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STRUCTURAL MODELS TO ESTIMATE FINANCIAL INSTITUTION'S DEFAULT PROBABILITY

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Abstract

This paper is intended to model the default probabilities for selected Iberian Financial Institutions through the application of Merton's Model (1973) framework. Through the use of three different Default Barrier (db) definitions, we were able to obtain very different outputs, stressing how crucial db definition is to the structural model output.

Throughout this crisis, liquidity risk was, in some dimension, offset by the ECB funding policies. db1 and db2 definitions, differing only on the way Central Bank loans were treated, were convenient to test non-standard applications of the model. In our study we introduce and test a procedure anchored on Distance to Distress calculation, to quantify the reduction in risk induced by ECB measures, finding that ECB actions effectively reduced bank's default risk.

Neste estudo procurámos, no âmbito do Modelo de Merton (1973), determinar a Distância ao Incumprimento (DD) para uma amostra de bancos Ibéricos. Através da especificação de três diferentes Barreiras de Imcumprimento (DB), foi possivel obter diferentes resultados, sublinhando a importância da DB para *output* do modelo.

Durante a crise, o risco de liquidez foi atenuado pelas políticas de cedência de liquidez levadas a cabo pelo BCE. As definições usadas para db1 e db2, diferem na forma como são tratados os emprestimos do BCE, permitindo implementar um procedimento assente no cálculo da DD para quantificar a redução no risco dos bancos induzida por estas medidas. Os nossos resultados demonstram que as políticas do BCE reduziram o risco de incumprimento dos bancos que constituem a amostra.

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Chapter I - Introduction

Throughout the last decades, with the improvements of Information Technologies, financial markets became increasingly global, leading to a spread of risk across a broader spectrum. In such a global environment, the bursting of the United States (US) housing bubble and the subsequent plummet of US real estate prices triggered a domino effect in financial institutions worldwide, leading to the bailout of several banks by national governments. Confidence in the solvency of the financial system weakened, causing a liquidity crisis and a global downturn in the stock markets. As a result, economies worldwide suffered a downturn.

As a result of the complex interplay between the credit boom and the financial innovation, issuance of financial agreements dependent/linked to mortgage or credit payments - such as mortgage-backed securities (MBS) and collateralized debt obligations (CDO) - expanded in the years prior to the 2007-08 Financial Crisis. These complex packages of mortgages and credits were sold globally, enabling investors worldwide to be exposed to U.S. housing market.

In this context, financial institutions became highly leveraged, most of them through off-balance sheet instruments (securitization or derivatives). Lehman Brothers (liquidated), Bear Sterns and Merryl Lynch (sold), Morgan Stanley and Goldman Sachs (converted in commercial banks, therefore under tighter regulation), Fannie Mae and Freddie Mac[1] held USD 9.000bn in debt or guarantee obligations (aprox. 65% of US GDP) at the time of the crisis. The total asset value of the entire US banking system was of about USD10.000bn[24].

In Europe, one of the first signs of a financial crisis appeared in August of 2007 by BNP Paribas, when the redemptions from three hedge funds invested in subprime mortgage debt were blocked, due to a liquidity squeeze. Later on, Northern Rock, a medium-sized British bank, requested protection from the Bank of England, leading to a bank run in mid-September 2007. In February 2008 Northern Rock was nationalized. From September 2008 throughout 2009 several other banks collapsed.

The turmoil originated by the 2007-08 financial crisis evolved into a sovereign debt crisis in Europe when, in 2009, the newly elected Greek government exposed that previous governments had masked the real Budget deficits. Greek debt was already over 120% of GDP and disseminated throughout European Bank's balance sheets. Unable to borrow from the financial markets, Greece was bailed out in April of 2010 with a first EUR 110 bn direct loan by the European Union and the International Monetary Fund (EU-IMF). The crisis spread to Ireland and Portugal[2] and placed Italy and Spain under pressure from the financial markets. The spread of sovereign debt in the

[1] Fannie Mae and Freddie Mac are US Government sponsored enterprises.

[2] The crisis had different natures: i) in Ireland it was related with the failure of relevant size Banks; ii) in Portugal the crisis was related with the public deficit and the stock of public debt.

European banks balance sheet arouse concerns regarding the risk exposure of the European banking system.

After a series of downgrades to Portuguese sovereign credit rating and an increasing pressure on Portuguese debt in the financial markets, Portugal requested, in April 2011, a EUR78bn EU/IMF/ECB bailout package in order to stabilise its public finances. This package, *Financial Assistance Programme* (FAP), included Eur 12bn to be used exclusively in recapitalization of the banking system.

Liquidity and stability of the banking system was a concern in FAP agreement and priority was given to strengthening Core Tier 1 ratio, raising it to 9% and 10%, in 2011 and 2012 respectively (above the Basel II agreements requirements). Deleveraging of the banks was also pointed as a major target in the agreement. Later on, this target was set to a transformation ratio of 120% until 2014 and to the creation of temporary core capital buffer to cope with the exposure to sovereign debt. The results of the stress tests carried out by European Banking Authority (EBA) on 71 European banks, estimated the need for a capital buffer of EUR 3,72 bn to the 4 Portuguese banks (BCP, BES, BPI and BANIF).

Under this scenario, the aggregated assets of Portuguese banks decreased, anchored on a reduction of stock of credit to clients, returned to levels of 2009. Clients' deposits revealed a favourable behaviour which, in conjunction with the effect of the reduction of the stock of credit, led to a reduction of the transformation ratio from 156.8% in 2009 to 127,6% in 2012[21].

By the end of 2012, Portuguese banking system had reached a core Tier 1 capital ratio of 11,7% and a solvency ratio of 12,9%[21], as result of a demanding effort of recapitalisation partly supported by the private sector through capital increases of approx. EUR 2bn. However, the bulk of the recapitalisation of EUR 7,25 bn was done with resource to FAP EUR 12 bn euros recapitalization line, through the issuance of hybrid instruments that qualify as core tier 1 capital (Coco bonds). These instruments were fully subscribed by the Portuguese government.

Although Spain had a relative low debt level when compared with other stressed countries, the bursting of the housing bubble increased pressure in the already leveraged Spanish banking system. Caja de Ahorros Castilla La Mancha was bailed out in 2009. In 2010 CajaSur followed and Bankia was created by merging 7 cajas de ahorros (savings banks); their *toxic* assets were transferred to Banco Financiero y de Ahorros (BFA)[3]. BFA was set up with a capital of EUR 4,5 bn from the Spanish government rescue fund. In July 2011 55% of Bankia was admitted to *Bolsa de Madrid*, following an initial public offering, and in May 2012, less than a year from the IPO, Bankia received a new EUR 19 bn bailout. The bank recognized that the stock of toxic assets related to real estate investments figured in between EUR 31,8 bn to EUR 40 bn and the board requested an injection of EUR 19 bn. Bankia was seized and restated its 2011 results, from a reported profit of EUR 309 mn to a loss of almost EUR 3 bn. Criminal complaints were filed against Bankia's management.

[3] In 2010, Banco Financiero y de Ahorros (BFA) was controlled by Caja Madrid, Bancaja, La Caja de Canarias, Caja de Ávila, Caixa Laietana, Caja Segovia and Caja Rioja, and owned Bankia.

This event led to a request of financial assistance to the Spanish banking system. The Eurogroup granted a financial support package of a maximum of EUR100 bn, transferred to a government-owned Spanish fund responsible to conduct the required bank recapitalisations - Fondo de Reestructuración Ordenada Bancaria (FROB).

An external assessment was performed on the Spanish Banking System and from its conclusions a recapitalization plan was drawn. Banks were classified into 4 groups, accordingly to their capital needs:

• *Group 0*, where no capital needs were found, and therefore no recapitalisation measures needed to be undertaken, comprised Santander, BBVA, CaixaBank, Banco Sabadell, Kutxabank, Unicaja and Bankinter.

• *Group 1* includes the nationalized Banks that were partially or fully in the possession of FROB

• *Group 2* comprises Banks with capital needs, that couldn't obtain the necessary funds from private initiative, therefore needing government assistance

• *Group 3* is composed by Banks with capital needs that resorted to private initiative to attain the necessary funds.

Finally an instrument was created, Sociedad de Gestión de Activos procedentes de la Reestructuración Bancaria (Sareb), owned in 45% by FROB and 55% by private equity, in order to absorb the toxic assets from the 4 nationalized Banks (BFA - Bankia, Catalunya Banc, NCG Banco - Banco Gallego and Banco de Valencia) or those undertaking a restructuring or liquidation process (Banco Mare Nostrum, CEISS, Caja3 y Liberbank).

Overall public funds used to recapitalize the Spanish banking system reached EUR 61,495 bn, of which EUR 7,942 bn obtained through the deposits warranty fund, coupled up with EUR 14,475 bn granted by the FROB. An additional amount of EUR 1,135 bn comprised hybrid instruments that qualified as core tier 1 capital subscribed by the FROB. In direct capital injections from the government in banks, the figure reached approximately EUR 38 bn[27].

This crisis affected the image of the banking system and the confidence between peers. Since the beginning of the crisis in 2007 the international debt markets environment has been tighter, in particular for banks from stressed countries, increasing concerns on liquidity risk and the stability of the banking system as whole.

The European Central Bank played a crucial role in granting liquidity to the financial system, avoiding the undesirable consequences of an abrupt deleveraging which could lead to a downward deflationary spiral. Besides the Eurosystem's standard open market liquidity-providing operations in euro, shorter term main refinancing operations (MROs) and long-term refinancing operations (LTROs), the ECB launched several non-standard initiatives:

- two liquidity-providing long-term refinancing operations in euro with a three-year maturity (maturing on January and February 2015):
- launched two covered bond purchase programmes: CBPP, which ended in June 2010, and CBPP2, which ended in October 2012;
- interventions in debt markets under the Securities Markets Programme (SMP) conducted between May 2010 and February 2012;

- Outright Monetary Transactions (OMTs), announced in August 2012, comprised interventions in government bonds with a remaining maturity of up to three years.

- In June 2014, ECB announced a series of targeted longer-term refinancing operations (TLTROs), during 2 years, to stimulate bank lending to the euro area non-financial private sector. This measure excludes loans to households for house purchase.

In this context, credit risk, already a fundamental concern within Basel II framework, has become a greater concern. Under Basel II and III, bank's economic capital requirements as a function of the risk of the credit portfolio became more demanding. This macro prudential requirement had two major effects for financial institutions: i) Increased operational costs to assess their credit risk exposures, either in processes, IT applications or in expertise; ii) Strong investments from Financial Institution's shareholders to fulfil the minimum capital requirements.

Credit risk modelling, taking into account the relationship between intrinsic characteristics of a borrower and its ability to fulfil its responsibilities, has become more and more popular. Founded by Merton's model (1974), structural models for credit risk approaches the value of the firm as claims from two different players: shareholders and debt holders. Shareholders have a positive payoff when the face value of firm's assets is superior to its liabilities. Consequently, in this case, the creditors can be reimbursed.

Whenever a firm's assets value is lower than the value of liabilities, a default event occurs and shareholders, who have limited responsibility, have a zero payoff. Shareholders claim is perceived as a call option on the firm's assets value. Credit risk and default probabilities are, therefore, explained with resource to balance sheet risk. The uncertainty of future value of assets, comparatively to the due payments on debt, is the driver of default risk.

This methodology results from the application of option theory and is also known in literature as Contingent Claim Analysis (CCA). A contingent claim is defined as a financial asset whose future payoff depends on the value of another asset, and therefore an option is a typical example of a contingent claim.

Banks transform liquid liabilities (deposits) into illiquid claims (loans, mortgages, car loans, etc), providing a crucial service to the economy. This intermediation role of banks is provided because maturities of liabilities and assets are mismatched. This maturity transformation, allowing inter-temporal optimizations of consumption or investment decisions, leave the banks exposed to liquidity risks, in the worst scenario bank runs[3]. In fact, even the determination of the amount of debt due in a given moment comes with a few *if*'s. Long term deposits, for instance, in a first approach could be classified as long term debt. However, if the depositor accepts the loss of the accrued interest, long term deposits can be withdrawn at any moment, becoming short term liabilities. In a crisis context, where lack of confidence may cause bank runs, this must be taken into account. On the other hand, short-term deposits can be renewed, showing more stable behaviour.

Assessing the credit risk of financial institutions is challenging, due to the difficulty in evaluating the quality of their assets and the extent of their liabilities. As already seen, in 2007 seven US financial institutions held 65% of US GDP in debt, without the necessary financial cushion to face losses or defaults. Structural models assume that equity markets know and value these uncertainties. Therefore, equity markets prices discount these risks.

Given its fundamental economic role and the possible relevant fiscal and/or social cost of a bank failure, most financial institutions, are regulated and, in face of possible distress, the regulator tend to act to avoid a default. In fact, very few financial institutions actually default, and therefore the calibration and testing of the model is changeling.

The use of models involves costs and risk. Not only the direct resource risks to develop and implement the model, but more importantly the risk of trusting an incorrect and misused model that could lead to losses. While implementing a model simplifications, approximations, or incorrect assumptions are taken, that may lead to incorrect outputs (Model Error). Even if the Model is properly implemented, it may be applied outside its application range. Thus Model Risk may be defined as the potential for adverse consequences based on incorrect or misused model output.

Model Risk has captured the attention of regulators and institutions, n order to develop model validation practices and to establish a comprehensive framework of proactive Model Risk management.

Therefore our proposal is to estimate the Distance to Default for a selected sample of Iberian Banks, using three definitions of Default's Barrier. We also intend to test a procedure to quantify the reduction in bank's risk induced by ECB's funding policy.

Chapter II- Contingent Claim Analysis Overview

Contingent Claim analysis framework was first presented by Merton in its paper "On the pricing of Corporate Debt: the Risk Structure of Interest Rates" (1974). For the first time, newly presented option pricing theory was applied to the capital structure of a non-financial companies, banks or non-bank financial institutions, allowing the assessment of default probability through market price of the company's equity and debt value. The asset of a bank financed by equity and debt, in Merton's Model approach modelled as zero coupon bonds, is therefore a sum of the market value of equity and the value of risky debt.

Under this framework, the holders of equity have a contingent claim on the residual value of assets in the future, and are entitled to a positive payoff if the asset value is above the liabilities level. Due to equity holders' limited responsibility, they have a zero payoff in case of default.

In this situation, debt holders have a right to take over the remaining assets and sell them, a far from desirable scenario. Under these circumstances debt holders may have to absorb losses. Therefore uncertainty in future asset value, when promised payments on debt are concerned, is the driver of default risk. This uncertainty in asset value is represented by a probability distribution at time horizon T.

Although the asset value is not observable in the market, its equity price is available and, with resource to Merton's options theory, it is possible to obtain the asset value, if the default point is known. Equity volatility can be written as function of leverage ratio, the hedge ratio obtained through the option theoretic approach and finally the asset value. Therefore, asset's market value and its volatility are derived from the equity value, equity volatility and liabilities by solving the call price and volatility equations.

Black & Cox (1976) relaxed the maturity assumption allowing the company to default at any moment, not only at maturity. In this model default occurs whenever payments are due to creditors, at discrete moments in time. This added some realism to the model but keeps the advantage of easy implementation as a closed form model. Furthermore they refer to the possible existence of an upper and lower boundary of the asset value, introducing for the first time the concept of default barrier as the lower boundary for asset value, below which default may happen.

A successful example of empirical use of the Merton Model is MKMV[4] methodology to predict the default probabilities of individual firms. In their tests MKMV found that probabilities from Merton's model tend to be unrealistic. MKMV considers that option-pricing relationship as characterized by Merton's approach with just two classes of liabilities (equity and a zero coupon bond), is

[4] KMV Corporation was acquired by Moodys in 2002, their model is proprietary. Crosbie & Bhon (2003) provided a simplified version to MKMV model that became widely used by the academic literature.

too simplistic. Instead, they propose the incorporation of five liability classes: short-term, long-term, convertible, preferred equity, and common equity.

MKMV considers the relationship between asset value and default barrier, critical to the accurate determination of default probability. In presence of adverse changes, either in asset value or leverage ratio, the default probability may not be accurate. As the leverage ratio isn't static, registering frequent changes, they consider that the model linking equity and asset volatility holds only instantaneously, therefore not providing reliable outputs. In their testing, MKMV found that the model biases default probabilities, given that for fast decreases in leverage the model tends to overestimate the asset volatility, conducting to higher default probability, when credit risk is actually decreasing. The reverse, for fast increases in leverage, also verifies.

To obtain asset market value and volatility, MKMV relies on the option nature of equity but with a twist, as they solve backwards from the option price and option price volatility to the implied asset value and asset volatility through an interactive process. The procedure generates an initial guess for asset value volatility used to determine an estimate of asset value and generate a series of asset returns. Next, with the set of asset returns, a new set of asset volatility is obtained and used to reinitiate the next iteration for a new set of asset values. The procedure is repeated until it converges.

Finally, distance-to-default (DD) is calculated as the number of standard deviations the asset's market value is from default barrier. This DD is then compared with a frequency table that matches DD with the probability of default. MKMV frequency table was generated with resource to an empirical database of defaults and bankruptcies including data of more than 250,000 company-years and about 4,700 defaults or bankruptcies events [8].

MKMV tested their frequency table for several variables such as industry, size or time, finding that the relation between DD and default frequency is constant, and differences across the considered variables seem to be captured in DD measure [8].

Another interesting extension was introduced by Geske (1977), who values debt and equity as compound options. Opposite to the restrictive zero coupon bond assumption of Merton Model, this model considers the fact that companies usually have more complex debt structures, usually involving coupon payments in different maturities.

Thereby Geske (1977) claimed that, in presence of multiple cash-flows, equity should be perceived as a compound option on the assets, where each cash flow represented a strike price for the compound option. The idea behind this formulation is that shareholders, whenever a payment is due, have the option to default. If the asset value is sufficient, implying a positive equity value, shareholders may issue equity at current prices to cope with the payment to creditors. If the asset value falls, the equity value will also fall making it more challenging to issue new equity to fulfil obligation to creditors. Under these circumstances, shareholders may choose not to exercise the compound call option, therefore defaulting on the due payments. Thereby, creditors assume control of the assets according to their priority. Under this mechanism, default is determined as the asset value that sets the value of equity equal to the next cash flow; asset value falling below this level means that equity value is negative. Default in this method is endogenous to the model.

According to this dynamics, new equity is issued for each payment to creditors, therefore reducing debt and increasing equity systematically. This implies a continuous deleveraging over time, and stands for the most criticisable assumption of the compound option structural model, since a systematic reduction of leverage is not realistic.

Also with an endogenous default barrier, but with a slightly different formulation, Leland (1994) developed a structural credit risk model that includes most of Black & Cox (1976) assumptions, but assumes the existence of one class of debt with infinite maturity and a fixed coupon. The default barrier is endogenous and determined as the lowest possible asset value that allows positive equity values.

Through the inclusion of parameters as taxes or bankruptcy costs, Leland incorporated features of capital structure decisions in a credit risk model, mainly treated as exogenous in structural credit risk models. Leland (1994) model provides close form solutions for debt and equity values, the default barrier and the optimal capital structure. Two years later Leland & Toft (1996) presented an extension to take debt maturity into account.

Longstaff & Schwartz (1995) extended Black & Cox (1976) to incorporate stochastic interest rates, using Vasicek's mean-reverting term structure dynamics. The default barrier is exogenous and constant for the life of the bank, just by assuming that every coupon or principal payment is financed with new debt issuances. The default process, described as first passage phenomena, has an innovative aspect; it assumes that, when the asset value of the company crosses the default barrier, debt holders may receive a percentage of the face value of the debt (recovery rate) and have to write-off the remaining. In other words, at default a corporate bond is exchanged for an equivalent default-free bond at a write-off rate, dependent on the priority and maturity of the issue. Thus authors point out that, for different categories of debt, different recovery rates may be found. Under these conditions, the value of a fixed-rate bond, with a given interest rate and default probability, is a function of the measure of distance to the default barrier (Asset Value (V)/ Default Barrier (K)), of the stochastic interest rate and the time to maturity.

Through empirical analysis, Longstaff & Schwartz (1995) found that credit spreads are negatively correlated with interest rates and equity returns, although the significance of the parameters differs across credit ratings or industries.

Later, Briys & Varenne (1997) presented an extension of Black & Cox (1976) model, introducing a stochastic default-free interest rate in the default barrier expression and the default write-down treatment of Longstaff & Schwartz (1995).

In general, a transversal characteristic of the previous models is a constant capital structure, which does not reflect reality. In fact, empirical studies suggest that companies do not maintain constant their capital structures, issuing or repurchasing debt, according to increases or falls in company's value. (Hsu et al (2010)).

Collin-Dufresne & Goldstein (2001) argue that the constant capital structure assumption leads to mispricing of risk premium of debt, as valuation of the debt should take into consideration not only the issued debt, but also the option to issue more debt. The authors argue that without any constrains on future leverage, firms may issue more debt, increasing leverage. This option implies changes in the default probability (increasing it), hence debt holders tend to reflect this risk increase in the price of current outstanding debt. Thereby, the authors propose an extension to Longstaff & Schwartz (1995) to cope for changes in leverage, moving the default barrier up and down accordingly. These movements in leverage are unpredictable, thus the default barrier is modelled as a stochastic process. This model brought some theoretical enlightenment on how capital structure changes affect bond prices' mechanism.

Although theoretically, extensions on Merton Model brought some enlightenment on bond pricing and default mechanisms; they also translate into more and more mathematical complexity. Does this extra complexity add predictability to the model? Several authors, such as Jones et al (1984) or Ogden (1987) tested Merton type models in order to validate for their predictability, concluding that these models tend to overprice corporate bonds. Jones, Mason & Rosenfeld (1983) used bond prices between 1977 and 1981, finding that prices obtained from Merton model overestimate in 452bp bond prices. Ogden (1987) found that yield spread is under-predicted by an average of 104 bp if Merton model is used.

Eom, Helwege & Huang (2004) tested five structural models - Merton (1974), Geske (1977), Longstaff & Schwartz (1995), Leland & Toft (1996), and Collin-Dufresne & Goldstein (2001) - finding better predictability of yield spreads on Longstaff & Schwartz, Leland & Toft, and Collin-Dufresne & Goldstein models, due to the inclusion of stochastic default-free rates. Nonetheless the error is large and error distribution show fat tails, thus extremely large or small spreads are common. Their conclusions also indicate that the five models don't behave well in pricing bond issues for companies with low leverage or volatilities.

Several tests on the financial system have been performed in the last decade. Gropp et al (2005) empirically tested the efficiency of DD and the subordinated bond spreads to anticipate the default risk of 100 European banks. Both indicators showed some predictive ability: i) DD revealed to be a useful mechanism for forecasting potential distress up to 18 months before the crisis, but poor predictive ability close to default; ii) subordinated debt-based signals showed good predictive power for smaller banks. They also found that the use of both indicators together granted more predictive power than each indicator on its own.

Later on, Harada, Ito & Takahashi (2010) examined DD patterns of eight failed Japanese banks in order to evaluate its predictive power for bank failures, showing that DD signalled the failure in many cases. The authors presented a

DD spread, defined as the difference of DD of a failed bank and the DD of sound banks, a measure that revealed to be useful to indicate the deterioration of a bank's health. However, for some banks in the sample, neither the DD nor the DD spread were able to signal the failures, a fact that the authors attributed to lack of transparency in financial statements and disclosed information.

Chapter III- The Merton Model

Companies are financed with debt (*D)* and equity (*E)*.

The total market value of assets (*A*) at any given time (*t*) of a company is equal to the market value of equity plus market value of risky debt maturing at time T.

$$A(t) = E(t) + D(t) \tag{1}$$

Asset value is stochastic and is assumed to follow a standard geometric Brownian motion. Asset value may decline below the point where scheduled debt payments can be made, also known as Default Barrier (*DB*). In this case the equity holders, due to their limited responsibility, have a zero payoff. Therefore the value of equity can be expressed as an option, where equity holders receive the maximum of either assets minus debt, or nothing in the case of default (*E = max [A – DB, 0])*.

If a default event occurs, debt holders are entitled to take over the remaining assets of the company and sell them; this fact can be regarded as a guarantee. Thus, risky debt holders' payoff is either the default free value or, in case of default, a claim on assets. The guarantee can be seen as an implicit put option (*P*) on assets yielding *max*[*DB* – *A*, 0], and can be read as the expected loss if default occurs. Default-free debt equals to the sum of value of risky debt and value of the guarantee. As the value of default-free debt is the distress barrier, risky debt at moment t is given by:

$$D(t)= DBe^{-r(T)}-P(t), \tag{2}$$

where *T* represents time to maturity and *r* the risk free interest rate.

As seen, assets and liabilities in the company's balance sheet can be related using implicit options, thus priced through the standard option pricing formula (Black-Scholes). The value of an option can be derived by forming a riskless hedge portfolio, constructed with resource to a position in a derivative security and a position in a stock, both exposed to the same source of uncertainty. In this scenario, if suitable positions are established, movements on the stock position will offset the movements from the derivative security and, at the end of the period, the overall value of the portfolio is known. The return of such portfolio is the risk free rate of interest.

The value of equity as a call option on company's assets at moment *t* is,

$$E(t)=AN(d_1)-DBe^{-rT}N(d_2) \tag{3}$$

where *A* is the value of the assets, *E* is the value of equity, *DB* is the default barrier, *r* is the risk-free rate of interest, *T* is the time to maturity on the default free bond in years. *N(d)* is the cumulative probability distribution function for a standard normal variable, and d_1 *and* d_2 can be written as,

$$d_1 = \frac{\ln(\frac{A}{DB}) + (r + \frac{1}{2}\sigma_A^2)T}{\sigma_A\sqrt{T}}$$

$$d_2 = \frac{\ln(\frac{A}{DB}) + (r - \frac{1}{2}\sigma_A^2)T}{\sigma_A\sqrt{T}} = d_1 - \sigma_A\sqrt{T} \tag{4}$$

where σ_A is the standard deviation of return on firm assets.

Although the company's asset value and volatility are not observable in the market, equity price is. With resource to Ito's Lemma can be obtained that:

$$E = \frac{\sigma_A}{\sigma_E} AN(d_1) \tag{5}$$

where σ_E is the standard deviation of equity.

Through the above formulation the standard deviation of equity can be derived from historical data and used to solve for asset volatility.

From this formulation two important measures arise: distance to distress and probability of default. DD computes the difference between the implied market value of company's assets and the distress barrier scaled by a one standard deviation move in those assets. It yields the number of standard deviations of asset value from distress.

$$DD = \frac{\ln(\frac{A}{DB}) + (\mu_A - \frac{1}{2}\sigma_A^2)T}{\sigma_A\sqrt{T}}, \tag{6}$$

where μ_A is the expected return on assets.

This metric can later be translated into the probability of default simply by replacing in the normal cumulative density distribution

$$P[A \leq DB] = 1 - N(DD) = N(-DD), \tag{7}$$

Keeping everything else constant, if asset value grows, company's leverage decreases and the probability of default lowers. In this scenario the price on the implicit put option from the guarantee lowers, as bondholders have a lower expectation of losses. If assets become very large, price on the implicit put option from the guarantee tends to zero. Therefore if asset value continuously grows, the risky debt value tends to the value of default-free debt (as the implicit put option tends to zero).

On the other hand if the company's assets continuously decline, probability that the company will not service its debt increases, implying a continuous increase in the price of the implicit put option from the guarantee and a continuous decrease in equity value.

If the asset's value volatility increases, the probability that assets value fall below the distress barrier increases and the price of the implicit put option from the guarantee increases. Company's assets will be closer to the default barrier, making a default event more probable, thus equity less valuable. Conversely, if volatility of company's assets approaches zero, DD increases and a default event is less probable. Equity value will increase and price of the implicit put option from the guarantee will decrease.

Chapter IV – Distance to Default in Iberian banking system

In our study we computed weekly DD for a sample of 8 Iberian Banks, within Merton Model framework, following the methodologies found in Crosbie & Bohn (2003) and Imerman (2012). The method applied may be summarized in 3 steps: i) Calculus of DB, ii) Determination of Asset Value Market and iii) Calculus of DD. All our calculations were made using Microsoft Excel.

To obtain DD it's crucial to determine the Bank's market asset value and its respective volatility (Step 2). We will determine market asset value with resource to an iterative process. To initiate the procedure we use a first estimate for the asset value, obtained by adding the book value of liabilities to the market value of equity (outstanding shares times share price). With this first estimate a set of asset returns and volatilities[5] is generated. This first estimate of volatility is later used in the option pricing model (equation [3] from previous chapter) to generate a second set of asset values. The second set of asset values is then used to obtain a new set of asset volatilities (equation [5] from previous chapter). Volatilities obtained will be used in equation [3] to generate the final set of Asset Values. For equation [5] of the previous chapter we, additionally, computed equity volatility (1 year historical standard deviation). Finally, for solving equation [3] we resorted to the use of Eurozone Yield Curve 1 year rate.

[5] The first estimate of Volatility is calculated trough excel function of standard deviation.

The third and final step in our study is DD calculation, defined as the difference between the market value of bank's assets (step 2) and the default barrier (step 1) scaled by a one standard deviation move in bank's assets (equation (6) from previous chapter). DD may be computed with resource to the risk-free rate or to asset's market value rate of return. According to Harada, Ito & Takahashi (2010), use of the return on asset's market value is more suitable to the determination of DD, as assets are managed at a floating interest rate and not at a risk free rate. In our computation of DD we follow Harada, Ito & Takahashi (2010) and used the rate of return on assets from the previous 12 months as an estimate for the expected return rate.

The scope of our analysis goes from 2006 to 2013, a range of 8 years, marked by different flows of news and events. Although we computed weekly DD, for the sake of result presentation, we will classify the time interval into 4 time intervals:

i) The years of 2006 and 2007, prior to the epicentre of the financial crisis, marked by a low perception of risk.

ii) The period between 2008 and 2010, characterized by an acute liquidity shortfall with a mild response from the ECB.

iii) The period between 2011 and 2012, when Portugal and Spain endured a demanding recapitalization process of the banking system. ECB reinforced its open market liquidity-providing operations and its newly designated president, Mario Draghi, made very clear that ECB "*...is ready to do whatever it takes to preserve the Euro. And believe me, it will be enough.*" [6].

iv) The year of 2013, characterized by some stability, a mild growth in client's deposits and a small reduction of ECB loans on total assets.

Balance sheet data for DB calculation was obtained from the Portuguese and Spanish banking associations, APB and AEB, respectively. For more detailed information regarding the liabilities we resorted to the bank's balance sheet information and its respective notes. Deposits were classified according to their nature (clients, financial institutions and central bank) and their maturity (less than 1 year, from 1 to 5 years, more than 5 years). We assumed that clients' and financial institutions' deposits with more than 5 years of maturity signalled a relation of great trust and therefore depositors are not going redeem their deposits before maturity. Bonds were classified according to maturity.

The remaining data used in our calculations was obtained in Datastream and Bloomberg.

Wholesale funding market suffered with the lack of confidence between peers, leading to a reduction of financial institutions deposits of -4,5% in 2011-12. This reduction was compensated by an increase of 46.2% in Central Bank deposits for the same period. During this period clients' deposits increased in 0.5%, revealing a very stable behaviour (more information in Appendix A). In face of the particular conditions financial institutions endured and the role

[6] Mario Draghi's intervention in Global Investment Conference, July 26, 2012, available at https://m.youtube.com/watch?v=hMBI50FXDps,. (Retrieved 2014-07-17)

played by ECB in granting liquidity to the financial system, we decided to use in our calculations, three different definitions for the DB, imposing some hypothesis:

- **Default Barrier 1 (db1)** - highlights the role of ECB as lender of last resort and follows Crouhy, Galai & Mark (2000) db definition: short Term + ½ long term liabilities. We assumed that all loans from the central bank are indefinitely renewable (not to be paid back) therefore not considered in the composition of the db1. Clients' and Financial Institutions deposits are considered as: i) short term if maturities up to 1 year, ii) long term if maturities from 1 to 5 years, therefore ½ is considered for DB calculus, iii) maturities of more than 5 years follow our assumption that the depositor is not performing an early redemption. All other items are classified according to their maturity.
- **Default Barrier 2 (db2)** - anchors on the hypothesis that there is no lender of last resort, so Central Bank loans have the same behaviour as other loans (either Financial Institutions or Households). Central Bank, Clients' and Financial Institutions deposits are considered as: i) short term if maturities up to 1 year, ii) long term if maturities from 1 to 5 years, and ½ is considered for DB calculus, iii) maturities of more than 5 years follow our assumption that the depositor is not performing an early redemption. All other items are classified according to their maturity.
- **Default Barrier 3 (db3)** - is the most extreme definition of the db used, where all deposits are considered as short-term liabilities and all bonds are long term, following Harada, Ito & Takahashi (2010) definition of db (more information available in Appendix B).

With these three different definitions of Default Barrier, we will generate three different DD's, DD1, DD2 and DD3.

The only difference between db1 and db2 is the way central bank deposits are treated. This specification allows a perception of the reduction of risk to banks, induced by the central bank liquidity granting actions and a quantification of that reduction. To further highlight this effect, we have decided to introduce a measure, DD2-DD1, corresponding to the difference between DD2 and DD1 that expresses the reduction on the number of standard deviations (std dev) induced by ECB actions. We choose to use a negative measure in order obtain a more immediate reading.

The banks chosen to integrate the sample are Millenium BCP, BES, BPI and Banif (the four listed private Portuguese banks) and Banco Santander, Banco Popular, Banco de Valencia and Bankia (to represent the Spanish Banking System). Most of these banks had to endure a severe recapitalization process, deleverage their assets and rationalize operating costs. The only exception is Banco Santander that did not need to reinforce the Core Tier 1 capital. For more information on the sample, please resort to Appendix D.

We computed weekly DD for three different definitions of db, finding that DD3, calculated with the most extreme default barrier, is in general, the lowest. However in the case of BES, this general rule does not apply, due to BES particular funding structure up to 2010, very dependent of bonds issuance

(Appendix C - figure 6). Approximately 30%[7] of the BES assets were funded through bonds until the end of 2010, and db3 assumes that all bond issuances are long term liabilities, therefore in this particular situation db3 is lower than db1 or 2 and consequently is more distant from default (DD3 > DD1> DD2). BES DD3 measure averaged 221, 90, 30 and 13,5 std dev for 2006-2007, 2008-2010, 2011-2012 and 2013 respectively. A continuous change in the maturity structure of liabilities, decreasing longer term and increasing shorter term maturities, led to this result. In 2006 DB3 represented 65% of total assets while in 2013 it represented 77% (bonds issuances represented only 12% of total assets vs 73% of deposits). From October 2013 onwards, DD3 reached values in the range of 2.34 to 0.43 std dev, signalling distress with 10 months in advance to BES' turmoil, which resulted in the splitting of the bank in a *good bank* (Novo Banco) and a *bad bank* (BES) (for detailed information please resort to Appendix D). The other two measures (DD1 and DD2) showed an increase of risk, but were not able to effectively signal distress.

By the end of 2011, with the launch of long term refinancing operations (3 years), BES converts the maturities of its liabilities to the ECB from shorter terms to longer terms, and by the end of 2012 only 1,5% of the total amount had a maturity inferior to 12 months. This conversion of maturities impacted our measures, reducing DD1 to levels closer to DD2. In Appendix C - figure 6 we can see an abrupt fall in DD1 and a raise in DD2-DD1 due to this event. These loans were due by the end of 2014, becoming short term by end 2013,

[7] For he same period BCP funded 10% of its assets with bonds, BPI 18%, BANIF 3%, Banco Santander 9%, Popular 17% and Banco Valencia 8%.

increasing again the gap between DD1 and DD2, by an average of 9 std dev. On average, the reduction of risk induced by the Central Bank actions in BES (DD2-DD1) was of 9, 13,4 and 12,3 std dev in 2008-2010, 2011-2012 and 2013, respectively (detailed data can be found in Appendix C- Table 9).

DD3 was also able to signal distress in Banif, when DD3 reached negative levels in July 2012, after the bank acknowledged EUR711 mn of impairments (Appendix C - figure 8). On the 31st of December Banif's severe recapitalization process was announced (for more details please resort to Appendix D). We obtained negative readings for DD3 until June 2013 (although decreasingly negatives), reaching positive readings on July 2013, after the capital increase of EUR450 mn. During the period where DD3 was negative, DD1 and DD2, averaged 150,85 and 100,59 std dev. These two measures, DD1 and DD2, more sensitive to changes in short term liabilities, reacted to the reduction of short term clients' deposits (-14% when compared with 2011) and other financial institutions (-85% Vs 2011), peaking on July 2013 with the capital increase. This effect was amplified by the low volatility of Banif's assets market value (averaging 0,22% since October 2011 to July 2013). In July 2013, an increase in asset's volatility from an average of 0,22% to an average of 0,93% led to an abrupt fall in DD1 and DD2.

In 2H2009, we can observe that db1 and db2 start diverging, as the wholesale funding market tightens and ECB steps in as the lender of last resort. Our DD2-DD1 measure deviates from zero and averages -11,9 std dev in 2008-2010. The weight of ECB loans on Banif's total assets keeps growing until 2013, from 8% in 2008-2010 to 18% in 2013. Our DD2-DD1 reflects that growth, reaching a peak in July 2013 of a reduction of 136,79 standard deviations std dev in Banif's distance to default. In 2011 semi-annual report Banif acknowledged €2,753bn of debt instruments acquired in 2010 under securitizations programmes, restating 2010 annual reports. Figure 8 of appendix C show an abrupt increase in asset value and in liabilities, consequently in all default barriers. We performed an adjustment on the series of asset returns, ignoring this jump on the asset value, to avoid the impact of the increase of 43% instantaneous return on asset value, and therefore in Appendix C - figure 8, we do not have a jump in DD results on July 2011.

DD3 readings for BPI reached levels close to zero since July 2013, averaging 2.12 until the end of the year (Appendix C - figure 7). For the abrupt fall, two different effects concur: i) a reduction of €2,3 bn in the credit portfolio and ii) the continuous change in the BPI's funding structure, as weight of bonds issued in total assets lowered from 8% in 2012 to 6% in 2013[8]. The effect of liabilities growth is also visible in DD1 and DD2, through the period we analysed. Specially in 2H2013, when we can observe an abrupt fall, with DD1and DD2 averaging 48,57 and 35,99. These results for DD1 and DD2 are significantly away from default due to a significant reduction of the percentage of assets funded by short term liabilities (from 51% in the end of 2012, to 45% in 2013)[9], as clients deposits maturing in 1 to 5 years grew 125% from EUR 1,8bn to EUR 4 bn, resulting in a conversion of deposits from shorter to longer

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[8] Author's calculations with resort to the bank's balance sheet. In 2006 the percentage of bonds issued in total assets was 20%. db3 regards all bonds issued as long term, therefore, keeping everything else constant, when the weight bonds issuance in the funding structure of the lowers, db3 increases and DD3 decreases.

[9] Author's calculations with resort to the bank's balance sheet.

maturities. Also in 2H2009, db1 and db2 started diverging and our DD2-DD1 measure deviates from zero, averaging -9 std dev for 2008-10 (Appendix C - figure 7). By the end of 2010, DD2-DD1 reaches a peak of -29,90 std dev, the maximum reduction in risk obtained from ECB's actions. With the beginning of the longer term refinancing operations (3 years), BPI converts short term loans into longer term and increases the amount of long term loans obtained from ECB (80% of ECB loans are long term). The difference between db1 and db2 lowers, with the respective increase in DD2-DD1.

In April 2008, BCP completed a capital increase of EUR 1,3 bn (Appendix C - figure 5), originating a jump in Asset Market Value. As a result, all DD measures increase. We can observe this movement until the end of 2009, when the weight of bond issued on total assets drops from 16% in mid 2009 to 14% by the end of the year, reaching 12% in the mid 2010[10]. DD3 falls from 62,62 to 48,56 std dev. Additionally, as the roll-over of maturing bonds issues became more difficult, the maturities profile of debt issued changes, as longer terms weight drop from 85% to 75%. DD1 and DD2 register an abrupt fall, from 109,12 to 75,62 and from 105,23 to 67,55 std dev respectively.

The ECB covered bond purchase program in conjunction with the tightening of international markets for the Portuguese Government (as already seen in BPI), motivated the growth of BCP's debt portfolio to EUR 6,7 bn (vs EUR 2,02 bn in 2009), of which 43% was due to the acquisition of Portuguese Sovereign Debt. The weight of ECB loans on BCP's assets grew from an

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[10] Greece was bailed out in April 2010. From then onwards Portuguese Sovereign Debt suffered several credit rating downgrades, impacting the country's credit spread, and banks credit spread as a consequence.

average of 2% until mid 2009, to a maximum of 16% in 2010, with the consequent reduction of db1. DD2-DD1 reflects that movement reaching a peak of -134.19 std dev in the end of 2011. In 2H2012 ECB loans to BCP are converted to long term, therefore db1 converges to db2 (the difference between the two is ½ of ECB's loans) and DD2-DD1 becomes closer to zero (averages -23 std dev, until the of 2013). During this period, the 2011 capital increases of EUR 260 mn originates a growth in all DD measures, effect that was amplified by a decrease of BCP asset volatility from an average of 0,67% (2006 to June 2011) to an average of 0,25% (July 2011 to September 2012). DD1, in particular, reaches a peak at 307,17 std dev away from default, due to the ECB funding programmes (db1 considers that ECB loans are indefinitely renewable). Finally, in October 2012, BCP completed a capital increase of EUR500 mn. The impact of the capital increase in DD's measures was offset by the growth of asset's volatility (average of 0,25% to 0,5% from September 2012 until the end of 2013).

Santander bank was included in the sample because it is a systematically important financial institution. In July 2007, db3 starts to diverge from db1 and 2 (Appendix C - figure 1), as the weight of bonds issues drop in Santander's funding structure, from 10% in December 2006 to 9% in July 2007. DD3, which until July 2007 differed from the other measures on average 3 standard deviations, increased that difference to an average of 11 standard deviations. In the first months of 2008, a reduction of 22% in other Financial Institutions loans in conjunction with a drop of 6% in clients' deposits, affect funding structure, with corporate bond regaining importance (15%). DD3 increases to 52,37 from 47,62 std dev. DD1 and DD2 register fall in this period, due to the reduction of deposits. In 2013, Santander absorbs Banco Banesto, member of Santander Group since 1994. In figure 1 we can observe a jump in asset value and liabilities due to this incorporation, with a respective increase in all DD measures. The impact of the ECB's funding policies is practically unperceived in Santander, as the maximum risk reduction is 8,39 std dev on July 2012.

In Banco Popular we can observe movements in the dbs similar to the ones registered in Banco Santander, converging or diverging according to changes in the funding structure (Appendix C - figure 2). In 2009, Popular incorporates Banco de Castilla, Banco de Credito Balear and Banco de Galicia, already members of Popular Group. Asset value liabilities register an increase in almost the same extent and all DD measures increase. The acquisition and merger of Banco Pastor, in June 2012, is responsible for another jump in the Popular's asset value and liabilities and for the increase in all DD measures. In 2H2013, the percentage of Popular's assets funded with short term liabilities increased from an average of 40% since 2012, to an average of 49%, as a consequence, DD1 and DD2 register a fall. Simultaneously the weight of corporate bonds issued in Popular's funding structure drops 0,6%, inducing an abrupt decrease in DD3. These movements were amplified by the increase in asset volatility registered since the beginning of 2012, from 0,5% to 0,78%. As in previous cases, the impact of ECBs funding policies are almost irrelevant, as DD2-DD1 reaches a peak of -27,30 std dev by the end of 2012.

In September 2011, before Banco de Valencia's 1st bailout (capital injection of EUR 1 bn[11]), DD1 and DD2 reached their maximum at 117 and 88 std dev, due to a fall in asset volatility from an average of 0,8% to 0,43% (until the 1st bailout) and a reduction of 4,5% in short term liabilities (Appendix C - figure 2).

The fast decrease in asset value and the restructuration of assets prior to the 2nd bailout impacted the asset value volatility which jumped to an average of 2,35% (January 2012 to February 2013) and to 18% after the 2nd capital injection. As consequence DD1 and DD2 register abrupt falls on the dates of the capital injections. DD3 started a downwards trend in the mid 2011, reaching negative levels in April 2012 (after the 1st bailout) and remaining negative until the second capital injection in March 2013. DD3 that does not have abrupt variations, revealed to be less sensitivity to changes in asset volatility.

For Banco de Valencia ECB's funding policy did not seem to be relevant until September 2011, when we observe a reduction in the banks' risk of -29.79 std dev. After the second capital injection and until the merger with Caixabank, ECB's funding policies become irrelevant to Valencia's risk.

Bankia at the epicentre of Spanish banking system turmoil, had its Initial Public Offering in July 2011, therefore our calculations start at that moment. In May 2012 Bankia restates its 2011 annual in order to acknowledge a loss of EUR3 bn and a first amount EUR4,5 bn of preferred shares were converted into ordinary shares at the request of the board of Directors of BFA. Our DD

[11] please resort to Appendix D for more detailed information

measures register an abrupt fall and for DD3 we obtain some negative readings. Later that year, in September, with the injection of EUR 4,5 bn by the FROB to restore the regulatory capital position of the group, DD3 shows signs of some relief and we obtain some positive readings, just to fall again. By the end of December 2012, with the recapitalization process (Capital increase of EUR 13,5 bn and the issuance of EUR 10,7 bn in CoCo Bonds) DD3 has an abrupt increase (Appendix C - figure 4). During this period DD2 becomes negative. Throughout 2013 it is perceivable a deleveraging process and the asset volatility jumps to an average of 2,41% (from an average of 1.96% in between May and December 2012). All our DD measures decrease and DD1 reaches negative levels. From the Summer 2012 until June 2013, the ECB funding policy impacted Bankia's risk with a reduction of 12,62 standard deviations on average.

Overall, the impact of the ECB's funding policies in our sample is irrelevant in 2006 and 2007, as DD2-DD1 for the sample averages -1.8 std dev (Appendix C – table 9). From 2008 to 2010, the funding structure of the banks in our sample revealed severe changes: i) Other Financial Institutions deposits weight on assets, fall to 15,4% from an average of 22,6%, ii) weight of Central Bank funding increased from 0.7% to 4,8%. During this period our DD2-DD1 is -7,9 std dev (a reduction of 7,9 standard deviations in risk). In 2011-2012, the most acute moment for Iberian banks, DD2-DD1 averages -27,9 std dev. In 2013, this measure is reduced to -17,8 std dev.

Chapter V – Conclusions

In this study we stress how important is the definition of Default's Barrier to the output of the structural model output. Through the use of three different Default's Barrier definitions, we were able to obtain very different outputs (DD1, DD2 and DD3), showing different sensitivities to the funding structure of the banks. DD3, as it considers all bonds issued as long term, proved to be very sensitive to changes in the funding structure, in particular to reductions of the weight of bond issued. This effect is rather visible in the results obtained for BES. Regarding DD1 and DD2, these measures showed more sensitivity to changes in maturity of the liabilities, stressing the risk of mismatch between maturities.

The timeline of our study comprises periods of highly leveraged balance sheets and the subsequent strong deleveraging. In general, our results are compatible with MKMV conclusions that the model biases default probabilities, overestimating the asset volatility for fast decreases in leverage the model and leading to higher default probability, even though credit risk is decreasing. The results obtained in 2013 for Santander, Popular, Bankia and BCP support this idea.

Although, in general all outputs followed the same behaviour, only DD3 was able to effectively signal distress in most cases. On the other hand, DD1 and DD2 definitions, differing only on the way Central Bank loans were treated, were convenient to use the model through non-standard pathways. Throughout this crisis, liquidity risk was in some dimension offset by the ECB funding policies. In our study we introduce and test a procedure anchored on Distance to Distress calculation, to quantify this reduction in risk induced by these actions. Our results show that ECB actions effectively reduced bank's default risk, particularly during 2011-2012.

When preparing the data for the computation of Distance to Default, we were surprise with the benign behaviour of clients' deposits, fact that we related to the deposits assurance policy and its reinforcement during the peak of the crisis. A study and quantification of this effect is left for future research.

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Appendix A – Deposits Behavior

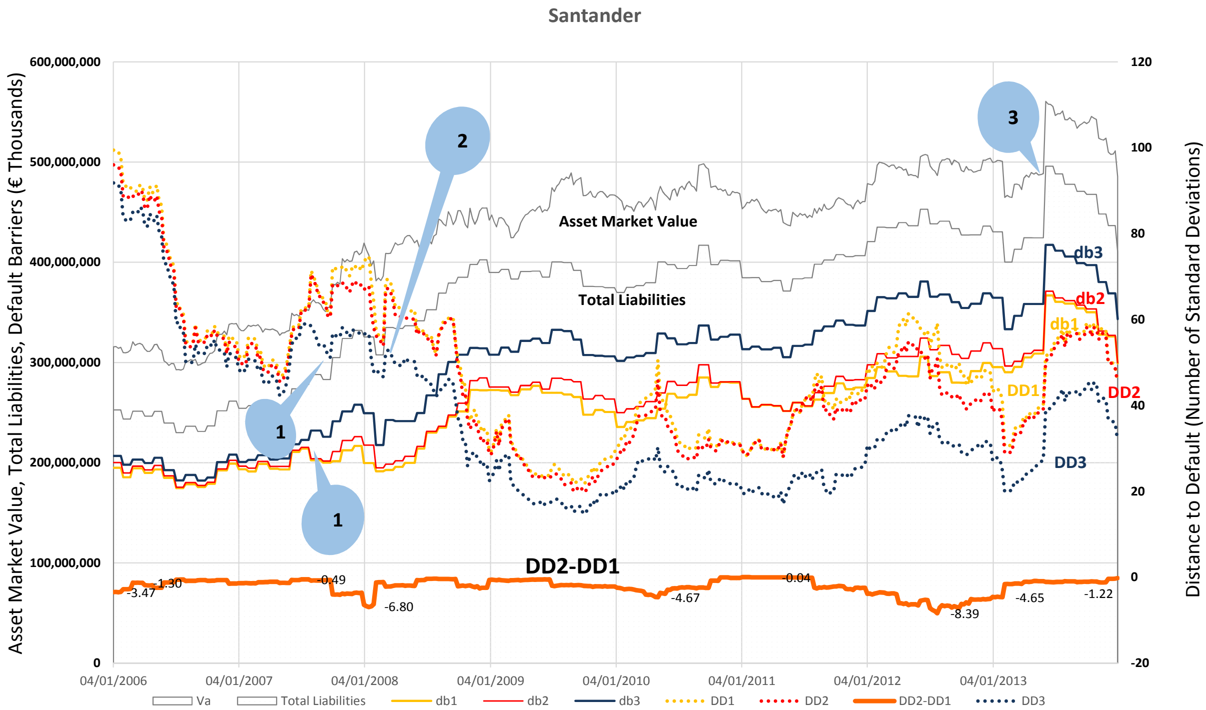
		Average Change				% on total Assets			
Bank	**Deposits**	**2006-2007**	**2008-2010**	**2011-2012**	**2013**	**2006-2007**	**2008-2010**	**2011-2012**	**2013**
Sample	Central Bank	**59.77%**	**39.8%**	**46.2%**	**-8.8%**	**0.7%**	**4.8%**	**9.5%**	**8.9%**
	Other IF	**3.2%**	**-0.5%**	**-4.5%**	**-5.9%**	**22.6%**	**15.4%**	**10.4%**	**11.6%**
	Clients	**4.2%**	**2.9%**	**0.5%**	**0.5%**	**43.3%**	**42.5%**	**42.4%**	**42.2%**
Santander	Central Bank	27.62%	28.9%	298%	-19%	1.23%	1.9%	4.0%	1.3%
	Other IF	-2.4%	2.3%	0%	1%	13.2%	10.5%	11%	11%
	Clients	0.85%	0.85%	0%	2.03%	43.29%	36.74%	36%	41.84%
Popular	Central Bank	-0.74%	25.9%	15%	-13%	0.56%	2.4%	7.4%	7.8%
	Other IF	0.2%	0.5%	3%	8%	16.0%	13.2%	8%	10%
	Clients	1.07%	2.22%	0%	-0.10%	54.57%	56.13%	59%	60.61%
Valencia	Central Bank	156.08%	3.8%	7%	-37%	0.30%	6.7%	15.4%	3.2%
	Other IF	3.0%	2.2%	-3%	2%	13.9%	12.2%	14%	33%
	Clients	1.46%	0.36%	-1%	-2.26%	68.30%	61.60%	60%	47.37%
Bankia	Central Bank			6%	-2%			8.4%	17.4%
	Other IF			2%	1%			8%	10%
	Clients			-1%	-0.43%			51%	42.91%
BCP	Central Bank	226%	102%	3%	-4%	1%	6%	14%	14%
	Other IF	4.41%	-13.82%	-14.60%	-4.38%	41%	21%	9%	7%
	Clients	2.18%	1.4%	1.08%	3.2%	36%	33%	35%	44%
BPI	Central Bank	-25%	9%	20%	-2%	0%	4%	7%	10%
	Other IF	5.67%	8.38%	-7.72%	-20.31%	20%	17%	14%	10%
	Clients	11.26%	0.8%	1.64%	2.6%	41%	43%	40%	44%
BES	Central Bank	34%	38%	7%	-5%	2%	4%	5%	0%
	Other IF	3.38%	12.37%	-14.62%	-10.67%	13%	14%	13%	8%
	Clients	4.18%	2.3%	3.46%	5.4%	15%	10%	10%	13%
BANIF	Central Bank	0%	71%	13%	10%	0%	8%	16%	18%
	Other IF	8.36%	-15.43%	-1.46%	-23.78%	41%	20%	6%	4%
	Clients	8.71%	12.5%	0.45%	-6.3%	45%	56%	47%	43%

Appendix B – Harada, Ito & Takahashi (2010) DB Definition

Liabilities	Classification
Deposits from central banks	ST
Financial liabilities held for trading	ST
Other financial liabilities at fair value through profit or loss	ST
Deposits from other credit institutions	ST
Deposits from customers	ST
Debt securities issued	
Certificates of deposit	ST
Bonds	LT
Other liabilities	ST
Financial liabilities associated with transferred assets	ST
Hedging derivatives	ST
Non-current liabilities held for sale	LT
Provisions	LT
Current income tax liabilities	ST
Deferred income tax liabilities	ST
Equity instruments	LT
Other subordinated liabilities	LT
Other liabilities	ST

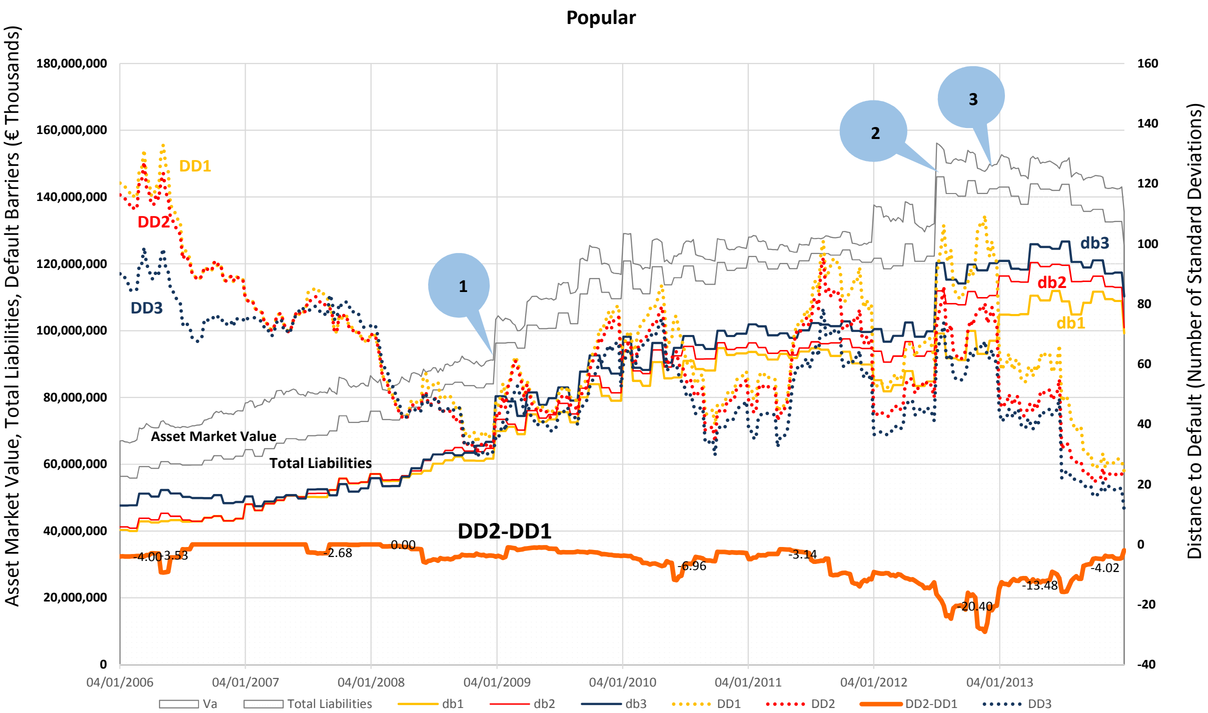
Appendix C – DD Results

Figure 1



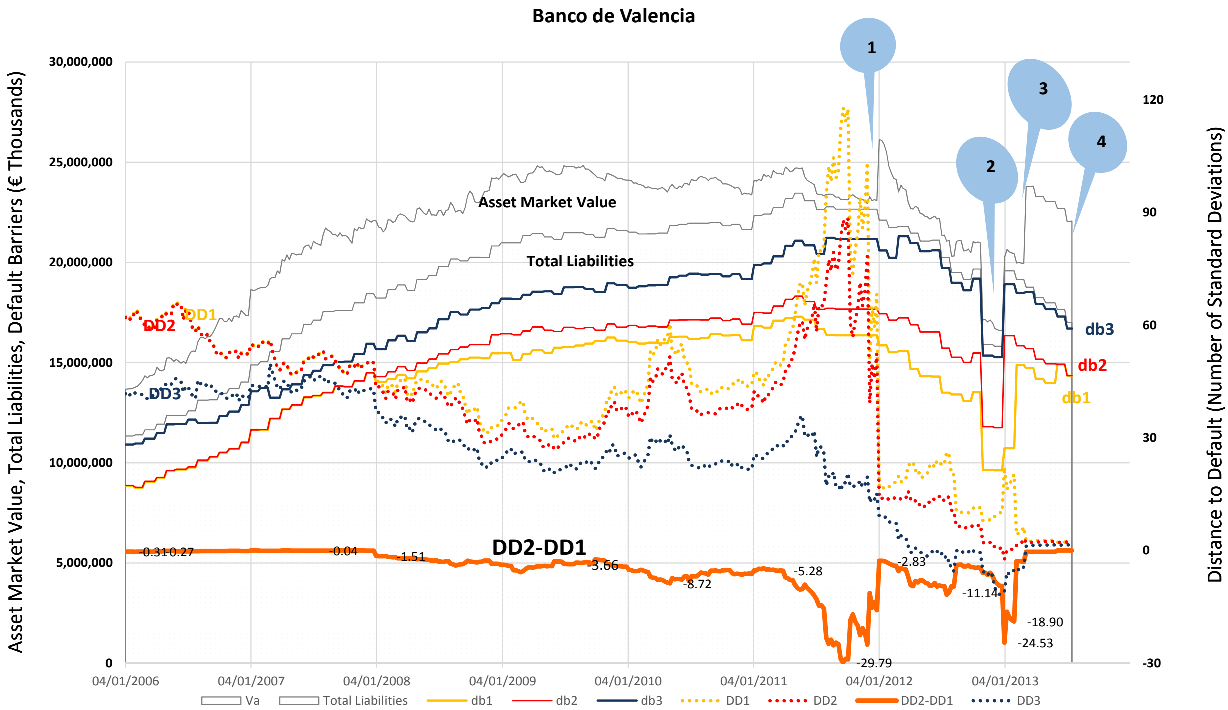
[1] Weight of bonds issues drop in Santander's funding structure from 10% in December 2006 to 9% in July 2007.DD3
[2] reduction of 22% in other financial intuitions loans in conjunction with a drop of 6% in clients' deposits, affect funding structure, with corporate bond regaining importance (15%). DD1 and 2 fall, while DD3 increases.
[3] Merger of Banesto, member of Santander Group since 1994, with Santander

Figure 2



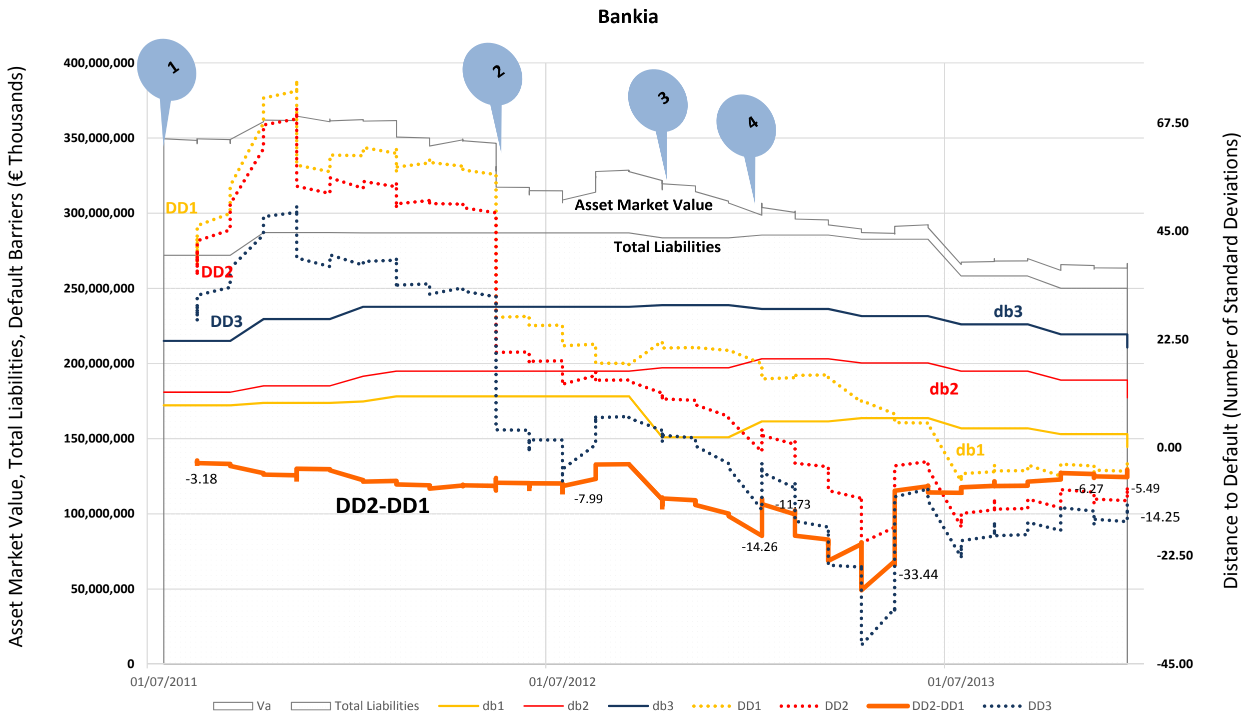
[1] Merger of Banco de Castilla,Banco de Credito Balear and Banco de Galicia, members of Popular Group, with Banco Popular.
[2] Acquisition and Merger of Banco Pastor with Banco Popular.
[3] Capital Increase of EUR 3,3 bn.

Figure 3



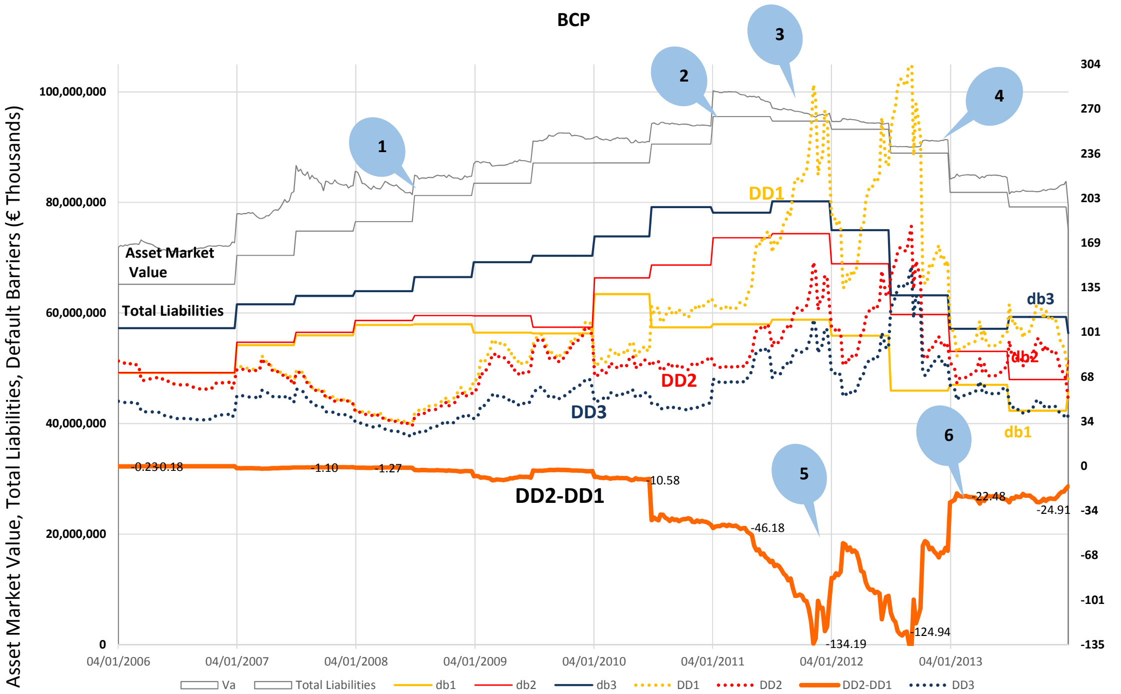
[1] 1[st] Baillout of Banco Valencia: Capital injection: € 1 bn, credit line: € 2 bn
[2] Equity reduction by absorption of losses, and transmission of toxic assets to SAREB
[3] 2[nd] Baillout of Banco Valencia: FROB's assistance for recapitalising the bank, in the form of shares valued in € 4.5 bn
[4] Banco Valencia is sold to CaixaBank

Figure 4



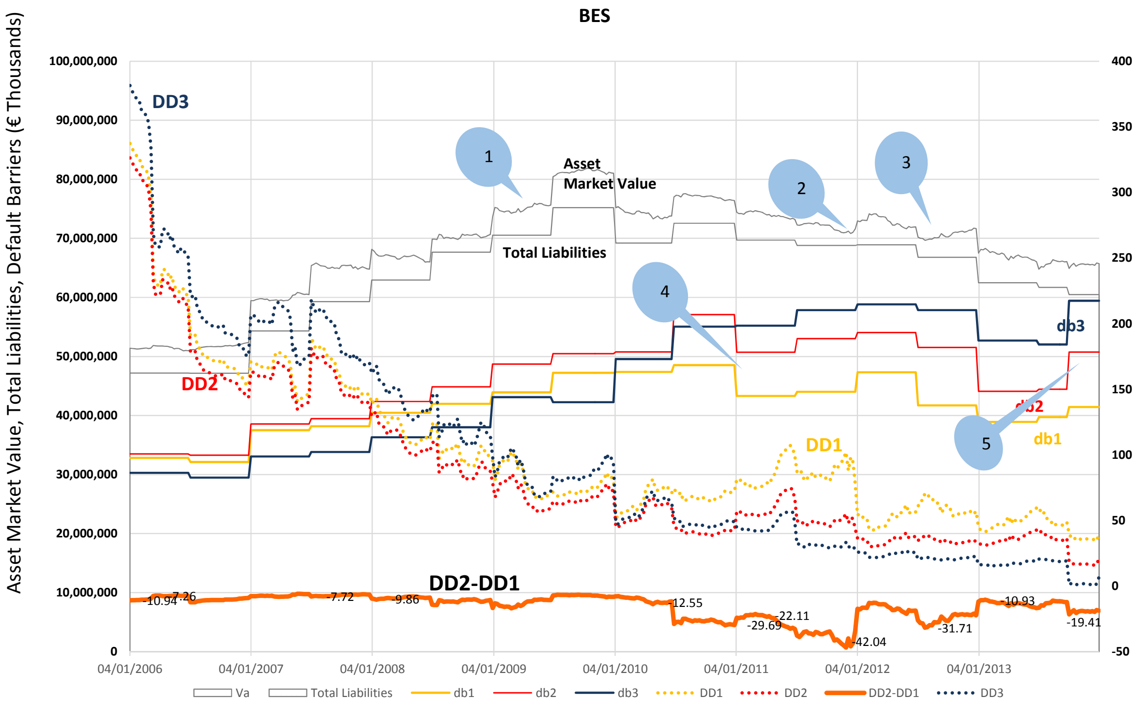
[1] BANKIA Initial Public Offering
[2] The first EUR4,5 bn of preference shares were converted into ordinary shares at the request of the board of Directors of BFA in May 2012.
[3] Injection of EUR4,5b n by the FROB in September2012 to restore the regulatory capital position of the group
[4] Capital increase of EUR13,5 bn and the issuance of EUR10,7bn CoCo Bonds

Figure 5



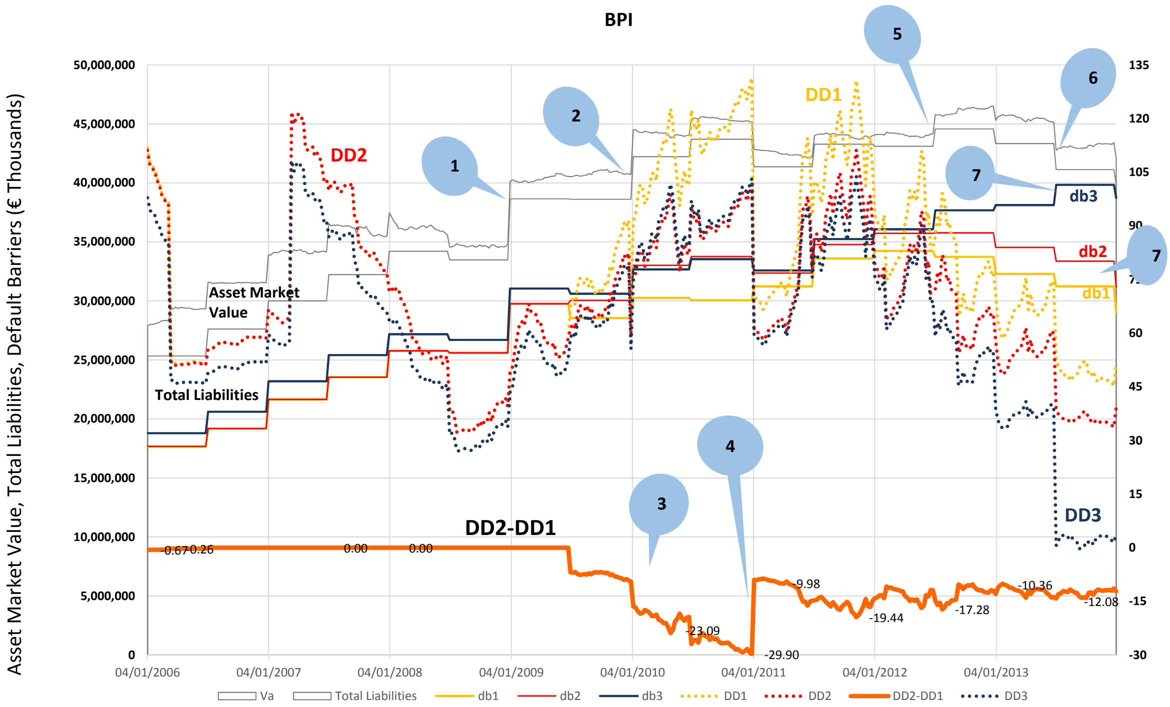
[1] Capital increase of EUR 1,3 bn in April 2008
[2] Growth in debt portfolio to EUR 6,7 bn (vs EUR 2,02 bn in 2009); 43% of this growth was due to Portuguese Soverign Debt.
[3] Capital increases in 2011 of EUR 260 mn
[4] Capital increase of EUR 500 mn in October 2012
[5] ECB loans weight on BCP's assets grow from an average of 2% until mid 2009, to a maximum of 16% in 2010, with the respective reduction of db1. DD2-DD1 reflects that movement
[6] ECB loans are converted to long term, db2 converges to db1 (the difference between the two is ½ of ECB's loans) and DD2-DD1 becomes closer to zero.

Figure 6



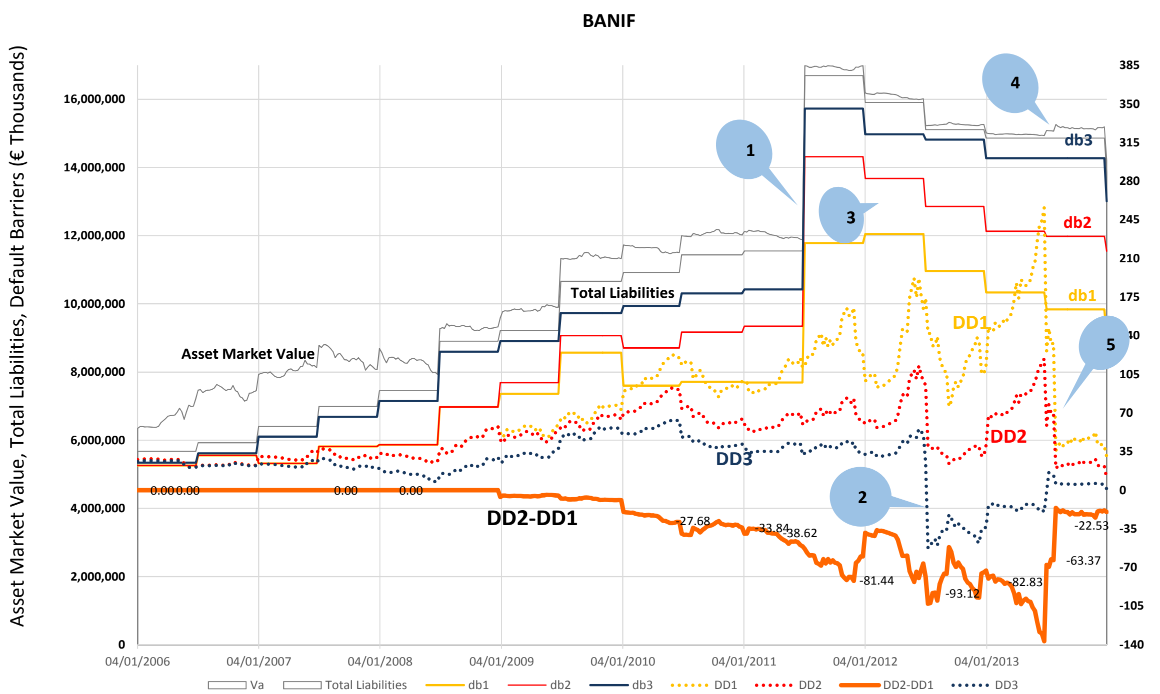
[1] Capital increase of EUR 1,19 bn in May 2009
[2] Capital increase of EUR 500 mn in December 2011
[3] Capital increase of EUR 1 bn in May 2012
[4] ECB's long term refinancing operations (3 years), that led to a conversion in the maturities of ECBs' loans to BES
[5] ECB's long term loans mature in 1 one year, therefore become short term lialibilities

Figure 7



[1] Capital increase 2008 of EUR 350 mn.Growth of the credit portfolio in EUR 1,7bn, funded gy an increase of €3bn in clients' deposits
[2] Acquisition of EUR4,7 bn in sovereign debt (+633% when comparing to 2008); 57,8% of the portfolio is Portuguese Sovereign debt
[3] ECB's non standard refinancing operations:CBPP and CBPP2; Securities Markets Programme
[4] ECB's long term refinancing operations (3 years): ECB's long term loans represent aprox. 80% of total loans.
[5] Capital increase 2012 of EUR 200 mn.
[6] Reduction of credit portfolio in EUR 2,3 bn.
[7] % Bonds issued on Total assets reaches 6% (increase in db3) and conversion of clients' deposits from shorter to longer terms (clients deposits maturing in 1 to 5 years grew 125% from EUR 1,8 bn to EUR 4 bn- decrease in db2 and 1)

Figure 8



[1] Acknowledge of EUR 2,753 bn of debt acquired under securitization programmes in 2010, and an extra EUR 0,5 bn in 2011
[2] Acknowledge of impairments of EUR 711 mn.
[3] ECB's long term refinancing operations (3 years), Banif's convert's aproximately 50% of ECBs' loans in long term liabilities
[4] Capital increase in 2013 of EUR 450 mn
[5] Increase in asset's volatility from an average of 0,22% to an average of 0,93% led to an abrupt fall in DD1 and DD2.

Table 9

Date	Event	Sample Average				Santander				Popular				Banco de Valencia				Bankia				BCP				BPI				BES				BANIF			
		DD3	DD1	DD2	DD2-DD1	DD3	DD1	DD2	DD2-DD1	DD3	DD1	DD2	DD2-DD1	DD3	DD1	DD2	DD2-DD1	DD3	DD1	DD2	DD2-DD1	DD3	DD1	DD2	DD2-DD1	DD3	DD1	DD2	DD2-DD1	DD3	DD1	DD2	DD2-DD1	DD3	DD1	DD2	DD2-DD1
	2006 up to 12/09/2007 Time Range Average	78,4	83,7	81,9	-1,8	60,6	65,9	64,6	-1,3	78,7	93,8	92,1	-1,7	43,3	55,7	55,6	-0,1					45,0	67,7	67,0	-0,7	68,7	77,7	77,6	-0,1	228,5	197,5	188,8	-8,7	23,9	27,5	27,5	0,0
19/09/2007	Northern Rock bank Run	71,9	74,6	73,4	-1,2	51,3	61,3	60,6	-0,6	74,8	70,8	70,8	0,0	42,0	47,8	47,8	0,0					44,8	57,3	56,3	-1,0	80,2	92,6	92,6	0,0	190,0	163,8	156,7	-7,1	20,2	28,6	28,6	0,0
	Time Range Average	66,0	69,7	67,8	-1,9	55,0	69,7	65,6	-4,1	73,6	69,1	69,0	-0,1	40,0	47,4	46,8	-0,5					37,1	47,8	46,8	-1,0	67,6	78,3	78,3	0,0	169,3	145,4	137,8	-7,6	19,5	30,5	30,5	0,0
20/02/2008	Northern Rock is nacionalized	55,7	59,6	57,6	-2,0	47,3	56,1	54,9	-1,2	57,6	54,1	53,4	-0,7	34,4	43,7	41,9	-1,8					30,0	39,9	38,6	-1,3	57,6	67,0	67,0	0,0	146,0	124,3	115,3	-9,1	16,9	32,0	32,0	0,0
	Time Range Average	55,3	59,8	57,6	-2,2	51,0	65,6	63,7	-1,9	51,6	48,6	48,0	-0,6	34,7	44,3	42,3	-2,0					30,1	39,5	38,2	-1,3	52,6	60,8	60,8	0,0	150,6	128,1	118,6	-9,5	16,5	31,9	31,9	0,0
26/03/2008	JP Morgan acquires Bear Stearns	53,6	58,4	56,2	-2,2	51,0	66,6	64,6	-2,0	47,2	44,6	44,1	-0,5	35,7	45,8	43,6	-2,2					29,0	37,7	36,5	-1,2	49,5	57,4	57,4	0,0	148,5	126,0	116,6	-9,4	14,4	30,6	30,6	0,0
	Time Range Average	49,0	54,3	52,0	-2,3	49,1	60,9	59,3	-1,6	45,2	48,3	45,7	-2,6	33,4	43,9	41,5	-2,4					25,6	34,3	33,1	-1,2	46,3	53,6	53,6	0,0	131,9	111,7	103,2	-8,5	11,7	27,6	27,6	0,0
02/07/2008	BCP - CMVM files a criminal complaint against BCP	48,6	56,0	52,3	-3,6	45,5	56,2	55,9	-0,4	48,0	53,1	48,1	-5,0	31,6	44,3	41,4	-3,0					24,7	39,9	37,0	-2,9	31,6	38,1	38,1	0,0	144,6	123,2	109,0	-14,2	14,1	36,8	36,8	0,0
09/07/2008	Fannie Mae and Freddie Mac placed in government conservatorship	49,5	56,7	53,0	-3,7	45,0	55,5	55,1	-0,4	48,5	53,6	48,6	-5,0	32,3	45,0	42,1	-3,0					26,5	42,1	39,1	-3,0	32,1	38,5	38,5	0,0	146,7	124,9	110,4	-14,5	15,3	37,5	37,5	0,0
23/07/2008	HBOS acquired by Lloyds at 18th Sep	42,7	49,8	46,8	-3,1	43,3	53,1	52,8	-0,3	43,8	48,5	43,9	-4,5	31,0	43,1	40,3	-2,8					26,0	41,5	38,5	-3,0	27,2	32,3	32,3	0,0	113,7	97,3	86,5	-10,9	14,2	32,9	32,9	0,0
	Time Range Average	44,6	52,6	49,2	-3,4	44,1	57,7	57,3	-0,4	45,0	48,3	43,5	-4,7	29,2	42,8	39,3	-3,6					28,3	44,7	41,5	-3,2	27,4	32,7	32,7	0,0	121,6	103,9	92,2	-11,7	17,0	37,8	37,8	0,0
10/09/2008	Fannie Mae and Freddie Mac placed in government conservatorship	45,9	53,4	50,0	-3,4	46,1	60,6	60,2	-0,4	45,4	46,1	41,8	-4,2	28,7	41,5	37,8	-3,7					30,3	46,4	43,3	-3,1	27,2	32,4	32,4	0,0	124,2	106,1	94,1	-12,0	19,2	40,5	40,5	0,0
17/09/2008	Lehman Brothers files for Chapter11 bankruptcy protection & Bank of America announces its intent to acquire Merrill Lynch FED authorizes a loan up to $85 billion to AIG.	46,6	54,3	50,9	-3,4	45,0	60,4	59,9	-0,5	45,4	46,0	41,8	-4,1	27,4	39,0	35,7	-3,3					31,3	47,8	44,6	-3,2	28,2	33,8	33,8	0,0	127,5	108,7	96,3	-12,4	21,4	44,4	44,4	0,0
24/09/2008	HBOS acquired by Lloyds at 18th Sep	44,2	51,6	48,6	-3,0	41,1	54,8	54,4	-0,4	40,7	41,2	37,8	-3,4	26,7	36,3	33,5	-2,7					32,6	48,9	45,8	-3,2	29,1	34,4	34,4	0,0	117,3	100,3	89,0	-11,3	21,6	45,1	45,1	0,0
01/10/2008	Dexia and Fortis Bank nationalised. Bradford & Bingley nationalised and partly sold to Santander Group	41,5	49,7	46,5	-3,2	37,0	50,5	48,4	-2,1	33,5	36,5	32,9	-3,6	27,4	37,7	34,8	-2,9					31,8	48,9	45,6	-3,3	28,3	33,7	33,7	0,0	109,0	93,4	83,1	-10,3	23,2	47,1	47,1	0,0
08/10/2008	Icelandic Crisis, LandsBanki, Glitnir and Kauphting Bank Nationalised	42,1	50,9	47,6	-3,3	35,9	48,9	46,8	-2,1	34,2	37,3	33,6	-3,7	27,4	37,9	34,9	-3,0					33,7	52,3	48,7	-3,6	29,9	35,7	35,7	0,0	111,5	95,4	84,8	-10,7	21,9	48,5	48,5	0,0
15/10/2008	RBS nationalised, Lloyds taken in 43.5% by the govenment,	40,1	48,7	45,5	-3,2	32,1	44,4	42,4	-1,9	32,9	35,9	32,3	-3,6	26,6	37,6	34,4	-3,1					31,9	48,6	45,4	-3,2	29,1	34,7	34,7	0,0	107,3	92,0	81,7	-10,2	20,8	47,6	47,6	0,0
22/10/2008	UBS bailout plan (17/10)	40,7	49,5	46,3	-3,2	32,0	45,0	42,9	-2,1	33,5	36,6	32,9	-3,7	27,2	38,3	35,1	-3,2					32,9	50,6	47,2	-3,4	29,4	35,1	35,1	0,0	108,2	92,6	82,3	-10,3	21,8	48,5	48,5	0,0
	Time Range Average	40,5	49,2	45,9	-3,2	28,0	38,0	35,9	-2,1	31,1	35,9	32,5	-3,4	22,7	32,5	29,7	-2,8					35,1	54,6	50,8	-3,8	31,8	37,6	37,6	0,0	111,2	95,3	84,8	-10,5	24,0	50,2	50,2	0,0
26/11/2008	Citigroup bailout plan	43,6	52,3	48,9	-3,5	27,8	36,8	34,7	-2,1	30,2	35,8	32,3	-3,4	22,2	31,3	28,7	-2,6					38,2	59,2	55,1	-4,1	34,5	40,9	40,9	0,0	124,7	106,6	94,6	-12,0	27,8	55,8	55,8	0,0
	Time Range Average	41,8	51,9	47,7	-4,2	25,2	32,6	30,9	-1,7	32,9	41,2	37,4	-3,9	24,4	34,0	30,3	-3,7					37,4	61,3	55,9	-5,5	39,4	45,4	45,4	0,0	105,9	95,1	82,5	-12,6	27,7	53,8	51,5	-2,3
21/01/2009	Anglo Irish Bank nationalized on the 15/01	45,8	58,9	53,4	-5,5	27,1	34,6	33,9	-0,7	40,8	53,6	49,1	-4,5	27,1	37,9	33,8	-4,1					45,5	79,4	70,6	-8,8	52,3	58,6	58,6	0,0	95,5	92,8	77,7	-15,1	32,2	55,3	50,0	-5,2
	Time Range Average	48,1	61,6	56,1	-5,5	24,6	33,1	32,4	-0,7	46,8	55,9	54,2	-1,7	25,4	37,5	32,4	-5,0					50,9	88,5	78,7	-9,7	57,8	64,6	64,6	0,0	98,9	96,1	80,4	-15,7	32,0	55,5	50,2	-5,3
01/04/2009	Caja de Ahorros Castilla La Mancha rescue plan	46,3	60,3	54,9	-5,3	19,6	28,5	27,7	-0,7	46,9	54,5	53,2	-1,3	24,1	35,2	30,5	-4,6					52,4	93,6	82,9	-10,7	56,6	63,2	63,2	0,0	91,2	88,7	74,3	-14,4	33,3	58,2	52,5	-5,6
	Time Range Average	49,2	63,4	56,8	-6,6	19,6	28,7	26,6	-2,1	54,3	62,1	58,8	-3,3	24,4	38,9	34,5	-4,4					54,0	88,4	82,1	-6,2	69,4	80,7	71,2	-9,5	74,2	69,9	61,2	-8,8	48,2	74,9	63,3	-11,6
05/05/2010	ECB - SMP Beginnig	58,9	84,3	70,9	-13,5	30,3	50,6	45,9	-4,7	69,2	78,8	71,9	-7,0	30,8	60,3	51,6	-8,7					57,1	92,8	82,2	-10,6	98,7	119,0	95,9	-23,1	66,1	74,2	61,7	-12,6	59,7	114,5	86,8	-27,7
26/05/2010	Cajasur rescue plan	53,1	77,1	64,4	-12,6	24,5	41,3	37,4	-3,9	59,4	67,8	61,7	-6,1	26,4	52,0	44,5	-7,6					53,0	86,1	76,3	-9,8	79,3	95,5	77,0	-18,5	66,6	74,9	62,1	-12,9	62,8	121,7	91,9	-29,8
	Time Range Average	54,2	78,3	65,1	-13,2	25,0	36,7	34,0	-2,8	57,5	72,6	61,5	-11,2	27,4	52,6	45,3	-7,3					54,8	88,5	78,5	-10,0	85,3	102,7	82,9	-19,8	65,9	73,8	61,5	-12,3	63,4	121,2	92,0	-29,2
30/06/2010	ECB - End of CBPP	48,9	82,6	60,6	-22,0	21,4	32,1	29,5	-2,6	53,5	65,6	58,4	-7,2	23,4	49,4	41,3	-8,1					47,4	120,7	79,8	-40,9	97,0	122,4	95,4	-27,0	52,0	74,4	45,6	-28,9	47,7	113,5	74,2	-39,4
	Time Range Average	47,3	79,9	58,5	-21,4	21,1	30,9	28,5	-2,4	49,6	60,6	54,1	-6,4	22,4	44,4	37,5	-6,9					46,3	118,1	78,0	-40,0	93,7	118,2	92,1	-26,1	49,4	70,9	43,3	-27,6	48,6	116,2	75,7	-40,4
28/07/2010	23/07- Four Spanish Cajas (Saving Banks) suspend the EU stress tests	45,0	75,8	55,6	-20,1	20,3	29,7	27,4	-2,3	46,7	56,8	50,9	-5,9	22,0	42,5	36,1	-6,4					43,4	108,9	72,3	-36,6	88,5	111,3	87,0	-24,3	45,5	64,8	39,9	-24,9	48,5	116,4	75,8	-40,6
	Time Range Average	45,6	83,1	61,2	-21,9	21,6	34,8	33,9	-1,0	50,0	64,6	59,8	-4,8	24,2	63,2	52,1	-11,1	38,6	57,8	53,5	-4,3	66,1	151,8	90,6	-61,2	82,9	102,6	85,0	-17,7	42,0	80,1	50,5	-29,6	38,9	109,9	64,2	-45,7
23/11/2011	21/11- Spanish government bails out Banco de Valencia	50,6	112,1	75,9	-36,1	24,5	44,1	41,2	-3,0	64,4	92,2	78,2	-14,0	17,5	90,9	68,9	-22,0	46,0	74,1	67,7	-6,4	85,3	220,0	118,1	-101,9	94,8	119,4	101,6	-17,8	31,0	97,5	52,2	-45,3	41,6	158,2	79,5	-78,7
	Time Range Average	45,1	93,8	64,2	-29,5	27,4	45,3	42,3	-3,0	49,0	69,7	58,7	-11,0	12,8	49,5	38,4	-11,2	38,7	59,8	54,4	-5,4	86,3	223,3	121,6	-101,7	82,6	102,6	87,6	-15,0	28,5	77,8	45,0	-32,8	35,2	122,2	65,8	-56,3
25/01/2012	ECB Long Term REF OPE 3Y maturity	39,7	76,7	54,6	-22,1	30,1	47,9	44,1	-3,8	37,5	54,0	44,2	-9,7	8,8	17,2	14,2	-3,1	38,7	62,4	55,4	-7,1	70,3	185,9	103,6	-82,4	72,3	88,7	75,3	-13,3	25,4	52,5	35,9	-16,6	34,3	104,9	63,8	-41,1
22/02/2012	ECB Long Term REF OPE 3Y maturity	35,1	67,2	48,5	-18,7	32,4	49,8	46,2	-3,6	37,1	54,2	43,9	-10,3	7,2	18,2	14,2	-4,1	33,2	57,3	49,8	-7,5	55,9	145,2	81,6	-63,7	62,5	76,2	65,1	-11,2	21,8	42,6	29,9	-12,8	30,8	93,8	57,1	-36,8
29/02/2012	ECB - SMP End	35,1	67,9	49,1	-18,8	33,7	52,5	48,7	-3,8	38,8	55,5	45,4	-10,2	2,9	19,7	14,2	-5,5	33,8	58,3	50,7	-7,7	54,7	140,9	79,5	-61,5	64,3	78,5	66,9	-11,6	21,7	42,6	29,8	-12,8	31,2	95,0	57,8	-37,2
	Time Range Average	39,2	78,5	55,5	-23,0	35,1	56,7	51,5	-5,1	43,1	61,0	49,9	-11,0	1,3	20,8	13,6	-7,2	33,0	58,6	50,6	-8,0	67,7	176,6	99,0	-77,6	73,4	89,7	76,4	-13,3	23,7	49,4	33,7	-15,7	36,2	115,2	69,1	-46,1
09/05/2012	Spanish Gov. Nationalizes BFA owner of Bankia	41,6	87,9	60,3	-27,5	37,3	60,5	54,1	-6,3	44,0	64,3	51,6	-12,7	-0,7	19,5	11,5	-8,0	26,1	53,5	44,9	-8,5	80,3	211,4	117,9	-93,4	79,0	96,8	82,3	-14,5	24,7	53,4	35,8	-17,6	42,0	143,7	84,4	-59,3
	Time Range Average	42,2	93,9	63,1	-30,9	36,5	59,9	53,5	-6,4	44,7	66,7	52,9	-13,8	-1,2	21,3	12,4	-8,9	11,3	35,4	27,9	-7,5	83,5	217,9	122,1	-95,8	87,7	107,7	91,4	-16,2	26,4	59,3	39,2	-20,1	49,1	183,1	105,0	-78,1
06/06/2012	BPI aproves issuance of Eur1,5 bn of Coco's Bond, BCP annouces the issuance of EUR3,5 bn of CoCo's	41,9	95,2	62,9	-32,2	37,6	57,9	52,4	-5,5	45,2	68,3	54,0	-14,3	-0,2	23,2	13,9	-9,3	3,6	27,3	19,9	-7,4	100,8	263,4	147,6	-115,8	75,1	91,5	78,2	-13,3	25,2	55,0	36,8	-18,3	47,8	174,6	100,7	-73,9
13/06/2012	Spain's financial assistance Package	42,4	95,4	63,5	-31,9	37,6	57,5	52,1	-5,4	45,2	68,6	54,1	-14,5	0,3	22,1	13,5	-8,7	3,0	27,3	19,8	-7,6	94,6	244,3	137,6	-106,7	77,0	93,7	80,1	-13,6	25,9	57,1	38,0	-19,1	55,6	192,2	112,6	-79,6
	Time Range Average	36,2	94,1	59,3	-34,8	35,5	56,5	49,6	-7,0	59,7	86,3	69,7	-16,6	**-1,2**	24,1	14,0	-10,1	-1,9	24,2	16,1	-8,1	113,7	254,9	143,9	-111,0	64,5	89,3	74,8	-14,5	22,7	62,4	37,1	-25,3	-3,3	155,2	69,2	-85,9
01/08/2012	ECB -OMTs	33,8	97,3	58,0	-39,3	32,0	51,1	44,0	-7,1	62,5	95,7	71,9	-23,8	**-5,4**	20,2	10,7	-9,5	0,6	21,5	15,0	-6,5	137,5	292,0	165,0	-127,0	65,3	96,9	80,2	-16,7	21,9	70,3	39,0	-31,3	**-44,5**	130,8	38,2	-92,7
	Time Range Average	31,1	81,3	49,6	-31,7	30,3	48,2	41,6	-6,6	59,1	88,0	68,0	-20,0	**-0,8**	11,4	6,8	-4,7	5,0	19,2	13,1	-6,1	116,4	245,1	139,3	-105,8	52,1	75,7	63,2	-12,5	20,5	60,6	34,7	-25,9	**-34,0**	102,4	30,3	-72,1
31/10/2012	ECB - End of CBPP2	25,2	71,5	43,3	-28,2	29,5	45,4	40,3	-5,1	65,0	104,4	76,9	-27,4	**-5,8**	8,0	2,0	-6,0	2,6	20,7	10,2	-10,6	75,9	152,6	89,6	-63,0	50,1	71,1	60,0	-11,1	20,9	55,1	33,0	-22,1	**-37,1**	114,8	34,5	-80,3
	Time Range Average	24,9	73,9	44,5	-29,4	30,8	47,1	41,9	-5,2	63,7	100,8	76,5	-24,4	**-8,6**	9,1	1,4	-7,6	-1,3	20,5	7,8	-12,8	78,7	157,6	92,8	-64,9	54,3	77,2	65,1	-12,1	21,9	55,6	33,8	-21,8	**-40,5**	123,3	36,7	-86,6
02/01/2013	BANIF- portuguese government anounces Recap. Program	16,4	60,2	36,8	-23,4	27,1	43,1	38,5	-4,6	44,6	64,7	50,0	-14,7	**-10,9**	22,2	-2,3	-24,5	-12,9	17,5	-0,9	-18,3	61,1	105,3	77,8	-27,5	38,8	70,9	57,9	-13,0	16,1	44,9	33,0	-11,9	**-33,0**	113,5	40,8	-72,7
	Time Range Average	15,7	52,7	35,6	-17,1	34,3	48,0	46,7	-1,3	30,6	45,8	36,1	-9,6	**-0,5**	5,1	2,0	-3,1	-16,8	2,7	-8,8	-11,5	49,5	100,4	76,7	-23,6	18,9	57,3	45,0	-12,3	13,5	46,0	31,2	-14,8	**-4,0**	116,4	55,6	-60,8
	Average 2006-2007	**77,0**	**82,0**	**80,3**	**-1,8**	**60,0**	**66,5**	**64,9**	**-1,6**	**78,4**	**90,6**	**89,1**	**-1,5**	**43,2**	**54,7**	**54,6**	**-0,1**					**44,2**	**65,3**	**64,6**	**-0,7**	**69,0**	**78,4**	**78,3**	**-0,1**	**220,9**	**190,8**	**182,5**	**-8,4**	**23,4**	**27,8**	**27,8**	**0,0**
	Average 2008-2010	**48,3**	**63,2**	**55,3**	**-7,9**	**28,6**	**39,0**	**37,2**	**-1,9**	**48,7**	**55,3**	**51,8**	**-3,5**	**26,4**	**41,1**	**36,8**	**-4,3**					**43,9**	**78,0**	**66,7**	**-11,3**	**63,9**	**76,1**	**67,0**	**-9,0**	**90,2**	**86,0**	**72,8**	**-13,2**	**36,3**	**67,1**	**55,2**	**-11,9**
	Average 2011-2012	**39,9**	**85,0**	**58,2**	**-26,7**	**27,3**	**44,6**	**41,3**	**-3,3**	**53,3**	**74,9**	**63,6**	**-11,3**	**11,7**	**44,6**	**34,3**	**-10,3**	**21,6**	**42,8**	**35,7**	**-7,0**	**83,7**	**190,4**	**108,4**	**-82,0**	**71,5**	**90,5**	**77,1**	**-13,4**	**30,7**	**71,2**	**44,7**	**-26,5**	**19,7**	**121,1**	**60,8**	**-60,2**
	Average 2013	**15,7**	**52,9**	**35,6**	**-17,3**	**34,2**	**47,9**	**46,5**	**-1,4**	**30,9**	**46,1**	**36,4**	**-9,7**	**-0,9**	**5,7**	**1,8**	**-3,9**	**-16,7**	**3,0**	**-8,6**	**-11,7**	**49,7**	**100,5**	**76,8**	**-23,7**	**19,3**	**57,6**	**45,3**	**-12,3**	**13,5**	**46,0**	**31,2**	**-14,8**	**-4,6**	**116,3**	**55,3**	**-61,0**

Appendix D – Additional Information on the sample

- **Millenium BCP;** founded in 1985, BCP is the largest Portuguese private bank, in terms of asset value. In 2012, as a result of EBA's valuation and the need to fulfil the capital requirements, BCP issued EUR 3 bn of contingent convertible subordinated bonds (CoCo), hybrid instruments qualifyable as tier 1 capital. CoCo Bonds were fully subscribed by the government with resource to PAEF bank's recapitalization fund. Additionally, BCP performed a capital increase of EUR 500 mn reserved to shareholders. As of May 2014 BCP had already paid back EUR 400 mn to Portuguese Government, and in July the bank made a capital increase of EUR 2,25 bn, of which EUR 1,85 bn are targeted to repay the public funds used to recapitalize the bank.

- **BES**; founded in 1920, was the second largest private financial institution in Portugal. In 2012, BES was the only of the four Portuguese listed banks to perform the recapitalization process without state's assistance, achieving a Core Tier 1 Ratio of 10,5%. The balance sheet deleveraging programme reduced transformation ratio from 198% in 2010 to 137% in 2012.

In 2013 Banco de Portugal (BoP) performed an audit inspection that went beyond the normal scope, requesting information regarding the main non-financial customers of the bank (ETRICC2 - Horizontal Review of Credit Portfolio Impairment) and found evidences that Espírito Santo Group might had developed a potentially fraudulent funding scheme between the companies belonging to the group[6].

BoP promoted a *ring-fencing* policy around BES, in order to protect it against further exposure to the group. However, even with this policy, BES' direct exposure to the ES Group grew in the 1H2014 from EUR 701,2 mn to EUR 1,572 bn, and clients' exposure grew from EUR 2,5 bn to EUR 3,1 bn[12].

In June 2014, the bank raised EUR 1,045 bn in capital, but warned investors regarding the bank's exposure to the family economic group. By the end of July, in its 1H report, BES wrote down EUR 4,254 bn of impairments and contingent costs, leading to a loss of Eur3,577 bn. Core Tier 1 Ratio lowered to 5,0% as of 30th June, bellow the minimum of 7% required by BoP. On 1st of August, the Governing Council of the European Central Bank decided to suspend BES access to monetary policy operations. Sunday, the 3rd of August 2014, BoP governor announced the split of BES into two institutions:

i) BES (*"bad bank"*), saw its banking licence revoked and kept the problematic assets, with BES' shareholders and subordinated creditors fully responsible for the losses registered from these assets;

ii) Novo Banco received the remaining assets and liabilities of BES, and was fully capitalized in EUR 4,9 bn by the newly formed Resolution Fund. Due to its low funding ability, Resolution Fund had to resort to a temporary loan from the FAP funds to obtain EUR 3,9 bn.

- **BPI,** created in 1984, is the third largest private bank in Portugal, in terms of assets. As an output of EBA assessment and to attain a Core Tier I Ratio of 9% with effect from June 2012, BPI was required to a temporary capital reinforcement of EUR 1,39 bn. This capital need was greatly due to the exposure to sovereign debt. BPI's recapitalisation occurred through the

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issuance of EUR1,5 bn in CoCo bonds with a five-year maturity, fully subscribed by the Portuguese Government in June 2012. During the 1H2014, BPI repaid EUR 920 mn, the remaining amount of CoCo bonds. BPI was the first Portuguese bank to fully repay the loan. In June 2014, the Core Tier 1 Ratio was 14.1%.

- **Banif**; EBA's 2011 evaluation detected capital needs of EUR 1,1 bn. In the beginning of 2013 BANIF started a recapitalization program of EUR 1,4 bn, being the remaining EUR 300 mn a safeguard to cope with future risks. The state assured the subscription EUR 700 mn in special shares and EUR 400mn in CoCo bonds to be repaid throughout 2013 and 2014. By the end of 2013, Portuguese Government owned 68,77% equity in Banif. In the summer of 2013, and in the context of the recapitalization program, Banif made a capital increase of EUR 450 mn reserved to private investors. In the end of 2013, the Core Tier 1 Ratio was 13,6%.

- **Banco Santander;** classified as a systematically important financial institution (*to big to fail),* was in 2013 the largest Spanish bank in terms of assets and 18th globally. It is the only bank in our sample that did not need to reinforce the Core Tier 1 capital.

- **Banco Popular,** is the sixth-largest Spanish bank in terms of assets, with a total of EUR 153 bn, and mostly focused on the retail banking business. Due to the output of EBAs stress tests, Banco Popular's Board was required to undertake measures to clean-up the bank's balance sheet, by creating provisions of EUR 9,3 bn euros and an internal "bad bank" to manage the problematic assets. EBA also identified the need of a capital reinforcement of EUR 2,5 bn. Popular was the only bank in our sample that did not require state assistance to perform the recapitalization required by EBA. The Core Tier 1 Ratio was 11.99% in 2013.

- **Banco de Valencia** was the first commercial bank to receive state help. In 2011 had approximately 65% of its credit granted to the housing sector (construction and real estate), for an average of 50.7% in the Spanish banking system. In November of 2011, Bank of Spain was forced to rescue it with EUR 1 bn and placed the bank under its official administration. In July 2012, FROB announced that found evidence of malpractices and would file criminal complaints of fraud and other irregularities against the former management. In November 2012, as part of the scope of Spanish banks' recapitalization process, FROB announced the injection of another EUR 4,5 bn , through a capital increase and the transmission of the problematic assets to SAREB. Later on, FROB's position in Banco de Valencia capital was sold to CaixaBank at the symbolic price of 1€. The merger of the two banks was effective on July 19th 2013.

- **Bankia:** all relevant information about Bankia is in Chapter I