional supervisory practices.[2]

Among the precursors, the International Monetary Fund launched the regular use of macro stress tests in the context of its Financial Assistance Assessment Programs as a consequence of the Asian financial crisis in the late 1990s. [3] With the recent financial crises, US and Europe have expanded the use of macro stress test as regular control. In both US and EU, stress tests became part of the policy for crisis management by the national authorities. In the US, the most important stress test was the Supervisory Capital Assessment Program (SCAP), in 2009; instead, in Europe it was started in 2009 by the Committee of European Banking Supervisors (CEBS) and continued in 2010, it was reinforced in 2011 by European Banking Authority (EBA), increasing the credibility of the process, in fact, the outputs of EU-wide stress tests have been viewed as essential information on the health of the system. The exercise increases the quantity and quality of bank's capitalization, reducing uncertainty of banking sector. [4]

Focusing on Europe stress test, the last stress test is the 2016 EU-wide stress test, in which the EBA has required, in cooperation with the European Systemic Risk Board (ESRB), the national supervisory authorities as the European Central Bank (ECB), the ESRB and the European Commission, to launch and coordinate European stress test to evaluate the resilience of financial institutions to adverse market shocks. The objective of the EU stress

[1] JAKUBÍK AND SUTTON (2011)
[2] MARCELO, A., RODRÌGUEZ, A,TRUCHARTE, C., (2008).
[3] HENRY, J., KOK, C., (2013)
[4] IMF (2013)

tests is to evaluate the resilience of financial institutions and the potential increasing of systemic risk due to adverse market developments. The evaluation is consistent and the results are comparable across the banks, since the methodology is the same across countries and banks. The stress test exercise considers a sample of banks and all the banks are subjected to baseline scenario and adverse scenario. Assuming a static balance sheet and zero growth assumption, the banks are required to stress common set of risks: credit risk, market risk, sovereign risk, securitization and cost of funding. The results show the percentage of CET1 (Common Equity Tier 1), of each bank, considering the different hurdle rates applied for the baseline scenario and for adverse scenario. [5]

Briefly, in US the stress test was more severe than the European stress test. The explanation is that the Supervisory Capital Assessment Program (SCAP) in 2009, in U.S has been considered effective for two reasons: firstly, in the event that the banks had not been able to raise capital through the market, there was a credible rescue parachute, or a government assistance program called the Capital Assistance Program. Secondly, the amount of information provided to investors was sufficient to increase the transparency about the solvency of institutions analyzed (more detailed information will be provided in next section).

By definition, macro stress testing analysis is an attempt to analyze how the balance sheet of banks is affected by different conditions and by shocks of financial markets. Accordingly, regular stress test should provide a more accurate and reliable assessment of the possible effect of adverse shocks in the form of extreme movements in variables liable to impact on the economic setting and the stability of the financial system. Consequently, a banking stress test is an analysis conducted under unfavorable economic scenarios which is designed to determine if a bank has enough capital to withstand the impact of adverse developments.[6]

For these reasons since the end of the 1990s, stress-testing has been increasingly used by financial institutions and supervisory authorities, both in Europe and US. The aim is to provide a quantitative, forward-looking assessment of the capital adequacy of the banking system and individual institutions within it. The primary objective is to identify, monitor and take action to remove or reduce systemic risks, with a view to protecting and enhancing the resilience of the financial system. The main values of stress test are the will to increase transparency, which contributes to market discipline, and reduce uncertainty in the market and the asymmetric information caused by adverse selection in the interbank market. [7]

[5] EBA (2014A)
[6] BANK OF ENGLAND, 2013.
[7] GYNTELBERG, J., KING, M., (2010) AND DE GROEN, W. P. (2014)

In conclusion, the Banks's stress tests may add value for four reasons: firstly can add value to the internal control of risk management. Secondly, it can serve as a basis for building prudential techniques of protection against adverse situations. Thirdly, it can be used as a prevention to capture preventively each potential problem and solve it immediately. The last reason concerns the different business areas of banks, the stress test can be useful to measure the possible impact of shocks on financial condition of each business area, in order for the management to be able to define their risk profile more precisely. At the end, these tests should be viewed as an additional resource available for prudential banking supervision and as a help for economic agents about the measures to be taken to preserve the financial stability. At the same time, the supervisory authority should consider the test as an exercise in self-discipline and in control by the other economic agents of its work in strengthening and safeguarding the smooth working of the financial system.[8]

## 1.1. Method to build a stress test

There are various types of methods of construction of a stress test, one method could measure the size of the changes of the risks factors, considering primarily the credit risk and market risk. To start, it could create a list of different stress testing methodologies, starting from the number of risk factors incorporated. This leads to split between sensitivity analyses or scenario analyses. The usefulness of a stress test as a risk management tool depends crucially on the choice of the scenarios; if the scenario is too much implausible, the test results will be ignored. Unfortunately, there is no standard accepted method regard to the choice of severity and plausibility of the scenarios. Indeed, they often are forced to face a trade-off between these two measures, too severe shocks and too plausible shocks in danger of becoming little credibility or invalidate the test results. Choose plausible shocks, and sufficiently extremes, is not simple, the most efficient shock should be sufficiently severe to produce significant turbulence in the system and affect a consistent part of financial portfolio. When a shock is severe, but losses are limited, then it is necessary to review the risk assessment process. For this reason, the implementation of a stress test is to be a continuous process, to adjust all the parameters. [9]

[8] MARCELO, A., RODRÌGUEZ, A,TRUCHARTE, C., (2008).
[9] ALFARO R. AND DREHMANN M. (2009).

Now there is the explanation of the two different types of stress test approaches, the sensitivity analysis technique based on univariate analysis regarding a single risk factor and subsequently, the scenario analysis technique based on several risk factors.

### 1.1.1. Sensitivity analysis

Sensitivity analysis considers the impact of a single variable, is performed to assess the stability of model parameters, such as correlation and volatility, the result obtained is subject to the condition that the other system variables remain unchanged. An advantage of these tests is the simplicity of implementation, because only a single variable is shocked, and the consequence is the lack of plausibility, because in a stress event it is unlikely that only a single key variable is significantly affected.[10]

This type of analysis may examine the impact of adverse developments in credit risk, or a shock on interest rate, but each shock would be analyzed individually regardless of improvement in foreign exchange risk or interest rate risk.[11] Usually, the time horizon considered is not very long, often almost "instant", and covers at most one full business year. In conclusion, this approach is very simple but it has an important limitation because it tests the health of a financial system, evaluating a specific risk factor, without considering the correlation with other factors. Secondly, the test is considered stable for all the period, but it is not credible because, for example, lower volumes of new business reduce profitability arising from the downturn. This is difficult to believe with a dynamic and connected economic environment, where financial institutions immediately react to negative shock by adapting their activity and business structure.

### 1.1.2. Scenario analysis

A more plausible approach to stress testing is a scenario analysis that considers the impact of a combination of two or more shocks on risk portfolios or on the whole institution, where the vulnerability is measured with respect to many risks occurring simultaneously. It is a more plausible approach, and it generates a more accurate estimation of the sum of credit and

[10] HENBEST J.(2006)
[11] KEARNS, A.,MCGUIRE, M., MCKIERNAN, A.,AND SMYTH D., 2006

market risk losses under adverse developments.[12] With this approach, the best way of examining the variation of variables is to use an econometric model. The model could be built ad hoc (hypothetical, historical, or probabilistic calibration or a combination of these) so a change of one variable could react and change the other variables of the model, thereby creating the desired stress scenario. The focus is on estimating how a particular scenario affects the key variables that determine the financial condition of the system and hence its possible impact on the system's stability. Additionally, the time horizon considered is usually longer than that used for sensitivity analysis, covering at least one full business year, but it could be extended beyond one year, for two or three business year, without lose efficiency of estimation. An example of scenario analysis is the reduction of growth in economy activity, this reduces the credit quality of banks' borrowers and increases credit risk. Banks react by cutting back on new lending, which will affect economic agents (households and firms), amplifying the original shock. Accordingly to the zero growth of initial scenario, in the future the growth will continue to be negative. This may appear simple, but the complicated relations between the financial and the real sector are hard to define and accurately estimate. In conclusion, scenario analysis is a starting point for a macro stress test because the aim is guarantee robustness of the financial system when there are stressed economic environments. To do this, it is necessary to find risk factors and shocks and estimate the financial condition. Of course, it is not simple to specify which variable moves during a stress event. The variables shocked in the stress tests are: interest rate and exchange rate, measures of inflation and unemployment and GDP.[13]

### 1.1.3. Bottom-up vs Top-down approach

Stress-testing methods can be identified in two different approaches, the bottom-up and top-down, and these characterize the level at which a stress-test is conducted; generally, the bottom-up approach is used by the financial institutions and the top-down approach is used by the central bank. The two models are very different because in the bottom-up approach, each individual bank performs the test using their own models, then the results are aggregated at the system for a comparison. On the other side, the top-down promoted by the central authority, considers the system as a whole, so they apply the same assumptions and models to

[12] BREUER, T. & KRENN, G. (2000).
[13] JAKUBÍK, P., SUTTON, G., (2011) AND MARCELO, A., RODRÌGUEZ, A.,TRUCHARTE, C., (2008)

all institutions' balance sheet data. The choice of the one or the other depends on the benefits and the results that they want to achieve.

There are several ways to design a scenario in a bottom-up stress-test, it should represent extreme events of risk factors that may impact on the financial system. The main source of risk examined with bottom-up stress-tests is credit risk and authority uses multi-year scenarios to capture any adverse shock of the business cycle, credit risk represents the main risk driver. Differently, market risk has a shorter time horizons, for this reason the market and credit risk are difficult to implement together due to different time horizon. After collecting all results, the final step is to aggregate all results at the level of the system, to see if the entire banking sector is able to deal with the adverse shocks and solve destabilized events for the financial sector. Usually, the contagion risk is not treated by bottom-up stress test and it is very difficult to predict bank's movement in stress situation. However, since 2008 ECB has developed bottom-up stress-tests as an instrument to predict potential financial crisis and increase transparency on risk exposure, in order to rebuilt trust in the banking market. The Committee of European Banking Supervisors (CEBS) coordinated the first macro stress-test to the banking system in 2009 and then the ECB has identified three conditions for the success of bottom-up macro stress-tests; firstly it could be efficient if the results are clear and interpreted as a whole, secondly there is an high level of disclosure and lastly it creates measures for institutions that do not pass the test with other policy. [14]

The top-down approach is useful for understanding and solving all potential vulnerability to the financial system after adverse shock. In general, the main objective of top-down stress tests is to evaluate the loss absorption capacity of a system when the initial weakness becomes real shock, with a consequence in the financial system. In detail the top-down approach has two important structures; common and standard. First of all, the structure has to be common in sense of tools and methodologies; secondly it has to be standard in term of uniformly application for all entities. The standard structure defines a coherent and consistent test, independently of the type and number of banks considered because the results are robust thanks to reduction of differences in the methodology, it considers all type of business of each individual institution. Consequently, stress tests should be an instrument for supervisory activity, using top-down stress test to estimate the capital requirement in adverse shock.

The main weakness of top-down approach is the lack of the detailed information for each bank and this becomes the main strength of the bottom-up alternative. The richness of the information and the detail available to individual institutions allows a much more accurate

[14] MARCELO, A., RODRÌGUEZ, A.,TRUCHARTE, C., (2008) AND ČIHÁK, M.,(2007)

perception of their risk profile and the impact that a particular negative event could have. So, there is a trade-off between the greater level of detail and uniformity of method that the central bank has to consider when deciding which approach to use.[15] In this connection, regarding the stress test of 2014, one might expect that the ECB has preferred to adopt a top-down approach in view of the primary commitment to ensure common rules for all financial institutions: indeed, at the beginning stress test was initially a bottom-up, with banks that have done individually between May and June 2014 using the guidelines outlined by the EBA, subsequently between July and August 2014 the ECB adopted a top-down approach using its own model that would be a baseline for comparing the results obtained by the institutes, who then were also compared with each other to ensure a further uniformity control. In this way, therefore, the ECB has succeeded in combining the advantages of both approaches, in fact, the most comprehensive stress test is a combination of bottom-up and top-down methods in policymaking, and by the way one is a complement of the other. It ensures a uniform treatment of the various participants and shows the most accurate results, reducing uncertainty.

## 1.2. European Stress test from the beginning

Since the crisis in 2007, the stress tests have become an integral part of macro-prudential regulation in Europe, with the aim to ensure that banks respect minimum capital requirements to absorb any future losses and that the financial system as a whole it is strong enough to withstand generalized shocks. The next paragraphs explain the five European stress test from 2009 promoted by the CEBS to 2016 promoted by the EBA. It is relevant to analyze how the meaning and the methodologies are similar between exercises and how during the years the exercise incorporates a lot of banks, from 22 banks in 2009 to 123 banks in 2014, the European stress test analyzed in Chapter III and IV. A small introduction about 2016 stress test conducted by the EBA that analyzes 51 banks without using capital threshold.

The focus is about resilience of European banks and which risks are relevant for banks and can create problems for the stability of banking system. Ensure stability and transparency of banking system, in an international environment, allows the maintenance of primitive function of banks, receive deposits, make loans to society and prevent further financial crises.

[15] MONTES, C.,AND ARTIGAS, C., (2011) AND MARCELO (2011)

### 1.2.1. Stress test 2009 CEBS

In May 2009 the Committee of European Banking Supervisors (CEBS) had coordinated the first EU-wide forward-looking stress test of the banking system, in cooperation with the European Commission and the ECB. The objective of the exercise was to increase the level of aggregate information available to policy makers for assessing the resilience of the European financial system. The exercise was conducted in a bottom-up fashion, where participating supervisors and banks had used the commonly agreed scenarios, taking into account the specificities and risk profiles of the participating institutions.

The test was built on common guidelines and scenarios, it was based on the situation at the end of 2008, and was conducted for the period 2009-2010, for a sample of 22 major European cross-borders banking groups, representing 60% of the total assets of the EU banking sector on a consolidated basis. About the scenario, it was based on baseline and adverse scenario and it analyzed two major risks, the credit and market risk. The assessment of credit risks should represent a severe but plausible shock- based on the input provided by the European Commission and the European Central Bank and a sensitivity analysis on the trading book. The assessment of market risk positions was based on commonly agreed parameters.

Considering the most important assumptions of 2009 stress test:

- Real GDP decreased by -4.0% in 2 009 and -0.1% in 2010 for the baseline scenario; and -5.2% in 2009 and -2.7% in 2010 for the adverse scenario;
- The unemployment rate is: 9.4% in 2009 and 10.9% in 2010 for the baseline scenario; and 9.6% in 2009 and 12.0% in 2010 for the adverse scenario;
- Yearly changes in property prices for Europe: for commercial property prices: -13% in 2009 and -6% in 2010 for baseline scenario and -17% in 2009 and -13% in 2010 for adverse scenario.[16]

At the end, about thresholds, the Tier 1 was of 6% both for baseline scenario and adverse scenario, the expected results of banks were sufficient to maintain an adequate level of capital also under negative circumstances. In fact, the aggregate Tier 1 ratio for the banks in the sample would remain above 8% and no bank would see its Tier 1 ratio falling under 6% as a result of the adverse scenario. However, Ministers and Governors had welcomed this exercise, because it was the first stress test and increased the transparency of the banking sector. The

[16] CEBS 2009

results were positive because the large EU banks appeared sufficiently capitalized to head off a severe macroeconomic deterioration. It is good for governors to monitor the economic situation and coordinate other more detailed stress test. For banks instead it is good to continue strengthening their financial position.[17]

### 1.2.2. Stress test 2010 CEBS

Following the discussion of 2009 stress test results, CEBS carried out a second EU-wide exercise aimed at assessing, in addition to the overall resilience of the banking sector to shocks, also "*the dependence of EU banks on public support and on the amount of capital available for further lending in the context of exit strategies should be provided".*[18] As for the CEBS 2009 it is a micro-prudential risk assessment and is conducted in bottom-up details.
The test started in March 2010 and it had applied a set of commonly agreed macro-economic scenarios developed in close cooperation between CEBS, national supervisory authorities, the European Commission and the ECB. In comparison with the exercise of 2009, more EU banks were involved, they analyzed 91 banks, covering 21 countries, representing 65% of the total assets of the EU banking sector and the 50% of assets of each national banking sector. It was based on data of consolidated year-end 2009, and was conducted for the period 2010-2011. About the scenario, it was based on benchmark and adverse scenario and focuses on credit and market risks, including the exposures to European sovereign debt (this is the big difference with CEBS 2009). The assessment of credit risk is based on the analysis of five main portfolios (financial institutions, sovereign, corporate, consumer credit and retail real estate) and sees how they react to stress. About market risk, they stressed the sovereign and financial institutions exposures only in the trading book.
The key macro-economic variables are: GDP, unemployment and interest rate. These are the assumptions for benchmark and adverse scenario:

- GDP growth is assumed at a level of +0.7 in 2010 and +1.5% in 2011 for the benchmark scenario; and -0.2% in 2010 and -0.6% in 2011 for adverse scenario;
- The unemployment rate is: 10.7% in 2010 and 10.9% in 2011 for the benchmark scenario; 10.8% in 2010 and 11.5% in 2011 for the adverse scenario;

[17] L. ONG AND C. PAZARBASIOGLU (2013)
[18] CEBS (2010a)

- The cumulative loss rates associated with these losses are 3.0% for corporate exposures and 1.5% for retail exposures for the benchmark scenario, and 4.4% for corporate and 2.1% for retail exposures under the adverse scenario.

At the end, as capital requirement again the governors had used Tier 1 at 6%, both for benchmark and adverse scenario, as for the CEBS 2009. The results arrived on 23 July 2010 and they showed how the threshold is decreased under the adverse scenario from 10.3% in 2009 to 9.2% by the end of 2011. Considering the sovereign shock, only seven banks have failed the stress with Tier 1 capital ratios below 6%, under the adverse scenario. It is important to consider that the minimum Tier 1 capital adequacy ratio is of 4%, so the seven banks that failed the threshold were in contact with the competent national authorities to solve that problem in term of recapitalization. The big difference with CEBS 2009 is the clarity of objectives, the aim of the CEBS 2009 was vague, in contrast, the objectives of the CEBS 2010 was explicit, analyze the overall resilience of the EU banking system in adverse condition and how they react and absorb those shocks.[19]

### 1.2.3. Stress test 2011 EBA

Subsequently, on 1 January 2011, CEBS changed into European Banking Authority (EBA), keeping the same tasks and responsibilities. On 13 January 2011, the EBA decided to initiate an EU-wide stress test, in cooperation with the national supervisory authorities, the European Systemic Risk Board (ESRB), the European Commission and European Central Bank (ECB) and published results in July 2011.

The EBA 2011 it is very similar to CEBS 2010, in term of methodologies and approaches both used the bottom-up test. It was in line with Basel III developments about definition of common equity capital (CT1) and the use of a stress hurdle rate of 5%, noting that a higher threshold than the legal minimum was *"necessary in assessing the resilience of banks in adverse circumstances if credibility and confidence in the banking sector is to be restored"*.[20]

For EBA 2011 more EU banks were involved, they analyzed 90 banks, representing 65% of the total assets of the EU banking sector and the 50% of assets of each national banking sector. It was based on data of consolidated year-end 2010, and was conducted for the period 2011-2012.

[19] ONG AND PAZARBASIOGLU (2013)
[20] EBA (2011a)

The focus of the 2011 exercise, as in 2010, was primarily on credit and market risks, then liquidity risk and cost of funding, to understand specific weaknesses in the solvency of banks. Regarding the credit risk, the method is based on three steps, forecast values under a given stressed scenario and time horizon; estimate the impact of the stressed variables on the two parameters of credit risk, (probability of default (PD) and loss given default (LGD)); at the end, use these parameters to evaluate the impact of the stress scenario on the banks' Profits and Losses (P&L) and solvency.[21] About the market risk, banks have to apply specific parameters only for trading book positions, both for baseline and adverse scenario, with an exception for sovereign position, which they are stressed through haircuts. For liquidity risk and cost of funding there is not a specific assessment, they consider these risks in connection with specific financial structure of the banks in question.

Considering the assumptions of 2011 stress test:

- GDP growth is assumed at a level of +1.5% in 2011 and +1.8% in 2012 for the baseline scenario; and -0.5% in 2011 and -0.2% in 2012 for adverse scenario;
- The unemployment rate is 10.0% in 2011 and 9.6% in 2012 for the baseline scenario; 10.3% in 2011 and 10.8% in 2012 for the adverse scenario;
- Inflation is +1.5% in 2011and +0.5% in 2012;
- Stock prices: -15% and house prices are not disclosed.

At the end, EBA decided to use Core Tier 1 (CT1) as a benchmark to assess banks, the threshold is set at 5% of risk weighted assets. This is above the 4%, the legal minimum requirement, they decided to use a high threshold to increase credibility of exercise, better analyze each bank and find appropriate measures to solve all problems. On 15 July 2011 EBA showed the results, considering only information data of 2010, 20 banks had failed the stress test with a CT1 below the 5%, subsequently the EBA allowed specific capital actions in the first four months of 2011 for the twenty banks that had failed the stress. After the capital-raising actions in 2011 the EBA 2011 results shows that eight banks fall below the capital threshold of 5% and 16 banks display a CT1R of between 5% and 6%.

In conclusion, the 2011 European stress test scenarios have been criticized as being too lenient, as well as they had not sufficiently stressed important risk factors, such as sovereign risk, because they consider only the trading book instead of banking book, in which there is the majority of sovereign exposures. This means that the main risk factors are not adequately

[21] FERRARI S., VAN ROY P., AND VESPRO C., (2011)

captured. Indeed, two banks Dexia in Belgium and Bankia in Spain had passed the EBA 2011 stress test and after few months have required significant restructuring. [22]

### 1.2.4. Stress test 2014 EBA

After the critiques of EBA 2011, supervisor decided to implement a new stress test, EU-wide stress testing of 2014, which is substantially an improvement over the previous exercises in 2010 and 2011 in various aspects. The stress test of 2014 is been required by the EBA, in cooperation with the European Systemic Risk Board (ESRB), national supervisory authorities as the European Central Bank (ECB), the ESRB and the European Commission, to launch and coordinate a European stress test to evaluate the resilience of financial institutions to adverse shocks. The EBA in coordination with the ECB had decided to conduct a comprehensive assessment; it is a mix of a supervisory risk assessment, asset quality review and a stress test.
The main features of the ECB stress test are:
*"The authority shall develop: common methodologies for assessing the effect of economic scenarios on an institution's financial position; common approaches to communication on the outcomes of those assessments of the resilience of financial institutions; common methodologies for assessing the effect of particular products or distribution processes on an institution; and common methodologies for asset evaluation, as necessary, for the purpose of the stress testing."* (Eba, 2014a).
The 2014 EU-wide stress test exercise is executed on a sample of 123 banking groups, including Norway, banks cover at least 50% of the national banking sector in each EU Member State and 70% of total banking assets. All the banks are subjected to baseline scenario and adverse scenario and the scenario covers the period of 2014-2016, starting from the consolidated year-end 2013. The assumptions are a static balance sheet and zero growth, banks are required to stress a common set of risks: credit risk, market risk, sovereign risk, securitization and cost of funding.[23]
There are two big differences between the stress test of 2011 and that of 2014, the first is about the time horizon, from two years to three years, and the second concerns the sovereign risk. This is a crucial point because in 2014, the supervisor perceives the importance of sovereign risk not only in trading book, as for 2011 stress test, but also in banking book. Indeed the sovereign risk exposures in the trading book it is a minimum part of total

[22] ONG AND PAZARBASIOGLU (2013)
[23] EBA (2014a)

exposures, only 17% with respect to the banking book in which there is 83% of its sovereign debt.

Now, the focus is on the assumptions of stress test 2014:

- GDP growth is assumed at a level of +1.5% in 2014, 2.0% in 2015 and +1.8% in 2016 for the baseline scenario; and -0.7% in 2014, -1.5.% in 2015 and 0.1% in 2016 for adverse scenario;
- The unemployment rate is 10.7% in 2014, 10.4% in 2015 and 10.1% in 2016 for the baseline scenario; 11.3% in 2014 and 12.3% in 2015 and 13% in 2016 for the adverse scenario;
- Inflation stood at 1.2% in 2014, 1.5% in 2015 and 1.7% in 2016 for the baseline scenario, and 1.1% in 2014, 0.6% in 2015 and becomes zero in 2016 for the adverse scenario. [24]

At the end, in the EBA stress test 2014 the indicator was the common equity tier 1 ratio (CET1), it is a ratio between the book value of the banks' capital and assets weighted for risk. The hurdle rates, in term of minimum capital available, are: 8% for baseline scenario, 5.5% for adverse scenario, with these thresholds 24 banks have failed the stress below the hurdle rate of 5.5% considering the information data of December 2013 and 13 of 24 banks remained with a capital shortfall also after restructuring capital during 2014. About this stress test will be discussed in detail in Chapter III.

### 1.2.5. Stress test 2016 EBA

The last stress test is the 2016 EU-wide stress test, it is required by EBA, in cooperation with the European Systemic Risk Board (ESRB), national supervisory authorities as the European Central Bank (ECB), the ESRB and the European Commission, to launch and coordinate European stress tests to evaluate the resilience of financial institutions to adverse market shocks and assess the capital position of EU banks. For the stress test of 2016 less EU banks were involved, they analyzed only 51 banks, representing 70% of banking assets in euro area. It was based on data of consolidated year-end 2015, and was conducted for the period 2016-2018.

[24] ESRB (2014)

The focus of the 2016 is on credit risk, market risk, counterparty credit risk (CCR) losses, Net Interest Income (NII), Conduct risk and other operational risk. Regarding the credit risk, the method is based on the impact of credit risk on capital available, through impairments and P&L, considering sovereign position and on the risk-weighted exposure amount (REA), the methodology is the same of EBA 2014. The market risk shows a simplification of number of scenarios, the application is based on more conservative constraints and considers all hedges. Conduct and operational risk, it is a new risk added to scope for 2016, the method is based on P&L and considers quantitative and qualitative approach. At the end, about Net interest income the method is based on fixed stress effect for main components.
Considering the assumptions of 2016 stress test:

- GDP growth is assumed at a level of 2.0% in 2016, 2.1% in 2017 and 1.7% in 2018 for the baseline scenario and -1.2% in 2016, -1.3% in 2017 and 0.7% in 2018 for adverse scenario;
- The unemployment rate is 9.2% in 2016 8.9% in 2017 and 8.9% in 2018 for the baseline scenario; and 9.9% in 2016 10.8% in 2017 and 11.6% in 2018 for the adverse scenario;
- Inflation is 1.1% in 2016, 1.6% in 2017 and 2.0% in 2018 for the baseline scenario; and -0.9% in 2016 -0.2% in 2017 and -0.2% in 2018 for the adverse scenario;
- Stock prices: -25.4% in 2016, -24.7% in 2017 and -16.4% in 2018.[25]

At the end, this stress test does not use capital thresholds but is used as a point into the Supervisory Review and Evaluation Process (SREP), it is divided into two parts: Pillar 2 requirements and Pillar 2 guidance. Pillar 2 requirements are binding and violation can have direct legal consequences for banks, instead Pillar 2 guidance is not directly binding so there isn't an automatically legal action. If a bank fails its Pillar 2 guidance, supervisors has to consider the reasons and define a supervisory measures. If the capital supply must be further reduced, automatic measures limiting are activated, for example with a reduction of dividends or bonuses. A further deterioration of the capital supply would create a problem about Pillar 2 requirements, and would add a request of additional supervisory actions. The result of stress test 2016 arrived on 29 July 2016 and showed as EU banking sector has greatly increased its capital in recent years with a CET1 of 13.2% at the end 2015 and then declines to 9.4% at the

[25] EBA (2016)

end of 2018 under the adverse scenario, differently the CET1 fully loaded ratio falls from 12.6% to 9.2%.[26]

## 1.3. Comparison with stress test USA

It is useful to make a comparison with the stress test carried out by the Federal Reserve Board in 2014 (DFAST 2014), primarily because it is useful to compare the methodology used in Europe with that of the United States, secondly because the US banking sector is a good comparison in terms of size and development of the economy. Moreover DFAST 2014 is widely considered a model of severity to which other stress tests should aspire. The implementation of stress test in US has become a regulatory requirement only since 2010 with the passing of the Dodd-Frank Wall Street Reform and Consumer Protection Act (Dodd-Frank Act or DFA), following of success of the Federal Reserve's Supervisory Capital Assessment Program (SCAP) of 2009.

The program was successful for three points; firstly the stress scenarios were severe, secondly public backstops were available from the U.S. Department of the Treasury, and lastly sufficient information was disclosed to mitigate solvency concerns. Afterwards, since November 2011 the first release of the Comprehensive Capital Analysis and Review (CCAR) stress scenarios was introduced by the Federal Reserve who has adopted the so-called "Capital Plan Rule," under which the US bank holding companies with consolidated assets equal to or greater than $50 billion must submit annually to the Comprehensive Capital Analysis and Review (CCAR).

This exercise requires to banks to send to the Fed the capital plans that include the description of internal processes for assessing capital adequacy, their policies regarding the issuance of new shares, the distribution of dividends, purchase of own shares and all shares on the capital planned for the next nine quarters. From 2013, the same bank holding companies that have participated in CCAR are subjected by the Fed to other annual supervisory stress tests (DFAST) under three scenarios, baseline, adverse and severely adverse, and it is compulsory to disclose the results. Moreover, the banks themselves must also submit themselves to other two stress tests. Unlike what happens in the CCAR, where banks are free to take any option transaction on the capital to do also in the future, the actions on capital specified by the Fed in DFAST are standardized.

[26] ESRB (2016)

The objective of the EU-wide stress tests is increase transparency and enhances market discipline. The CCAR 2014 is executed on a sample of thirty bank holding companies (BHCs) with more than $50 billion in total consolidated assets, representing 80% of total banking assets. [27] All the banks are subjected to different scenarios designed by Fed: baseline, adverse, and severely adverse; additional scenarios or components of scenarios for all or a subset of the companies possible. The scenario covers nine quarters, from the last quarter of 2013 until the last quarter of 2015. Banks are required to stress common set of risks: credit, market and operational risk.

Fed in 2014 used the following assumptions regarding the main macroeconomic and financial variables for adverse scenario:

- The real GDP falls by about 4.75% in the third quarter of 2013 and the end of 2014, with a moderate recovery of 2% in 2015 and 4% in 2016;
- In the same period the consumer price index below 1% back then to 1.5% between the end of 2015 and the end of 2016;
- The unemployment rate increased by 4% from the third quarter of 2013, reaching a peak of 11.2% in mid-2015, a level above the highest level reached in the last 70 years;
- The prices of the stock market drop by 50% with the volatility index reaching 68%: this is the market's expectations on volatility of 30 days and is calculated using the implied volatilities of a wide range of options listed in the S & P 500. House prices fell by 25% while prices of commercial real estate fell by 35%.

The results show, by risk type, the percentage of CET1 of each bank. The hurdle rates applied are different, Five regulatory ratios: Tier 1 Common ratio: 5% in all quarters; CET1 ratio: 4% in 2014 and 4.5% in 2015; Tier 1 risk-based ratio: 5.5% in 2014 and 6% in 2015; Total Risk-based Capital Ratio: 8% in all quarters; Tier 1 leverage ratio: 4% in 2014 and 4% in 2015.[28]

[27] CLARK, T., AND RYU, L., (2015).
[28] STEFFEN, S. (2014)

# CHAPTER II:
# STRESS TEST METHODOLOGIES ON MAIN RISKS

The stress test is primarily focused on the assessment of the impact of risk drivers on the solvency of banks. It is important to stress test the following common set of risks using a determined methodology: Credit risk; Market risk; Sovereign risk; Securitization; Cost of funding. Briefly, credit risk is risk of losses due to the insolvency or the deterioration in the creditworthiness of the counterparty to meet the obligations to the bank, both in terms of the interest payments that the principal amount. Market risk is risk of losses on the trading portfolio (trading book) as a result of adverse changes in market factors: interest rates, exchange rates, prices of financial instruments. Sovereign debt is the risk associated with the possibility that a government fails to meet their financial obligations, the failure may come from economic, financial and political problems. It can be connected to the economy or develop in the medium to long term and it is associated with government bond yields and therefore to the interests that a State must correspond to the investors in order to finance them. Securitizations calculated at fair value were subjected to market risk, while those held in the banking book were subjected to credit risk. Divided into three risk categories (low, medium, high) considering the increased risk resulting from the probability of migrating from a better rating in a worst class. At the end the cost of collection it has been suggested an increase correlated to that of spreads on sovereign bonds, totaling a minimum of 100% in the case of funding sources "wholesale", to 50% in the case of corporate deposits and 30% in case of retail deposits. It was also imposed a limit of 75% to transfer the increase in rates on deposits to rates on new loans, excluding the residential mortgage on which a 50% limit has been imposed.

The next paragraphs illustrate the main risks of stress test, credit risk, market risk and liquidity risk.

## 2.1. Credit Risk

Credit, in commerce and finance, denotes transactions involving the transfer of money or other property, from creditor to debtor, on promise of repayment in the future. By the way, credit risk is an investor's risk of loss arising from a borrower who doesn't make payments as promised or shows a reduction in the creditworthiness. Based on this indication it is possible to classify the credit risk in five different categories:

- Credit Default risk: occurs when the loss comes from the complete failure of the counterparty. The given is deemed in default when the creditor bank considered very unlikely that the debtor is able to meet its obligations or when have passed 90 days (past due) by the expiration of the position.
- Migration Risk: credit risk is not only the default of the counterparty, but it includes also the change in the creditworthiness of counterparty. The reduction of creditworthiness can for example occur as a result of the downward revision of credit's rating (Downgrading), by agencies, as a loss in value of the position or as an increase of the possibility of a future insolvency;
- Risk as unexpected risk, recovery risk: in this case the risk occurs when the recovery rate of a specific credit operation was lower than expected. The recovery rate is the portion of the exposure that the lender expects to reclaim, after the occurrence of a default event.
- Exposure Risk. Credit risk is not limited to common bank’s assets, but it considers also the positions out-off balance sheet, for example over-the counter financial derivative, exchange transaction. Indeed the authority, when it considers the minimum capital requirement, requires that the capital covers the exposure in and out-off balance sheet.
- Country risk. The risk arises when the state fails to fulfill its obligations; the country risk can be defined as sovereign risk due to political or economic problems of the country itself.

So if in the first place, the credit risk can be defined as the insolvency of one of the parties to a contract, resulting in a loss for the creditor. This definition only contemplates the extreme case in which the debtor becomes insolvent. A loss in value of the credit position may also result from a deterioration in economic and financial conditions of the debtor to which the

ability (or willingness) to meet financial commitments, while not becoming insolvent. In a sense less simplified, for credit risk is then the possibility that an unexpected change in the creditworthiness of a borrower may give rise to unexpected changes in the value of the loan.
It is important to distinguish between the expected and unexpected losses. The first is expected from the bank so it is the mean of distribution losses, in this way banks don't consider it as a risk because it is already accounted and estimated ex-ante from the bank, and it is covered with a spread on the rate applied.
The meaning of credit risk concerns the unexpected losses which is the crucial element of credit risk, because it represents the part of losses not anticipated because it refers to the degree of variability of around its expected value loss rate. Generally the equations of expected losses (EL) and unexpected losses (UL) are[29]:

$$EL = E[L] = EAD\ x\ LGD\ x\ PD$$

$$UL = \sqrt{Var(L)} = \sqrt{Var(\ EADx\ LGD\ x\ L)}$$

Where:

- L = Loss, loss variable is a binary variable, it is equal to 1 in case of Default and 0 in the other case;
- EAD = Exposure at Default, in time exposure of insolvency;
- PD = Probability Of Default, the probability of debtors' insolvency;
- LGD = Loss Given Default, the loss in case of insolvency, it is equal to one minus recovery rate (RR):

$$LGD = 1 - RR$$

Considering these definitions it is clear the importance of stress test to guarantee the financial stability and permit to understand if and how the banking system is able to react against adverse shocks. For this reason, credit risk is the most significant risk faced by banks, in fact for a lot of stress test, credit risk section covers all counterparties (e.g. sovereigns, institutions, financial and non-financial firms and households) and all positions exposed to risks arising from the default of counterparty. Those included in the accounting categories loans and receivables (mainly loans to customers), held to maturity (securities held until the deadline)

[29] BARRO DIANA, 2004.

and positions in the available for sale and designated at fair value through profit and loss. To analyze credit risk the main approaches used are the Standardized Approach and the Internal Rating-Based (IRB) Approach, divided into base method (IRB Foundation) and advanced method (IRB Advanced). The point in common of three methodologies is the definition of capital requirement, which remains at 8% of risk-weighted assets (RWA) and could be calculated as:

$$Capital\ Requirement\ =\ Exposure\ x\ Risk\ Weight\ x\ 8\%$$

The differences between the different approaches is identified in the method for establishing the risk-weighting. The details of the methods are presented in the following paragraphs.

### 2.1.1. Standardized Approach

The Standardized Approach is used to measure the credit risk in a standardized manner, supported by external credit assessments. It came from revisions to the 1988 Accord for risk weighting banking book exposures. The main point is the determination of risk weight and this permits to banks to use the ratings issued by Export Credit Agencies (ECAs) or specialized external credit assessment institution (ECAI). The first must publish its risk scores and subscribes to the OECD agreed methodology. Banks may choose to use the risk scores published by individual ECAs that are recognized by their supervisor, or the consensus risk scores of ECAs participating in the "Arrangement on Officially Supported Export Credits". The second, ECAIs are Rating Agency on the risk of credit that operates against any bank customer. To be approved agencies meet the following six requirements[30]:

- Objectivity: The methodology for assigning credit assessments must be rigorous, systematic and subject to some form of validation based on historical experience;
- Independence: An ECAI should be independent and should not be subject to political or economic pressures that may influence the rating. The assessment process should be free and without conflict of interest;
- Transparency about the methodology and judgments, the general methodology used by the ECAI should be publicly;

[30] BISa, 2006 AND BISc (2015)

- Disclosure: An ECAI should disclose a lot of information, the methodologies, the definition of default, the time horizon, and the meaning of each rating; the actual default rates experienced in each assessment category; and the probability of a changing of assessments over time;
- Adequate resources: An ECAI should have sufficient resources to estimate high quality credit assessments. Such assessments should consider qualitative and quantitative approaches;
- Credibility: The credibility of an ECAI is also underpinned by the existence of internal procedures to prevent the misuse of confidential information.

The Standardized approach identifies the exposure value, starting from the carrying value of each risk assets, determined by taking into account the forms of credit protection in place (real and personal guarantees). Once quantified, the exposures are divided into 17 classes homogeneous (wallets) in relation to the technical features of the relationship). Subsequently, each position will be weighted according to the agency rating.[31]

### 2.1.2. Internal Rating-Based (IRB) Approach

As an alternative to the standard approach, banks may use their own estimates of risk weights to determine the regulatory capital on condition that the valuation methods are approved from the monitoring center. In particular, the rating's internal system must be operational for at least 3 years.

The objective, for both the IRB Foundation approach for both the Advanced IRB, is to develop a weight function for the risk by which the credit risk components are transformed in the weighting coefficient, useful for defining the capital requirement. The use of this internal approach leads to reward brokers and banks with the best investment selection methods, allowing the detention of more consistent capital requirements with the level of risk assumed, for a more efficient use of resources. Both for Foundation and Advanced approaches there are three key elements:

- Risk components: estimates of risk parameters (PD, LGD, EAD and M) provided by banking corporations;

[31] BANCA D'ITALIA, 2011

- Risk-weight functions: risk components are transformed into risk-weighted assets and therefore capital requirements.
- Minimum requirements: for a given asset class, the minimum standards that must be met for a banking corporation to use the IRB approach.

The Risk-Weight Functions represent the first key element of this approach. Since the weighting functions (f (PD; LGD; M)), depend on major credit risk components (the recovery the counterparty risk, etc.), the fundamental point of IRB is the assessment of reference variables among which it is possible to identify the probability of default (PD), the effective loss given default (LGD), the exposure at default (EAD) and, as an added, the maturity (M) intended as the residual financial transaction duration expressed in years. In addition, while in the basic method banks use their own estimates of PD and estimates for the other risk components rely on supervisory, in the advanced approach banks use their own estimates of the parameters PD, LGD, EAD and where expected M. In summary, the IRB approach can be represented as follows[32]:

$$Capital\ Requirement = EAD \times f\ (PD;\ LGD;\ M) \times 8\%$$

About risk components there are:

- Probability of default (PD): the estimation of PD is equal both or Foundation and Advanced approach, it is estimated internally by banks for the exposures that are placed in the "Corporate" category and "Bank", it cannot be estimated at less than 0.03%; the PD of defaulted exposures is by definition 100%.
- Loss given default (LGD): A bank has to provide an estimation of the LGD for each corporate, sovereign and bank exposure. With the Foundation approach, the LGD estimates for exposures to "Corporate", "Sovereign" and "Bank" not insured by a recognized guarantee is 45%. All subordinated exposure included in these categories are characterized by an LGD of 75%. On the other hand, in the Advanced approach, supervisory may permit banks to use their own estimates of loss given default accounting the mitigation effects of the risk deriving from personal nature collateral credit.

[32] SUPERVISOR OF BANKS (2015)

- Exposure at Default (EAD): the Foundation approach is pretty similar to what happen in standardized approach, through the application of credit conversion factors, chosen ex ante by the supervision. For the Advanced IRB approach, for each exposures banks can apply conversion factors internally estimated;
- The effective maturity (M) of each exposure: for banks that use the Foundation IRB, against corporate exposures, M is 2.5 years, except for repo-style transactions, where the effective maturity is 0.5, six months. For the Advanced IRB approach, banks are required to calculate the effective maturity of the position in different ways, it is expressed in years and not less than one and not greater than five. For risk assets with cash flow is predetermined M defined as follows: Effective maturity (M)

$$Effective\ Maturity\ (M) = \frac{\sum_t t^* CF_t}{\sum_t CF_t}$$

where CFt denotes the cash flows (principal, interest payments, and fees) contractually payable by the borrower in period t (with t measured in units of years).[33]

Risk weights assets is measure in term of PD and LGD, expressed as a decimal number and EAD in foreign currency:

$$Risk\ Weighted\ Assets\ (RWA) = K \times 12{,}5 \times EAD$$

Where K represents the capital requirement and is calculated as[34]:

$$\text{Capital Requirement (K)} = [\text{LGD} \times \text{N}[(1-\text{R})^{-0.5} \times \text{G}(\text{PD}) + \left(\frac{\text{R}}{1\text{-R}}\right)^{0.5} \times \text{G}(0.999)] - \text{PD} \times \text{LGD}] \times \frac{(1+(\text{M-2.5}) \times \text{b})}{(1\text{-}1.5 \times \text{b})}$$

With:

- Ln is the natural logarithm;
- N(x) is the cumulative distribution function of a standard normal random variable;
- G(z) is the inverse distribution of a normal variable;

[33] OSFI-BSIF (APRIL, 2014)
[34] BANCA D'ITALIA, 2011

- R is the correlation between the assets of enterprises financed whose algorithm is:

$$\text{Correlation ( R)} = 0{,}12 \times \frac{1\text{- e}^{(-50 \times \text{PD})}}{(1\text{-e}^{-50})} + 0{,}24 \times \left[\frac{\left( 1\text{- e}^{(-50 \times \text{PD})}\right)}{(1\text{- e}^{-50})}\right]$$

- B is the adjustment as a function of maturity:

$$"Maturity\ adjustment\ (b)\ =\ (0{,}11852 - 0{,}05478\ \times\ ln(PD))2"$$

where *ln* is the natural logarithm.

For exposures to companies, the IRB approach allows to distinguish the Small and Medium Enterprises (SMEs), for which sales for the consolidated group is less than €50 MLN. The correlation formula considers a new variable S, representing annual sales in millions between €50 MLN and €5 MLN (5 MLN is the minimum allowed also for enterprises with less than 5MLN of sales):

$$\text{Correlation (R)}= 0{,}12 \times \frac{1\text{- e}^{(-50 \times \text{PD})}}{(1\text{-e}^{-50})} + 0{,}24 \times \left[\frac{\left( 1\text{- e}^{(-50 \times \text{PD})}\right)}{(1\text{- e}^{-50})}\right] - 0{,}04 \times \left(1\text{-}\frac{\text{S-5}}{4\text{s}}\right)$$

### 2.1.2.1 Satellite model: KMV model

To apply the IRB approach there are different considerations about the probability of default (PD) especially on its calculation method. Now is explained the model developed by Moody's KMV. The methodology proposed by KMV, a consulting firm specializing in the analysis of credit risk, it allows to determine the probability of default and the distribution of the portfolio loss with reference both to the default risk and migration risk.

The model is based on the expected default frequency EDF (Expected Default Frequency) determined by historical default frequencies provided by the rating agencies. The model KMV could be divided into two different stages: the first, which is the main innovation of the calculation method, introduces a defined risk index, the distance to default (DD), which

assumes higher values for the best companies; the second permits to associate the DD with the probability of default or EDF based on past experience.[35]

KMV uses a quantity called default point (DP), an asset value at which the insolvency occurs. In this case it does not coincide with the full value of the debt, but with the sum of short-term liabilities (b) plus 50% of liabilities in the long term (l):

$$DP = b + \frac{1}{2} l$$

In the second step is estimated the distance to default (DD):

$$DD = \frac{A_0 - DP}{A_0 \times \sigma_A}$$

Where $A_0$ is the asset value and $\sigma_A$ is the volatility of asset value. In this way the distance to default is the difference between the asset value and the default point, standardized for the volatility.[36] The DD indicator expresses the credit risk inside the asset structure of the company and is expressed in term of standard deviations. Greater is the distance to default, lower is the probability of default of companies. In this situation is better to have a high asset value and at the same time less volatility (sigma A); if a company has a strong asset volatility, this could generate a lower level of (DD), corresponding to a higher probability of default. Once calculated the (DD), there is the direct association to Expected Default Frequency (EDF) through a frequency table, built on the basis of empirical investigations. One of the strengths of the KMV model is that it takes into account both the structural features of the company, both the cases of failure in the market (in terms of frequency). In this way, it is possible to estimate the PD, or the EDF (expected default frequency), or the default frequencies expectations for companies belonging to the same class of DD.

[35] CASTRÉN, FITZPATRICK, AND SYDOW (2008)
[36] ÅSBERG AND SHAHNAZARIAN (2008)

## 2.2. Market Risk

The main risks analyze from stress test are the credit and market risk, the first as a risk of counterparty the second as a risk of losses in all balance sheet positions arising from movements in market prices. The market risks had disclosed a continuous problem due to three important factors:

- the securitization process caused a gradual replacement of illiquid assets (loans, mortgages, etc.) with activities with a liquid secondary market and, therefore, a continuous price formation;
- the increasing complexity of financial instrument and the progressive growth of the derivatives markets, whose main risk profile is represented by the change in the market value due to fluctuations in the price of the underlying;
- The increased volatility in financial markets, due to the progressive international integration.

The supervisory considers market risk as a risk connected with the trading book of banks, as a pool of financial positions taken for a limited period of time in the balance sheet of banks which try to profit in market exchange.
There are four categories of market risk:

- Currency risk: risk arising from the sensitivity of positions to changes in the exchange rate. Financial assets and liabilities denominated in foreign currencies and derivatives whose value depends on the exchange rate (buying and selling spot and futures, currency swaps, currency options);
- Interest rate risk: risks arising from the sensitivity of positions taken to changes in the rate of interest. For example (bonds, forward rate agreements, interest rate futures, interest rate swaps, caps, floors, collars);
- Equity risk: risks arising from the sensitivity of positions taken with stock market trend. It's the case of (equities, stock-index futures, stock options, etc.).
- Commodities risk: when the market value of positions taken are sensitive to fluctuations in commodity prices. The most exposed positions are: purchases and sales spot and futures of commodities, commodity swaps, commodity futures, commodity options etc.

At the beginning to measure market risk, supervisor used the traditional approach or sensitivity approach, but both approaches had showed a lot of limits. Briefly, the traditional approach is based on nominal value of single position, in other word both exposure risk and any imposed limitation operations are expressed in term of nominal value. This is a very simple and low cost model but at the same time there are big limitations: the nominal value does not reflect its market value and does not take into account the degree of sensibility of positions to changing in market factors; finally, it does not take into account the conditions of volatility and the correlation between price and rate.

To overcome these problems, adding the growing and complex activities of trading of banks, supervisor decided to use a sensitivity measures for each positions such as, the duration and basis point value for bonds, the beta for equities and deltas, gamma, vega and rho for options. However, also this approach shows several limitations: The first is associated with the fact that different positions are quantified by different coefficients, excluding the possibility to aggregate and compare risks of different positions; the second is associated with the fact that the sensitivity measures are not additive, they cannot be mutually aggregated; finally, as for the traditional method, it does not take into account the conditions of volatility and correlation of various market factors.

### 2.2.1. Modern Approach: the Value at Risk (VaR)

To overcome these problems and with the increasing complexity of the trading portfolios it was necessary to change the traditional risk measures adjusted to fit the different instruments (duration, convexity, beta, delta, gamma and vega), in a uniform risk measure in the sense of market factors (interest rates, exchange rates, equity prices). What it has led to an overall quantification of exposure of a bank towards the different financial variables.

Consequently, the model actually used is the Value at Risk (VaR), the definition commonly accepted is characterized by three elements:

- the maximum potential loss that a position (financial assets) or a portfolio of assets can adjust;
- a certain confidence level (or probability of occurrence of the maximum loss);
- a given reference time horizon.

The VaR of a position or a portfolio is a probabilistic measure, which assumes different values at different confidence levels. If *pr (E)* indicates the probability of event *E*, *c* is defined as the confidence level and L the loss, the formula is:

$$Pr\,(L > VaR) = 1 - c$$

Therefore, the VaR is an estimation of the potential change in value of the portfolio, with a certain level of statistical confidence and for a given reference time horizon. The VaR models allow obtaining risk measures related to different portfolios, which are comparable to each other, because the model uses uniform assumptions for all positions[37]. For this reason, the model has three important applications:

- compare the different alternatives of use of the risk of a financial institution's capital;
- assess the profitability of allocated capital;
- "price" correctly each operation based on the relative degree of risk.

The VaR model is important for two important characteristics. The first is that it obtains a consistent measure of risk between different positions and risk factors. The second is that it considers the correlations between the various risk factors.
Despite its advantages, the VaR also has three important limitations. The first problem is the use of historical data to predict potential future losses, focusing on the assumption that the relationship will continue to remain the same also in the future. The second problem concerns the static assumptions of VaR that cannot be valid in any given circumstances, this problem leads to compromised results. Finally, VaR model is very complex. There are three methods of calculating it:

- Approach the variance-covariance (analytical or parametric approach);
- The historical simulation;
- Monte Carlo simulation.

A short explanation, the approach variance-covariance is used in the presence of linear portfolios (bonds or deposits), while the Monte Carlo simulation is preferred in the presence of portfolios characterized by non-linear dependencies (options). The historical simulation is

[37] JORION (2004)

placed in an intermediate position; the model assumes that the price trend follows a pattern which is repeated over time. Accordingly, the construction of the variation in the value of the portfolio is carried out on the basis of historical data and not based on assumptions about the distribution of returns (called non-parametric method).

#### 2.2.1.1. Monte Carlo Simulation

The Monte Carlo method is a process which allows general a very large number of the scenarios. Historical data are used to determine the parameters (mean, volatility and correlations) which describe the probability distribution chosen. The calculation of VaR with the methodology of Monte Carlo simulation can be summarized through the following steps[38]:

- Breakdown of the securities included in the portfolio in primary risk factors.
- Collection of market data related to risk factors of a past time.
- Simulation of scenarios relating to risk factors.
- Consider the correlations and calculate prices and return of individual assets held in the portfolio

These steps are important to simulate a high number of times the evolution of a market variable and recalculate the market value at each risk position of each of the scenarios so constructed. Calculating the average of the obtained values is obtained the expected value of the impact of the risk factor under examination. If the number of simulations is high enough, usually 10,000 simulations for risk factor, this average value is an estimator unbiased, and converges to the most plausible scenario expected.
As with the other model also Monte Carlo Simulation has advantages and limitations. The model presents three important advantages[39]:

- The first is the flexibility of method and it is appropriate for complex instruments, it is suitable for use with any functional form of the distribution of market returns.
- The second it overcomes the problem of non-linearity and non-monotonicity of the payoff of positions, because it simulates not only the evolution of market factors but also the evolution of these variables in the same period.

[38] MEHTA A., NEUKIRCHEN M., PFETSCH S AND POPPENSIEKER T., (2012)
[39] JORION (2004)

- The third is the possibility to analyze the risk associated with particular categories of options.

Although there are advantages, the model presents two limitations:

- The first is connected with the simulation of several market variables, because the method needs to estimate the covariance matrix of the market factors, therefore it is necessary to produce current value of covariance with sophisticated estimated models of volatility;
- The second is based on the cost of the method, it is a very expensive method in terms of time and computer resources, although being numerically efficient compared to other numerical procedures.

## 2.3. Liquidity Risk

Liquidity risk is typical of banking risk, because it comes from the transformation of maturities in relation to the amount of available sources. The time balance between the sources of assets and liabilities defines the financial structure and determines the bank's ability to meet its regularly payment obligations. In case of temporal mismatch between short-term liabilities and long-term assets will create an imbalance between the cash inflows and outflow. The factors that determined the liquidity risk can be divided into two groups; Individual factors (downgrading bank rating, it is a trigger events the failure to repay the credit); Systemic factors, for example country or markets crisis due to interconnection between states. The bank may find it unable to fulfill its payment obligations or it may not ensure stability and continuity to the credit circuit, due to its inability to raise funds (funding liquidity risk) or to the presence of limits to sell assets (market liquidity risk).[40]

Funding liquidity risk is the risk that the bank is not able to efficiently raise funds on the market or make the payments of expected and unexpected cash outflows, without jeopardizing the financial equilibrium. Market liquidity risk is the risk that a bank in order to cash a position in financial assets is unable to convert into cash an asset position or is unable to liquidate without making a price deduction. This problem concerns the lack of liquidity in the market in which the asset is negotiated or for a temporary failure of the market itself. Funding and market liquidity risk are intrinsically connected among them. Because in the case in

[40] BASEL COMMITTEE ON BANKING SUPERVISION (2002)

which there was a sudden outflows of cash (funding liquidity risk) the bank could decide to sell immediately on the market its financial assets, even accepting a price lower than their current market value and suffering a capital loss (market liquidity risk). [41]

Liquidity risk is not specifically assessed as part of this exercise of stress testing, because of the difficulty to quantifying the effects of the shock of this type of risk factor. In next paragraphs will illustrate the models of Bangia et al. used to define a measure of risk, Liquidity-adjusted Var (L-VaR), including direct liquidity costs, as measured by the distribution of bid-ask spread.

### 2.3.1. Liquidity-adjusted Var (L-VaR)

The paper of Bangia et al. focuses on the inability of classic VaR models to consider the liquidity costs. The authors affirm that the techniques used to take into account the illiquidity of some positions are inadequate because they come from subjective judgments, for example the choice of time horizon to liquidate a financial position. The authors divide the liquidity risk in exogenous and endogenous factors, the former is interpreted as the result of market characteristics, common to all market participants and not influenced by the actions of an individual participant (systemic risk) and is associated with the bid-ask spreads observed. As far as the endogenous factor is determined by the ratio between the size of the position over the total volume in the market, the larger the size, the greater the endogenous illiquidity.

The model is based on the uncertainty of market value of the assets, defining one-day asset returns at time t, rt, is the log difference of mid-prices:

$$r_t = \ln[P_t] - \ln[P_{t-1}] = ln\left(\frac{P_t}{P_{t-1}}\right)$$

The mid-price change is calculated in the timeframe of one day and assuming that one-day returns are Gaussian, the 99% worst value is:

$$P_{99\%} = P_t e^{(E[r_t]-2{,}33\sigma_t)}$$

[41] HENRY, J., KOK, C., (2013)

where $\mathrm{E}[r_t]$ and $\sigma_t$ represent respectively the expected value and the standard deviation (the first and second time) of the distribution of the asset returns, while the 2.33 factor represents the percentile of the normal distribution to the selected confidence level. They calculate volatility as an exponentially weighted moving average (EWMA) of past squared returns to take account of the volatility clustering of returns.[42]

The authors, as a practice, pose zero expected value $\mathrm{E}[r_t]$ of daily return and the standard parametric VaR (henceforth P-VaR) is:

$$P - VaR = P_t\left(1 - e^{[-2{,}33\sigma_t]}\right)$$

For simplicity of the treatment is considered the normality of distribution as assumption, but the same authors point out that the model does not rely crucially on this hypothesis. The same fact provide for an adjustment for "fat tails" by estimating a correction factor θ amending the above formula to that effect:

$$P - VaR = P_t\left(1 - e^{[-2{,}33\theta\sigma_t]}\right)$$

The θ adjustment factor is calculated using the following formula:

$$\theta = 1.0 + \varphi \ln\left(\frac{k}{3}\right)$$

where, in the example estimated through a regression between the P-VaR and the historical VaR of 14 exchange rates, it represents a constant based on desired confidence level (1%, 2.5%, and so on), and k is the kurtosis (fourth moment) of the empirical distribution of returns, used in practice to precisely define the thickness of the queues. For the normal distribution is not provided, no adjustment in that k = 3 and therefore θ = 1; the correction factor therefore grows with the increase of kurtosis of the distribution (the further away from the Gaussian distribution, as θ is large). The parametric VaR obtained by considering only the mid-price, only reflects the market risk in the "pure" form, underestimating the overall risk. In the presence of transaction costs, the liquidation value is due to the bid price, which differs

[42] BANK FOR INTERNATIONAL SETTLEMENTS (BISb)

from the mid- price of a quantity equal to half the bid-ask spread. Since the distribution of bid-ask spread, the exogenous cost of liquidity (COL) is equal to this formula:

$$COL = \frac{1}{2}[P_t(\bar{S} + \alpha\check{\sigma})]$$

where $P_t$ it is the mid-price at time t, S the relative spread (calculated as $\left[\frac{(Ask-Bid)}{Mid}\right]$), $\check{\sigma}$ is the volatility of the relative spreads and $\alpha$ is the variable scale value based on the selected confidence level, which should cover 99% of the probability distribution (i.e. the critical value 1% of the empirical distribution of the relative spread). This forecast is dictated by the fact that the distribution of relative spread is difficult to approximate to a normal and therefore, greater is the distance of the empirical distribution from the Gaussian, greater is the value$\alpha$. The new value of the Liquidity-adjusted Var (L-VaR) takes into account, as well as the percentile for the distribution of returns, including that relating to the distribution of its spread, for the same confidence level.

Graphically summarized in Figure 1:

**Figure 1. Combining Market and Liquidity risk**

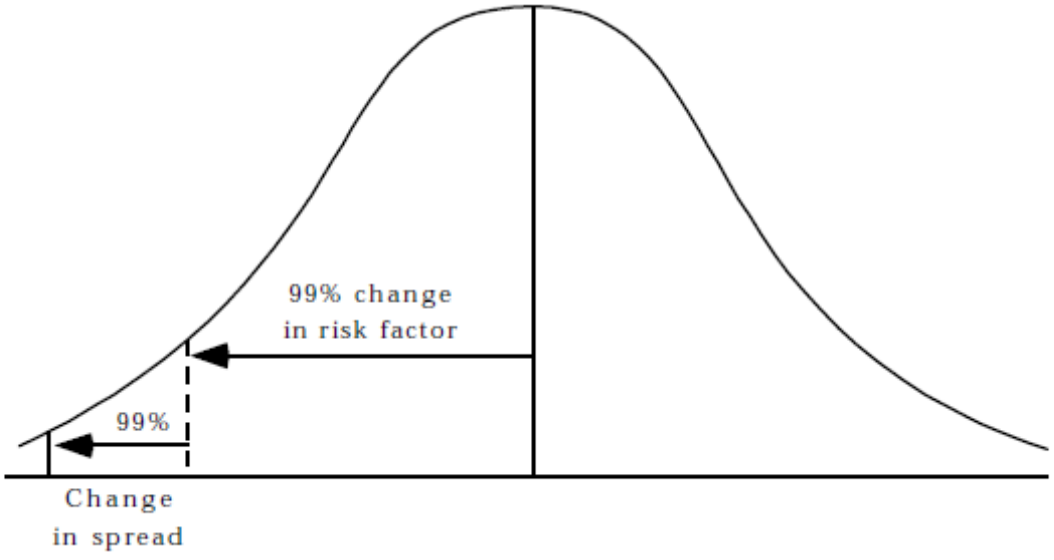



**Figure 1: Source: Bangia et al. Modeling Liquidity Risk, With Implications for Traditional Market Risk Measurement and Management**

Analytically the union of the two risks, market into a "pure" and exogenous liquidity, is described by the following formula:

$$L - VaR = P_t\left(1 - e^{[-2{,}33\theta\sigma_t]}\right) + \frac{1}{2}[P_t(\bar{S} + \alpha\check{\sigma})]$$

The approach used has the advantage of being able to consider observable data for most of financial market. The model allows the integration of existing methods for measuring the bid-ask spread based solely on the distribution of returns with the parametric approach used to market risk. On the other hand, however, there are also two criticisms of the model, the first concerns the concept of simultaneity between returns and spreads in the case of particularly adverse scenarios, according to the authors the two variables are positively correlated, but according to the critics the correlation is not strong enough to consider the simultaneity. The second criticism is about the lack of consideration of the volume of traded positions, excluding the endogenous component in the calculation of overall VaR.[43]

[43] LE SAOUT E., (2002)

# CHAPTER III

# EU-WIDE STRESS TESTING 2014, AN APPLICATION OF MACRO STRESS TEST

The first two chapters of this work provide a set of generic concepts on stress tests. Initially, it was provided a definition of stress tests, a panoramic on European stress tests since 2009 (CEBS) to 2016 (EBA), and subsequently, it was shown some analysis models of the three major banking risks. After an overall analysis, this chapter will describe in detail the stress test of 2014 set up by the European Banking Authority (EBA) with regard to 123 financial institutions in Europe, which will be the subject of empirical analysis, in the next chapter, to analyze their impact on the market.

The stress test of 2014 follows the much-criticized stress test of 2011, the main objective of the previous stress test was to assess the resilience of the banking system to different risk factors. This test was widely criticized for three important factors, the stress test scenarios were too lenient, and they didn't sufficiently stress important risk factors, such as sovereign risk and they considered only 90 banks with respect to stress test of 2014, in which the EBA has considered 123 banks. In contrast with EBA 2011, the stress test of 2014 has been run in conjunction with the Comprehensive Assessment, the most extensive analysis carried out by the ECB.[44] The Comprehensive Assessment started on 23 October 2013 when the ECB announced it would carry out, in cooperation with national supervisory authorities, a thorough assessment on the 130 major European banking groups. It has been divided into two parts, a first part, called Asset Quality Review, has reviewed the quality of the balance sheet assets of these institutions, and a second part, called stress test, has tested the strength of credit institutions during a hypothetical economic crisis scenario.[45]

The ECB had announced on 23 October 2013, the will to conduct a Comprehensive Assessment in preparation for entry into force one year later, i.e. 4 November 2014, under the name "Single Supervisory Mechanism", the body through which the ECB took over the tasks of direct supervision of credit institutions tested with depth assessment. The comprehensive assessment comprises three complementary pillars [46]:

[44] GASSMANN, P., WACKERBECK, P., CRIJNS, J. AND KARSTEN, C. (2014)
[45] BREUER, T. (2014)
[46] ECB (2013)

- A supervisory risk assessment, a preliminary analysis to determine the inherent risk profile of banks from several points of view, including liquidity, leverage and funding. It is a quantitative and qualitative analysis based on past information to assess the bank's intrinsic risk profile, the analysis tries to estimate the future position of bank in relation to its peers and its vulnerability to a number of exogenous factors
- The asset quality review (AQR) examines the asset side of bank balance sheets as at 31 December 2013. The aim is to enhance the transparency of bank exposures by reviewing the quality of banks' assets. This assessment is expansive and inclusive, including credit and market exposures, on and off-balance sheet positions and domestic and non-domestic exposures.
- A stress test, which integrated the asset quality review by providing a simulation of the capacity of banks to absorb possible shocks under baseline and adverse scenario. The ECB and the EBA worked in close cooperation and they explained all details about methodology and the scenarios that would have to analyze and the corresponding capital thresholds.

By the way, it should be clear that the stress tests conducted were two: one played by the ECB within the Comprehensive Assessment and one carried out by the EBA, both use the same assumptions. The stress test conducted by the EBA analyzed 123 banking groups, instead the stress test conducted by the ECB analyzed 130 banks. This difference is due to 27 banks subjected to the Comprehensive Assessment that have not participated in the EBA stress test as subsidiaries of other banks. Moreover 20 banks from countries outside the euro or the EU (Denmark, Poland, Hungary, Sweden, the United Kingdom and Norway) have not participated in the Comprehensive Assessment but took part in the EBA stress test.[47]

This work analyses in detail the stress test conducted by the EBA, in coordination with ESRB that provides a common scenario on which the stress test can be carried out and with the ECB that is responsible for ensuring that banks correctly apply the common methodology developed by the EBA. As said before the focus of the Union-wide stress tests is to assess the resilience of financial institutions to adverse market developments. The authority explained all methodologies to test banks about different risk factors under two scenarios. The stress test exercise is executed on a sample of 123 banking groups, including Norway, banks cover at least 50% of the national banking sector in each EU Member State, expressed in terms of total consolidated assets as of end of 2013, and 70% of total banking assets. The exercise has used

[47] ECB (2014)

a bottom-up approach, as said in Chapter I, in the bottom-up approach each individual bank performs the test using their own models, and successively the results are aggregated at the system for a comparison. Banks are subjected to two macro-economic scenarios, baseline scenario and adverse scenario, and the scenario covers the period of 2014 - 2016 starting from the consolidated year-end 2013. Considering a static balance sheet, zero growth assumption, for both the baseline and the adverse scenario, banks should replace assets and liabilities that mature within the time horizon of the exercise, with similar financial instruments in terms of type, credit quality and residual maturity as at the start of the exercise. About the assumption of static balance sheet, 26 banks use a dynamic balance sheet only if it is allowed and approved by the European Commission due to the restructuring plans publicly announced before the 31/12/2013. In addition, 6 banks from Cyprus, Ireland and Greece have seen approve restructuring plans by the European commission after the end of 2013, reference date. In addition, the exercise assumes that banks maintain the same business mix in term of products and geographical strategies throughout the time horizon.[48] All banks are required to stress common set of risks to see the impact of risk drivers on the solvency of banks. Both trading and banking book assets are subject to stress at the highest level of consolidation of the banking group. Banks are required to stress the following common set of risks: Credit risk; Market risk; Sovereign risk; Securitization; Cost of funding.

Although the primarily tested risks remains on credit and market risks, banks are also requested to assess the impact on interest income, including the increase in the cost of funding, during the all time horizon of stress test. A big difference with the stress test of 2011 is an increased consideration of sovereign risk not only in trading book (2011) but also in banking book.[49]

All these set of risks are used to see the impact of risk on the capital of banks, so the definition of capital is in term of Common Equity Tier 1, as defined in the Capital Requirements Regulation (CRR), and minimum hurdle rate across all participating banks are: Common Equity Tier 1 at minimum 8% for the baseline scenario; Common Equity Tier 1 at minimum 5.5% for the adverse scenario.

[48] EBA (2014a)
[49] EBA (2014b)

## 3.1. Baseline scenario

The baseline scenario is based on the previsions made by the Directorate General for Economic and Financial Affairs (DG ECFIN) of the European Commission. It produces three fully-fledged European Economic Forecasts per year – in winter, spring and autumn. The forecasts cover the principal macroeconomic aggregates for the European States, taking into account whole euro area and international environment. The projections for the 2014 are based on the forecast published by European Economic Forecast and cover only two-year time horizon.

The projections for the 2016 are based on a model-based approach, created only for the purpose of the stress test, because the Commission services has noticed how longer is the time horizon, higher is the chance of having errors connected to judgmental forecasts. The approach considers both the supply and demand side in term of output gap. With respect to the supply side, the approach takes into account technology, employment and capital formation as determinants of potential output. With respect to the demand side, there are three target variables: GDP, unemployment and inflation. All variables are driven by the closure of the output gap, only GDP forecast uses also the information from potential output.

The forecast highlights start from an economic recovery in the Europe area, considering the recovery in economic growth from the spring 2013 and in the three consecutive quarters.[50]

The setup of real GDP growth is of 1.5% in the EU and 1.2% in the euro area in 2014, activity grows faster in 2015 to 2.0% in the EU and 1.8% in the euro area. For 2016 the model-based has estimated project GDP growth of 1.8% in EU and 1.7% in the euro area. By the way, the forecast are based on the assumption that the European policy measures want to sustain improvements in confidence and financial conditions, these policies of potential growth are applied to each Member State.

The labor market is characterized by a high unemployment rate, even if there is a rise in employment from 2014. However, unemployment rate declines from 12% to 11.7% in the euro area and from 10.7% to 10.4% in EU in 2014 and 2015, for 2016 it reaches 10.1% in the EU and 11.3% in the euro area, with big differences between Member State. About consumer-price inflation is expected to prevail in the EU and the euro area in 2014 at rates of 1.2% and 1.0% respectively, before rising slightly at 1.5% in 2015, for 2016 is expected at 1.7%.

Nominal residential property prices in the EU are: 0.9% in 2014, 2.7% in 2015 and 3.8% in 2016; instead in the euro area the estimated increases in house prices will be more moderate

[50] EUROPEAN COMMISSION DIRECTORATE GENERAL ECONOMIC AND FINANCIAL AFFAIRS (2014)

over the forecast horizon: -0.2% in 2014, 2.1% in 2015 and 3.8% in 2016. For commercial property prices (CPP) is pretty equal to residential property prices, in fact it is 1% in 2014, 2.5% in 2015 and 3.6% in 2016 for EU; into euro area the CPP growth rate are equal 1.5% in 2014, 2.8% in 2015 and 3.4% in 2016 respectively. At the end, about interest-rate assumptions, there is a difference between Short-term interest rates and Long-term interest rate. The first is derived from futures contracts into euro area. The second is calculated using implicit forward swap rates, corrected for the current spread between the interest rate and swap rate for euro area and Member States.

## 3.2. Adverse scenario

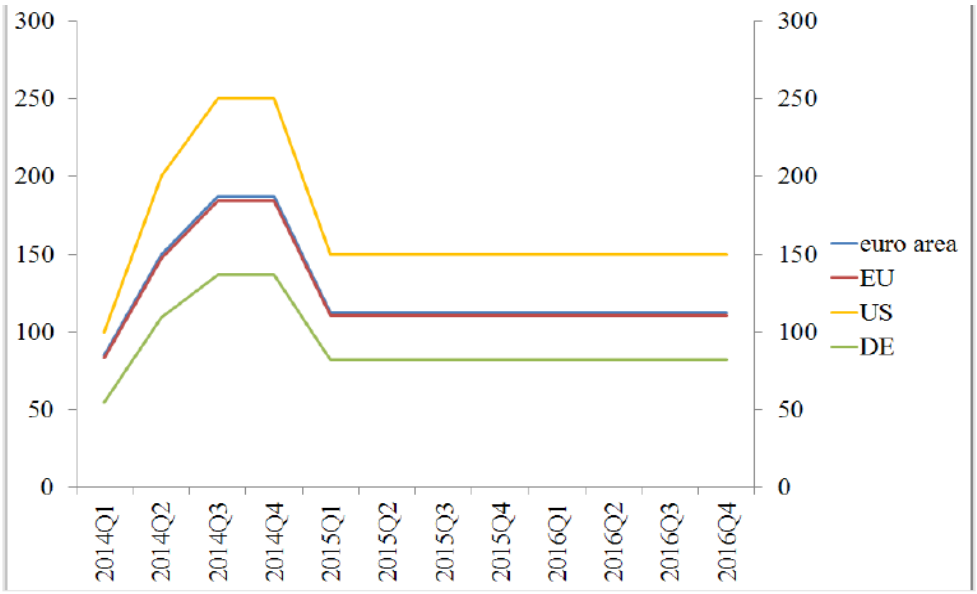
The aim of an EU-wide stress test is to assess the resilience of financial institutions to adverse market conditions. One crucial element to measure the elasticity of banks is the using of adverse market conditions under common methodologies. The adverse macroeconomic scenario is based on five elements, as GDP growth, inflation, unemployment, interest rates and stock prices, and covers the horizon 2014-16. The proposed adverse scenario was designed by the ESRB General Board in order to reflect the systemic risks, considered the most dangerous to the stability of the European banking sector. The scenario analyzes four different threats: Firstly, an increase in global bond yields amplified by a severe reassessment of risk, especially in emerging market economies (EMEs); Secondly, a further deterioration in credit quality in countries with weak domestic demand, with feeble fundamentals and a vulnerable banking sector; Thirdly, the failure to approve the reforms in politics and the consequences connected with the losses of the sustainability of public finances; and finally the lack of corrective actions on bank balance-sheets, this risk reflects doubts about the presence of public safety nets for the adjustment of bank balance-sheets.

In line with these risks, the adverse scenario starts from an increase in investor aversion to long-term fixed income securities. This causes an increase of US long-term interest rates, causing a global increase in long-term bond yields, a steepening of yield curves and an additional market problem in emerging markets. This affects particularly the group of countries identified as the “Fragile Five” (Brazil, India, Indonesia, South Africa and Turkey) and other BRICS. These financial effects have further important real economy spillover effects, especially for emerging market economies (EMEs). The latter, already weak economies show an increase of capital outflows, consequently become countries excluded

from international capital markets since they are perceived as too risky. At the same time, EMEs exhibit a reduction of their internal demand.

Generally, the worldwide negative effects bring a market deterioration of foreign demand for EU exports and a reduction of GDP growth. All these distresses lead a further weakening of EU real economic activity with consequences for banking sector. Turning to the specific calibration of these various shocks, the adverse scenario involves an increase in US long-term government bond yields. The rise in US long-term bond yields leads to a generalized upward shift in EU long-term interest rates, (as in Figure 2). Overall, the financial shocks have a sizeable negative impact on real economic activity worldwide, in Europe the impacts are especially on trade and on confidence about fixed investment and private consumption in all EU countries. This leads a slowdown of domestic demand across the EU countries. One consequence of reduction of domestic demand is the contraction of supply-side, in term of cost-push shocks which negatively affects total factor productivity (TFA), for example an increase in factor costs, in term of nominal wages and cost of capital.

Figure 2. Source: EBA 2014. Government bond yield shocks in US, EU, euro area and Germany




The sudden deterioration of the real and financial economic environment also destabilizes real estate markets, especially the price of residential property across the EU countries. The resulting shocks for the euro area is: -6.9% in 2014, -11% in 2015 and -11% in 2016, for the EU is: -8.7% in 2014, in 2015 and -14% at end-2016.

In addition, for the European banking system, beyond the shock to short-term interest rates, the adverse scenario also involves a generic shock for the access to funding of EU banks. The

ikjshocks to banks' access to funding are assumed to capture country-specific funding vulnerabilities, in term of cost of corporate credit and of interest margins on loans to households. This induces banks to reduce their credit standards on loans to the private sector, causing a negative impact on real economic activity. The funding shock results are equal to -0.04% in 2014, -0.09% in 2015 both for euro area and EU, they change for 2016 in which are equal to -0.12% for the euro area and -0.13% for EU.

The various financial and real shocks from the international environment (especially for trade and prices), cause a negative impact on economy activity. The most important measure is the GDP, the scenario leads to a growth rate of -0.7% in 2014, -1.4% in 2015 and 0% in 2016 for the euro area, in term of deviation from its baseline level, the results are equal to -1.9 percentage points (PP) in 2014, -3.2 PP in 2015, and -1.8 PP in 2016. For EU the real GDP growth is -0.7% in 2014, -1.5% in 2015 and 0.1% in 2016, the deviation from baseline level is to -2.2 PP in 2014, -3.4 PP in 2015, and -1.7 PP in 2016. Across the countries, the level of impact ranges from around -5.4% (Netherlands) to around -13.6% (Croatia).

As regards EU inflation, annual inflation rates for the Euro area are 1% in 2014, 0.6% in 2015 and 0.3% in 2016, with a deviation from baseline of -0.1 PP in 2014, -0.6 PP in 2015 and -1.3 PP in 2016. Annual inflation rates for the EU are 1.1% in 2014, 0.6% in 2015 and 0% in 2016, with a deviation from baseline of -0.1 PP in 2014, -1 PP in 2015 and -1.7 PP in 2016. Across the countries, the level of impact ranges from around -1% (Luxembourg) to around -8.8% (Sweden).

The adverse scenario also implies that the Euro area unemployment is higher than its baseline level, by 0.3 PP in 2014, 1.2 PP in 2015 and 2.2 PP in 2016. This implies an unemployment rate of 12.3% in 2014, 12.9% in 2015 and 13.5% in 2016. For EU the deviation is of 0.6 PP in 2014, by 1.9 PP in 2015 and by 2.9 PP in 2016. This translates in EU unemployment rates under the adverse scenario of 11.3% in 2014, 12.3% in 2015 and 13.0% in 2016. Across the countries, the level of unemployment ranges from -5.5% (Austria) to around -26.7% (Spain).

The shocks consider also the prices of residential property that implies deterioration with respect to their baseline level, of -8.7 PP in 2014, of -8.8 PP in 2015 and of -5.8 PP in 2016. On average, of EU house prices reduce of 21% compared to the baseline level in 2016. Across the countries, the level impact ranges from around -8% (Estonia) to -34% (Romania).

The scenario incorporates projections of commercial property prices (CPP) that show growth rates equal -2.4% in 2014, -2.5% in 2015 and -0.6% in 2016 in euro area. This implies that the CPP level under the adverse scenario stands about 12% below baseline levels in 2016. Across

the countries, the level of impact ranges from around -4% (Austria) to around -27% (the UK).[51]

## 3.3. Aggregate results

The application of two different scenarios, the baseline and the adverse scenario has conducted to significant results, contemplating the deterioration of different macro-economic variables to assess the resilience of European banking system. As said before, the test includes 123 banking groups across the 22 Member States with a total of EUR 28,000BN of assets covering more than 70% of total EU banking assets.

The resilience of banking sector is measured in term of Common Equity Tier 1 (CET1) ratio for which a 5.5% and 8.0% hurdle rate are defined for the adverse and the baseline scenario respectively, through the use of common set of risks and methodologies on the different scenarios. In mean, banks participating to the test have begun the exercise with a solid Capital, in fact the weighted average Common Equity Tier 1 Capital ratio is 11.5% at the end of 2013, which is above the minimum required and in line with international peers. After a reduction of 40bps due to the asset quality review, the starting capital ratio for the stress test is 11.1% Common Equity Tier 1 Capital. Comparing with the stress test of 2011, there is a huge increase of precautionary capital raisings. After the publication of results of the stress test of 2011, it was criticized because it was considered a lenient stress test. This has leaded a recapitalization of a lot of banks and an increase of capital preservation recommendation resulted in a significant and permanent injection of capital by the EBA. Consequently, capital ratios rose significantly. Since December 2011 until December 2013 the Core Tier 1 capital ratio, applying the EBA's definition used during the recapitalization exercise, increased from 9.2 in 2011, to 10.8% in 2012 and 11.6 % in 2013.

From the end-2013 to the next three years, the EBA registered a decrease of CET1 under the adverse scenario from 11.1 in 2013, to 9.8% in 2014, 9% in 2015 and 8.5% at the end-2016. The reduction is due to total capital deterioration of EUR 261BN over the three years of the exercise, including the impact of total risk exposure amount (EUR 67BN), the main reasons for this impact are credit losses (-440 basis point impact on CET1 Capital ratio), which is only marginally offset by continued earnings, and an increase in total risk exposure amount (risk weighted assets) with an impact of -110 basis point on the CET1 Capital ratio. This may be

[51] EUROPEAN SYSTEMIC RISK BOARD (2016)

the result of different drivers, the different characteristics of the scenario for different countries, the composition of banks' portfolios and their different business areas.

The results, published on 26 October 2014, show a failure to 24 participating banks to the stress test, in term of CET1 ratio under 5.5% into adverse scenario, these banks have failed the defined thresholds leading to an aggregate maximum capital shortfall of EUR 24.6BN. The weighted average of CET1 ratio of these 24 banks is 2% instead of 5.5%. Across the banks, the level of CET1 ranges from around -8% (Co-operative Central Bank Ltd (Cyprus) or -6.4% Eurobank Ergasis (Greece)), to around 5.2% (Banca Popolare Emilia Romagna (Italy) or 5% Dexia (Belgium)). In term of capital, the maximum shortfall is of 24.6BN, so distributed, from 4.63BN of Eurobank Ergasis (Greece), 4.25BN of Banca Monte Paschi di Siena (Italy) and 3.43BN of National Bank of Greece (Greece), to a very small shortfall of 0.03BN of Nova Kreditna Banka Maribor and Nova Ljubljanska banka (Slovenia) and 0.13BN of Banca Popolare Emilia Romagna (Italy). These are the results without consider the additional capital increased in 2014, accepted by ECB. [52]

On the other hand, the additional capital grown in 2014 by different banks has reduced the shortfall from 24.6BN to EUR 9.5BN and the number of banks from 24 to 14. The weighted average Common Equity Tier 1 Capital ratio is 1.5% instead of 5.5%. Across the banks, the level of CET1 ranges from around -6.4% Eurobank Ergasis (Greece) and -2.4% Banca Carige (Italy), to around 5% Dexia (Belgium) and 4.4% Nova Kreditna Banka Maribor (Slovenia).

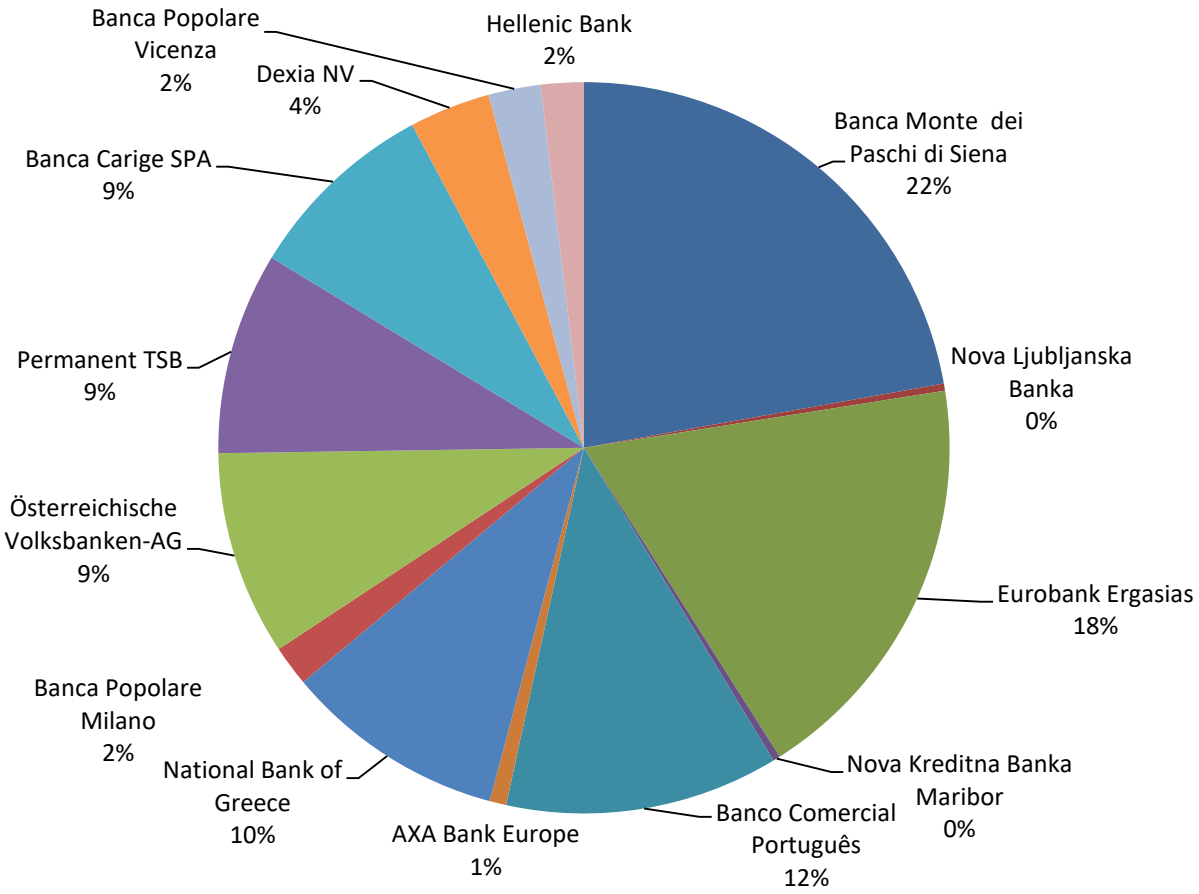
In term of capital, the shortfall under adverse scenario at the end-2016 after capital raised is of 9.52BN Euro, so distributed from 2.11BN of Banca Monte Paschi di Siena (Italy) and 1.76BN Euro of Eurobank Ergasis (Greece), and 1.15BN of Banco Comercial Português (Portugal), to a very small shortfall of 0.03BN of Nova Kreditna Banka Maribor and Nova Ljubljanska banka (Slovenia) and 0.07 of Axa Bank Europe (Belgium). Out of the 24 banks with a shortfall under the adverse scenario, 9 Italian banks had an aggregate shortfall of EUR 9.4BN. 3 Greek banks with EUR 8.7BN of aggregate shortfall – based on the static balance sheet assumption – and another 3 Cypriot banks with EUR 2.4BN of aggregate shortfall.

Banks experienced a shortfall not only in adverse scenario but also in the baseline scenario, with a capital threshold lower than 8%. In total, 24 banks experienced a shortfall in the adverse scenario, including the 16 banks with a shortfall in the baseline scenario. All banks report the maximum shortfall in the 2016 leading to an aggregate shortfall of EUR 9.4BN in the baseline scenario. Across the banks, the level of CET1 ranges from around 0.5% of Co-operative Central Bank (Cyprus), to around 32% BPI France (Banque Publique

[52] ACHARYA, V., STEFFEN, S., 2014.

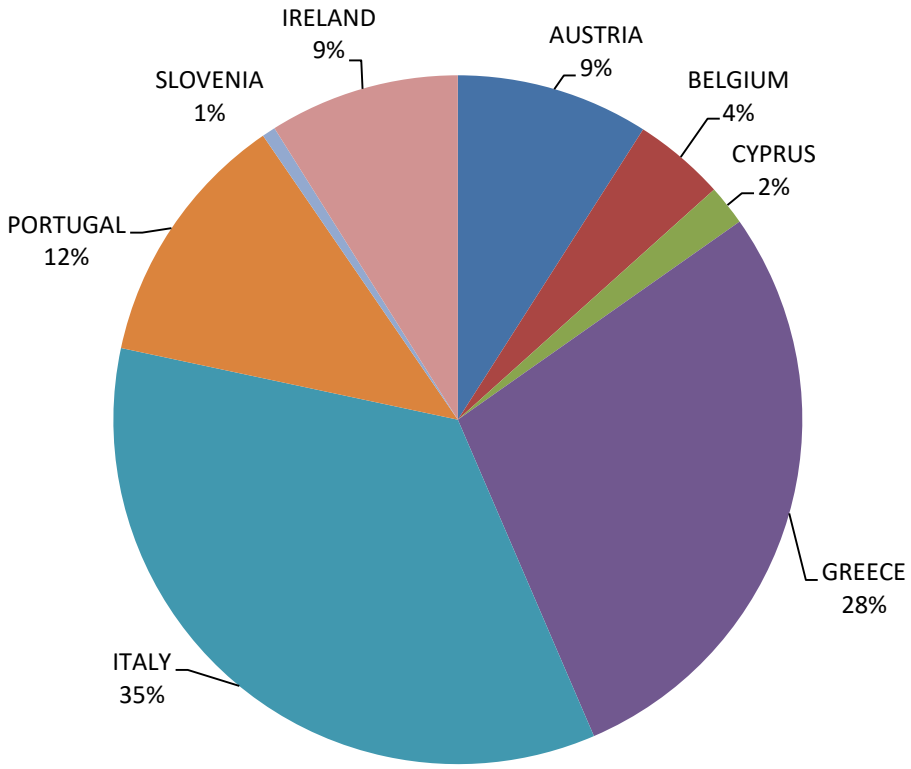
d'Investissement) in France. The next two graphs show the distribution of shortfall in the adverse scenario at the end of 2016 for each bank and country.

Graph 1: Allocation of 9.52 billion of shortfall for each bank under the adverse scenario[53]




[53] SOUCE: EBA RESULTS (OCTOBER 2014)

Graph 2: Allocation of 9.52 billion of shortfall for each country under the adverse scenario




After the publication of these results, the EBA required to each bank with a capital shortfall to increase the capital, through recapitalization or the reduction of costs. The meaning of stress test should be considered in a wide range that includes all banks participants to stress test and just those that failed the stress test. There are different common building blocks, which all participating countries have agreed:

- The stress test is relevant not only for banks that "fail" the stress test for lack of capital thresholds, but includes all banks participating. This increases the transparency of banking sector, publishing all detailed results for each country;
- The stress test can be used to understand the potential weaknesses of banks, considering all the vulnerabilities connected with each risk, from credit risk to funding risk, and possibly banks can begin different supervisory actions to recovery all potential losses. The primary supervisory action is connected to capital. Between capital actions there is the possibility to raise capital in short term, but if the weaknesses are so high, they can undertake other types of capital strengthening, including restrictions on dividends. In addition, there are other actions that might be considered, for example changing strategies and business of banks, reducing cost and

concentrations, improving or cleaning balance sheets by disposing of nonperforming loan and other riskiest assets.

For the banks who failed the stress test because have registered a capital threshold below the 5.5% under the adverse scenario, the ECB requires to recover the capital shortfall. Banks have to present capital plan to their competent authorities within two weeks after the disclosure of the results, in which they describe in detail how they intend to cover the shortfalls. Competent authorities have to control and they are responsible for assessing banks' plans and guarantee the implementation of the plans. Consequently, banks have six months to cover shortfalls arising from the baseline scenario, and nine months to cover shortfalls arising from the adverse scenario of the stress test.

The EBA controls each bank also after the approbation of capital plan to ensure that EU banks are well capitalized and can lend money to society without problem. Before 26 October 2014, banks have already done actions to mitigate the stress test capital impact and reduce the shortfall across the sample. In fact, between January and September 2014 the Common Equity Tier 1 Capital is increased of EUR 53.6BN as a result of capital increase or as a conversion of hybrid instruments. The additional capital has reduced the shortfall from EUR 24.6BN to EUR 9.5BN and the number of banks from 24 to 14. A significant proportion of the shortfall, i.e. EUR 8.7BN of EUR24.2BN in the adverse scenario, is due to 3 Greek banks that have approved a restructuring plan of EUR 6.36BN, the second country with a significant proportion of the shortfall is Italy, EUR 8.87 BN of EUR 24.2BN in adverse scenario, with a restructuring plan of EUR 8.16BN, both restructuring plans have been approved by the European Commission after the reference date for the stress test, 31/12/2013.[54]

## 3.4. Restructuring plan

As a result of the stress test, 14 banks have failed the test with a capital threshold below the 5.5% under the adverse scenario, the banks with a shortfall above 1BN are: Banca Monte dei Paschi di Siena with 2.11BN (Italy), Eurobank Ergasis with 1.76BN (Greece), Banco Comercial Português with 1.15BN (Portugal). As said before, each bank with a shortfall in the adverse scenario should repair in nine months, now it is explained how the different banks have recovered the losses.

[54] EBA (2014c)

Banca Monte dei Paschi di Siena in Italy is, undoubtedly, the bank with the maximum exposition to shortfalls, with EUR 2.11BN despite the recapitalization of EUR 2.14BN done between 1 January 2014 and 30 September 2014. Excluding these mitigation actions, the Common Equity Tier 1 Ratio of the Bank amounted to 2.7%. Following the publication of these results, the Bank submitted to the ECB the Capital Plan to fill the gap, within a period of nine months (i.e. by the end of July 2015). The Capital Plan was approved by the ECB on 10 February 2015 and includes the following main activities: an increase in the rights issue up to a maximum of EUR 2.5 billion; shares of non-dilutive for shareholders, represented by additional actions of capital management estimated at around Euro 220 million, as sales of holdings and non-core assets of the high capital absorption proprietary portfolio.[55]

The second bank for shortfall is the Eurobank Ergasis in Greece with a lack of EUR 1.76BN under the adverse scenario, also this bank has done a recapitalization of EUR 2.86BN but as for the National Bank of Greece with a shortfall of EUR 0.93BN, they have recovered all the amount during the 2014, due to the application of the dynamic balance sheet.

It is pretty the same for Banco Comercial Portuges (Portugal) that shows a shortfall of EUR 1.15BN but due to dynamic balance sheet, they have approved a measure for EUR 2.25BN in July 2014 to increase capital, this means it does not have to take any additional measures to strengthen its capital ratios. [56]

Banca Carige in Italy shows a shortfall of EUR 0.81BN after the recapitalization of EUR 1BN during 2014. To recover this loss the Board of Directors of the Bank approved the Capital Plan, by providing as key measures to increase share capital not less than EUR 500 million operations and asset disposal (divestment of the Group's operations in the insurance sector and in the private banking and consumer credit) and the reorganization of the minority interests of the subsidiary banks.[57]

Of the 8 remaining banks, Dexia (Belgium) with a shortfall of EUR 0.34BN, Thursday 22 May 2014 the ECB declared that Dexia bank is not able to bear a financial crisis in a European stress test, so they eliminate a further help from the State. In this way, the bank has begun the resolution and it was not necessary a capital increase. The capital shortfalls of Nova Ljubljanska Banka and Nova Kreditna Banka Maribor (Slovenia), both with a shortfall of EUR 0.03BN was covered by the measures taken in 2014 to structurally improve profitability and retain earnings. For the Hellenic Bank (Cyprus) with a shortfall of EUR 0.18BN after the recapitalization during the 2014, the deficit is covered by the conversion of convertible debt

[55] BANCA MONTE DEI PASCHI DI SIENA (2015)
[56] LUÍS COELHO AND RÚBEN PEIXINHO (2014)
[57] BANCA CARIGE (2015)

securities and issue of additional equity. Axa bank in Belgium, with a shortfall of EUR 0.07BN, it has not to make actions because it has sold non-core activities and raised capital during 2014. For Österreichische Volksbanken (OVAG in Austria) the shortfall is equal to EUR 0.86BN and to recovery this amount they decided to change the structure of business. Finally, in Italy the Banca Popolare di Milano equity gap, with a shortfall of EUR 0.17BN has been eliminated thanks to the removal of the add-on recognized by the Bank of Italy while that of Banca Popolare di Vicenza, with a shortfall of EUR 0.22BN has been filled thanks to the conversion of a bond issue.

# CHAPTER IV
# ANALYSIS OF EU-WIDE STRESS TEST 2014: THE IMPACT ON MARKET

In this chapter is explained the empirical analysis carried to understand the impact of stress test on the trend of stock prices of European banks. The stress test has an important impact because it considers a lot of banks, 123 banks in comparison with the 91 banks of 2011. The Authority has explained in detail the methodology and the timeline and it is an initial point to see if the European banking system is without asymmetric information and if investors know everything about banks.

From this point, the analysis starts from the hypothesis that the financial panic due to the crisis of 2008 is due to banking opacity. The reason is for the presence in banks' balance sheet of activity and financial exposures not transparent because does not exist a reference market in this way, it is difficult to understand and see the risk connected with these exposures.

The focus of stress test is to evaluate the resilience of financial institutions, considering the European banking sector as a whole, but at the same time giving the information about each bank of the sample, the stress test provides to investors general information about banking system reducing bank's opacity. To analyze if the stress test has triggered a stock market movement or if it has increased the information of the market, the model used is a statistical method called event study, in which it analyzes the behavior of a time series (typically bond yields or trading volume) in the period around the event (or in the specific event). The purpose of an event study is to assess its impact on economic series.

## 4.1. Bank's opacity

One of the reasons why the financial crisis of 2008 has created also a financial panic is due to bank opacity. The banking opacity means a difficulty in valuing opaque and heterogeneous securities for a lack of information. This leads an increase of price volatility and market risk, and creates an illiquidity market. There are different items about the opaqueness of the banks, compared to other firm. Rationally, it might be thought that banks are transparent, so the market is able to accurately assess the intrinsic true values of banks without asymmetric information.[58] Actually, economists disagree about whether banks are more opaque than other

[58] MORGAN, D. P., PERISTIANI, S., SAVINO, V. (2014).

types of firms. Morgan (2002) and Haggard and Howe (2007) analyze that banks are more opaque than industrial firms, while Flannery et al. (2004) provide evidence that banks are no more opaque. In detail, Morgan (2002) examines the ratings of new bonds issued by banks and industrial firms. He sees that there is disagreement between two major rating agencies (Moody's and Standard and Poor's) indeed the authors use the split bond rating as an indication of firm opacity. The disagreement derives from the loans and other types of assets that define banks, trading assets in particular, therefore they conclude that banks are more opaque than industrial firms. By contrast, Flannery et al. (2004) provide evidence that banks are no more opaque than other firms. Starting from the first paper of Flammery et al. (1999) and confirmed in the second paper Flannery, Nimalendran, and Kwan (2004), they conclude that banks are not particularly opaque. They use two proxies for firm's opacity: the stock's market microstructure properties and the ability of analysts to forecast firm earnings. If banks are not transparent, there is a difficulty for outsiders and investors to understand the real value of stocks, so they based their expectation on other trading characteristics, as their bid-ask spreads, trading volume and return volatility. By the way, equity analysts should have greater difficulty forecasting a more opaque firm's earnings and this implies that the firm is harder to understand. Flannery et al. have found that large bank holding companies (BHCs) have very similar trading properties in comparison with nonfinancial firms, instead the smaller BHCs differ quite substantially from their control sample. On the other hand, for the small BHCs, equity analysts predict their earnings more accurately than the control sample, instead for large BHC they consider the forecast of control sample. In conclusion, for Flannery et al. (2004), banks are no more opaque than industrial firms.

In reality, banks are opaque and the regulation and protection of banks are based on this assumption, which means that the market is unable to accurately assess the true value of banks. With opacity investors are not able to distinguish between trustworthy and untrustworthy institutions sample.

The lack of trasparency favored the financial crisis of 2008, because the shortcomings in the regulation has supported the transfer of risk outside the bank's balance sheet and its spread through the network of special purpose vehicles, that is, in fact, "vehicle" created specifically to spread financial instruments complex high-yield, but in turn at high-risk, or those who are called "toxic assets." The dangers inherent in such securities is derived mainly from their opacity, or the fact that proved virtually impossible to trace the loans that had originated them and identify the risk inherent potential. Initially, to reduce this opacity, banks decided to use a system of ratings, but implicitly also the system of rating is wrong because was based on unreal information and biased evaluation methods.

As a measure to contrast this opacity the supervisors have decided to introduce the stress test not only to measure the resilience of banking system, but also as measure to increase transparency and confidence in the banks, to prevent the bank run. Initially, the introduction of the stress test was greeted with a mixture of worry and skepticism by financial analysts, especially for the undercapitalized banks because analysts were unaware of the measures that would be taken according to the test results. As said, opacity is connected with the panic caused by the loss of information.

One of the focus of stress test in Europe as in US is the reduction of panic by improving the flow of information to investors reducing the asymmetric information. In fact the U.S. Treasury Secretary Timothy Geithner indicated as much in his statement of the SCAP results: "The stress test will help replace the cloud of uncertainty hanging over our banking system with an unprecedented level of transparency and clarity. The potential information value of the stress test is even more important given that banks are presumed to be relatively opaque even in ordinary times". For the European stress test 2014: "it also ensures that the stress test results can be effectively disseminated in a transparent and comparable fashion at an EU-level, with the publication of results in detail"

Actually, economists disagree about opacity of banks, consequently, there are three opposing hypotheses: banks are completely opaque, banks are completly transparent and an intermediate case that is a mix of previous hypotheses. At one extreme is the hypothesis that banks are completely opaques to the market, they are black boxes. In this case, it is expected that the market is surprised to know which banks have capital gaps and the size of the gaps. At the other extreme is the hypothesis that banks are completely transparent to the market, they are open books. In the intermediate case where banks are neither black boxes nor open books, the market is unsurprised to learn which banks have gaps, but they are surprised by the size of the gaps.[59]

One possibility to analize the bank's opacity is the use of a statistical method, called "event study", which demonstrates if banks react to particular event or not. The next paraghaph illustrates the methodology of event study and its application to European stress test of 2014.

[59] HAGGARD, K. S., AND J. S. HOWE. 2007.

## 4.2. Event study: methodology

Economists are interested to measure the effects of an economic event on the value of firms. It could be a difficult measurement, but there is a simple method called *event study* that could be used. The event study methodology is an econometric method of measuring security price reaction to some announcement or event. It is a useful tool to measure the event's economic and productivity impact. About economic impact, it can be constructed using equity prices observed over a long or short time period. About productivity impact, it can be constructed only by using many months or years of observations.

The event study has many applications, from event of specific firms to events of world economic. There are in literatures examples of mergers and acquisitions or earnings announcements, announcements of macroeconomic variables, for example, trade deficit or increase of unemployment. The application is based on the effect of an event on the price of a particular class of stocks.

The event- study was introduced in a seminal paper by Fama et al. (1969) and the focus is to give an accurate figure of realty, estimating the effect of the events on the selected firms or country, the application is wide. Before start, the model assumes rationality of the marketplace, this guarantees market efficiency based on movement of stock prices that reflects all information available to traders in financial market. Therefore, without asymmetric information, stock prices reflect the real value of securities. The paper introduces the methodology that is pretty similar to methodology in use today.

Successively, MacKinlay et al. (1997) discusses of this method in terms of applications in common equity, they identify the structure of an event study, dividing it in five main steps: event definition, selection criteria, normal and abnormal returns, estimation procedure and testing procedure.

For the first step, it is necessary to define the event of interest, if it is a single event or multiple, and identify the event window, the period over which the security prices involved in this event will be examined. In practice, the event window is larger than the specific period of interest, in fact it is expanded to multiple days, including minimum the day of the announcement and the day after the announcement. But it could be useful to consider not only the post-event, necessary to capture the reaction of investors to events, but also the pre-event dates, because it could incorporate information acquired before announcement.

The second step is the selection criteria and it is based on the selection of given firms that will be included into sample. The criteria is various, it can involve restrictions due to data

availability or membership in a specific industry. For the selection, the sample can consider determined characteristics (firm market capitalization, industry representation, country, distribution of events through time, etc.), take care any potential biases which may have been introduced through the sample selection.

The third step requires a measure of the normal and abnormal return. The event study tests in the event window. The normal return is defined as the expected return without conditioning on the event taking place. The normal return is measured as the normal behavior of the stock in the period before the event. The abnormal return measures if the return deviates statistically significant from normal return. The abnormal return is measured as the effective return minus the normal return of the firm over the event window. By the way, the abnormal return represents the yield component directly attributable to the event in question.

To this end, it is necessary to determine an econometric model that defines the normal behavior of the series, which will be the reference for evaluating the abnormality in correspondence of the event. Between the statistical models for estimating the expected return, some require the implementation of regressions on time series while other involve the use of simple average. The approaches available for MacKinlay (1997) can be divided into two groups, the first is based on statistical method and the second based on economic model. Statistical models depend only on statistical assumptions concerning the behavior of asset returns and do not depend on any economic theories. In contrast, models in the second category rely on assumptions concerning investors' behavior. It is necessary for the economic establish statistical assumptions. The value added of this method is the opportunity to measure the expected return more precisely thanks to using the economic restrictions. For the statistical models, the assumptions are that asset returns are jointly multivariate normal and independently and identically distributed through time.

Two are the techniques belonging to statistical methods mostly made used to model the normal return:

- Market model: A statistical model in which the abnormal return is calculated as the difference between the yield of the title in question and the yield of the reference market
- Constant mean return: a statistical method in which the abnormal return is calculated as the difference between the yield of the title in question and the mean yield of the title calculated in a period without event study.

There are two techniques also for the economic model for estimating normal return includes the Capital Asset Pricing Model (CAPM) and the Arbitrage Pricing Theory (APT).

- The CAPM is an equilibrium theory where the expected return of a given asset is determined by its covariance with the market portfolio. Model is common in event studies of the 1970s. However, the researchers have discovered deviations from the CAPM, compromising the validity of the model, consequently the use of CAPM is ended.
- The APT is an asset pricing theory where the expected return as calculated as a linear combination of multiple risk factors. But in the model there is one more important factor that moves as a market factor, and additional minor factors that have not explanatory power. The APT improves and eliminates the biases introduced by CAPM and this is the main potential gain of this model.

However, the completeness of statistical method eliminates the biases from economic model, in this way the statistical method dominates for event study. In particular, the Market model is preferable to the Constant Mean Model because it incorporates a removal of the portion of the return that is related to variation in the market's return.
For the analysis, it is assumed the existence of a relationship, usually linear, between the return of the stock and the return of market portfolio. In other word, for each stock i:

$$R_{i,t} = \alpha_i + \beta_i R_{mt} + \varepsilon_{i,t}$$
$$E(\varepsilon_{i,t} = 0) \text{ and } Var(\varepsilon_{i,t}) = \sigma^2_{\varepsilon t}$$

In which:

- $R_{i,t}$: Expected return for stock i in period t
- $\beta_i R_{mt}$: Expected return for market portfolio in period t
- $\alpha_i$: Intercept and the part of the return independent of market performance
- $\beta_i$: Constant measuring the expected change in $R_i$ under a given change in $R_m$
- $\varepsilon_{i,t}$ : Zero mean disturbance term

The return of single stock is calculated as follow:

$$R_{i,t} = \ln\left(\frac{P_{i,t}}{P_{i,t-1}}\right)$$

In this way, $R_{i,t}$ becomes the logarithm return of stock I at time t. It is useful to avoid problem connected with non-stationarity of data; the elements $\alpha_i$ , $\beta_i$ are parameters of market model and the estimation is through the technique of OLS (Ordinary Least Squares). As a proxy of market portfolio is resorted to the use of stock index.

After the estimation of $\hat{\alpha}_i$ and$\widehat{\beta_\iota}$, it is possible to calculate the axtected returns of the stock, using this formula:

$$E\left[R_{i,t}\right] = \widehat{\alpha_\iota} + \widehat{\beta_\iota} R_{mt}$$

For firm i and event date t the abnormal return is calculated as the difference between the return of the title in question and the normal return, the return in normal circumstances, without the event:

$$AR_{i,\tau} = R_{it} - E(R_{it}|X_t)$$

where $AR_{it}$, $R_{it}$, and $E(R_{it}|Xt)$ are the abnormal, actual, and normal returns respectively for time period t. Xt is the conditioning information for the normal return model.

The abnormal return is equal to the disturbance term of the market model estimated at the beginning of the model:

$$\widehat{\varepsilon_{\iota,t}} = R_{i,t} - (\widehat{\alpha_\iota} + \beta_i RM_t)$$

Between statistical properties, under the null hypothesis, the distribution of abnormal return could be approximated as a Normal with a zero conditional mean and conditional variance$\sigma^2\left(\widehat{AR_{\iota,t}}\right)$:

$$\sigma^2\left(\widehat{AR_{\iota,t}}\right) = \sigma_{\varepsilon i}^2 + \frac{1}{L_1}\left[1 + \frac{(R_{mt} + \hat{\mu}_m)^2}{\sigma_m^2}\right]$$

Where:

- $\sigma_{\varepsilon i}^2$ : the variance of disturbance term;
- $L_1$ : length of the estimation window of market model;
- $R_{mt}$: market return at time t;

- $\hat{\mu}_m$: the average return of the market observed in the estimation window;
- $\sigma_m^2$: the variance of market index.

Afterward the estimation of normal and abnormal return, the fourth step is the estimation procedure and period. The length of estimation window $L_1$ can usually be chosen to be large enough to estimate robust returns and make the second component of the variance of the abnormal return equal to zero. However, the length of window is not standard. The period has to be long enough to eliminate potential outliers.

At the end, the last step is the test procedure, it states the hypotheses and the test statistic to test whether the calculated abnormal returns differ significantly from the market return, typically it is used the t-test to test if abnormal return accumulated over the event window differ significantly from the market return.

The abnormal return observations are aggregated in order to draw overall inferences for the event of interest. The aggregation is along two dimensions, through time and across stocks. The first aggregation is through time for an individual stock and then the aggregation considers both stocks and time. The concept of a cumulative abnormal return is necessary to include multiple period event windows.

$$CAR_i(t_1; t_2) = \sum_{t_1}^{t_2} AR_{i,t}$$

Asymptotically, when $L_1$, length of the estimation window of market model, increases, the variance of CAR could be approximated as the following expression, remembering the abnormal returns are assumed independently:

$$\sigma_i^2(t_1; t_2) = (t_2 - t_1 + 1)\, \sigma_{\varepsilon i}^2$$

Therefore, it is possible to calculate the average abnormal returns aggregated through a determinate time window:

$$\overline{CAR}\,(t1;\ t2) = \frac{1}{N} \sum_{i=1}^{n} CAR_i(t_1\ ;\ t_2)$$

The assumption for the variance estimators is the not overlapping of the event windows of the N securities, therefore the covariance terms is zero, the variance is equal to:

$$\text{var}[\overline{CAR}(\text{t}_1; \text{t}_2)] = \frac{1}{\text{N}^2} \sum_{\text{i}=1}^{\text{n}} \sigma_{\text{i}}^2 (t_1; t_2)$$

Assuming that the average cumulative abnormal returns are distributed as a Normal distribution, the equation of CAR is equal to:

$$\overline{CAR}(\text{t}_1; \text{t}_2) \sim \text{N}[\text{o}; \text{var}\,[\overline{CAR}(t_1; t_2)]$$

In the absence of abnormal performance, the expected value of the cumulative prediction error is equal to zero.[60] To prove if there is a possible deviation from the expected value is abnormal or simply due to chance, it is necessary to estimate the statistical significance. It is possible to make inference on the average CAR, using a *t-stat*, calculated as the $\overline{CAR}(t_1;\ t_1)$ over its standard deviation, in which under the null hypothesis $H_0$ that affirms the event has no impact on the behavior of returns (mean or variance). The formula is:

$$T\ = \frac{\overline{CAR}(t_1;\ t_1)}{\sqrt{var[\overline{CAR}\ (t_1;\ t_2)]}}$$

To verify the validity of null hypothesis, it is necessary to compare the absolute value of *t-stat* with its critical value of reference distribution with n-k degree of freedom, where n is the number of observations and k is the number of parameters estimated in the market model.

If the null hypothesis $H_0$ is verified, it means the event has no impact on the behavior of returns, therefore potential discrepancy between the effective return and normal return it could be due to chance. On the other hand, if the null hypothesis is rejected and the CAR is statistically different from zero, it is possible to affirm that the abnormal returns are caused by the event.

In the literature there are a lot of authors that used event study to analyze stress test, in Europe as in US, for example, Cardinali and Nordmark (2011) analyzed the stress test of 2010 in Europe and the results showed as the stress test was uninformative to markets. In contrast, Resti and Petrella (2013) and Candelon and Sy (2015), they use a standard event study

[60] P. DODD AND G. B: WARNER. 1983

methodology to analyze the European stress test of 2011, and they discovered as was highly informative for all group of banks.
In the next paragraph will be analyzed the European stress test of 2014.

## 4.3. Empirical verification of impact on stock market

The main objective of this thesis is to understand the impact of European stress test of 2014 conducted by Eba on market price of main European banks. The objective is certified or not the hypothesis that different events, from the announcement to the results, have had an impact on stock market and the impact is statistically significant. The study could be useful to understand the bank's opacity, measured as market efficiency.
As said before, the bank's opacity is an important factor regarding the market efficiency. There are three opposite hypotheses that can be tested in this event study, banks are completely opaque, they are black boxes. Under this hypothesis, it is expected that the market is surprised that some banks have capital shortfalls so the investor is unable to evaluate the real value of the bank and the solidity of financial institution.
On the other opposite hand, banks are completely transparent, they are open book, and this means the market is perfectly efficient so there isn't asymmetric information. Under this hypothesis the market is able to estimate potential capital gaps and the size of the gaps.
At the end the intermediate case it seem the more realistic chance, it is a mix of previous hypotheses, where banks are neither black boxes nor open books, the market is unsurprised to learn which banks have gaps, but it is surprised by the size of the gaps.[61]

### Event definition

The event study is the technique used to manage the test, implemented following the model structured into five steps, the meaning of the test is analyze the trend of the banks' share prices belonging to a sample composed by the major financial institutions. The technique concerned the event windows next to the date in which EBA has communicated details regarding the stress test in question.
The event windows are various and divide into four groups, (-1, +1), (-2, +2), (-3, +3) and (-4, +4). From the shorter event window (-1, +1) that covered three-day windows, the day before and post event, to the longer windows (-4, +4), that covers nine-days windows, allow to

[61] MORGAN, D. P., PERISTIANI, S., SAVINO, V. (2014).

capture the leakage of news (before the event) and delayed market reactions (after the event). Although, the experiment covers various time windows, the standard time window is on five-days (-2, +2), that is considered more accurate, because covers the two days before event, as a leak before the formal announcement, and the two days post event, as a slow reaction to event. The table will show all results for all time windows, and in each window the time zero is at the time event. For the European stress test 2014 there are six events:

- **31 January 2014** (announcement): The European Banking Authority (EBA) announced the key components of the forthcoming 2014 EU-wide stress test that will be conducted on a wide sample of 123 EU banks. The EBA declared the objectives, the risks analyzed and the capital thresholds. It communicates that the methodology and scenario are expected to be published in April 2014 and that banks' individual results is expected to be released at the end of October;
- **4 March 2014** (preliminary draft): The EBA starts an informal discussion with banks on its preliminary draft methodology and templates for the stress test. Create an overview on stress testing methodology according to risk type and a preliminary template;
- **29 April 2014** (methodology): The EBA releases its methodology and macroeconomic scenarios for the simulation. It is based on a common methodology and underlying assumptions cover a wide range of risks. It explains the market and sovereign risk scenarios by country, designed by the ESRB, and differently from stress test 2011 the methodology explains in detail the sovereign risk and haircut for different country.
- **20 August 2014** (final template): The European Banking Authority publishes the final templates that all EU banks will have to use. Illustrate the type and the format of data that will be disclosed on a bank by bank basis. This guarantees the transparency of results and the availability of data.
- **10 October 2014** (publication date): The EBA announces that detailed individual results for all banks participating in the EBA EU-wide stress test, along with detailed balance sheets and exposure data as of end 2013, will be published on Sunday 26 October 2014 at 12:00 Central European Time.
- **26 October 2014** (results): The European Banking Authority publishes the results of the 2014 EU-wide stress test of 123 banks. It is a Sunday so the stock market is closed, it is not able to react immediately to event, in this way, for the event study the event considerate is the 27 October 2014.

## Selection criteria

In the case of this event study, the sample is composed by 80 European banks, 53 banks are banks participated to the stress test, called "banks tested" (for detail see Appendix 1). The remaining 27 banks are "banks not tested", they are not included in the sample of 123 banks participating to stress test but they belong to same countries of banks tested (for detail see Appendix 2).

The standard methodology is used to this event study, as described in previous paragraphs. The steps are the following; calculate the market model to see the normal and abnormal returns. To create a more precise model, the regression is chosen to two factors, the National Stock exchange index for each title and a specific Stock Exchange index of banks, in that case the Euro Stoxx Banks.

Both bank tested and banks not tested are estimated along an estimation window of 782 observations, to estimate the parameters more precisely, from the 1 January of 2011 to the 31 December of 2013 of closing prices. This estimation permits to determine a normal return to compare with effective return, during the event.

The market model is calculated as follow:

$$R_{i,t} = \alpha_i + \beta_{1i} R_{INDEX,t} + \beta_{2i} R_{Eurostoxx,t} + \varepsilon_i$$

Where:

- $R_{i,t}$ is the effective return of bank I at time t
- $R_{INDEX,t}$ is the National Stock Exchange Index of bank I at time t
- $R_{Eurostoxx,t}$ is the Stock Exchange index of banks, Euro Stoxx Banks;
- $\varepsilon_i$ is the disturbance term, and is expected equal to zero.

Increase the estimation window over 150/200 days, guarantees the robustness of results and permit to estimate parameters with the Ordinary Least Square (OLS) model.

## Normal and abnormal returns and statistical significance

As said in the previous paragraphs, once determined the market model, it is possible to measure the abnormal returns (AR). They are measured as the difference between the

effective return of bank at time t and the normal return, as predicted in Market model. It is calculated for each event date:

$$\widehat{AR_{i,t}} = R_{i,t} - \left(\hat{\alpha}_i + \widehat{\beta_{1i}} R_{INDEX,t} + \widehat{\beta_{2i}} R_{EUROSTOXX,t}\right)$$

The abnormal return observations are aggregated in order to draw overall inferences for the event of interest. For each event window is possible to calculate the Cumulative Abnormal Return, (CAR):

$$CAR_i(event\ window) = \sum_{t=min}^{max} AR_{i,t}$$

Then the procedure is applied for each bank i of the sample to determine the average cumulative abnormal returns. It is a good indicator to understand the effect of stress test on N banks tested over the banks not tested. The formula is:

$$\overline{CAR}(event\ window) = \frac{1}{N}\sum_{i=1}^{N} CAR_i(event\ window)$$

The test wants to measure if the CAR is different from zero, due to event, but it is necessary to use a t-test to see if the value is statistical significant or not.

Under the null hypothesis, $H_0 : \overline{CAR} = 0$, the event has no impact on the behavior of returns, the effective returns that is registered is perfectly in line with normal return. Under the alternative hypothesis, $H_0 : \overline{CAR} \neq 0$, this means that event changes the performance of banks with respect to investor's expectations. So if the alternative hypothesis is accepted, there is an abnormal return due to event. To prove if the deviation from the expected value is abnormal or simply due to chance, it is necessary to estimate the statistical significance. As said in previous paragraph the model uses the t-test with two tails, considering the bi-directionality of returns. The level of significant chosen is of 95%, so with a α of 0.05.

## 4.3.1. Results of empirical analysis and interpretation

After the estimation of market model and the abnormal return (AR) for each event window, with aggregation of AR to compute cumulative abnormal return (CAR), the last step is the economic and statistical interpretation of results. The focus is on the differentiation between the banks tested and the banks not tested, see if the average CAR is statistical significant. To better understand if market has all information to forecast what are the financial institutions with capital shortfalls and size of that, the model divides the sample banks according to their CET1 ratios after the adverse simulations. The best 8 banks, with CET1 above 11%, remembering that the minimum required is 5.5% under the adverse scenario, and the worst 8 banks with CET1 below 5%, after the capital raised during 2014, so are the worst banks despite restructuring plan during 2014. The scope is to verify if there are difference between the best and worst banks and if the results are statistical significant. [62]

The meaning of results could be divided into two parts, if the null hypothesis is accepted, both for tested and not tested banks; it means that the market is efficient so there aren't abnormal returns. The information is well known so the price reflects the true value of banks, banks could be considered transparent, "open book".

On the other hand, if the null hypothesis is rejected so the CAR is different from zero, it means effective returns of banks are not in line with normal return, but the discrepancy is due to the new information available to investors. The asymmetric information prevails, and the market is not able to predict the real value of banks, the banking system is not transparent.

Not all the events have an impact on stock prices, the most precise time window is (-2, +2) so the consideration is about this window. The test shows two tables, the first table is the gap between Euro Stoxx banks and the abnormal return of difference group of banks, in bold the big and significant gap. The second table shows the CAR and the t-test for each group of banks.

Starting from the first announcement, on 31 January 2014, the results are positive but not significant. Analyzing the information before the 31 January, it is clear that in October 2013 the EBA said that in January 2014 would start a stress test for the European financial institution. In the next months, precisely at the beginning of 2014, the European Central Bank, declared the number of banks participating to stress test. So the information is noted to the market before the 31 January, this explains why the returns of the sample are in line with Euro Stoxx banks (Table 1). In Table 2, is expressed the average cumulated return for all the

[62] URQUHART, A. 2014.

groups of banks, the CAR is positive, investors have appreciated the exercise to measure the resilience of banking sector, but the results are not consistent (Table 2), because the information is known.

Table 1: Comparison of Euro Stoxx Return before and after time window with each group of bank

| | GAP EURO STOXX, SAMPLE 31 JANUARY | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (- 1) | (+ 1) | (- 2) | (+ 2) | (- 3) | (+ 3) | (- 4) | (+ 4) |
| EURO STOXX BANKS: RETURN | 0,4157 | -2,9188 | 0,1055 | -0,7401 | 0,6558 | -0,1156 | 0,2679 | 0,5283 |
| TOTAL SAMPLE: ABNORMAL RETURN | 0,1535 | 0,1624 | 0,1174 | -0,0565 | 0,0531 | 0,1299 | -0,1457 | 0,1536 |
| BANKS TESTED: ABNORMAL RETURN | 0,2772 | -0,2336 | 0,1970 | -0,0209 | 0,0910 | 0,0968 | -0,1515 | 0,0759 |
| BANKS NOT TESTED: ABNORMAL RETURN | 0,0297 | **0,5584** | 0,0377 | -0,0922 | 0,0152 | 0,1630 | -0,1399 | 0,2313 |
| BEST 8 BANKS: ABNORMAL RETURN | 0,2973 | 0,1706 | 0,1542 | **0,4650** | -0,2781 | **0,3421** | -0,2928 | 0,1040 |
| WORST 8 BANKS: ABNORMAL RETURN | **1,2065** | **1,1727** | **0,3913** | **0,5489** | -0,0689 | **0,3795** | **-0,4003** | **0,4237** |

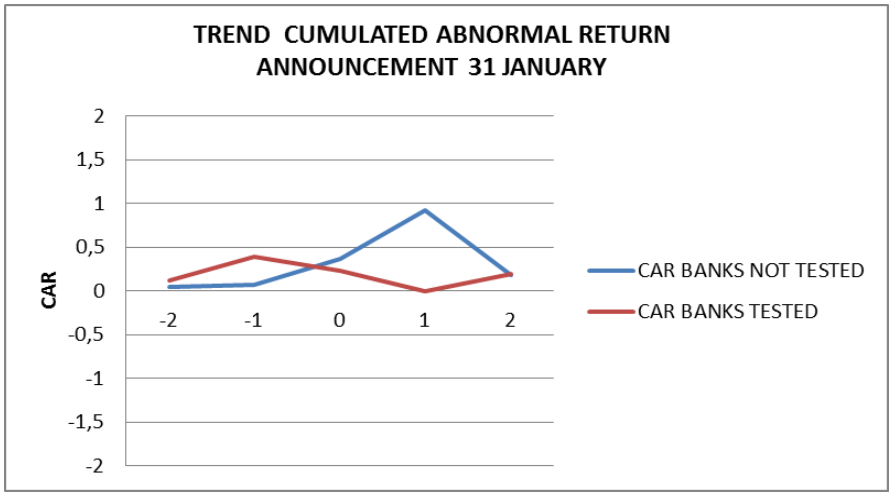
Table 2: Car and t-test – 31 January[63]

| | STOCK MARKET: ANNOUNCEMENT 31 JANUARY | | | |
|---|---|---|---|---|
| | (-1 + 1) | (-2 +2) | (-3 +3) | (-4 +4) |
| TOTAL SAMPLE | 0,24 | 0,3027 | 0,2231 | -0,5167 |
| T TEST | 0,7 | 1,48 | 1,15 | 1,9* |
| BANKS TESTED | 0,1175 | 0,2342 | 0,1134 | -0,7655 |
| T TEST | 0,22 | 0,67 | 0,39 | 2,10** |
| BANKS NOT TESTED | 0,3212 | 0,367 | 0,337 | -0,2679 |
| T TEST | 1,66* | 2,16** | 2,04** | 1,23 |
| BEST 8 BANKS | -0,1817 | -0,1706 | -1,3134 | -1,6503 |
| T TEST | 0,43 | 0,54 | 4,07*** | 4,95*** |
| WORST 8 BANKS | -0,2719 | -0,6957 | -1,685 | -3,0797 |
| T TEST | 0,34 | 1,32 | 3,74*** | 5,36*** |

The graph 3 explains the difference between CAR of tested and not tested banks in the event window (-2, +2), the most precise, there are not too much differences between two groups, they move before and after the event in a range between 0 to 0.5% of CAR.

[63] Notes: *** = 1%, ** = 5% and *= 10%, significance level.

Graph 3: trend of CAR (-2, +2) – 31 January




The second announcement is on 4 March 2014, it is a preliminary draft, in which the EBA starts an informal discussion with banks on its preliminary draft methodology and templates. The date of announcement is not noted but the contents of draft are noted from 3 February 2014 when the European Central Bank has defined the consequence for an eventually shortfalls and the timeline for the recovery. This is confirmed from results in Table 4; in fact they are not statistically significant. The CAR is positive for the total sample, for the banks tested and for the worst banks, probably for the possibility to recovery any losses in nine months and for the transparency of results. It is negative for banks not tested and for the best banks, this is confirmed also from the difference between Euro Stoxx banks results and the AR of these groups of banks, the negativity is very low, -0.15 PP for bank not tested and -0.12 PP for Best banks and it is not relevant. (Table 3)

Table 3: Comparison of Euro Stoxx Return before and after time window with each group of bank

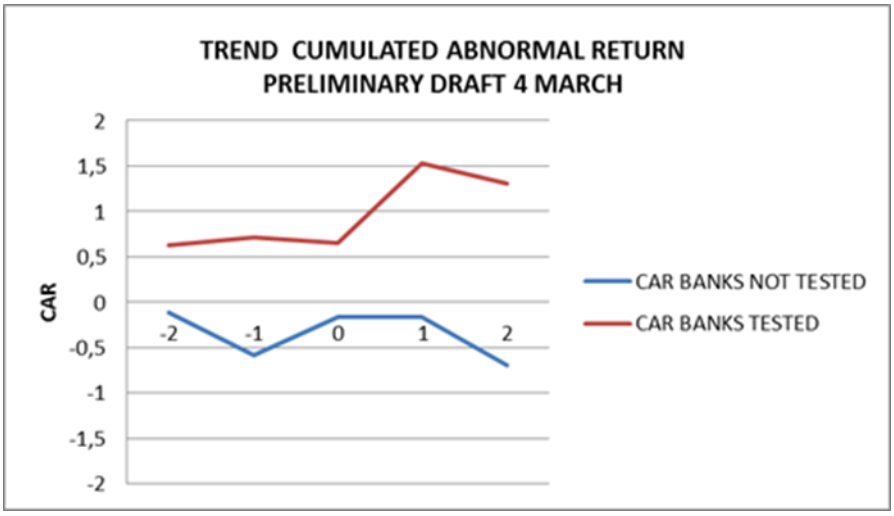
| | GAP EURO STOXX, SAMPLE 4 MARCH | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (- 1) | (+ 1) | (- 2) | (+ 2) | (- 3) | (+ 3) | (- 4) | (+ 4) |
| EURO STOXX BANKS: RETURN | -3,8439 | 1,3465 | -1,8560 | 1,0067 | -1,2081 | -0,0061 | -1,0585 | 0,1421 |
| TOTAL SAMPLE: ABNORMAL RETURN | -0,1891 | **0,4361** | 0,0347 | 0,0308 | 0,0489 | 0,0738 | -0,0664 | 0,1161 |
| BANKS TESTED: ABNORMAL RETURN | 0,0947 | **0,8782** | **0,3597** | **0,3324** | **0,3648** | 0,2893 | 0,1355 | 0,2949 |
| BANKS NOT TESTED: ABNORMAL RETURN | **-0,4730** | -0,0060 | -0,2904 | -0,2708 | -0,2670 | -0,1416 | -0,2684 | -0,0626 |
| BEST 8 BANKS: ABNORMAL RETURN | 0,0056 | -0,0199 | 0,0247 | -0,1962 | -0,1647 | 0,1423 | -0,1209 | 0,0414 |
| WORST 8 BANKS: ABNORMAL RETURN | **1,8109** | **4,1768** | 0,9541 | **1,5565** | **1,4223** | **1,0346** | **0,5410** | **1,2100** |

Table 4: Car and t-test – 4 March

| | STOCK MARKET: PRELIMINARY DRAFT 4 MARCH | | | |
|---|---|---|---|---|
| | (-1 + 1) | (-2 +2) | (-3 +3) | (-4 +4) |
| TOTAL SAMPLE | -0,0125 | 0,2528 | 0,3372 | -0,0891 |
| T TEST | 0,01 | 0,52 | 0,94 | 0,31 |
| BANKS TESTED | 0,0231 | 0,6477 | 1,0228 | 0,4704 |
| T TEST | 0,02 | 1,02 | 1,98** | 1,16 |
| BANKS NOT TESTED | -0,0481 | -0,1558 | 1,0228 | -0,6487 |
| T TEST | 0,08 | 0,42 | 1,98** | 2,71*** |
| BEST 8 BANKS | -0,1697 | -0,1258 | -0,6694 | -0,6588 |
| T TEST | 0,16 | 0,21 | 1,53 | 1,96** |
| WORST 8 BANKS | 0,6739 | 0,7711 | 3,13 | 1,0272 |
| T TEST | 0,58 | 0,86 | 3,23*** | 1,34 |

The Graph 4 shows as the two groups of banks are very different, the CAR (-2,+2) is alway negative for banks not tested, but close to zero and very positive for banks tested, investors appreciate the rigidity of stress test and the transparency.

Graph 4: trend of CAR(-2, +2) – 4 March




The third announcement is on 29 April 2014 and explains in details the methodology and scenarios of the stress test. Investors knew from the the first announcement that at the end of April the EBA would publish the methodology and macroeconomic scenarios for the simulation. The Table 5 shows that the return is in line before and after the event between each group of banks, but the situation change in the event date. The Table 6 shows as the CAR of the event date is negative and significant for the event window (-3, +3), the meaning is the worry of the investors for the scenario drafted, for the adverse scenario the EBA predicts a lot of losses and big haircut for sovereign scenario. The announcement causes a

negative CAR for each groups of banks, except for the best banks that is positive but close to zero. Important is the big losses of about 1 PP for the worst banks, worry for the probability of not pass the exam.

Table 5: Comparison of Euro Stoxx Return before and after time window with each group of bank

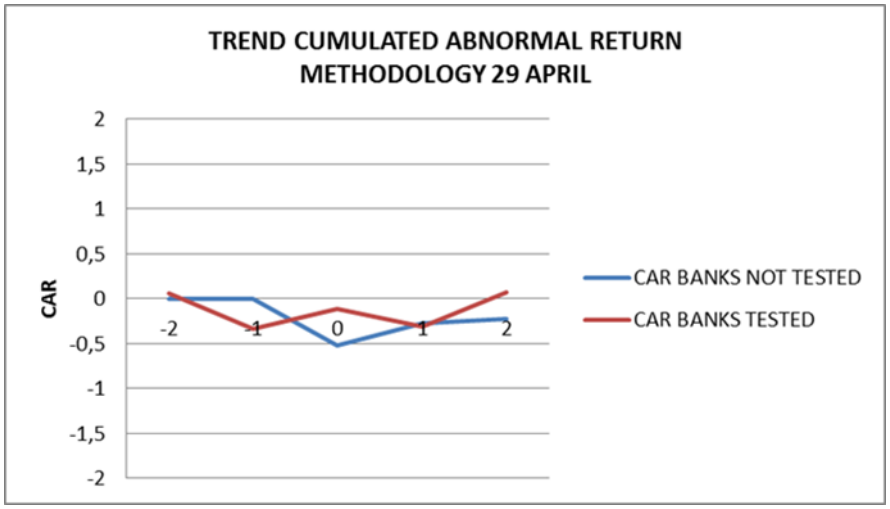
| | GAP EURO STOXX, SAMPLE 29 APRIL | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (- 1) | (+ 1) | (- 2) | (+ 2) | (- 3) | (+ 3) | (- 4) | (+ 4) |
| EURO STOXX BANKS: RETURN | 0,0985 | -1,1229 | -0,9912 | -0,5592 | -0,4816 | -0,4998 | -0,6108 | -0,4819 |
| TOTAL SAMPLE: ABNORMAL RETURN | -0,2000 | 0,0271 | -0,0852 | 0,1212 | -0,1842 | 0,2454 | -0,0924 | 0,2026 |
| BANKS TESTED: ABNORMAL RETURN | **-0,3952** | -0,1983 | -0,1676 | 0,0902 | -0,2494 | 0,2304 | -0,1015 | 0,1332 |
| BANKS NOT TESTED: ABNORMAL RETURN | -0,0048 | 0,2525 | -0,0029 | 0,1522 | -0,1190 | 0,2605 | -0,0834 | 0,2721 |
| BEST 8 BANKS: ABNORMAL RETURN | **-0,8872** | -0,0304 | **-0,3226** | 0,2918 | **-0,3897** | -0,0862 | -0,2369 | -0,0686 |
| WORST 8 BANKS: ABNORMAL RETURN | -0,1797 | -0,2916 | -0,3539 | 0,1544 | **-0,6580** | **0,8053** | -0,0793 | **0,6383** |

Table 6: Car and t-test – 29 April

| | STOCK MARKET: METHODOLOGY 29 APRIL | | | |
|---|---|---|---|---|
| | (-1 + 1) | (-2 +2) | (-3 +3) | (-4 +4) |
| TOTAL SAMPLE | -0,3558 | -0,30642 | -0,7006 | -0,5178 |
| T TEST | 1,2 | 1,46 | 3,60*** | 3,45*** |
| BANKS TESTED | -0,1734 | -0,1133 | -0,5263 | -0,184 |
| T TEST | 0,34 | 0,31 | 1,86* | 0,82 |
| BANKS NOT TESTED | -0,5229 | -0,524 | -0,5263 | -0,8517 |
| T TEST | 3,31*** | 4,30*** | 1,86* | 7,06*** |
| BEST 8 BANKS | -0,1228 | 0,1191 | -0,4048 | -0,183 |
| T TEST | 0,19 | 0,3 | 1,33 | 0,78 |
| WORST 8 BANKS | -0,4651 | -0,9932 | -2,2594 | -0,6025 |
| T TEST | 1,22 | 2,93*** | 4,39*** | 1,57 |

The Graph 5 shows as the CAR of banks tested and not tested is for both negative but close to zero from the two days before and after the event. They are in line with the market and with the negativity of the scenarios.

Graph 5: trend of CAR(-2, +2) – 29 April




The fourth event is on 20 August 2014 when the EBA published the final template that all EU banks will have to use. This guarantees the transparency of results and the public availability of data. This increases of transparency with respect to stress test 2011 and this could be a reason of negative CAR for all group of banks (Table 8). Among the data included in the template, there are those concerning the composition of the institutions of capital, risk-weighted assets, the income statement, exposure to government bonds, the credit risk and securitization. For the first time also the EBA will communicate to each bank to common equity tier 1 capital ratio (or CET1) which includes the Basel III rules applied at full capacity. The biggest difference are between the best and the worst banks, from -0.25 PP to 0.90 PP, both are not statistically significant.

Table 7: Comparison of Euro Stoxx Return before and after time window with each group of bank

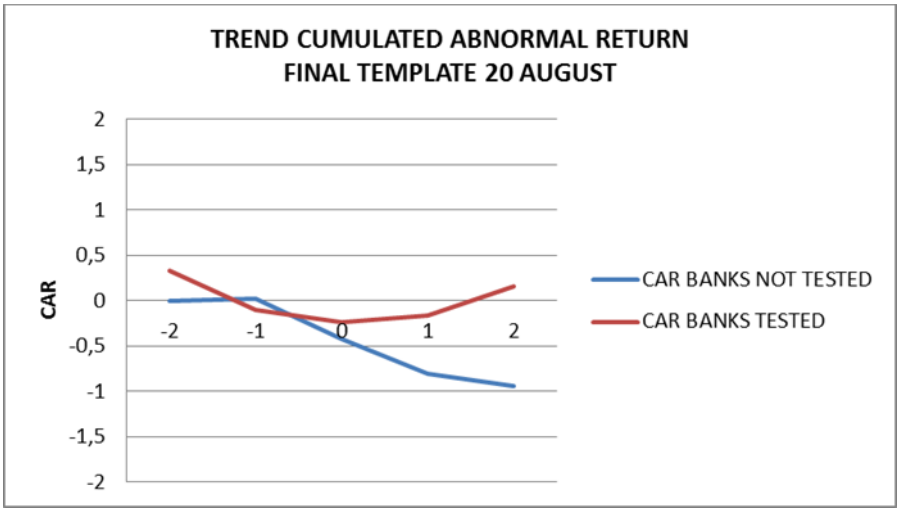
| | GAP EURO STOXX, SAMPLE 20 AUGUST | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (- 1) | (+ 1) | (- 2) | (+ 2) | (- 3) | (+ 3) | (- 4) | (+ 4) |
| EURO STOXX BANKS: RETURN | 0,4450 | 1,9325 | 0,8483 | 0,8954 | 0,3593 | 1,3638 | 0,1245 | 1,4586 |
| TOTAL SAMPLE: ABNORMAL RETURN | -0,2105 | -0,1485 | -0,0211 | -0,0317 | 0,0671 | -0,0602 | -0,0165 | -0,0015 |
| BANKS TESTED: ABNORMAL RETURN | **-0,4412** | 0,0764 | -0,0525 | 0,1974 | 0,0511 | 0,1463 | -0,0276 | 0,1581 |
| BANKS NOT TESTED: ABNORMAL RETURN | 0,0202 | **-0,3735** | 0,0102 | -0,2607 | 0,0830 | -0,2667 | -0,0054 | -0,1611 |
| BEST 8 BANKS: ABNORMAL RETURN | **-0,9620** | 0,1992 | **-0,3692** | 0,2073 | -0,1927 | 0,0586 | 0,0165 | -0,0668 |
| WORST 8 BANKS: ABNORMAL RETURN | **-0,9528** | **-1,6219** | -0,2049 | **-0,6459** | 0,2029 | 0,1334 | 0,0028 | 0,2000 |

Table 8: Car and t-test – 20 August

| | STOCK MARKET: FINAL TEMPLATE 20 AUGUST | | | |
|---|---|---|---|---|
| | (-1 + 1) | (-2 +2) | (-3 +3) | (-4 +4) |
| TOTAL SAMPLE | -0,4873 | -0,331 | -0,0891 | -0,354 |
| T TEST | 1,39 | 1,49 | 0,51 | 1,92* |
| BANKS TESTED | -0,5711 | -0,2349 | 0,0234 | -0,2404 |
| T TEST | 1,31 | 0,84 | 0,1 | 1,06 |
| BANKS NOT TESTED | -0,4245 | -0,4244 | 0,0234 | -0,4664 |
| T TEST | 1,56 | 2** | 0,1 | 2,45** |
| BEST 8 BANKS | -0,4675 | -0,2438 | -0,0836 | 0,5603 |
| T TEST | 1,12 | 0,78 | 0,36 | 3,40*** |
| WORST 8 BANKS | -1,3948 | -0,852 | 0,1664 | -0,431 |
| T TEST | 1,76* | 1,59 | 0,4 | 1,1 |

The Graph 6 shows how the two groups move in different way, the banks tested in the event have a negative CAR but then recovery all losses, instead the banks not tested continue to lose and the losses is statistical significant at 5%. One of reason could be a transfer of investment from banks not tested, considered riskiest than banks tested.

Graph 6: trend of CAR(-2, +2) – 20 August




On 10 October 2014, the EBA announces that detailed individual results for all banks participating in the EBA EU-wide stress test will be released Sunday 26 October 2014. This causes a big volatility of the market before and after the 10 October, as it shows in Table 9, for each group of banks except the best banks that move in line with the Euro Stoxx. The results is however negative for the event date and for each groups of banks, the CAR is -0.60 PP for the total sample and it is statistically significant at 1%. The worst banks lose less than best banks, but it is not statistically significant, because banks with problems of capital had

approved capital restructuring during the 2014, so the majority of banks thought that would pass the test. (Table 10)

Table 9: Comparison of Euro Stoxx Return before and after time window with each group of bank

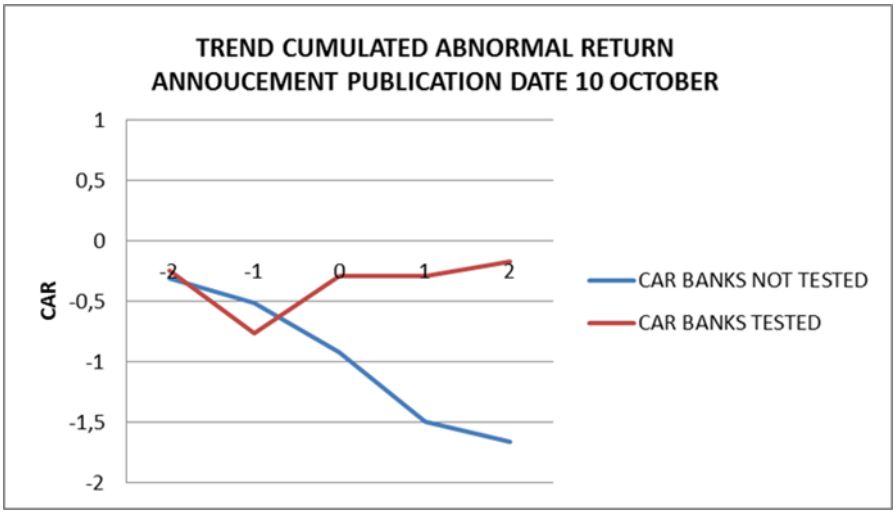
| | GAP EURO STOXX, SAMPLE 10 OCTOBER | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (- 1) | (+ 1) | (- 2) | (+ 2) | (- 3) | (+ 3) | (- 4) | (+ 4) |
| EURO STOXX BANKS: RETURN | -1,0609 | 0,3774 | -1,0536 | 0,0847 | -1,4075 | -1,5603 | -0,9064 | -1,6975 |
| TOTAL SAMPLE: ABNORMAL RETURN | **-0,3616** | -0,2896 | **-0,3178** | -0,1548 | -0,1473 | -0,0449 | -0,0395 | -0,0037 |
| BANKS TESTED: ABNORMAL RETURN | **-0,5206** | -0,0013 | **-0,3789** | 0,0617 | -0,1332 | 0,1539 | -0,0190 | 0,1648 |
| BANKS NOT TESTED: ABNORMAL RETURN | -0,2025 | **-0,5780** | -0,2567 | **-0,3714** | -0,1614 | -0,2437 | -0,0600 | -0,1723 |
| BEST 8 BANKS: ABNORMAL RETURN | 0,0569 | -0,1868 | -0,2913 | -0,0844 | -0,1542 | 0,0354 | -0,0867 | 0,0434 |
| WORST 8 BANKS: ABNORMAL RETURN | **-0,3862** | **-0,3572** | -0,1769 | **-0,4759** | -0,1674 | 0,2786 | 0,1533 | -0,0611 |

Table 10: Car and t-test – 10 October

| | STOCK MARKET: ANNOUNCEMENT PUBLICATION DATE 10 OCTOBER | | | |
|---|---|---|---|---|
| | (-1 + 1) | (-2 +2) | (-3 +3) | (-4 +4) |
| TOTAL SAMPLE | -0,329 | -0,6033 | -0,3984 | -0,1257 |
| T TEST | 1,83* | 4,75*** | 1,39 | 0,45 |
| BANKS TESTED | -0,0541 | -0,2913 | 0,0668 | 0,3906 |
| T TEST | 0,17 | 1,42 | 0,14 | 0,9 |
| BANKS NOT TESTED | -0,6045 | -0,9154 | 0,0668 | -0,642 |
| T TEST | 2,83*** | 4,5*** | 0,14 | 3,04*** |
| BEST 8 BANKS | 0,2451 | -0,3943 | -0,2743 | -0,1587 |
| T TEST | 0,7 | 1,39 | 0,76 | 0,51 |
| WORST 8 BANKS | -0,2392 | -0,2069 | -0,3553 | 0,76 |
| T TEST | 0,54 | 0,48 | 0,72 | 1,33 |

The Graph 5 shows how both CARs of banks not tested and tested is negative in all the time windows. Much more negative for the not tested banks as a results of big volatility in the days following the event.

Graph 7: trend of CAR(-2, +2) – 10 October




At the end, the last event is the day of results on 26 October 2014, it is Sunday so for the event study is used the 27 October. The result is positive for the total sample of 0.02 PP, so not relevant and not statistically significant. Important is the discrepancy in Table 11 in which it is clear that before the event, the big volatility creates positive returns especially for the worst banks, they do not expect to lose test. But after the release of results, the worst banks lose between 1.9% to 1.4% more than Euro Stoxx banks. This is confirmed in Table 12 in which the worst banks have a CAR of -4.23 PP and it is statistically significant at 1 %. On contrast the best banks earn 0.86 PP in the event and it is however relevant. In conclusion the most important thing of this event is that the market does not expect the big gap of capital shortfalls for worst banks and it is surprised for the CET1 of best banks.

Table 11: Comparison of Euro Stoxx Return before and after time window with each group of bank

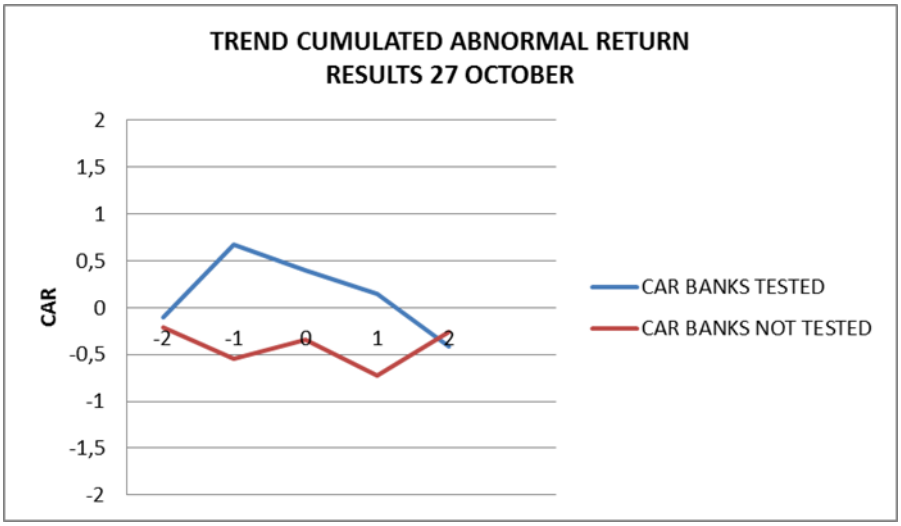
| | GAP EURO STOXX, SAMPLE 27 OCTOBER | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (- 1) | (+ 1) | (- 2) | (+ 2) | (- 3) | (+ 3) | (- 4) | (+ 4) |
| EURO STOXX BANKS: RETURN | 0,6957 | -0,3568 | 0,8974 | -1,2637 | 0,8495 | -1,0307 | 1,4596 | -0,2848 |
| TOTAL SAMPLE: ABNORMAL RETURN | 0,2225 | -0,1770 | 0,0311 | -0,1324 | 0,1178 | -0,1971 | 0,1278 | -0,2305 |
| BANKS TESTED: ABNORMAL RETURN | **0,7777** | -0,2629 | **0,3355** | **-0,3617** | 0,2096 | **-0,3091** | 0,2755 | **-0,4139** |
| BANKS NOT TESTED: ABNORMAL RETURN | **-0,3328** | -0,0911 | -0,2733 | 0,0970 | 0,0261 | -0,0852 | -0,0199 | -0,0470 |
| BEST 8 BANKS: ABNORMAL RETURN | 0,1491 | **0,8123** | -0,2012 | **0,6790** | -0,2543 | **0,4946** | 0,1345 | **0,3196** |
| WORST 8 BANKS: ABNORMAL RETURN | **1,1874** | **-1,5810** | 0,0829 | **-1,4142** | **0,5208** | **-1,3805** | 0,2041 | **-1,8791** |

Table 12: Car and t-test – 27 October

| | STOCK MARKET: RESULTS 27 OCTOBER | | | |
|---|---|---|---|---|
| | (-1 + 1) | (-2 +2) | (-3 +3) | (-4 +4) |
| TOTAL SAMPLE | 0,1876 | 0,0273 | 0,3186 | 0,4764 |
| T TEST | 0,46 | 0,09 | 1,27 | 1,58 |
| BANKS TESTED | 0,5078 | 0,401 | 0,3587 | 0,8321 |
| T TEST | 0,72 | 0,8 | 0,91 | 1,83* |
| BANKS NOT TESTED | -0,1325 | -0,3463 | 0,3587 | 0,1207 |
| T TEST | 0,8 | 2,64*** | 0,91 | 0,64 |
| BEST 8 BANKS | 1,4155 | 0,864 | 0,5035 | 1,8044 |
| T TEST | 3,38*** | 2,57*** | 1,85* | 5,11*** |
| WORST 8 BANKS | -3,2085 | -4,23 | -2,8336 | -3,5796 |
| T TEST | 1,7 | 3,52*** | 2,89*** | 3,45*** |

The Graph 8 demonstrates as the CAR of non-tested banks is negative but close to zero, due to the excess of volatility in the market and the contagion between banks on the market, important is the positivity of banks tested, perhaps for the good test of a lot of banks, the good restructuring plan during the 2014 that reduce the failed banks from 25 to 13.

Graph 8: trend of CAR(-2, +2) –27 October



### 4.3.2. Results and analysis for geographic area

An important analysis could be the trend and the CAR of different countries, the work selects six countries, (Italy, Portugal, Ireland, Belgium, Greece and Austria), are the six countries in which banks have registered capital shortfalls and have not passed stress test. At the beginning the banks that have lost the stress test were 25 from different states, but with the restricting plan executed during the 2014, the results showed a big reduction from 25 to 13 banks and in term of capital shortfalls, from 24.6BN to EUR 9.5BN. The analysis wants to deepen the event study dividing for geographic area, to see if there is correspondence with country risk. So a positive or negative effect could be independently or not from the stress test but connected to country, or it shows if country has an effect or not on the results. The objective is to measure not only the bank's opacity but also if belong to one country instead of other has in impact on national banks, if there is a contagion between banks belonging to same countries, regardless of CET1 and the presence of capital shortfalls.

The process is the same of before; the first table shows the gap between Euro Stoxx banks and the abnormal return of difference country, in bold the big and significant gap. The second table shows the CAR and the t-test for each country. As it can see the CAR is different from previous results, as a confirmation of big volatility in country riskiest.

On the first announcement of 31 January, the notice is noted and the returns are in line except for Portugal and Ireland that earn a lot before the event (Table 13). For the Table 14, the CAR is positive on average and statistical relevant at 1%, it confirms the results of the total sample, so investors appreciate the transparency and the will to stress and measure the banks.

Table 13: Comparison of Euro Stoxx Return before and after time window with countries

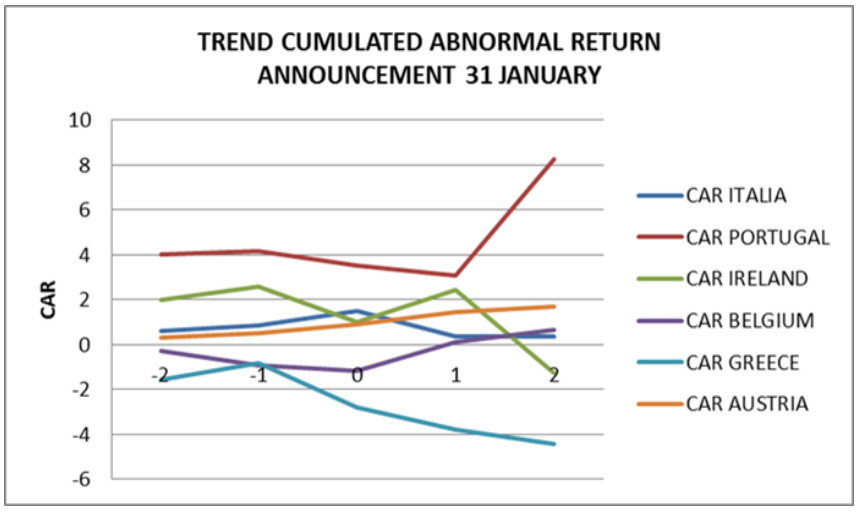
| | GAP EURO STOXX, SAMPLE 31 JANUARY | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (- 1) | (+ 1) | (- 2) | (+ 2) | (- 3) | (+ 3) | (- 4) | (+ 4) |
| EURO STOXX BANKS: RETURN | 0,4157 | -2,9188 | 0,1055 | -0,7401 | 0,6558 | -0,1156 | 0,2679 | 0,5283 |
| ITALY: ABNORMAL RETURN | 0,2740 | **-1,1357** | 0,4400 | -0,5601 | -0,3437 | 0,0595 | **-0,9647** | 0,1442 |
| PORTUGAL: ABNORMAL RETURN | 0,1332 | -0,4481 | **2,0872** | **2,3694** | 0,7674 | **1,7475** | 0,5464 | 0,7510 |
| IRELAND: ABNORMAL RETURN | 0,6346 | **1,4434** | **1,3041** | **-1,1316** | **2,1879** | -0,7938 | 0,8614 | -0,4572 |
| BELGIUM: ABNORMAL RETURN | -0,6450 | **1,2804** | -0,4577 | 0,9222 | -0,3257 | 0,3374 | -0,1387 | -0,2783 |
| GREECE: ABNORMAL RETURN | 0,7371 | -0,9966 | -0,4201 | -0,8035 | 0,3479 | **-1,1620** | 0,5545 | -0,5547 |
| AUSTRIA: ABNORMAL RETURN | 0,1674 | 0,5021 | 0,2501 | 0,3900 | -0,2852 | 0,1255 | -0,3932 | 0,0251 |

Table 14: Car and t-test – 31 January[64]

| | STOCK MARKET: ANNOUNCEMENT 31 JANUARY | | | |
|---|---|---|---|---|
| | (-1 + 1) | (-2 +2) | (-3 +3) | (-4 +4) |
| ITALY | 0,8907 | 1,4967 | -0,4142 | -3,2421 |
| T TEST | 0,79 | 2,06** | 0,71 | 3,85*** |
| PORTUGAL | -0,5152 | 3,5259 | 1,6537 | 1,5372 |
| T TEST | 0,64 | 2,05** | 1,3 | 1,45 |
| IRELAND | -0,9654 | 1,008 | 4,9635 | 1,8455 |
| T TEST | 1,4 | 1,1 | 4,17*** | 2,12** |
| BELGIUM | -0,9018 | -1,1721 | -1,2338 | -0,8114 |
| T TEST | 2,03** | 2,70*** | 3,30*** | 3,85*** |
| GREECE | -1,2237 | -2,8009 | -0,9171 | 0,2572 |
| T TEST | 0,69 | 1,84* | 0,85 | 0,28 |
| AUSTRIA | 0,5977 | 0,9304 | -0,4252 | -1,1423 |
| T TEST | 2,02** | 2,91*** | 2,24** | 5,01*** |

The CAR is in line with the announcement indeed also after the event it remains stable, except for Portugal (increases) and Greece (decreases) but the difference is due to the big amount of non-performing loans for Greece and for Portugal. For the latter, Standard & Poor's announced that they no longer long-term government bonds on negative watch, so the exit from recession and the positive announcement from S&P gives liquidity to the market.

Graph 9: trend of CAR(-2, +2) of countries –31 January




The announcement of 4 March of preliminary draft, known from 3 February 2014, has a positive effect and statistically significant only for Italy and Ireland for the good news over the possibility to pass the exam, instead has a negative effect for Greece that lose the 5.46% and it is statistically significant, the explanation is on the fact that Troika has accepted a lower

[64] Notes: *** = 1%, ** = 5% and *= 10%, significance level.

standard capital ratio, to pass the exercise, so investors receive an insecurity in Greek banks. For other country the returns of announcement are not relevant and before and after event they are stable (see the Table 15 and Graph 8).

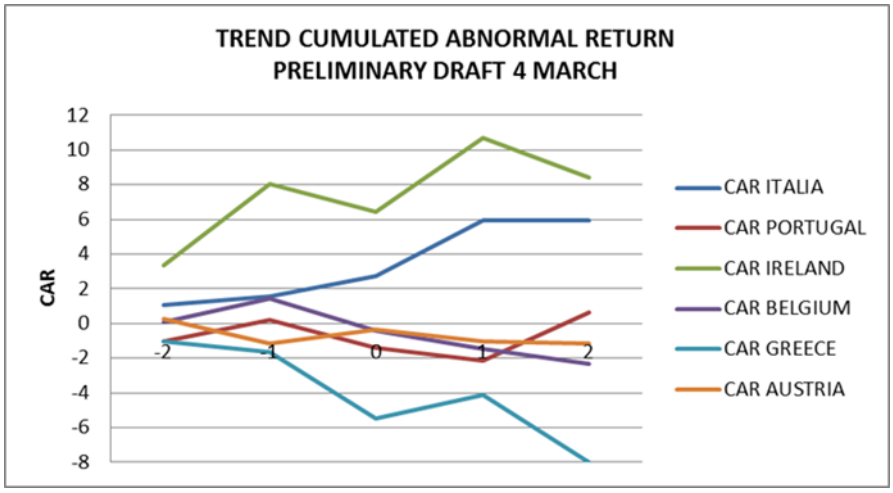
Table 15: Comparison of Euro Stoxx Return before and after time window with countries

| | GAP EURO STOXX, SAMPLE 4 MARCH | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (- 1) | (+ 1) | (- 2) | (+ 2) | (- 3) | (+ 3) | (- 4) | (+ 4) |
| EURO STOXX BANKS: RETURN | -3,8439 | 1,3465 | -1,8560 | 1,0067 | -1,2081 | -0,0061 | -1,0585 | 0,1421 |
| ITALY: ABNORMAL RETURN | 0,5213 | **3,1914** | 0,7800 | **1,5892** | **1,1308** | **1,1939** | **0,9372** | **0,9922** |
| PORTUGAL: ABNORMAL RETURN | **1,2378** | -0,6964 | 0,1039 | **1,0285** | -0,2975 | 0,8408 | 0,0566 | **0,9995** |
| IRELAND: ABNORMAL RETURN | **4,6850** | **4,2989** | **4,0143** | **0,9888** | **3,5869** | **1,6230** | **2,2552** | 0,4317 |
| BELGIUM: ABNORMAL RETURN | **1,3807** | **-1,0266** | 0,7232 | -0,9289 | 0,1784 | -0,6556 | 0,0145 | -0,4095 |
| GREECE: ABNORMAL RETURN | -0,6163 | **1,3670** | -0,8186 | **-1,2826** | -0,4421 | **-2,6874** | **-1,4033** | **-1,3533** |
| AUSTRIA: ABNORMAL RETURN | **-1,4103** | -0,6839 | -0,5837 | -0,3978 | -0,5120 | -0,3292 | -0,4842 | -0,3624 |

Table 16: Car and t-test – 4 March

| | STOCK MARKET: PRELIMINARY DRAFT 4 MARCH | | | |
|---|---|---|---|---|
| | (-1 + 1) | (-2 +2) | (-3 +3) | (-4 +4) |
| ITALY | 1,7004 | 2,7391 | 4,5715 | 4,9281 |
| T TEST | 0,86 | 2,06** | 3,51*** | 4,09*** |
| PORTUGAL | -0,391 | -1,421 | -2,5212 | -1,4023 |
| T TEST | 0,29 | 1,28 | 2,89*** | 2,02** |
| IRELAND | 3,0804 | 6,4241 | 9,156 | 7,4163 |
| T TEST | 1,97** | 3,63*** | 4,72*** | 4,45*** |
| BELGIUM | -0,509 | -0,4434 | -1,3544 | -1,8319 |
| T TEST | 0,5 | 0,64 | 2,16** | 4,09*** |
| GREECE | -4,4407 | -5,4617 | -5,1507 | -9,4375 |
| T TEST | 4,13*** | 4,29*** | 3,54*** | 5,01*** |
| AUSTRIA | -0,5743 | -0,3315 | -0,7001 | -1,1011 |
| T TEST | 0,59 | 0,55 | 1,58 | 2,86*** |

Graph 10: trend of CAR(-2, +2) of countries – 4 March




The day of methodology Table 18, the CAR is negative on average but it is statistical significant only for Belgium, Greece and Austria. For Greece the CAR is positive, 2.16 PP, because in the day before the Troika promotes the restructuring policy of banks. For Belgium the CAR is negative, -2.8% PP for the condition of Dexia bank. The gap shows a positive discrepancy for Ireland and negative for Greece, after the event Greece is in line with the other banks (Graph 11).

Table 17: Comparison of Euro Stoxx Return before and after time window with countries

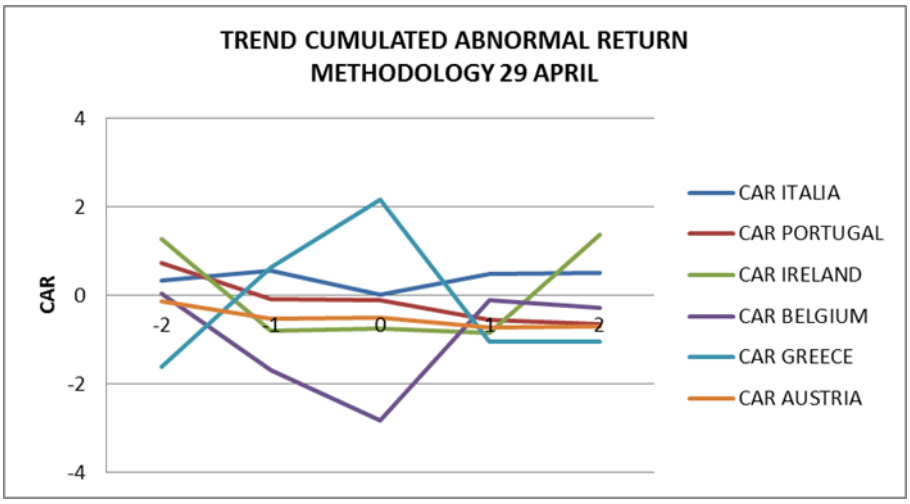
| | GAP EURO STOXX, SAMPLE 29 APRIL | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (- 1) | (+ 1) | (- 2) | (+ 2) | (- 3) | (+ 3) | (- 4) | (+ 4) |
| EURO STOXX BANKS: RETURN | 0,0985 | -1,1229 | -0,9912 | -0,5592 | -0,4816 | -0,4998 | -0,6108 | -0,4819 |
| ITALY: ABNORMAL RETURN | 0,2309 | 0,4546 | 0,2809 | 0,2403 | 0,1687 | 0,3404 | 0,0564 | 0,1712 |
| PORTUGAL: ABNORMAL RETURN | -0,8092 | -0,4547 | -0,0355 | -0,2699 | -0,6986 | -0,6196 | -0,5960 | -0,5476 |
| IRELAND: ABNORMAL RETURN | **-2,0697** | -0,0987 | -0,3983 | **1,0601** | **-1,0919** | 0,4562 | -0,4191 | 0,3716 |
| BELGIUM: ABNORMAL RETURN | **-1,7180** | **2,7160** | -0,8357 | **1,2682** | -0,6463 | 0,6235 | -0,7703 | 0,8787 |
| GREECE: ABNORMAL RETURN | **2,2419** | **-3,2142** | 0,3191 | **-1,6036** | -0,1924 | 0,4717 | 0,4725 | 0,2436 |
| AUSTRIA: ABNORMAL RETURN | -0,3983 | -0,2283 | -0,2587 | -0,1058 | -0,4119 | -0,0516 | -0,3435 | -0,1625 |

Table 18: Car and t-test – 29 April

| | STOCK MARKET: METHODOLOGY 29 APRIL | | | |
|---|---|---|---|---|
| | (-1 + 1) | (-2 +2) | (-3 +3) | (-4 +4) |
| ITALY | -0,3063 | 0,0245 | -0,0312 | -0,3118 |
| T TEST | 0,59 | 0,05 | 0,09 | 1,08 |
| PORTUGAL | -0,8404 | -0,1022 | -2,1268 | -2,41506 |
| T TEST | 1,07 | 0,2 | 3,58*** | 4,28*** |
| IRELAND | -2,0091 | -0,7361 | -3,215 | -1,6157 |
| T TEST | 2,33** | 1,14 | 4,85*** | 3,53*** |
| BELGIUM | -2,8559 | -2,8093 | -3,0766 | -4,2192 |
| T TEST | 3,13*** | 5,02*** | 7,19*** | 1,08 |
| GREECE | 3,7663 | 2,1626 | 0,9473 | 3,4146 |
| T TEST | 3,29*** | 2,79*** | 1,03 | 4,12*** |
| AUSTRIA | -0,3683 | -0,4874 | -1,2057 | -1,3438 |
| T TEST | 1,12 | 2,06** | 4,6501*** | 5,41*** |

The Grafh 11 shows as Greece and  Belgium move in opposite side at time zer, but then all countries are in line, close to zero.

Graph 11: trend of CAR(-2, +2) of countries – 29 April




The publication on 20 August of tempatle that EBA will decide to use in October generates a big volatility in the market expecially after the announcement. The reason is the detail of templates. Table 20 shows as the CAR is negative and significant for Portugal (-3.6PP) and for Austria (1.4 PP)

Table 19: Comparison of Euro Stoxx Return before and after time window with countries

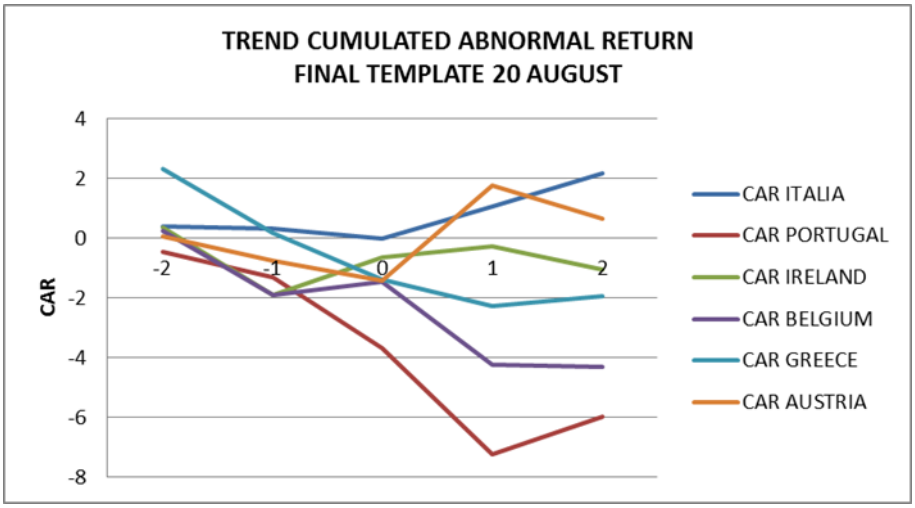
| | GAP EURO STOXX, SAMPLE 20 AUGUST | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (- 1) | (+ 1) | (- 2) | (+ 2) | (- 3) | (+ 3) | (- 4) | (+ 4) |
| EURO STOXX BANKS: RETURN | 0,4450 | 1,9325 | 0,8483 | 0,8954 | 0,3593 | 1,3638 | 0,1245 | 1,4586 |
| ITALY: ABNORMAL RETURN | -0,0717 | **1,0648** | 0,1684 | **1,1008** | -0,0712 | 0,6691 | -0,0712 | 0,6691 |
| PORTUGAL: ABNORMAL RETURN | -0,8426 | **-3,5656** | -0,6511 | **-1,1540** | -0,5887 | -0,5103 | -0,0027 | -0,4786 |
| IRELAND: ABNORMAL RETURN | **-2,2472** | 0,3844 | -0,9471 | -0,1969 | 0,0419 | **1,0932** | 0,2792 | **1,0697** |
| BELGIUM: ABNORMAL RETURN | **-2,1488** | **-2,7679** | -0,9401 | **-1,4269** | -0,1268 | -0,8398 | -0,3333 | -0,8924 |
| GREECE: ABNORMAL RETURN | **-2,1305** | -0,8745 | 0,0933 | -0,2725 | 0,0309 | -0,2995 | -0,1891 | -0,2550 |
| AUSTRIA: ABNORMAL RETURN | -0,8106 | **3,1755** | -0,3747 | **1,0370** | -0,2279 | 0,8319 | -0,2193 | 0,6411 |

Table 20: Car and t-test – 20 August

| | STOCK MARKET: FINAL TEMPLATE 20 AUGUST | | | |
|---|---|---|---|---|
| | (-1 + 1) | (-2 +2) | (-3 +3) | (-4 +4) |
| ITALY | -0,42 | -0,0115 | 0,3219 | -0,633 |
| T TEST | 0,5 | 0,02 | 0,71 | 1,38 |
| PORTUGAL | -3,2039 | -3,6636 | -4,1276 | -2,3723 |
| T TEST | 2,24** | 2,60** | 3,28*** | 2,43** |
| IRELAND | -0,9925 | -0,6395 | 1,3802 | 2,3713 |
| T TEST | 1,12 | 1,12 | 1,96** | 3,32*** |
| BELGIUM | -1,7262 | -1,4576 | 0,0421 | -0,9104 |
| T TEST | 1,96** | 1,61 | 0,06 | 1,38 |
| GREECE | -3,6877 | -1,3706 | -1,4646 | -2,3136 |
| T TEST | 1,99** | 1,33 | 1,89* | 3,09*** |
| AUSTRIA | -1,4721 | -1,411 | -1,3451 | -1,5385 |
| T TEST | 1,23 | 1,96** | 2,58*** | 3,73*** |

From the Graph 12, it can note as in the time window (-2,0) they move close to each other, instead after the event so (0, +2) they lose value expecially the next day, 21 August. The great depressions are for Portugal 0 PP to – 6 PP and for Belgium from 0 PP to – 4 PP. In general all the banks show a contagion.

Graph 12: trend of CAR(-2, +2) of countries – 20 August




On 10 October 2014 the EBA declared that on 26 October would publish the results, the CAR on average is positively, the only big discrepancy is of Greece that earns 2.4% above the Euro stoxx returns (Table 21), this is due to national good expectation and for positive words declared from the European Central bank. About CAR, except Ireland with negative and statistically significant CAR, the other countries are positive and close to zero. (Table 22)

Table 21: Comparison of Euro Stoxx Return before and after time window with countries

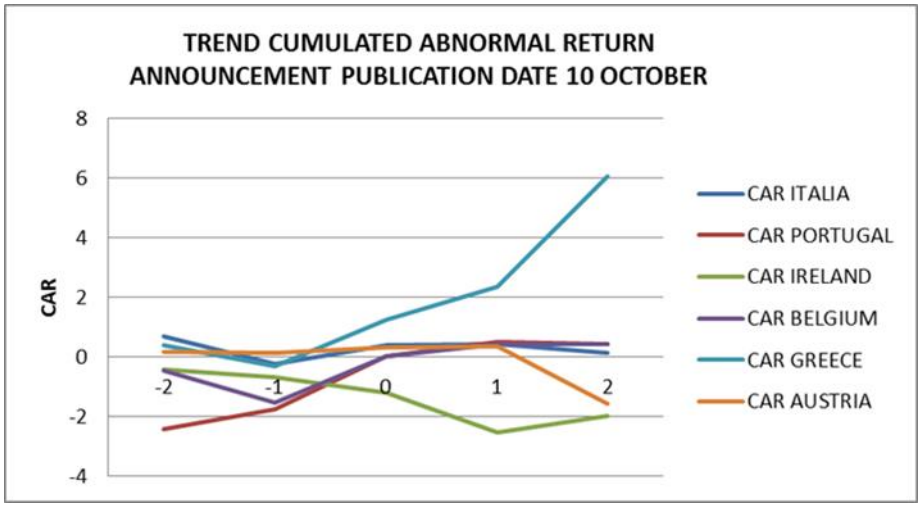
| | GAP EURO STOXX, SAMPLE 10 OCTOBER | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (- 1) | (+ 1) | (- 2) | (+ 2) | (- 3) | (+ 3) | (- 4) | (+ 4) |
| EURO STOXX BANKS: RETURN | -1,0609 | 0,3774 | -1,0536 | 0,0847 | -1,4075 | -1,5603 | -0,9064 | -1,6975 |
| ITALY: ABNORMAL RETURN | -0,9456 | 0,0078 | -0,1202 | -0,1313 | 0,1714 | -0,3521 | 0,1474 | -0,4277 |
| PORTUGAL: ABNORMAL RETURN | 0,6844 | 0,4888 | -0,8637 | 0,2067 | -0,7474 | 0,4159 | -0,7968 | 0,2759 |
| IRELAND: ABNORMAL RETURN | -0,2947 | **-1,3269** | -0,3446 | -0,3861 | -0,3954 | 0,0009 | -0,2511 | -0,3130 |
| BELGIUM: ABNORMAL RETURN | **-1,0762** | 0,3955 | -0,7634 | 0,2086 | 0,1053 | **1,1732** | 0,1914 | 0,1914 |
| GREECE: ABNORMAL RETURN | -0,6907 | **1,1033** | -0,1451 | **2,4014** | 0,1081 | **3,2280** | 0,3733 | **3,1884** |
| AUSTRIA: ABNORMAL RETURN | -0,0623 | 0,0550 | 0,0642 | -0,9448 | -0,1343 | -0,6983 | -0,0149 | -0,4700 |

Table 22: Car and t-test – 10 October

| | STOCK MARKET: ANNOUNCEMENT PUBLICATION DATE 10 OCTOBER | | | |
|---|---|---|---|---|
| | (-1 + 1) | (-2 +2) | (-3 +3) | (-4 +4) |
| ITALY | -0,5824 | 0,4169 | 1,1714 | 1,247 |
| T TEST | 0,31 | 1,09 | 1,58 | 2,05** |
| PORTUGAL | 0,113 | 0,2176 | -0,4766 | -1,4216 |
| T TEST | 0,21 | 0,62 | 0,59 | 2,13** |
| IRELAND | -0,7971 | -1,1917 | -1,6886 | -1,5068 |
| T TEST | 2,04** | 2,69*** | 4,45*** | 3,91*** |
| BELGIUM | 0,4864 | 0,0358 | 1,8787 | 2,3281 |
| T TEST | 0,88 | 0,09 | 2,42** | 2,05** |
| GREECE | 0,8537 | 1,25 | 1,8688 | 3,0375 |
| T TEST | 0,76 | 0,8 | 1,01 | 1,55 |
| AUSTRIA | 0,1251 | 0,3158 | -0,2154 | 0,179 |
| T TEST | 0,57 | 0,82 | 0,65 | 0,42 |

The Graph 13 confirms as said before, a lot of countries have a CAR close to zero in all the event window, Greece starts from 0 PP and arrives to 6 PP due to the good news from ECB and the Parliament who approved the exit from Troika.

Graph 13: trend of CAR(-2, +2) of countries – 10 October




It is important to explain in details what happens on 27 October, the day following the publication of results. The huge discrepancy from the Euro stoxx are from: Italy, Ireland and Greece. For Italy (+1%) and for Greece (+1.7%) before the event, these two countries have the returns higher than Euro Stoxx, due to high volatilityof the market. Investors bet on the worst banks because different analysts were sure that a lot of banks would passed the stress test. In the following days after event Italy has a reduction of about 2% with respect to Euro Stoxx, investors do not expected that Monte Paschi di Siena had this huge amount of capital shortfalls, despite the capital restructuring approved in the summer. For Irish banks the

situation is the opposite, they lose a lot before the event (-2%) and in the days following they are in line. About the CAR, it is negative and statistically significant for Ireland, positive and statistically significant for Greece, Portugal and Austria. This volatility is due to the reduction of shortfalls after the restructuring plans approved during 2014. Important is the recovery of Greece that had an amount of 8.72 BN of shortfalls but thanks to recapitalization has reduced them to 2.70BN (70% of recovery during 2014). (Table 23)

Table 23: Comparison of Euro Stoxx Return before and after time window with countries

| | GAP EURO STOXX, SAMPLE 27 OCTOBER | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (- 1) | (+ 1) | (- 2) | (+ 2) | (- 3) | (+ 3) | (- 4) | (+ 4) |
| EURO STOXX BANKS: RETURN | 0,6957 | -0,3568 | 0,8974 | -1,2637 | 0,8495 | -1,0307 | 1,4596 | -0,2848 |
| ITALY: ABNORMAL RETURN | **2,3892** | -0,7168 | **1,0081** | **-1,8128** | 0,4430 | **-2,0485** | 0,6454 | **-1,9571** |
| PORTUGAL: ABNORMAL RETURN | **1,8809** | **2,1350** | 0,3402 | -0,1625 | 0,1424 | -0,1559 | 0,7774 | -0,5721 |
| IRELAND: ABNORMAL RETURN | **-5,4872** | 0,1780 | **-2,0350** | 0,6787 | 0,0274 | 0,9806 | -0,1083 | 0,3276 |
| BELGIUM: ABNORMAL RETURN | 0,7266 | -0,7850 | 0,3567 | -0,7019 | -0,1029 | -0,0141 | -0,7490 | -0,5552 |
| GREECE: ABNORMAL RETURN | **2,7653** | **1,5516** | **1,6982** | 0,6467 | **1,0432** | 0,6771 | -0,1851 | 0,5369 |
| AUSTRIA: ABNORMAL RETURN | 0,9463 | 0,0638 | -0,0445 | -0,1784 | -0,2643 | 0,2350 | -0,1544 | 0,2101 |

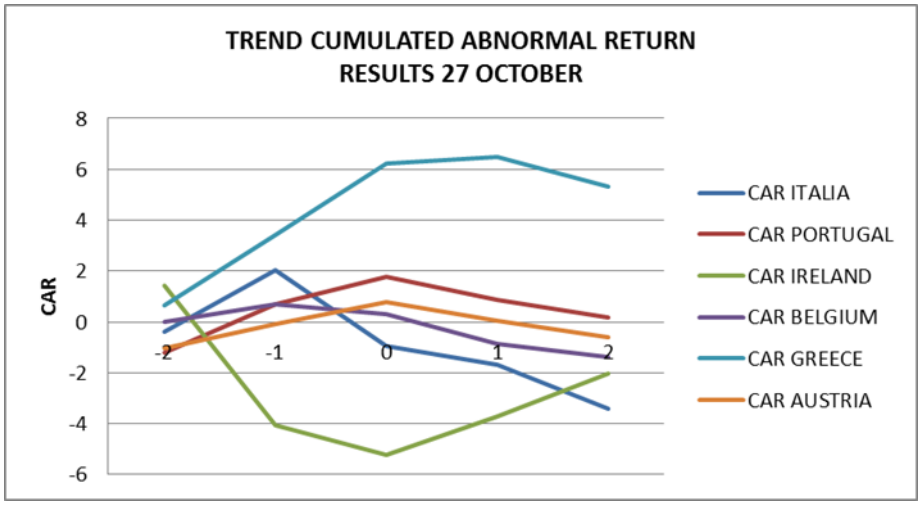
Table 24: Car and t-test – 27 October

| | STOCK MARKET: RESULTS 27 OCTOBER | | | |
|---|---|---|---|---|
| | (-1 + 1) | (-2 +2) | (-3 +3) | (-4 +4) |
| ITALY | 0,24 | -0,9555 | -1,6426 | -0,39 |
| T TEST | 0,07 | 0,74 | 1,49 | 0,35 |
| PORTUGAL | 2,9935 | 1,793 | 1,5399 | 4,2224 |
| T TEST | 3,71*** | 2,47** | 2,76*** | 5,24*** |
| IRELAND | -6,6485 | -5,2313 | -1,079 | -1,5945 |
| T TEST | 3,41*** | 3,92*** | 0,95 | 1,82* |
| BELGIUM | 0,3256 | 0,3123 | -0,7097 | -3,397 |
| T TEST | 0,43 | 0,55 | 2,08**1,3 | 0,75 |
| GREECE | 5,605 | 6,2362 | 5,9692 | 2,0994 |
| T TEST | 2,75*** | 3,45*** | 3,96*** | 1,89* |
| AUSTRIA | 1,8099 | 0,7747 | 0,0707 | 0,24 |
| T TEST | 4,43*** | 2,11** | 0,18 | 0,78 |

The Graph 14 confirms the previous results, Greece and Ireland are at the extreme, a big recovery from 0 PP to 6 PP, due to political stability and restructuring plan, and instead Ireland started from +2 PP and then reaches the negative peak at time zero -5 PP and then recovery until -2 PP. For the other countries their trend is the same, in the period (-2, 0)

recovery for the positive expectations, in the period (0, -2) they show a negative trend from an average of (+1 PP) to (-2 PP).

Graph 14: trend of CAR(-2, +2) of countries –27 October




In conclusion, before and after the 27 October, the investors demonstrate the big volatility of the market, they have high expectations before the event but after the declaration of failure of 13 banks by the EBA, they move in different way, someone appreciates the reduction of capital shortfalls (Greece) other are disappoint, but in general at time zero (the event date) and after the event, the banking system shows a big short selling.

# CONCLUSIONS

This thesis analyses the impact of stress test on the European banking market, studying the objectives and the methodologies to construct a valid stress test. The most important goals are to prevent any form of financial instability, as it happened in the recent financial crisis, and increase transparency of banking system.

The work analyses the European stress test of 2014, conducted by the EBA, with a particular focus on 80 European banks, to verify if exist market reactions to the events of stress test. The objective is to understand how investors react to new information, positive or negative, in the time window close to event, considering the investors' expectations.

Investors create their expectations on the basis of information available in the market, for this reason the bank's opacity is an important factor regarding the market efficiency. The event study wants to demonstrate which of the three hypotheses regarding bank's opacity is valid, as said in chapter IV, banks as black boxes (not transparent), open boxes (completely transparent) and an intermediate case composed by a mix of two cases.

The study rejects both the extreme hypothesis of banks completely transparent or banks as black boxes. The reactions on stock market induces to reject the first hypothesis of banks completely transparent, because investors change expectations in the day of event, in this way they are not able to completely predict the real value of bank. In this situation, the null hypothesis of abnormal return equal to zero for the sample is not accepted for different events. In this way, the movement of market reaction is not due to chance but as a consequence of new information available in the market, especially on 27 October 2014 the date of publication of results.

On the other hand, the results reject the alternative hypothesis of banks completely opaque, in which investors are unable to evaluate the real value of the bank and the solidity of financial institution. Investors consider all information available in the market, in fact for some dates there is not a significant impact for each group of banks. For example, on 4 March 2014, there is no movement in the market, because the information is known by 3 February 2014, or also on 20 August 2014, when the EBA published the final templates that would be used, there aren't effects on stock market prices.

At the end, the intermediate case it seems the best hypothesis, where banks are not neither black boxes nor open books. In favor of this hypothesis the results of the event study, in which it is clear that the market it is unsurprised to learn which banks had gaps, but primarily

investors are surprised by the size of the gaps. The results are confirmed especially for the group of worst and best banks. At the beginning of the stress test, on 31 January 2014, and then with the explanation of methodology on 29 April 2014 the event study has showed how the worst banks have lost more than the best banks. As a result of what investors were expecting, they have predicted which banks would have had gaps in term of capital.

The most important result is on 27 October 2014 when the EBA has published the results for each bank. This has caused a big volatility in the market, due to bank's opacity or underestimation of problems connected with non-fair assets or sovereign exposures. On 27 October, investors have sold a big volume of worst banks - 4 percentage points more, as a result of an unexpected size of gap. In general, the results are positive, considering all groups of banks analyzed, the market appreciates the transparency and the possibility to analyze each bank in detail.

In this end, the stress test of 2014 had has less market effect with respect to stress test of 2011, studied by a lot of authors. The previous stress test had a statistically and economically significant effect on EU banking stocks. Caused by the lack of transparency in the process of stress test, therefore it has received a lot of critiques due to the clemency of the methodology and of the results. Differently, the stress test of 2014 shows a reduction in banks' opacity, even if it is not totally eliminated because it is present in the event dates more important, as for the methodology and results. In general, there are not great differences between tested and not tested banks. Accordingly, banks move together, one can lose or earn one percentage point more but there is interdependency between banks and market.

The results are in line with previous studies, like the paper of Sahin and Haan and Billeskov in which they have demonstrated how the announcement of the assessment and the results had no significant effect on stock prices of banks in the full sample.

In order to get a clear and complete picture of the reaction occurring in the occasion of the stress test, it was decided to carry out a more thorough investigation in order to quantify the abnormal movements in the perception of risks related to the country of origin.

Based on tested banks divided by country of affiliation, the results change; there is some evidence of stock market reaction for all the countries. Especially for Austria, Portugal, Irish and Greece banks have registered abnormal returns statistically significant in each event considered.

This experiment allowed, therefore, to identify clearly the impact of the effect arising from the solvency risk of a particular country or geographical area, the abnormal reactions that

occurred allow you to show empirical evidence in favor the arguments made by Flannery, Kwan and Nimalendran (2010), proving that there is some form of opacity in valuation of banking companies operating in a difficult economic environment than other operating in relatively stable environments, due to the uncertainty of market or the presence of asymmetric information.

In conclusion, the EU-wide stress test of 2014 had a little impact on the stock market of European banks, this suggests a reduction of bank's opacity, in fact one explanation is that outcomes of the assessment are in line with market expectations. Different is the situation of banks belonging to a determinate geographic area in which the results are relevant and significant.

The success of stress test is not based only on the short-term market responses, but it analyses the current state of banks and uses all information in implementing its new responsibility for bank supervision in the Eurozone. Investors should consider also that several banks during 2014 have increased their capital regardless of the hypothetical shortfalls for different reasons, such as internal targets or market opportunities. The objective is measure the resiliency of banking system and this is a long-term objective to improve the transparency of banking system and make the market much more efficient.

# Appendices

Appendix 1: Table 1: LIST OF "BANKS TESTED"

| | |
|---|---|
| AUSTRIA | RAIFFEISEN BANK INTL. |
| | OBERBANK |
| | VOLKSBANK VBG.PC. |
| BELGIUM | DEXIA |
| | KBC GROUP |
| CYPRUS | HELLENIC BANK |
| DENMARK | DANSKE BANK |
| | JYSKE BANK |
| | SYDBANK |
| FRANCE | BNP PARIBAS |
| | CREDIT AGRICOLE |
| | SOCIETE GENERAL |
| GERMANY | COMMERBANK |
| | DEUTSCHE BANK |
| | IKB DEUTSCHE INDSTRBK. |
| GREECE | EUROBANK ERGASIAS |
| | BANK OF PIRAEUS |
| | ALPHA BANK |
| | NATIONAL BK.OF GREECE |
| IRELAND | PERMANENT TSB GHG. |
| | ALLIED IRISH BANKS |
| | BANK OF IRELAND |
| ITALY | UNICREDIT |
| | INTESA SAN PAOLO |
| | BANCA POPOLARE MILANO (BPM) |
| | BANCA POPOLARE |
| | MONTE DEI PASCHI DI SIENA (MPS) |
| | UNIONE DI BANCHE ITALIANE (UBI) |
| | BANCA CARIGE |
| | CREDITO VALTELLINO |
| | MEDIOBANCA |
| | CREDITO EMILIANO |
| | BANCA POPOLARE EMILIA ROMAGNA |
| | BANCA POPOLARE SONDRIO |
| POLAND | BANK BPH |
| | PKO BANK |
| | GETIN NOBLE BANK |
| PORTUGAL | BANCO BPI |
| | BANCO COMMERCIAL PORTUGUES |
| SPAIN | BANCO DE SABADELL |
| | SANTANDER |
| | BANKINTER 'R' |

| | |
|---|---|
| | **BBV.ARGENTARIA** |
| | **LIBERBANK** |
| | **BANCO POPULAR ESPANOL** |
| **SWEDEN** | **SWEDBANK 'A'** |
| | **SVENSKA HANDBKN.'A'** |
| | **NORDEA BANK** |
| | **SEB 'A'** |
| **UK** | **BARCLAYS** |
| | **HSBC HDG. (ORD $0.50)** |
| | **ROYAL BANK OF SCTL.GP.** |
| | **LLOYDS BANKING GROUP** |

Appendix 2: Table 2

Table 2: LIST OF "BANKS NOT TESTED"

| | |
|---|---|
| AUSTRIA | AUTOBANK |
| BELGIUM | KBC GROUP |
| | BANQUE NALE.DE BELGIQUE |
| DENMARK | SPAR NORD BANK |
| | BANKNORDIK |
| | SYDBANK |
| FRANCE | CRCAM NORMANDIE SEINE GDR |
| | CRCAM ATLANTIQUE VENDEE |
| | CREDIT AGR.LOIRE-H-LOIRE GDR |
| | CRCAM ILLE-VIL.CCI |
| | CREDIT AGR.TOURAINE |
| | CRCAM LANGUED CCI |
| GERMANY | UMWELTBANK |
| | QUIRIN BANK |
| | MERKUR BANK |
| | OLDENBURGISCHE LB. |
| GREECE | ATTICA BANK |
| | BANK OF GREECE |
| ITALY | BANCA ETRURIA |
| | BANCO DESIO |
| | BANCO DI SARDEGNA RSP |
| | BANCA PROFILO |
| POLAND | BANK ZACHODNI WBK |
| | MBANK |
| | BANK MILLENNIUM |
| PORTUGAL | MONTEPIO |
| SPAIN | CAIXABANK |
| | BANKIA |
| SWITZERLAND | CREDIT SUISSE GROUP N |
| | UBS GROUP |
| | BANK COOP |
| UK | RASMALA |
| | SECURE TRUST BANK |
| | BGEO GROUP HDG. |
| | STANDARD CHARTERED |

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