

**GOVERNMENT BONDS AND CREDIT RISK: AN
ASSESSMENT OF DIVERSIFICATION AND A SAFE
ASSET IN THE EURO AREA**

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ABSTRACT

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Abstract <p>Banks' exposure to risky government bonds has become one of the main reasons of financial instability in recent years, especially in the euro area. The connected fate of banks and their sovereign government, the insufficient amount of safe assets, the high percentages of non-performing loans, as well as the low level of loans supplied to the economy are some of the main issues that need to be tackled in the financial system today. This paper examines the potential benefits of government bond diversification and the introduction of tranches via a new asset in banks' balance sheets from five countries in the euro area, Greece, Italy, Spain, Portugal and Germany. Additionally, the application of zero risk-weights and the absence of exposure limits to government bonds in banks' balance sheets is questioned. With the aid of a simulation technique, the distribution of potential future losses for various compositions of banks' balance sheets is calculated. Furthermore, the credit risk is measured via the VaR or CVaR method. On the one hand, results indicate that diversification of government bonds, may positively reduce banks' credit risk and thus, lead to an increase in loans supplied. On the other hand, in more stable financial environments such measures may be counter effective. The introduction of sovereign bond backed securities seems to tackle these issues more effectively. When banks hold the safest tranches of such assets, the reduction of credit risk is more effective in all economies examined, which leads to an increase in loan supply in all five countries. Therefore, this study finds support for the creation of a safe asset, as it is suggested in previous literature, in order to tackle some of the main issues that cause financial instabilities in the euro area.</p>	
Keywords Banks; Government Bonds; Credit Risk; Diversification; Safe Asset; Loan Supply; VaR;	
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1 INTRODUCTION

1.1 Motivation

Following the introduction of the euro currency in the euro area and prior to the global financial crisis in 2008, market participants falsely believed that nations in the euro area bore the same credit risks. As a result, all sovereign bonds of countries in the Economic Monetary Union (EMU) were perceived as risk-free assets and yielded low interest rates. In addition, sovereign bond spreads were expected to converge more in the future. This delusion, accompanied with the credit boom, created the appropriate circumstances for the increased speculative behavior of banks and eventually the banking crisis in the euro area. The case of Dexia and the Bank of Cyprus carry trade gone wrong was presented by Acharya & Steffen (2013), where both banks were bailed out with taxpayers' money. During the period of 2008-2012, almost 600 billion € were used for the rescue of the distressed financial institutions. It was then understood that an ex-post solution of bailing out failing banks is not a sustainable way of dealing with the banking crisis in the euro area (Benczur et al., 2017).

Figure 1. illustrates the long-term (10-year) government bond yields of Greece, Ireland, Italy, Portugal, Spain, and Germany for the years 2005-2018. It verifies the previously stated market view on euro area risks. Before 2008, all government bonds seem to be very closely correlated. However, after the realization of the sub-mortgage crisis and the collapse of Lehman Brothers, spreads between German and peripheral EU countries government bonds started to increase. In other words, all government bonds of nations inside the euro area were considered to be risk-free assets, a perception that changed after markets realized that peripheral EU countries might not be default-free after all, because questions about the future repayment of government obligations started to rise. The accumulation of very high government debt levels played a major role in the creation of uncertainty about full repayment of government debt.

More often than not, banks hold high percentages of government bonds in their balance sheets, 9% of their total assets on average (Gennaioli, Martin & Rossi, 2018). Furthermore, in the euro area, banks tend to hold a higher percentage of domestic government bonds in vulnerable countries (Brunnermeier et al., 2017). When a government fails to pay back its obligations, banks go down with them. Similarly, failing bank bailouts and the deposit insurance scheme create unbearable costs for governments as well and this connection creates a vicious cycle that is hard to break.

Since there is a non-zero probability that a government might not pay its obligations in full, this thesis provides an analysis that treats government bonds as risky assets. The default probability of government bonds should be properly measured and assessed so that banks will hold the appropriate levels of capital

to support their portfolios and mitigate the vicious cycle of sovereign-bank default.

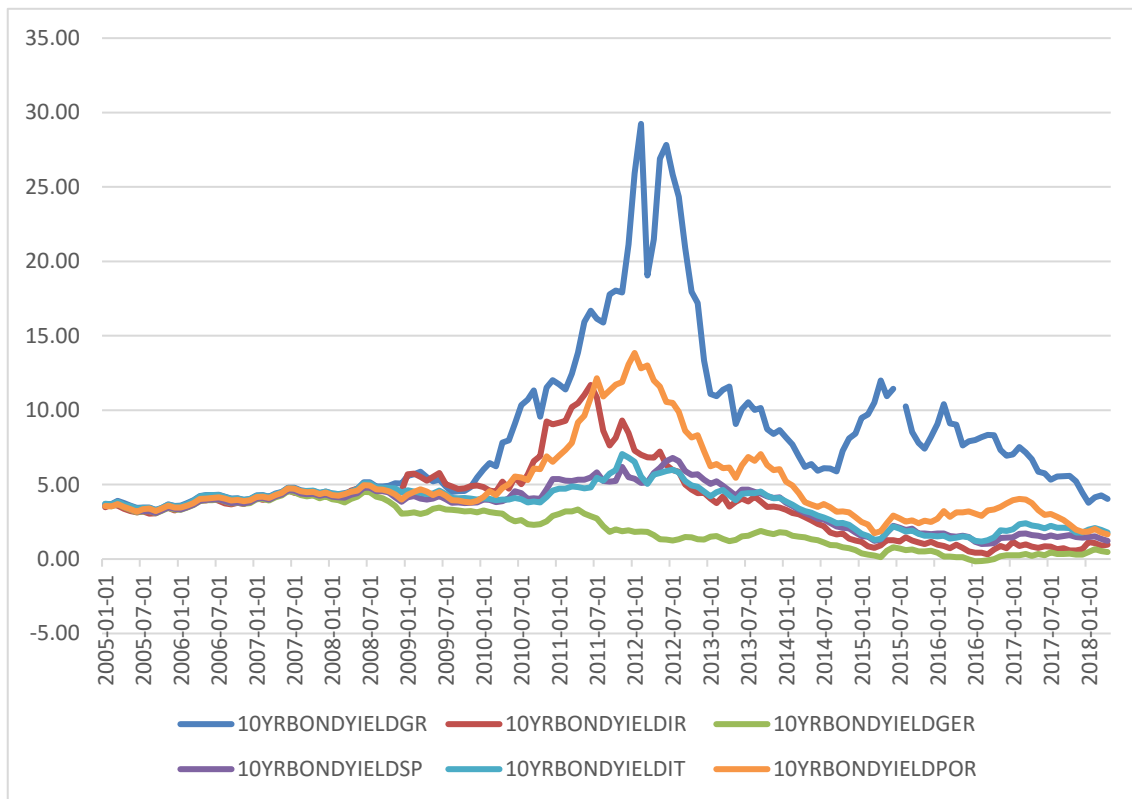


Figure 1. 10-year Government Bond monthly Yields (%) for Greece, Ireland, Italy, Portugal, Spain, and Germany, 2005-2018, data retrieved from <https://fred.stlouisfed.org>

This vicious cycle of banking and government crises, the “doom loop” (Bénassy-Quéré et al., 2018; Schneider & Steffen, 2017) also known as the “diabolic loop” (Brunnermeier et al., 2016), demonstrates the importance of creating a secure and stable financial sector inside the monetary union. In contrary, the system that exists at the moment increases the sovereign debt exposure of banks resulting to home bias, doom loop, flight-to-quality and risk spillovers from peripheral to core countries (Schneider & Steffen, 2018). So far, EMU members have not agreed on a plan to mitigate these issues inside the euro area’s financial sector. Divided between the suggestions of additional stabilization and risk-sharing mechanisms on the one side (France) and tougher enforcement of fiscal rules and increased market discipline on the other (Germany), effective reforms that could strengthen the EMU area and prevent banking and sovereign debt crises from occurring as a duo have not been put into action yet (Frieden, 2018).

An examination of the possible ways that would increase financial stability in the euro area and reduce the connection between banking and sovereign debt crises is thus, an essential requirement for the preservation of the system and further financial integration inside the euro area.

1.2 Research questions

This paper uses a Monte Carlo simulation for the derivation of a distribution for credit losses of banks' portfolios that consist of loans and government bonds. The distribution of losses is used to calculate the maximum loss for a 1-year period, with 99.9% confidence level, a measure known as Value at Risk (VaR). VaR equals the credit risk of the portfolio and is also interpreted as the minimum capital that is required for a bank to hold in order to absorb unexpected losses and remain solvent with a 99.9% probability during the period of 1 year.

The Basel accord follows the same interpretation of credit risk in the measurement of minimum capital requirements framework. With the aid of this simulation model, the following research questions are examined:

- 1) What is the effect of government bond diversification in the credit risk of banks' balance sheets and does increased diversification improve the supply of loans?
- 2) How does the banks' exposure to government bonds affect credit risk and would a 25% exposure limit to single government bonds, make banks' balance sheets safer?
- 3) Which is the right risk weight for banks' government bond holdings?
- 4) Does the introduction of a safe asset reduce the credit risk of banks in the euro area and would it increase the supply of loans?

1.3 Main findings

The simulation study shows firstly, that increasing the diversification of government bonds effectively reduces credit risk of banks that operate in countries which issue risky government bonds. However, for banks that operate in low risk environments and hold low risk government bonds may be in a worse position when holding the diversified portfolio. Secondly, even though the PD of CCC-rated government bonds is much higher compared to BB-rated bonds, increasing the exposure of BB or CCC government bonds has almost similar effects on credit risk. Therefore, high exposure limits to risky government bonds can positively affect the composition of banks that behave in risky environments. Thirdly, appointing zero risk weights to government bonds that are not risk-free makes banks hold lower capital than what would be required from them to support the riskiness of their holdings. Lastly, the introduction of Sovereign bond backed securities (SBBS) in the euro area would effectively remove the sovereign risk from banks' balance sheets and thus, break the main link that creates the vicious cycle of defaults between banks and their sovereign government. Subject

to credit risk constraints, increased diversification of government bonds and/or the inclusion of SBBS in banks' balance sheets is in a position to positively impact the level of loans supplied to the economy.

The remainder of this thesis is organized as follows. Chapter two briefly examines the extent of the connection between banking and sovereign crises. Chapter three provides the literature and regulation that tackles the phenomena of twin crises, as well as, a discussion for the creation of a safe asset in the euro area. Chapter four reviews the simulation method applied in this study and reports the values used for the parameters in simulations. Chapter five presents the results of the research. Chapter six discusses policy implications and finally, chapter seven concludes.

2 THE LINKED FATE OF BANKS AND GOVERNMENTS

Banking and sovereign crises have been occurring throughout the history and most likely will continue to do so. As Kindelberger & Aliber (2005) state, human nature cannot be tamed and hence periods of “Manias, Panics and Crashes” are bound to be a part of societies. In the analysis that follows, the connected fate between banks and their sovereign is examined.

2.1 Evidence from the past

After the global financial crisis and the risk spillovers to other sectors of the economy, various authors have examined whether sovereign government and banking crises are closely connected. For example, financial shocks that emerged from the banking sector in 2008, were the main drivers of output decrease in the euro area, due to increase in cost and/or decrease in supply of credit (Gerali, Neri, Sessa & Signoretti, 2010). In a paper that analyses the connection between sovereign default and domestic financial crisis, Arellano & Kocherlakota (2014) predict that banks and their governments default simultaneously because solvency status of borrowers, lenders and their sovereign governments are closely linked. Leonello (2017) also finds that the probability of default of banks and government debt crises is closely correlated. Arslanalp & Liao, (2014) find correlation between CDS spreads and contingent liabilities created by banks which as they argue, proves that financial stability and sovereign risk affect each other.

Furthermore, various authors’ findings suggest risk spillovers from banking crises to sovereign debt distress. Reinhart & Rogoff (2011) argue that the occurrence of a banking crisis increases the likelihood of a sovereign default. More specifically, the authors find that banking crises help predict sovereign debt defaults. Similarly, Hoque, Andriosopoulos D, Andriosopoulos K., & Douady (2015) in a paper that examines the effect of regulation to banks’ return and risk during the sovereign crisis, observe that banking crises tend to create sovereign debt crises.

The linked fate of banks and governments has been observed in emerging and developing countries to a great length. Balteanu & Erce (2018) gather data from 104 emerging and developing countries for the period 1975-2007 and find 100 sovereign debt crises out of which, 16 evolved into sovereign-bank crises. The authors also observe 81 banking crises out of which 18 evolved into bank-sovereign crises. These results show that there is a high chance of spillover between the two crises. Out of the total observed incidents, 16% of sovereign debt crises and 22.22% of banking crises evolve into twin crises.

Another study that examines the period 1976-2012 in 67 countries, finds 16 sovereign defaults in emerging and GIIPS countries. A significant number of

13 sovereign defaults in those countries also trigger a banking crisis, with 16 additional banking crises occurring without a reported sovereign debt incident (Arellano & Kocherlakota, 2014). In middle-income countries, the results are quite similar. Out of 39 sovereign defaults, 24 of them evolve into a twin crisis. One possible explanation for the increased spillover of risks compared to the previous paper's findings is the addition of observations from the global financial crisis and the GIIPS countries. However, no significant information concerning the mitigation of banking crisis to twin crisis is provided.

Prior to the global financial crisis, it was perceived that a number of advanced and developing countries were safe against financial crises, due to the fact that they were in a position to issue debt with low-interest rates in their own currency; one of these cases being the U.S. Governments would therefore retain the ability to bail-out distressed financial institutions and a crisis would be avoided.

Nevertheless, the experience of the past decade has shown us that incentives to accumulate large levels of debt in the public and private sector can destabilize the integrity of this system. Even developed countries have not managed to break the connection of bank and government default. Acharya, Drechsler & Schnabl (2014) use credit defaults swaps of European sovereigns and banks for the period 2007-2011 and find evidence for a two-way contamination of banks' and sovereigns' credit risk. Boone & Johnson (2014) discuss the learning outcomes of the leverage era and argue that in the period 1970-2011, 80% of G20 nations witnessed at least one banking crisis. This argument indicates the immunity of nations to the vicious cycle is seldom. In addition, Reinhart & Rogoff (2013) find that the frequency and duration, as well as, quantitative measures before and after the occurrence of the crisis are quite similar between middle-income and developed countries.

2.2 Factors that intensify the connection

Since the sovereign-bank nexus phenomenon has been observed as a global scale issue, it is essential to analyze the various factors that contribute to the strengthening of the link between the two crises.

A number of authors have spotted aspects of the domestic economy that strengthen the connection of sovereign and banking default. Arellano & Kocherlakota, (2014) point out that the domestic financial system and the sovereign government may default simultaneously when the economy suffers from a liquidity squeeze. Moreover, they argue that the occurrence of the twin crisis increases when the economy lacks strong bankruptcy measures. It has also been found that the sovereign-bank default link intensifies when bank funding depends on short-term borrowing (De Bruyckere, Gerhardt, Schepens & Vennet, 2013). These findings are in line with the ECB's Refinancing Operations, Quantitative Easing (QE) and "whatever it takes" statement to encounter the European crisis.

Furthermore, Shambaugh, Reis & Rey (2012) conclude that a growth crisis can lead to austerity measures which can reduce the tax revenues of the government. As growth drops, the role of indebtedness plays a significant role as well. De Bruyckere, Gerhardt, Schepens & Vennet (2013), examine the connection of banking and sovereign debt crises via CDS spreads data on 5-year sovereign bonds for 15 countries and 40 banks for the period 2007-2012. Their results indicate that as Debt-to-GDP ratios increase, the link that connects banking and sovereign debt crises intensifies. Similarly, Reinhart & Rogoff (2011) analyze over 2 decades of data from 70 countries and find that prior to a banking crisis the levels of private indebtedness rises rapidly as well. Last but not least, in the unlikely event of a reduction in equity, the bank has to re-balance the equation of assets and liabilities which leads to reduced supply of loans (Gerali, Neri, Sessa & Signoretti, 2010).

In addition to the aggregate economy, it has been found that bank-specific aspects can also strengthen the bank-sovereign nexus. Gennaioli, Martin & Rossi, (2018) point out that banks in emerging markets own high levels of sovereign bonds, with 9% of their balance-sheet-total on average. The percentage rises in countries that have defaulted to 13.5% in non-defaulting years and 14.5% in defaulting years, a behavior that increases banks' exposure to domestic government bonds, also known as home bias. It has been observed that increased home bias of banks is an important determinant of the vicious cycle. Acharya, Drechsler & Schnabl (2014) gather data from 2010 Eurozone bank stress tests and find that 70% of government bonds that banks hold, have been issued by their domestic government. They further show that the home bias manages to explain changes in CDS.

Banks' size also plays a major role in the sovereign-bank nexus. Albertazzi, Ropele, Sene, & Signoretti (2014), examine the recent financial crisis in Italy and state that banks' size affects the transmission of risks from banks to sovereign debt markets and vice versa. Larger banks own less capital, accumulate larger funding gap and are more likely to participate in non-traditional banking activities. According to De Bruyckere, Gerhardt, Schepens & Vennet (2013) traditional banking activities reduce the sovereign-bank nexus, hence bank operations that move further from their traditional business of gathering deposits and supplying loans further intensify the sovereign-bank loop.

In a theoretical analysis that examines the effect of government guarantees on banking crises and sovereign default in a closed economy model, Leonello (2017) finds that national government guarantees to financial institutions link closely together the probability of default of a nation and its banks. Government guarantees create a channel where the depositor bank-runs and the creditor withdrawal behaviors are closely related to each other. Similarly, Acharya, Drechsler & Schnabl (2014) find that bank-bailouts by the government create a tradeoff between reduced financial sector credit risk and increased sovereign credit risk. Finally, it is highlighted that bank-bailouts further intensify the link between bank and sovereign credit risk.

The synergies of financial and sovereign credit markets to the economy have been implemented more systematically into macro models only after the

global financial crisis occurred. Despite the fact that the initial modelling of financial markets emphasized the importance of credit demand, the role of credit supply is examined in a theoretical model in Gerali, Neri, Sessa & Signoretti (2010). It is argued that the banking sector competition, pricing policies and the financial soundness of banks are essential in the interpretation of business cycle variations.

Interpreting the role of loan supply in the economy and the causes and effects of loan supply shocks is essential for more extensive macroeconomic modelling. Empirical evidence further supports the latter statement, as Gambetti & Musso (2017) find that loan supply shocks have a significant impact on economic activity and credit markets for the U.S, U.K and euro area. It is pointed out that the impact of loans supply shocks has increased over the past few years. In addition, the impact of bank-specific aspects to the supply of loans has been examined by Gambacorta, & Marques-Ibanez (2011). They conclude that additional balance-sheet information, as well as, further understanding of bank behavior in risk taking, could help regulators to form better policies and provide the right incentives to optimize the supply of loans. Furthermore, Gennaioli, Martin, & Rossi, (2018) examine 20 sovereign defaults in 17 countries, in which 16 out of 17 occur in emerging markets for the period 1998-2012. Their findings suggest that bank holdings of sovereign bonds reduce loans-to-assets ratio by 1% and the growth rate of loans is decreased by an additional amount of 7% compared to banks that do not own government bonds.

Summing up, Figure 2 demonstrates the channels that intensify the loop between banks and their sovereign government. A banking crisis leads to an increase in sovereign default risk through bank bailouts and the deposit insurance scheme. The increased risk of sovereign default leads to decrease of government bonds value. In an attempt to support their sovereign debt markets, banks raise their exposure to government bonds, leading to an increase of home bias. However, risk-averse market participants continue to sell their holdings which leads to a decrease in banks' equity and government bond values. Additional factors as short-term funding, the size of banks and non-traditional banking activities, further increase the spillover of credit risk from banks to sovereign debt markets.

Banks in adverse periods reduce their loan supply and the national economy suffers a recession, which leads to reduced tax revenues for the government. This cycle can continue for years if there is no intervention.

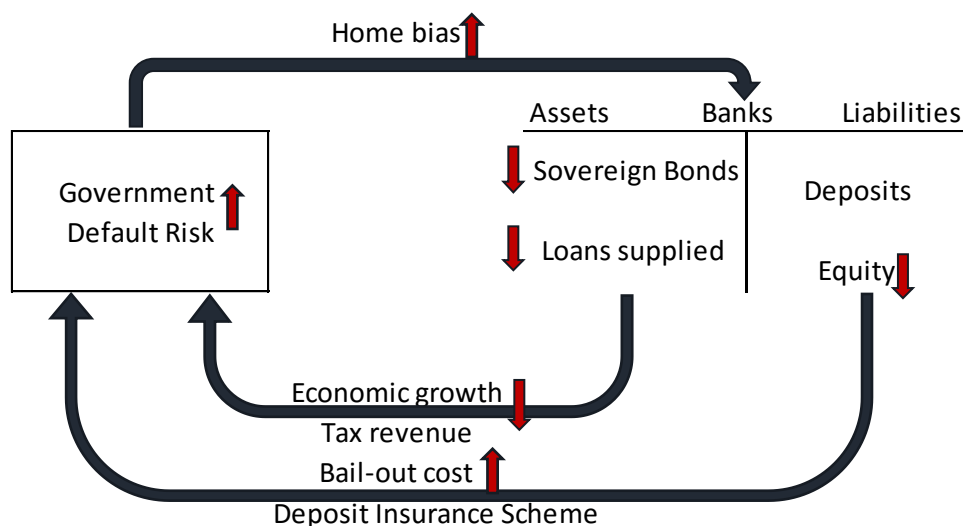


Figure 2. The links between the banks and government default risks, based on Brunnermeier et al. (2016)

The consequences of twin crises are extremely hurtful to the economy. Postwar data analyzed by Reinhart & Rogoff (2013), implies that during the first three years following a financial crisis hit, government debt rises about 86% on average and output, unemployment and asset prices continue to drop for several years after the occurrence of the crisis (Reinhart & Rogoff, 2009). Finally, the close connection between bank and government defaults leads to increased risk exposures via carry-trade activities, increased chance of risk spillover from sovereign debt markets to banks and an overall unstable financial system (Lenarčič, Mevis & Siklós, 2016). It is therefore essential for the well-being of nations and their economies, to seek the right policies that would increase bank stability and mitigate the links between banking defaults and sovereign debt crises without the additional burden for the taxpayers.

3 MITIGATING THE CONNECTION

Even though past experience has demonstrated that on some occasions, governments fail to pay back their obligations in full, for the most part, government bonds are still treated as risk-free assets to their majority. Banks are free to apply zero risk-weight to sovereign bonds in their risk measures, leading to lower capital requirements than what they should own to bear the risks in their portfolios. In addition, high exposures to risky government bonds together with the home bias phenomenon and in some cases the inability of the government to issue more money to pay its obligations in full due to EMU further intensify the vicious cycle of banking and sovereign default.

3.1 Previous propositions

In the recent years, a number of scholars have proposed solutions to mitigate the connection between banks and their sovereign governments. Boone & Johnson (2014) find that strict no-bailout laws and increased capital requirements, similar to the ones introduced in Basel II and III framework, can improve the stability of the financial system. Secondly, they point out the necessity for the existence of a framework that would provide solutions for across borders issues, which is an essential point for the survival of the EMU. Finally, they highlight that it is important to avoid conflicts of interest of regulators that move to the private sector and take advantage of regulatory loopholes. Another study that provides support for the Basel accord finds that increasing the capital adequacy level of banks (Tier 1 ratio) strongly diminishes the occurrences of twin crises (De Bruyckere, Gerhardt, Schepens & Vennet, 2013). In addition, it is pointed out that decreasing a bank's short-term funding as well as increasing traditional banking activities, diminishes the connection between defaults of banks and sovereigns.

Lenarcic, Mevis, & Siklos (2016) argue that an introduction of positive risk-weights in sovereign bonds would reduce the risk of sovereign-banking crises. However, caution is advised and expected by regulators in order to limit the funding capabilities of nations. In addition, policies to limit or diversify the exposure of sovereign default risk are non-existent, even though they could reduce the exposure of banks to sovereigns and vice versa. Arnold (2012), analyses EU bank data and proposes firstly, a 25% exposure limit to government debt, quite commonly to what is already in use for single private borrowers and secondly, a reduction and diversification of banks' exposures to sovereign debt. It is pointed out that both proposals would reduce the link between banking and sovereign debt crises. Similarly, Bénassy-Quéré et al. (2018) propose the introduction of sovereign concentration charges to reduce home bias. These charges would require banks that hold EU sovereign bonds of a certain level (more than 25%) to increase their capital requirements. In that way, banks will be highly motivated

to diversify their sovereign bond holdings, while maintaining the demand of sovereign bonds in general.

3.2 Regulation

In order to understand how policymakers make decisions, it is important to remind ourselves some basic finance. The basic idea behind regulatory rules is the difference in the payoff function of equity and debt investors. Equity produces a convex payoff function, making equity holders risk-lovers. In contrast, debt has a concave payoff function, making debtholders risk-averse. Therefore, it makes sense that a bank should be operated by equity holders when times are favorable, but let creditors take control in the case of a bankruptcy (Freixas & Rochet, 2008). However, the pursuit of higher profits when the economy is growing makes banks increase their total balance sheet size, which is mostly done via increasing credit levels since it is a cheaper funding mechanism compared to equity. In addition, banks face competition which leads to taking positions of excessive risk, when legitimate investments are hard to find. In these situations, if a negative shock hits in the economy similar to the one in the global financial crisis, the increased levels of leverage create unsustainable pressure for the banks. Subsequently, this may lead to bankruptcies, as it was observed during the global financial crisis.

In order to reduce this behavior of profit-maximizing banks, policymakers have introduced a counter-cyclical policy. The countercyclical capital buffer (CCyB) was added to Basel III and will be fully effective by January 2019. It is one of the tools meant to have an impact on the stabilization of the banking sector. Such a measure requires banks to hold increasing amounts of capital in boom periods and reduced amounts during recessions. In that way, banks will remain safer in times when excess credit levels may harm the economy against unexpected losses (Basel Committee on Banking Supervision (BCBS), Feb. 2018).

In the euro area, the Basel rules are implemented by the Capital Requirements Regulation (CRR/CRD-IV). It allows zero risk-weights to be assigned in sovereign bonds, which are issued in the same currency in which a bank operates as stated in article 114, paragraph 4. Basel III has not made any changes on how sovereign credit risks are weighted. Intuitively, appointing zero risk-weights to an asset that is not risk-free, leads to lower minimum capital requirements than what is actually required for a bank to be secure against credit risks. Policymakers' response to the above measure is that a 150% risk-weight is assigned to sovereign bonds that have had a default incident in the past 5 years. Nevertheless, for countries close but not yet at default there are no provisions foreseen (Saunders & Cornett, 2018). In addition, it is argued that sovereign bonds are risk-free by their nature, due to the fact that in the case of a sovereign default, the national central bank has the ability to cover for its government's obligations. Inside the EMU though, governments cannot use monetary policy to encounter a sovereign debt distress, neither can the European Central Bank (ECB) finance any public

entities, since financing to public entities is prohibited by the Treaty on the Functioning of the EU, as it is stated in the article 123.

After witnessing the adverse effects of the financial crisis in 2008, the Basel accord has introduced two more risk-based capital standards, the large exposures framework and the Liquidity Coverage Ratio (LCR). The large exposure framework prevents banks from accumulating exposures to any single counterparty higher than 25%. However, current legislation in the EU area does not require any exposure cap from the zero risk-weighted sovereign bonds. Applying such a measure together with increased capital requirements could possibly stabilize the financial system inside the EU area further. LCR was introduced on the first of January 2015 with a 60% requirement and has been stably rising to reach a 100% requirement by the beginning of 2019. Sovereign bonds are considered as high-quality liquid assets in the LCR standard (Lenarčič, Mevis & Siklós, 2016) in which banks are required to hold a sufficient number of highly liquid assets, so that they will be able to survive a period of liquidity squeeze that can last up to 30 days (BCBS, April 2018).

Another requirement introduced by Basel III is the Leverage Ratio Requirement (LRR). The LRR is a non-risk-weighted requirement defined as the ratio of Tier 1 capital divided by on- and off-balance sheet items. The minimum requirement by the Basel standard for this ratio is 3% and aims to provide stability at times when the risk-weighted tools fail to effectively measure risk exposure. Lenarcic, Mevis & Siklos (2016) argue that LRR will make banks hold sufficient capital during financial crises.

However, Kiema & Jokivuolle (2014) find that an LRR of 3% might be too low to improve bank stability. Their analysis consists of a simplified model where banks' balance sheets consist of low-risk and/or high-risk lending. The authors argue that a significant unexpected change to the default probability of the low-risk loans could have severe consequences and even worse if the shock affected high-risk loans. Still, a higher LRR requirement, up to the average level of risk-based capital requirements though, would improve bank stability with a non-significant increase in the cost of capital, since banks can increase their LRR simply by reshuffling loans among themselves. Nevertheless, the banking system would still be unsafe from an extremely high unexpected change in the probability of default in low-risk loans.

Implementing the optimal policies to stabilize the banking sector and break the vicious cycle of banking and sovereign crises is not an easy task. Whether the Basel framework in its third revision will be successful in breaking the loop is a question that cannot be answered with certainty, yet. However, certain policies that provide incentives to increase domestic government bond exposure of banks and assign zero risk-weights to risky government bonds, diminish any positive effects that would break the connection between banks and their governments.

3.3 Discussion for the creation of a safe asset in the euro area

3.3.1 Background

When thinking about a safe asset, one that is risk-free in its core, a specific government bond comes into mind. U.S treasury bills; short-term government debt issued by a nation that has always paid its obligations in full and will continue to do so in the future. A similar example for the euro area would be German bonds. On these grounds, the essence of an asset that makes it safe needs to be examined.

Caballero Farhi & Gourinchas (2017) define a debt instrument as safe when it manages to preserve its value throughout favorable and adverse times. He, Krishnamurthy & Milbradt (2016) find that the number of investors that hold an asset determines whether it is assumed to be safe or not. The number of investors must exceed a certain threshold which is increasing with the level of debt issued and decreasing with the country's fundamentals similar to fiscal surplus. In addition to the characteristic of money being a good store of value, it is argued that investors appreciate the high liquidity that a safe asset has to offer. The U.S economy has good fundamentals compared to other possible safe asset suppliers, which has allowed U.S bonds to retain or even increase their safety feature, while all other countries' fiscal conditions have worsened globally as time has passed. The same phenomenon has been noted in the euro area, where the sovereign debt crisis worsened the ability of governments to repay their obligations, leaving Germany as the lone supplier of safe assets.

Financial institutions also have a high demand for safe assets and maybe higher than private investors, because they are allowed to utilize such assets as collateral for repo agreements and other financial transactions. Caballero & Farhi (2013) explain how the lack of safe asset supply to meet the demand for such debt instruments in the economy created the right circumstances for the creation of toxic instruments that led to the sub-prime mortgage crisis. The contagion to the euro area also triggered the increase in funding costs in peripheral countries of the euro area, which was one of the leading causes for the sovereign debt crisis.

3.3.2 Sovereign Bond Backed Securities (SBBS)

The discussion for the creation of a safe asset began when euro area financial stability problems initially occurred (Leandro & Zettelmeyer, 2018). Various suggestions have appeared over time with limited success in creating momentum for putting these ideas into action. However, recently the discussion has been brought back into light again and looks more promising than ever.

Initial discussions about the creation of a safe asset proposed to gather euro area debt into a single safe asset, a Eurobond, guaranteed by the members of the EMU. Originally the purpose of such an asset was to create a large and liquid bond market that would aid in the financial integration, as well as in the

creation of a mechanism that would maintain a stable source of funding for countries in a crisis. The idea did not move forward since risk-sharing is a deal breaker for some members inside the monetary union. In a way, it is logical that countries with low levels of government debt per GDP like Finland, Germany or the Netherlands would be unwilling to share default risks of countries that have high Debt to GDP ratios like Greece, Italy and Portugal.

More recent proposals discuss the SBBS alternative. In a feasibility study conducted by the European Systemic Risk Board High Level Task Force (ESRB HLTF, 2018), SBBS are defined as “securities with varying levels of seniority backed by a diversified portfolio of euro-denominated central government bonds”. Moreover, “because they are created through private contracts, SBBS do not mutualize sovereign risks, as each government would remain responsible for servicing its own debt obligations” (ESRB HLTF 2018, p. 4). The latter would provide incentives for governments with low debt levels and good fundamentals not to veto the creation of such an asset, since moral hazard of governments that issue risky government bonds would not increase. The aim of creating SBBS will be to increase the supply of safe assets inside the euro area, which would reduce the perceived shortage of safe assets in the region and replace government bonds on banks’ balance sheets (Brunnermeier et al., 2017).

A recent paper from Bénassy-Quéré et al. (2018) attempts to harmonize the path of risk sharing on the one hand and the path of market discipline on the other; views backed by both French and German political parties. The authors suggest that one of the reforms that are required inside the euro area in order to achieve market stability and sustaining prosperity for EU nations is the introduction of a safe asset. Such an asset could possibly solve some of the main issues inside the non-integrated market of the euro area. Schneider & Steffen (2017) examine the viability of various regulatory proposals and find that only SBBS can provide the means to reduce future doom loops, spillovers of risks from peripheral EU countries to the core countries, the home bias of banks’ sovereign debt and avoid a flight-to-quality of assets from peripheral to core countries.

3.3.3 Pooling and Tranching

The literature on safe assets suggests that SBBS would be divided into different seniorities with varying risk-levels. The senior division would maintain a less risky nature, compared to the junior, since junior bonds will be the first to experience losses. More specifically, Brunnermeier et al. (2017) point out that if 70% of the total amount of the pooled portfolio would be divided into the senior tranche, they may have similar risk characteristics to German government bonds and will be perceived as risk-free. It is also suggested that the rest 30% of the pooled portfolio, should be divided into 2 more tranches. 20% of the newly created assets, the mezzanine bonds, would be bought by conservative investors and the final 10%, the junior bonds, for high-yield seeking investors. The division of the pooled bonds in different levels of seniority is what makes SBBS effective. Holders of risky junior bonds will be experiencing losses first. Only when the

total amount of junior bonds will be wiped out, the second division, the mezzanine bonds, will start experiencing losses. Finally, senior bonds will start receiving losses when the total value of junior and mezzanine bonds will be zero.

Figure 3 explains how SBBS would be created. An independent entity gathers government bonds that are freely traded in private markets from euro area countries and members of EMU. The weights for each country's bonds are predetermined through some estimate that connects relative GDP values of each nation, for example, ECB capital key values (ESRB HLTF, 2018). The independent entity follows algorithmically a rulebook to create the tranches of seniority and finally sells the whole package of senior bonds to banks and the total amount of junior bonds to other investors. If junior division is constructed to have 2 separate tranches, mezzanine bonds would be sold to conservative investors and junior bonds to yield-seeking investors. The independent entity does not carry any risk, it only assures that SBBS are created and distributed to their buyers.

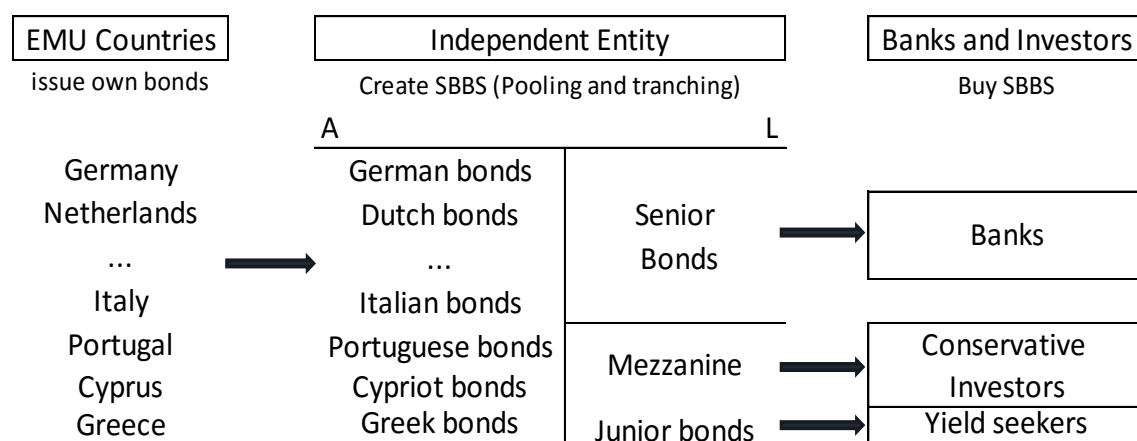


Figure 3. The role of the independent entity in the creation of SBBS, as explained in ESRB HLTF (2018)

The division of the junior branch into additional levels of seniority is an issue that falls beyond the purpose of this study. Therefore, this thesis does not make an additional division for the junior branch and it is assumed that the rest 30% of the pooled portfolio is one whole level of seniority which experiences losses first, up to the point where its whole value is wiped out.

3.3.4 The circumstances required for SBBS to succeed

There are certain issues that are needed to be solved for SBBS to be feasible in the European market.

Firstly, the study of ESRB HLTF (2018) states that various regulatory rules which are in action at the moment would treat SBBS as securitized assets. This implication would reduce the incentives of banks to hold SBBS. Capital requirements are higher for securitized assets compared to government bonds, due to the increased counterparty risk. In addition, securitized assets are not perceived as highly liquid assets, whereas government bonds are. Therefore, banks might

prefer holding government bonds to meet their LCR requirement, instead. Secondly, it is crucial to ensure that government bonds and SBBS have the same payoff structure, otherwise, the independent entity does not hold a neutral position. Two rules are necessary to ensure that this happens. One, an entity should purchase government bonds that are participating in primary markets and two, the bonds need to be priced competitively. Thirdly, SBBS issuance has to be demand led by all the tranches so that the issuer of SBBS does not hold any exposure after the completion of issuance. Thus, the number of senior bonds created will also depend on the demand for non-senior bonds. This relationship raises some questions on whether the demand for the riskier tranches would suffice to produce the number of senior bonds that the market requires for SBBS in order to replace government bonds holdings of euro area banks. De Sola Perea, Dunne, Puhl & Reininger (2018) argue that in the case where SBBS are divided into 70:20:10 tranches, mezzanine bonds will have same risk as Italian and Spanish bonds and junior bonds will be less risky compared to the riskiest bonds in the euro area but will carry more market-based losses. In addition, it is argued that junior bonds will be more liquid than single government bonds, which is an aspect that could attract investors into buying junior bonds.

To ensure that such an asset would have a positive impact on increasing banking stability in the euro area and mitigate the sovereign-bank loop, these main issues need to be seriously considered prior to the creation of SBBS.

4 RESEARCH METHOD

4.1 Measuring Credit Risk with the Value at Risk Method

Credit risk, in general, emerges due to uncertainty about the full payment of a counterparty's obligations. (Papaioannou, 2006). In the case of government bonds, sovereign governments rarely face an outright default. However, government bondholders can still lose a significant percentage of their investments when a government announces default or repudiation, which translates to the ceasing of full repayment. In addition, restructuring or renegotiation of debt, where sovereigns and lenders agree to reduce the remaining payments can lead to huge losses. Finally, a regime switch, which is a change of government or the default of another sovereign bond that changes the future perceived risk, can also lead to a loss of investment value (Duffie & Singleton, 2012).

Evaluating and measuring credit risk of sovereign bonds can be a troublesome process because of the lack of data and the fat-tailed and skewed distribution of credit losses as demonstrated in figure 4. The non-normality of losses distribution occurs due to high probability of small gains and low probability of high losses that defaults create. Standard deviation is not a good measure of risk anymore, because skewed and leptokurtotic returns (losses) contain additional risk factor than just standard deviation. The Value at Risk (VaR) approach manages to measure additional risks occurring from the non-normality of the distribution, and hence provides a more generalized approach of risk measurement (Campbell, Huisman & Koedijk, 2001).

One practical way to measure the credit risk is to generate a high number of scenarios about the future losses of a portfolio with Monte Carlo simulations. In marked-to-market models, losses occur when there is a downgrade of the credit rating assigned to a counterparty, while in the binomial approach losses occur only in the case of default. These approaches can be seen as reduced form models, which assume that the default incidents cannot be predicted, hence they occur randomly. Consequently, it is possible to calculate the losses of each scenario and finally derive the distribution function of losses. The exposure of credit risk is measured as the Value at Risk (VaR), which is calculated as the alpha percentile worst loss for a certain period of time. For example, in a case of 10,000 scenarios created, the 99.9% VaR would be the tenth worst result. A bank that holds capital up to the calculated VaR, would be safe against a bankruptcy for 99.9% of the cases for the calculated period.

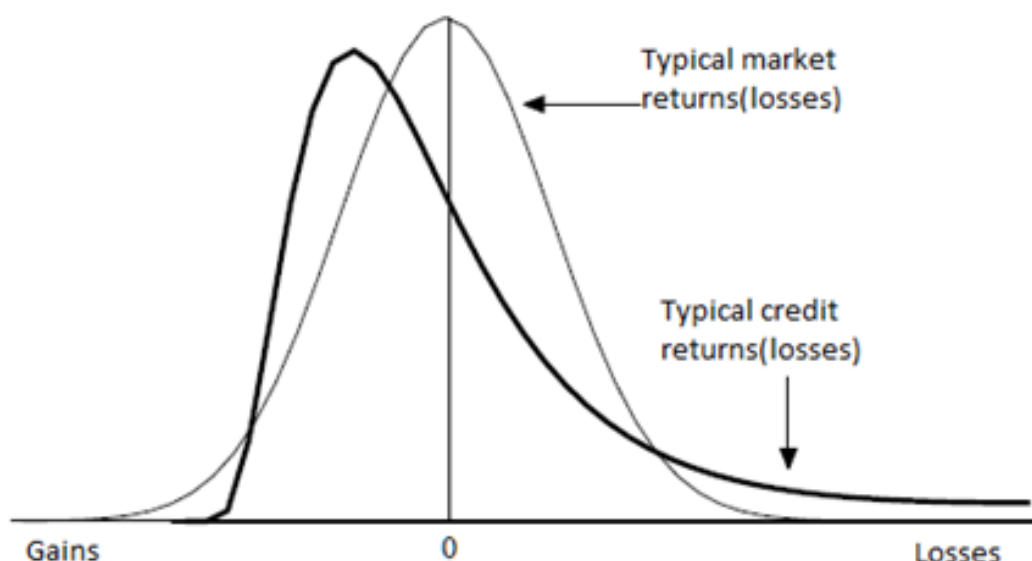


Figure 4. Distribution of typical credit and market returns/losses¹

Additional inputs required for measuring credit risk are the empirical estimates on the probability of default (PD) and loss given default (LGD). If past data does not exist for these values, estimates can be used instead. In addition to determining the VaR and the capital required to support the portfolio's credit risk, the distribution of losses can be used for regulatory purposes, portfolio optimization and structuring, as well as, the pricing of debt portfolio derivatives (Vasicek, 2002).

This paper also adopts the Conditional VaR (C-VaR) approach, also known as the Mean Excess Loss, Mean Shortfall or Tail Risk (Krokhmal, Palmquist & Uryasev, 2002). C-VaR is defined as the conditional expectation of losses that exceed the VaR for a given distribution and probability level, as it is shown in figure 5 below. In contrast to VaR, C-VaR does not contain multiple local extrema, and therefore is easier to optimize. An additional aspect of C-VaR is that minimization of C-VaR achieves minimization of VaR as well.

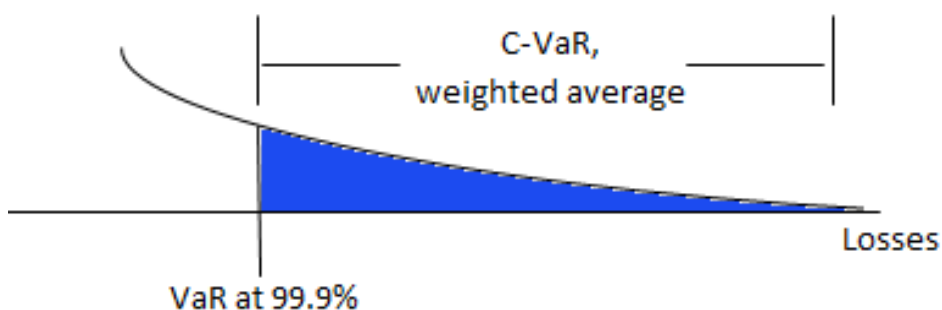


Figure 5. Demonstration of C-VaR

¹ Note that losses are depicted on the right and returns on the left side of x-axis

4.2 Monte Carlo Simulation for the Distribution of Portfolio Losses

The research method used in this study is a Monte Carlo simulation for portfolio credit losses. This method is a useful risk analysis tool that is used for various reasons in financial economics. The future contains a high amount of uncertainty and unfortunately, most of the times past data cannot predict the future accurately or there is lack of data. With the aid of Monte Carlo Method, one can evaluate a high number of possible outcomes and in that way make better interpretations of risk (Vasicek, 2002; Papaoioannou, 2006). For this thesis, a high number of scenarios is generated for the future value of a portfolio that contains loans and government bonds. These scenarios can be used to derive the distribution of portfolio credit losses. The main use for the distribution of credit losses in this study is the calculation of the Value at Risk (VaR), which is a measure of credit risk. VaR can also be interpreted as the capital that is required to be held so that the value invested will be safe against a bankruptcy with a certain level of confidence and time period, 99.9% and one year in this case.

Following the paper of Vasicek (2002), in which the next period's value of each asset in a portfolio is determined by the following equation:

$$X_j = Y \cdot \sqrt{rho} + Z_j \cdot \sqrt{1 - rho} \quad (1)$$

where Y and Z_j values are identically and independently distributed variables that follow the standard normal distribution and rho is a parameter that catches the exposure of an asset to Y and Z . The variable Y is a systematic risk factor that affects the portfolio in whole and Z_j variables are the asset-specific idiosyncratic risk factors. A vector Y_i for the systematic risk factor and a matrix $Z_{i,j}$ for the idiosyncratic risk of each asset are generated. The systematic risk factor is the same for every asset in each scenario n , but the idiosyncratic risk factor differs for all assets j in every scenario i . Following equation (1), the matrix $X_{i,j}$ is created which contains the values of all assets j for every scenario i .

For simplicity, losses occur only due to defaults and not due to credit rating changes. Hence, the following step determines the point of default (D_j) for each asset with the binomial approach. Since n scenarios have been generated for the future value of each asset i , the distribution of their value can be derived. By assuming that each asset value follows the normal distribution and since the PD is known, the point D_j where each asset defaults can be determined.

If the value of $X_{i,j}$ is lower than D_j then the issuer of the asset defaults. Each time a default incident occurs, it produces losses equal to LGD value multiplied by the asset's size, otherwise losses are zero. Hence, the total amount of loss for each scenario i is defined as follows:

$$\begin{cases} Loss_i = LGD \cdot size_j, & \text{for } X_{i,j} < D_j \\ Loss_i = 0, & \text{otherwise} \end{cases} \quad (2)$$

Finally, the sum of losses occurred from all assets in the portfolio of each scenario i are saved in a vector L and the histogram of this vector produces the distribution of portfolio losses, i.e.,

$$L_i = \sum_{i=1}^n Loss_i \quad (3)$$

Figure 6 illustrates the distribution of portfolio credit losses when PD is 2% or 15%. The two graphs show that when PD increases the distribution moves to the right since there are more losses occurring, which leads to higher size of unexpected losses. In addition, the mean of the distribution rises with higher PD, therefore expected losses also rise.

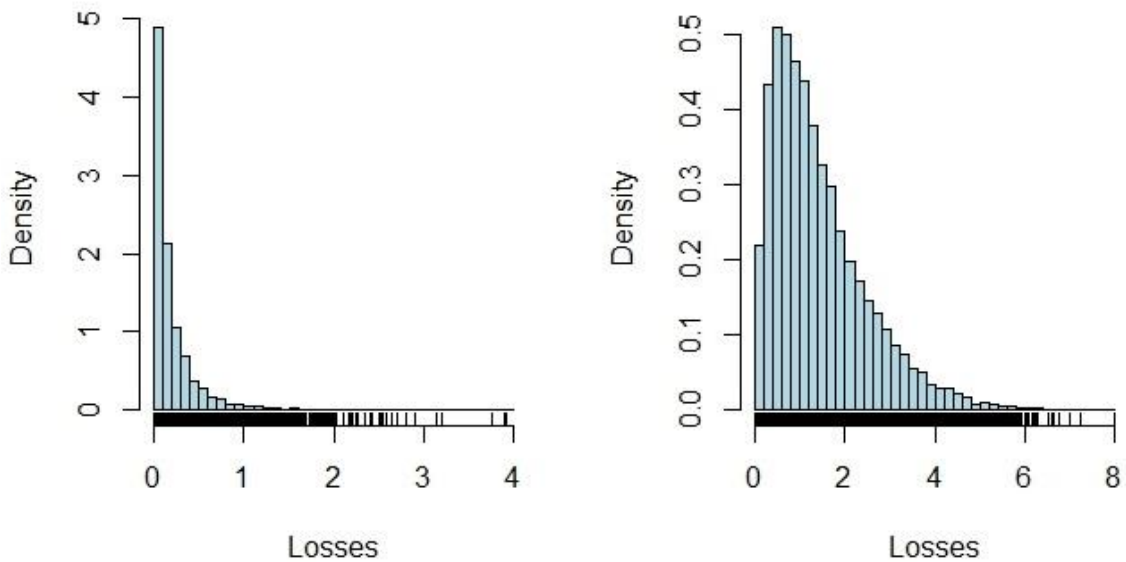


Figure 6. Distribution of portfolio losses for PD=2% (left) or PD=15% (right)

Keeping PD stable and changing LGD values, does not affect the shape of the distribution. Figure 7 demonstrates the distribution of losses when LGD is equal to 35% or 75%. The shape of the distribution is similar in both graphs, with the only difference being the scale of x-axis which is higher for higher LGD value. In the left graph, the majority of the distribution lies between 0 and 1.5 while on the right graph the majority of the losses lies between zero and a little over 3, which is demonstrated in the black bar underneath each distribution. So, the shape of the distribution is same in both graphs, but when LGD is higher the losses of the portfolio are more scattered. Similar to changes in PD, the mean of the distribution rises with higher LGD, therefore expected losses also rise.

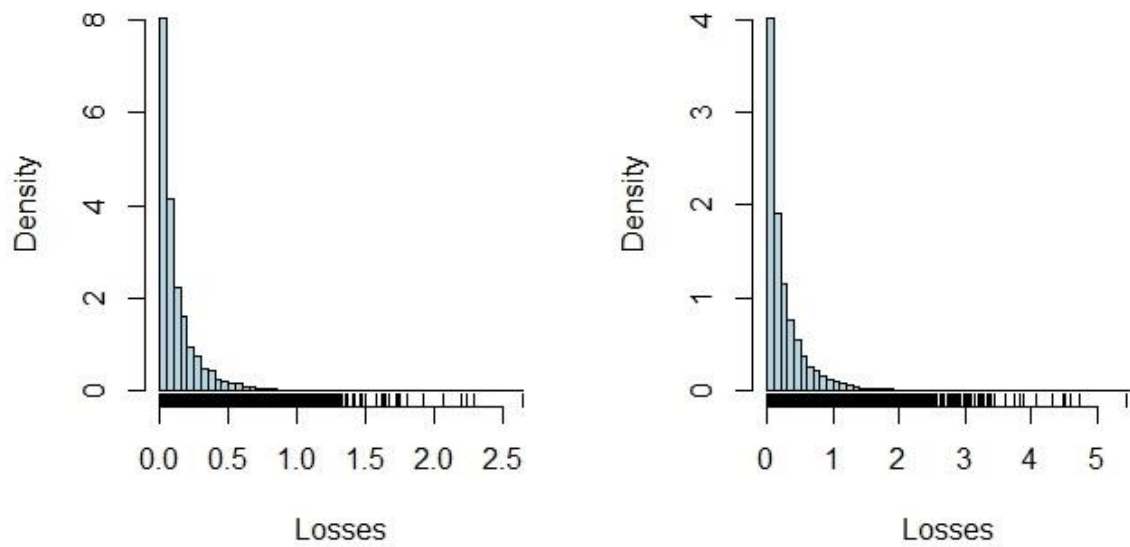


Figure 7. Distribution of portfolio losses for LGD=35% (left) or LGD=75% (right)

The result of changing the parameter rho to 10% or 30% in the simulation is shown in figure 8. The increase in rho makes the distribution of losses have fatter tails since there are more losses occurring in the far end of the x-axis.

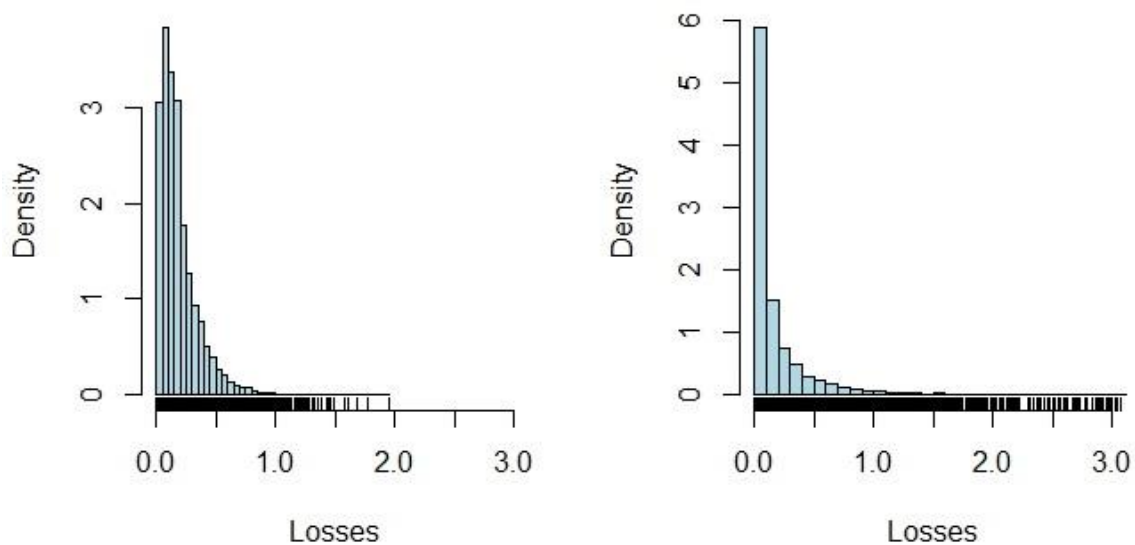


Figure 8. Distribution of portfolio losses for rho=10% (left) or rho=30% (right)

In order to calculate the VaR of the portfolio, the L vector can be sorted from highest to lowest and then the $(n \cdot \alpha)^{th}$ worst loss is the VaR with $(1-\alpha)\%$ confidence level for the period calculated, where n is the number of scenarios computed and alpha is the significance level.

Furthermore, Appendix 1 depicts the reaction of VaR to changes in PD, LGD, rho and confidence level. The graphs show that VaR has a linear relationship with LGD and a non-linear relationship with the other three parameters, PD,

rho and alpha. In addition, it can be seen that the non-linear connection between VaR-PD increases with a decreasing pattern, while the non-linear connection between VaR-rho and VaR-alpha increase with an increasing pattern. Finally, it is interesting to point out that when PD or rho reach the value of 1, VaR reaches a limit of 50%. This is a characteristic of the simulation. When rho or PD are getting very close to the value of 1, VaR also approaches the LGD value used for the simulation. In this Demonstration, LGD is set to be 50%.

Banks' simplified version of balance sheet is set to satisfy equation (4), as described below,

$$Lo + B = D + E \quad (4),$$

where Lo is the value of loans supplied to the economy, B is the value of government bonds that the bank holds, D is debt and E is equity. The sum of $Lo+B$ equals assets and $D+E$ equals the liabilities of the bank.

Next, various portfolios with different amounts of Lo and B can be created and their exposure to credit risk can be measured with VaR. A simplified version of a bank's assets can be assumed to be a high number of small size loans, 500-1000 loans, and a small number of high size government bonds, 1-20 bonds. By changing the exposure to government bonds from 0 to 50% or the number of countries that government bonds come from, 1 to 20, the relation of exposure to government bonds and VaR can be analyzed.

4.3 Estimation of parameters

Unless stated differently, LGD is going to take the value of 50% and rho is going to be equal to 20%. Confidence level (1-alpha) is set to be 99.9% same as in the Basel framework, the number of scenarios created are 20.000 and the time period is one year. Additional values used in this study are demonstrated below.

4.3.1 Probabilities of default, weights for diversification and consolidated banking assets

Table 1 reports credit ratings of EMU countries, PDs in benchmark and adverse scenario, as well as the weights used to create a diversified portfolio of government bonds. Credit rating values vary from 1 to 5, with 1 being the safest and 5 the riskiest. However, the values that are set do not necessarily depict a specific timeline, rather they maintain a more general chronological approach of the last decade. The weight values of column 4 are taken from the paper of Brunnermeier et al. (2017). The authors set the weights for the diversified government bond portfolio to be equal to nations' relative GDP with the constraint that the maximum amount pooled from each country cannot exceed the outstanding debt level

of each nation. Consolidated banking assets are taken from the dataset of the banks.eu website², data as it were in 2017.

Table 1. Portfolio government bond ratings, Probability of default and weights used for pooling EMU government bonds

	Credit Rating	PD% (Benchmark scenario)	PD% (Adverse scenario)	Weights for pooled portfolio	Consolidated banking assets (in bln)
Germany	1	0.02	1	28.17	6864
Netherlands	1	0.02	1	6.61	2463
Luxemburg	1	0.02	1	0.18	822
Austria	1	0.02	1	3.21	949
Finland	2	0.03	5	2.02	419
France	2	0.03	5	21.25	6946
Belgium	2	0.03	5	3.93	994
Estonia	2	0.03	5	0.03	25
Slovakia	2	0.03	5	0.67	78
Ireland	3	0.07	15	1.8	428
Lithuania	3	0.07	15	0.25	27
Malta	3	0.07	15	0.07	48
Slovenia	3	0.07	15	0.37	42
Spain	3	0.07	15	10.77	3536
Latvia	3	0.07	15	0.17	29
Italy	4	1.32	30	16.52	2633
Portugal	4	1.32	30	1.77	381
Cyprus	5	18.6	50	0.2	68
Greece	5	18.6	50	2.01	263
Sum				100	27013

The creation of a diversified portfolio consisting of government bonds with weights determined by column 4 of table 1 are reported in figure 9. The percentages of government bonds by credit rating used in the diversification process of government bonds are shown in the figure.

² Retrieved from <https://thebanks.eu/compare-countries-by-banking-sector>

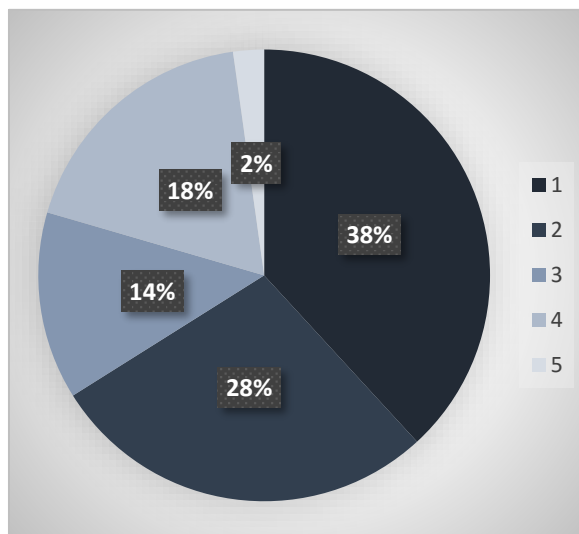


Figure 9. Weights for diversified portfolio of government bonds by credit rating

4.3.2 Exposure levels of banks to euro area government bonds

Following sovereign exposures of EU banks from the paper of Andritzky et al. (2016), figure 10 reports the exposure of Greek, Italian, Spanish, Portuguese and German banks to government bonds by credit rating from 1 to 5, with 1 being the bond with the lowest risk and 5 the bond with the highest risk to default. The proportions reported here are values from 2015 and might be quite different today. Nevertheless, the values of 2015 serve well the purposes of this paper. Greek banks' exposure is not reported in the same paper and hence an estimate is created instead. The last column demonstrates a pooled portfolio with bonds from all 19 members of the EMU with weights taken from table 1, column 4.

Greek banks hold 5% bonds with rating of 1 and 2 each, 10% with rating of 3, 50% with rating of 4 and 30% with rating of 5. Italian banks hold 20% with rating of 1, 5% with rating of 2, 70% with rating of 3, 3% with rating of 4 and 2% with rating of 5. Spanish banks hold low levels of safe assets, 2,5% of 1 and 2 rated bonds and the majority of their exposure is to bonds with rating of 3 at 90%. The rest of their exposure is at 4% for 5 rated and 1% for 5 rated bonds. Portuguese

banks hold 14% of 1, 0,1% of 2 5% of 3, 80% of 4 and 0.9% of 5 rated government bonds.

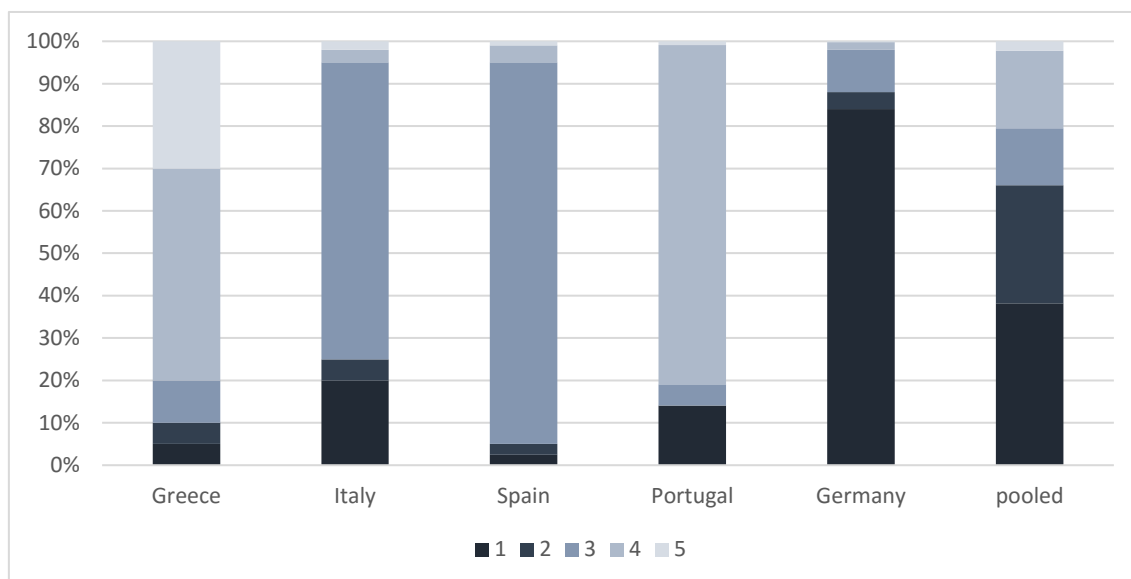


Figure 10. Sovereign exposures of euro area banks to EU governments by credit rating

4.3.3 Non-Performing Loans (NPLs) in EU

As it is stated in the briefing of EU commission (2018), loans are considered as non-performing when payments are delayed for over 90 days or when it is highly unlikely that their total value will be paid in full. Hence, the past, as well as, the future performance of a loan is considered in the determination whether a loan is an NPL. Two European authorities are responsible to publish information about the state of NPLs in the European continent the European Banking Authority (EBA) which publishes the Risk Dashboard and ECB via Supervisory Banking Statistics.

After the global financial crisis and up to 2012 NPLs in the euro area rose from 3% to 8% as seen in figure 11. Mr. Draghi's effective intervention in European markets and further policies afterwards have managed to mitigate the problem of NPLs in the area and from 2016 and afterwards the ratio of NPLs in the euro area has decreased to a level lower than the global NPL ratio. Despite that, the level of 3% is still much higher compared to other developed financial markets like those of the U.S and Japan. There is still room for reducing the problem of high NPL ratios in the euro area especially for countries that are experiencing much higher levels of NPL ratios like Greece, Portugal and Italy up to this day.

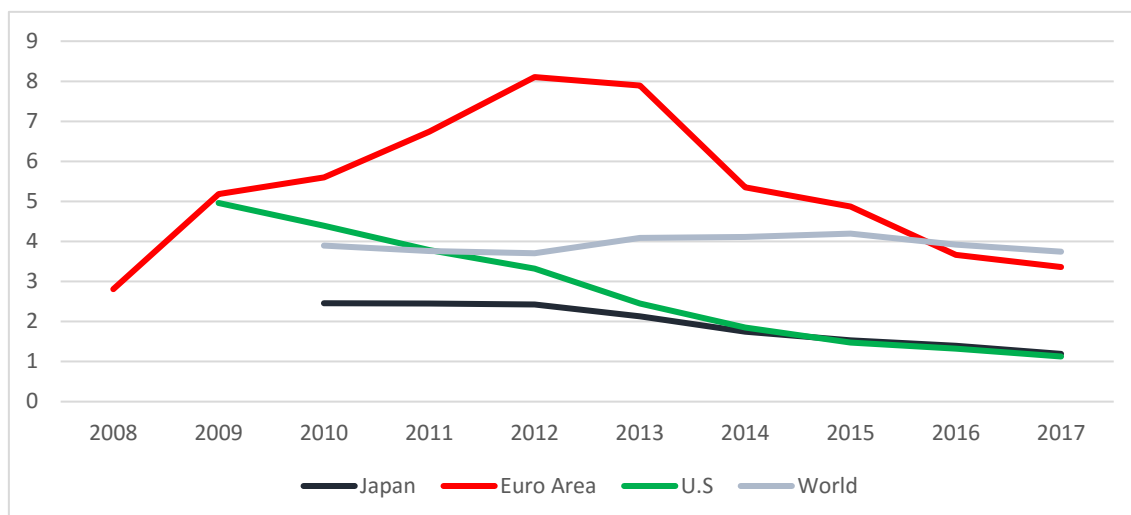


Figure 11. Non-performing loans ratios of Japan, euro area and U.S (2008-2017)³

Information about the PD of banks' loans is not easy to find. The percentages of NPLs are used instead of PD of banks' loans in order to replicate the situation of each country's banks' state in a simplified way. The values reported in table 2 which are taken from CEIC Data⁴ are a little higher than the NPL levels observed at the moment. This reduction has been achieved thanks to the European Commission's decision to tackle the high percentages of NPL of countries inside the euro area. However, the values chosen are indicative of the overall performance of loans in each economy.

Table 2. Percentage of Non-Performing Loans in Greece, Italy, Spain, Portugal, and Germany

	Greece	Italy	Spain	Portugal	Germany
NPLs	40%	15%	10%	8%	2%

³ Source: The World Bank data on NPLs: <https://data.worldbank.org/indicator/FB.AST.NPER.ZS?view=chart>

⁴ <https://www.ceicdata.com/en/indicator/european-union/non-performing-loans-ratio>

5 RESULTS

5.1 Diversification of government bonds and VaR

Modern portfolio theory suggests that increasing the number of assets in a portfolio decreases risk, due to diversification. In contrast, increased exposure to a small number of counterparties would increase risk. The values reported in Figure 12 comply with modern portfolio theory. Credit risk is higher when a bank owns bonds from one country only. The risk decreases as more bonds are added from other countries. Figure 12 demonstrates that as a bank moves from 1 government bond portfolio to 5 government bond portfolio VaR decreases with a downward pace.

Another interesting observation from Figure 12 is that the minimum capital requirement of 8% is high enough to protect the portfolios that contain government bonds from 4 and 5 different governments even when the summed exposure to government bonds is 50%, but only with risk weights set to 100%. With risk weight set to 100% and exposure to government bonds set to 40%, even portfolios that contain bonds from 3 countries are supported by the capital requirement of 8%. For the portfolio of 2 countries the safe level of exposure is 30% and lastly, for the portfolio that contains bonds from 1 country only, the exposure is required to drop below 15%.

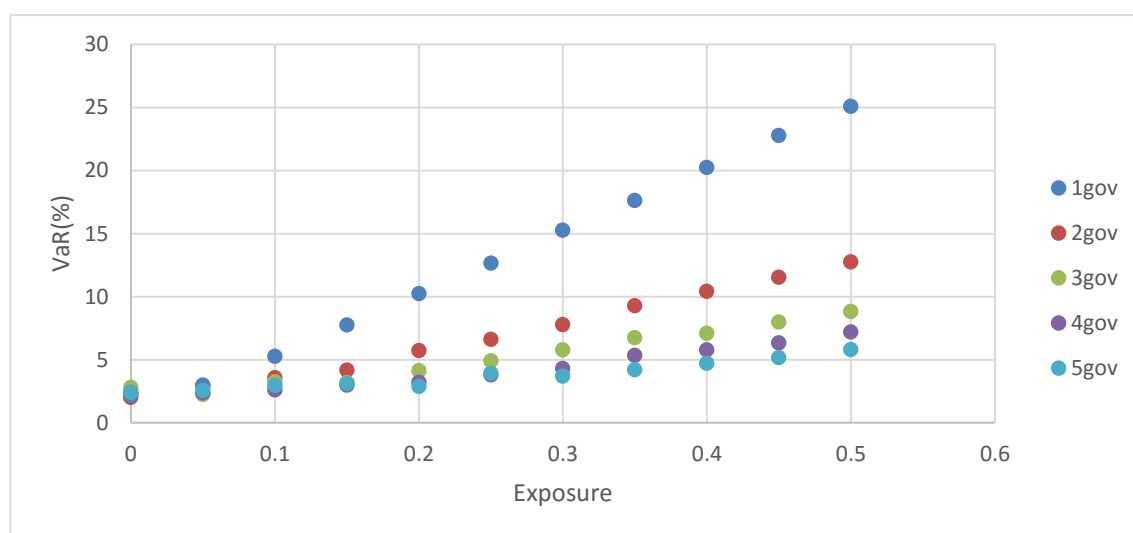


Figure 12. VaR percentages for different exposures to government bonds⁵

⁵ PD=0.2% for all assets. Labels indicate the number of governments bonds come from separate issuers

The decrease in VaR is higher with the first addition of a country and continues to decrease as more countries are included, but each addition reduces VaR less than the previous reduction. Column (1) of table 3 reports the percentage changes in VaR when exposure to government bonds is 20%. Column (2) shows how much does VaR change compared to the VaR of 1-country portfolio and column (3) shows the percentage change when adding one extra country to the portfolio. The addition of a second country reduces VaR from 10.24% to 5.72% a 44.14% reduction. The addition of a third country decreases VaR further, but the effect is lower than the previous, just 27.74%. The addition of a fifth country decreases the VaR just by 10.56%. It is important to note here that the reduction of credit risk is caused due to diversification only and not because some country might be less risky since all the default probabilities are assumed to be equal to 0.2% in this example. As expected, the decrease of risk due to diversification decreases as more assets are added to the portfolio.

Table 3. The effect of diversifying government bonds to VaR, when exposure to government bonds is at 20%

N. of Countries	(1) VaR	(2) %change from 1-country portfolio	(3) %change from +1 country
1	10.24%		
2	5.72%	-44.14%	-44.14%
3	4.13%	-59.64%	-27.74%
4	3.22%	-68.55%	-22.10%
5	2.88%	-71.88%	-10.56%

5.2 The effect of government bonds probability of default to VaR

Different PD values for government bonds have been used as an input to the simulation to create figure 13. PD of loans is set to be equal to 1% and labels indicate the PD for government bonds. As it is expected it can be seen that lower PD values return lower VaR and higher PD values produce higher VaR. The effect of higher PD producing higher VaR is small when the exposure to government bonds is low and increases as the exposure rises. At 50% exposure to government bonds, VaR reaches to a 27.4% of total assets when PD is 18.6%. The point with the lowest VaR value is also at a 50% exposure point when the PD of government bonds is set to be the lowest at 0.02%.

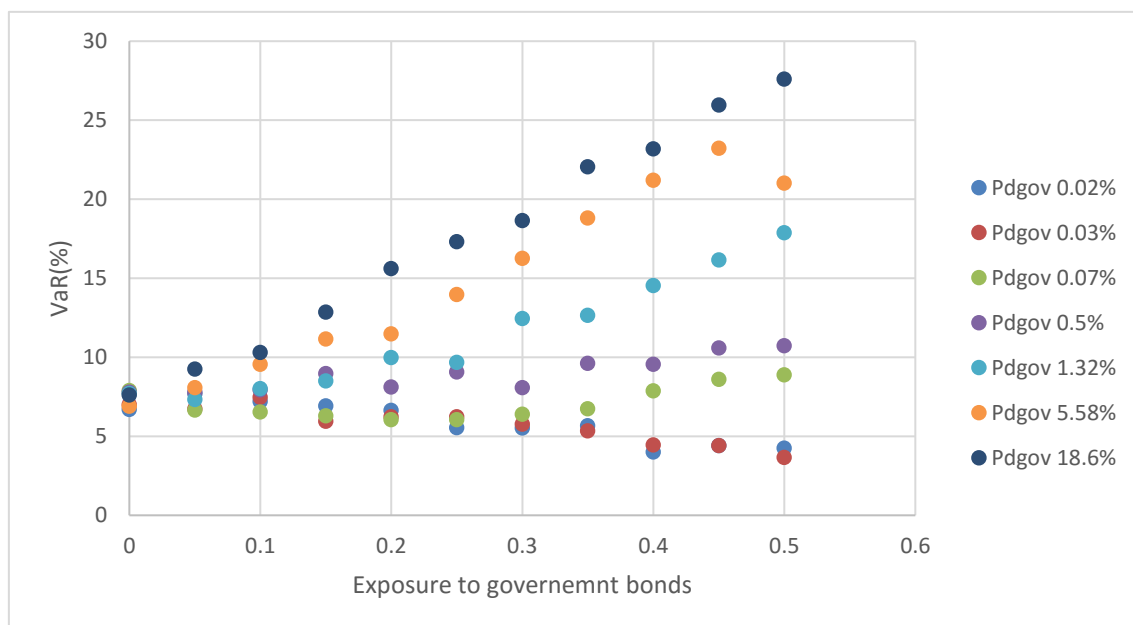


Figure 13. VaR percentages for different exposures of government bonds as a percentage of total assets

5.3 Different weights for different assets

Determining the optimal weights for a portfolio can be a troublesome process when the portfolio has more than two assets. Modern portfolio theory proposes to find the efficient frontier, the area in a graph with certain weight combinations in which returns are maximized and standard deviation (risk) is minimized.

In this study, the expected return of a bank's portfolio is equal to zero, because of the way the simulation is designed. Asset values are determined by equation (1), which returns values that follow the standard normal distribution and therefore the expected return of each asset is equal to zero. Since expected returns are zero there is no use in maximizing returns, hence the optimal portfolio problem can be solved by minimizing risk, which is measured with VaR because standard deviation is not a proper measure of risk when returns (losses) follow skewed distributions with fat tails.

Figure 14 demonstrates a number of portfolios that consist of loans and government bonds and their VaR is measured. Probability of default of loans is equal to 1%, governments bonds with the rating of A have a 0.03% PD, bonds rated with BB have PD equal to 1.32% and bonds with CCC rating are the riskiest with a 18.6% PD. Exposure to loans is kept stable at 75% and exposure to government bonds at 25%. Different weights are used for sovereign bonds and the reaction of VaR is demonstrated.

Increasing the weight of an A rated asset decreases the VaR of the portfolio. In contrast, by increasing the weight of BB and CCC assets in the portfolio, the VaR also increases. In other words, as the weight of the A-rated asset reduces in

the portfolio, the risk in the portfolio rises. Therefore, the safest portfolio in the figure is the one that consists of 25% A rated bonds.

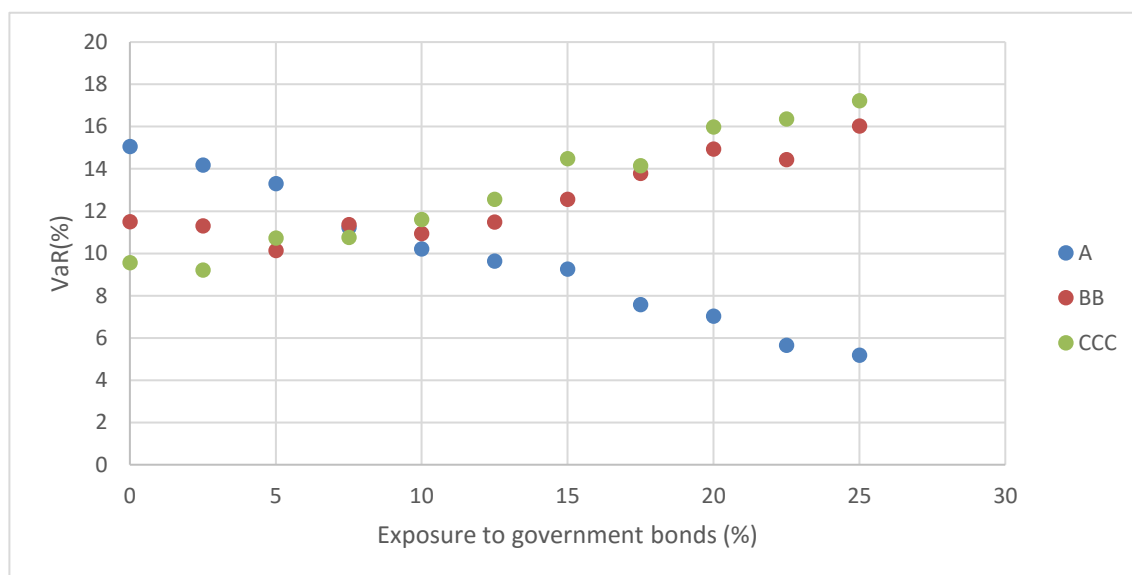


Figure 14. VaR as a percentage of total assets with different weights per risk category

Banks that hold government bonds from countries that are issuing very low-risk government bonds manage to keep their VaR lower. In contrast, banks that hold riskier government bonds are actually increasing their exposure to credit risk. Interestingly, even though the PD of CCC assets is much higher compared to BB assets, increasing the exposure to BB or CCC government bonds has almost similar effects on credit risk. These results demonstrate the importance of holding government bonds with low probability of default. For this to happen the home bias of banks has to be reduced, especially for countries in which governments issue risky bonds, similar to the riskiness of BB and CCC.

5.4 Replication of EU banks' exposure to government bonds

Following sovereign exposure levels of euro area banks to EU members as depicted in Andritzky et al. (2016), Sovereign exposures of 5 countries have been constructed to test how does their exposure affect the VaR values.

The left y-axis of figures 15, 16, 17 and 18, depicts the percentage of exposure to each government bond by credit rating. The composition of government bond holdings is demonstrated in each column. While safer government bonds with lower credit rating value, have darker color, riskier government bonds have lighter color. In addition, the right y-axis in the figures shows the level of VaR for each level of exposure to government bonds. The VaR values are calculated for various sizes of exposure to government bonds as it is depicted in the figures. While the light blue line shows the VaR for 5% exposure to government bonds,

the dark blue line accounts for 10% exposure, the green line for 25% exposure and the red line for 50% exposure.

Firstly, the exposure of banks to government bonds organized by credit rating is examined, while keeping everything else equal. In other words, the performance of loans in each country in which a bank operates is the same for all countries, equal to 1%. As it can be seen in figure 15, the riskiest government bond composition is that of Greece and Portugal. Italy and Spain come next and Germany has a slightly better government bond portfolio compared to the other countries. It seems that higher exposure to government bonds with credit rating of 4 and 5 have a higher effect on the increase of VaR when their exposures are high in a portfolio. On the other hand, exposures to government bonds with credit rating of 1, 2 and 3 do not make a big difference. In Spanish, Italian and German banks, higher exposure to government bonds reduces VaR. In contrast increasing the exposure to the composition of government bonds that Greek and Portuguese banks hold leads to a significant increase in VaR.

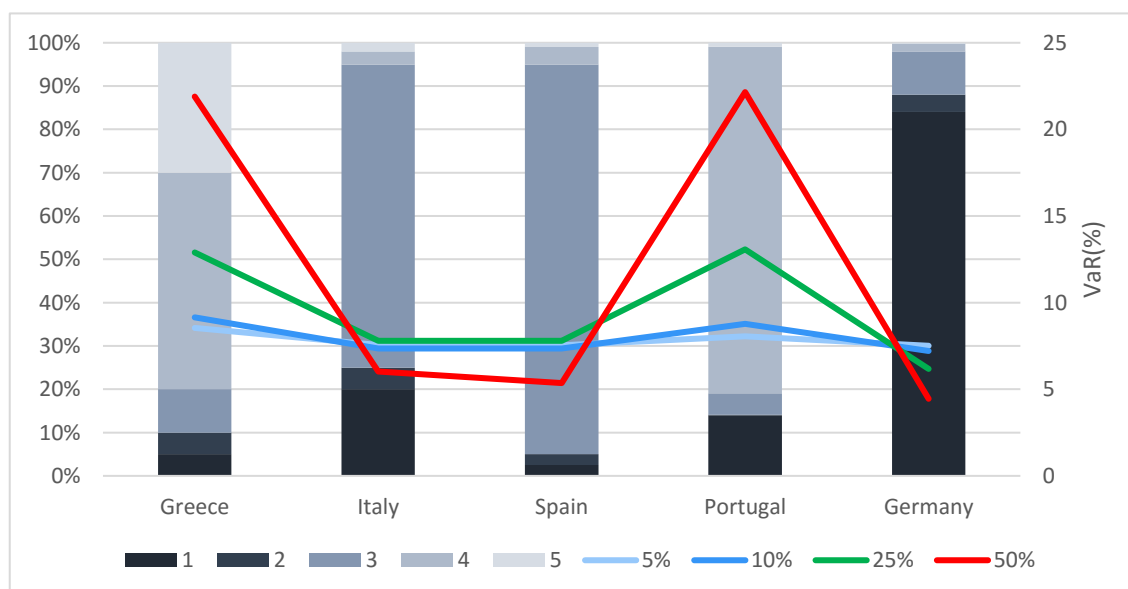


Figure 15. Composition, exposure to government bonds and VaR per country⁶

When each country's loan performance is taken into consideration, results show even higher risks. PD of loans for each country is set to be close to the percentage of Non-Performing Loans (NPLs) in each country. Greece has the highest level of NPLs in the euro area equal to 40%. Italy's PD of loans is much lower but is still high compared to other countries in EU, equal to 15%. The rest of the analyzed countries have lower values with Spain at 10%, Portugal at 8% and Germany equal to 2%.

In figure 16, Greek banks carry the highest risk, with VaR values above 40%. Increasing the exposure to government bonds in Greek banks manages to

⁶ Government bond credit rating exposure of banks in Greece, Italy, Spain, Portugal and Germany (Left bar), and VaR(%) for different exposures of government bonds in banks' balance sheet (Right Bar),

reduce banks' risk, but has a low impact, since the composition of government bonds is also risky. In contrast the increase of government bonds in Spanish and Italian banks decreases VaR more effectively. Portuguese banks are the only ones for which an increase in government bond exposure leads to an increase in credit risk. German banks are the least risky and, in their case also, increasing the exposure to government bonds has a positive effect on VaR.

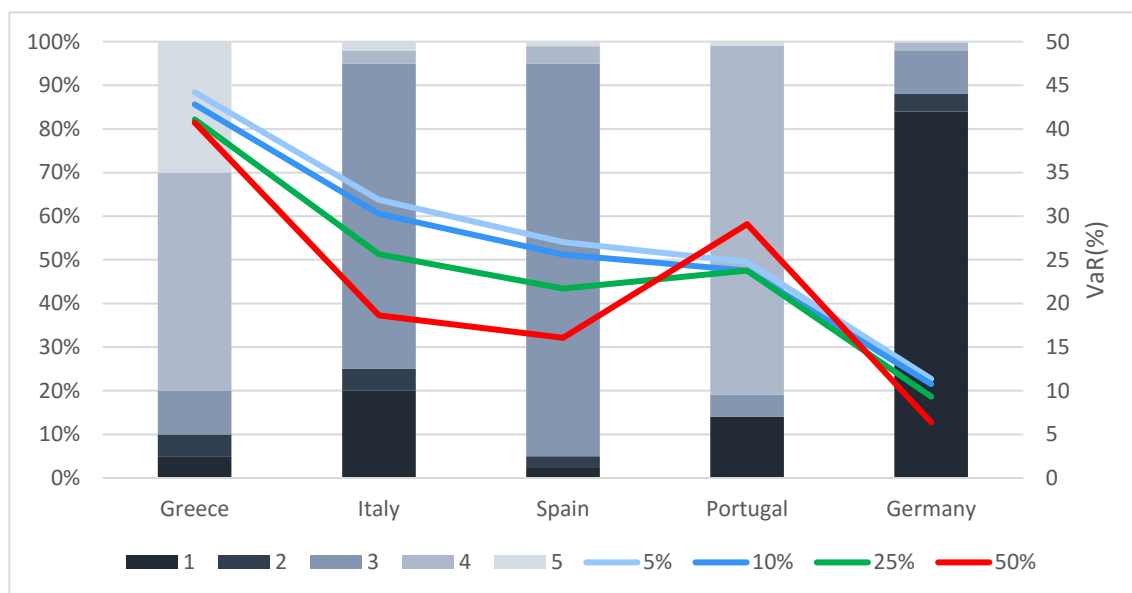


Figure 16. Composition, exposure to government bonds and VaR per country with level of NPLs taken into consideration

5.5 Results from the introduction of SBBS

The creation of a diversified portfolio of government bonds from the 19 members of EMU was achieved by using weights from column 4 of table 1. In Figure 17 it can be seen that exposure to the pooled portfolio and VaR are negatively connected in all 5 countries. Greek banks credit risk now varies from 24% to 43% depending on the level of exposure to the diversified portfolio. Italian banks VaR varies between 18-30%, Spanish banks is at 16-27%, Portuguese banks at 15-24% and German banks around 8-11%.

The pooled portfolio manages to reduce VaR of banks from Greece and Portugal, countries which were exposed to risky government bonds the most, as shown in table 4. Italian and Spanish banks experience a slight increase in their VaR around 0-1% and German banks 2-5% if the exposure to government bonds is at 5-25% or 30.25% increase if the exposure is 50%.

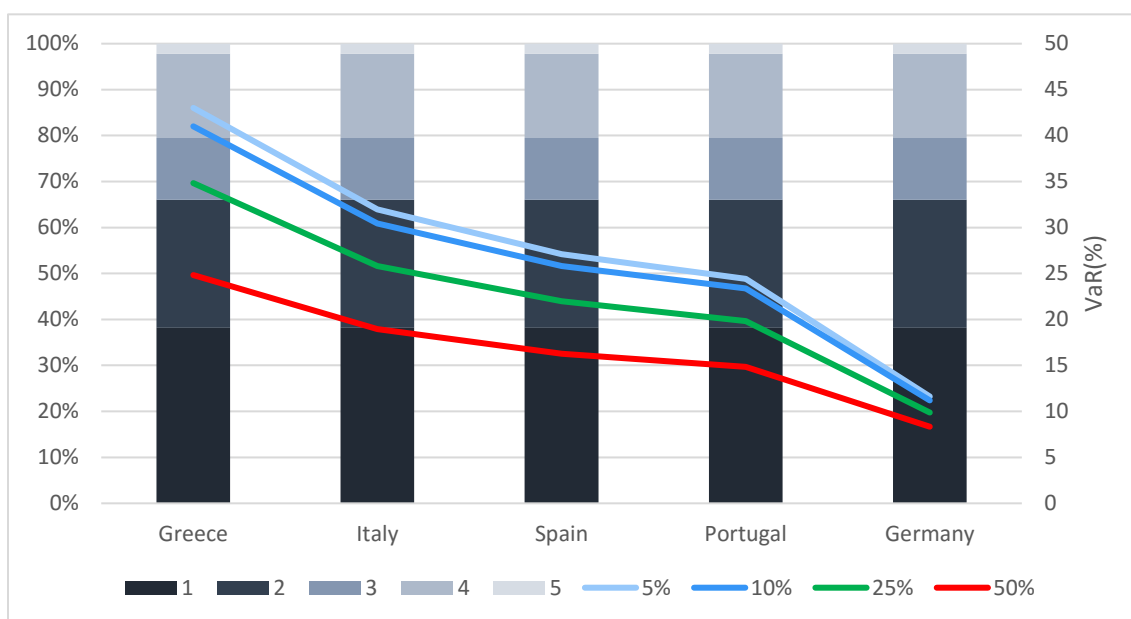


Figure 17. Composition, exposure to pooled government bonds and VaR per country⁷

Table 4. Reduction in VaR from diversified portfolio of EMU government bonds

Exposure	Greece	Italy	Spain	Portugal	Germany
5%	2.71%	-0.25%	-0.20%	1.40%	-2.30%
10%	4.22%	-0.63%	-0.76%	1.59%	-4.01%
25%	15.23%	-0.63%	-1.23%	16.57%	-5.91%
50%	39.04%	-1.55%	-1.26%	48.96%	-30.25%

Creating tranches by seniority into junior and senior bonds manages to reduce VaR of bank's balance sheets more effectively. Senior bonds, the safest division, which amounts to 70% of SBBS assets created start to experience losses when the total value of junior bonds is wiped out.

Introducing senior bonds to banks' holdings manages to reduce VaR in all 5 countries exposure levels as shown in figure 18. It is assumed that banks hold only senior bonds, otherwise, the positive effect of tranching fades away. Depending on the exposure to senior bonds the VaR of Greek banks varies around 22-42%. Italian banks have a VaR of 16-31%, Spanish banks 12-26%, Portuguese 14-26% and German banks 5-11%.

⁷ VaR(%) of banks' portfolios consisting of EU governments with weights from table 1 column 4 (no-tranching). LGD=50% and PD loans=NPL values: Greece 40%, Italy 15%, Spain 10%, Portugal 8% Germany 2%

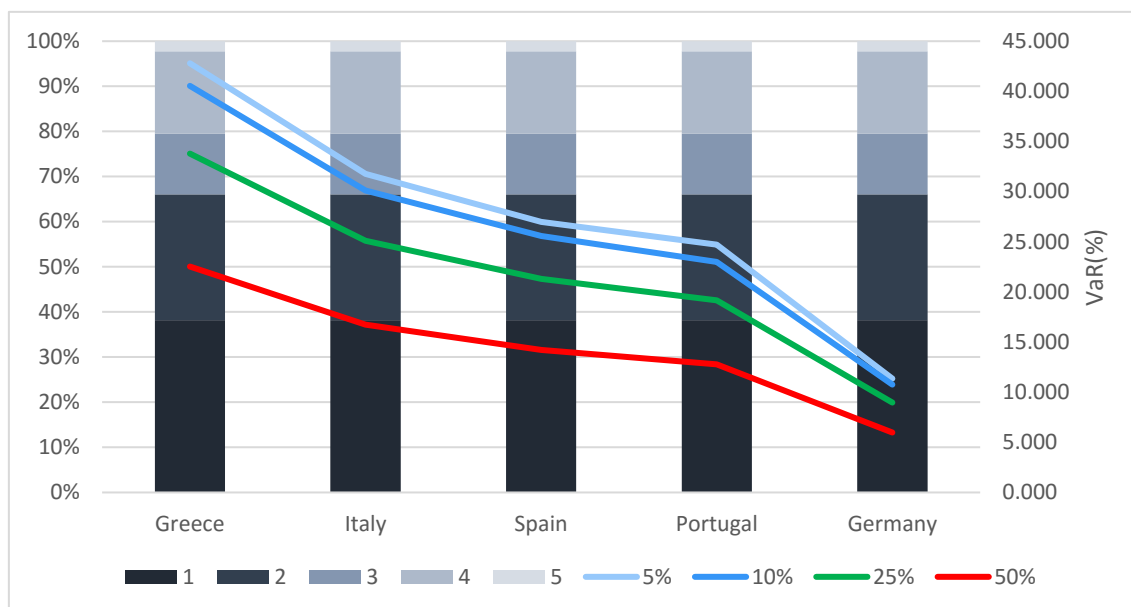


Figure 18. VaR(%) for banks holding SBBS⁸

The reduction of VaR in banks of all 5 countries is shown in table 5 more clearly. The smallest reduction is a bit over 0% and the highest around 56%. In addition, Italian, Spanish and German banks are not negatively affected by the riskiness of the portfolio anymore, when adding tranching in addition to diversifying government bonds.

Table 5. Reduction in VaR(%) by holding SBBS

exposure	Greece	Italy	Spain	Portugal	Germany
5%	3.20%	0.31%	0.18%	0.18%	0.04%
10%	5.29%	0.48%	0.20%	3.22%	0.09%
25%	17.77%	2.15%	1.96%	19.32%	3.89%
50%	44.69%	10.32%	11.66%	56.10%	6.64%

Changing PD to adverse scenario values, which are reported in table 1 return results as shown in table 6. When LGD is 35%, junior bonds manage to absorb all the losses in both scenarios and hence the VaR in both scenarios for all countries takes identical values. When LGD is set to 50% there are some very small increases in the VaR in the adverse scenarios, but the differences are still small, around 0.3% in average. Finally, when LGD is 75% the differences in VaR are much higher in the adverse scenario, 7% higher on average. This increase occurs due to the fact that as LGD is higher, the number of junior bonds that are

⁸ LGD=50% and PD loans=NPL values

wiped out also rises. When junior bonds are wiped out, senior bonds, which are held by banks start experiencing losses, which leads to higher VaR.

Table 6. VaR(%) of banks' portfolio in benchmark and adverse scenarios for different LGDs, when banks hold senior bonds

exposure	Benchmark Scenario					Adverse Scenario				
	Greece	Italy	Spain	Portugal	Germany	Greece	Italy	Spain	Portugal	Germany
LGD=35%										
0.05	29.96	22.24	18.89	16.99	7.95	29.96	22.24	18.89	16.99	7.95
0.10	28.38	21.07	17.89	16.10	7.53	28.38	21.07	17.89	16.10	7.53
0.25	23.65	17.56	14.91	13.41	6.27	23.65	17.56	14.91	13.41	6.27
0.50	15.77	11.71	9.94	8.94	4.18	15.77	11.71	9.94	8.94	4.18
LGD=50%										
0.05	42.80	31.78	26.98	24.73	11.35	42.85	31.78	26.98	24.27	11.35
0.10	40.55	30.11	25.56	23.00	10.76	40.76	30.11	25.56	23.00	10.76
0.25	33.79	25.09	21.30	19.16	8.96	34.09	25.13	21.34	19.20	9.08
0.50	22.53	16.73	14.20	12.78	5.98	22.73	16.78	14.23	12.83	6.13
LGD=75%										
0.05	64.20	47.67	40.47	36.41	17.03	64.84	47.90	40.68	36.74	17.46
0.10	60.82	45.16	38.34	34.49	16.13	61.73	45.70	38.76	35.30	16.82
0.25	50.68	37.63	31.95	28.74	14.44	52.61	38.79	33.30	29.96	15.21
0.50	33.79	25.09	21.30	19.16	8.96	37.94	28.91	24.75	22.76	12.88

The reduction in percentage of VaR from holding SBBS in a bank's portfolio conditional to LGD and PD of loans is shown in figure 19. As the weight of SBBS in a portfolio increases from 0 to 50% VaR decreases in a constant rate. For higher LGD values the VaR in a portfolio is higher and hence the green line lies above the red line. Similarly, lower PD values for bank's loans produce lower VaR, which makes the blue line to lie below the red line.

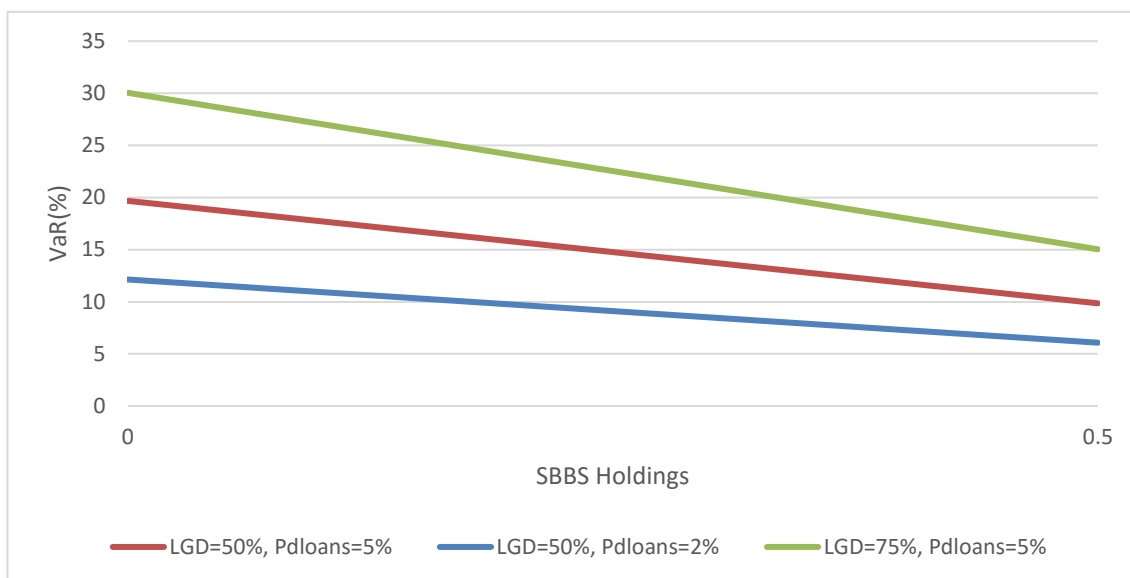


Figure 19. The reduction of VaR from SBBS holdings

5.6 Brief analysis of junior bonds

Junior bonds, which amount to 30% of SBBS assets, are much riskier than senior SBBS, since they are the ones that absorb the losses first. The distribution of losses for junior bonds are reported in appendix 2 for different LGD values and scenarios. In the benchmark, scenario losses are much lower and distributed much closer to zero compared to the adverse scenario. In the adverse scenario, the distributions have much fatter tails compared to the benchmark, leading to higher VaR for junior bonds in the adverse scenario.

Table 7 reports the VaR of junior bonds and the number of scenarios where the total value of junior bonds is completely wiped out. It is clear that junior bonds are much safer in the benchmark scenario with VaR taking the values of 13.28% to 28.46% depending on the LGD level of government bonds. In the adverse scenario, VaR is much higher, even when LGD is set to 35%, taking the values of 61.13% to 98.77%. From the total amount of 20,000 scenarios generated, the number of scenarios in which the value of junior bonds is wiped out is zero in the benchmark scenario for all LGD values. Similarly, in the adverse scenario, when LGD is 35% there are 0 scenarios that junior bonds lose their value completely. As LGD rises the scenarios increase to 6 when LGD is 50% and 175 when LGD is 75%.

Table 7. VaR(%) of Junior bonds and number of scenarios that the whole value of junior bonds is wiped out in benchmark and adverse scenario for different LGD values

LGD	Benchmark		Adverse	
	VaR(%)	# wiped out	VaR(%)	# wiped out
35%	13.281	0	61.127	0
50%	18.972	0	87.324	6
75%	28.458	0	98.771	175

5.7 C-VaR and loan supply

As the final exercise, the optimal level of loan supply when holding different bundles of government bond portfolios is examined. Loan weights take the values of 50% to 100% and government bond bundles weights vary from 0% to 50%. Banks hold either their normal government bond compositions, the fully diversified government bond portfolio or SBBS assets. The results for the five countries that are being analyzed are reported in figure 20 for Greek banks, figure 21 for Italian banks, figure 22 for Spanish banks, figure 23 for Portuguese banks and figure 24 for German banks. For 100% loans-to-total-assets a bank is indifferent to which composition to choose. However, as the weight of loans decreases, and the weight of government bonds increases, the gap between the three lines increases. For all the countries the most efficient government bond composition is the bundle that contains SBBS assets, because it returns higher supply of loans for every given level of C-VaR. The second most efficient composition of government bonds is the diversified portfolio for Greek, Italian, Spanish and Portuguese banks. For German banks the diversified portfolio is the second most efficient up to a certain point. The diversified bundle is the second most efficient when exposure to government bonds is 6.1% or lower. For exposure higher than 6.1%, the line of normal bond holdings of German banks produces higher loan supply for every given C-VaR level.

If the risk management of each country's representative bank behaves in a way that has a certain level of credit risk that has to satisfy and decides the levels of loans supplied and bonds bought with a certain constraint for the level of C-VaR, the improvement from adopting a different bundle instead of the normal composition of government bonds can be examined. Assuming a C-VaR constraint of 41.5% for the risk manager of the Greek bank, the improvement from adopting a fully diversified government bond bundle is very high. The loan supply when Greek banks hold their usual government bond compositions is around 50% of total assets. The diversified bundle returns a level of loan supply around 90.35% of total assets and the SBBS portfolio returns 90.5% of loans supplied.

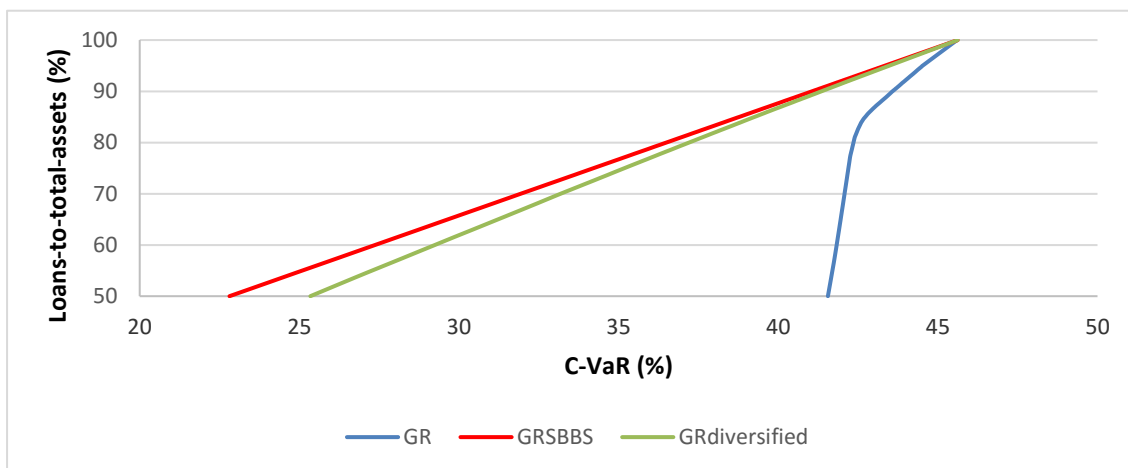


Figure 20. Greek bank's credit risk for different compositions of government bonds

Assuming a constraint C-VaR level of 31.3% for the Italian banks, for the normal bundle of government bonds the loans supplied equals the 89.85% of the banks' total asset value. For a diversified bundle, the supply of loans increases a little to 90.4% of total asset value and when the banks hold SBBS assets, supply of loans is around 91.3%.

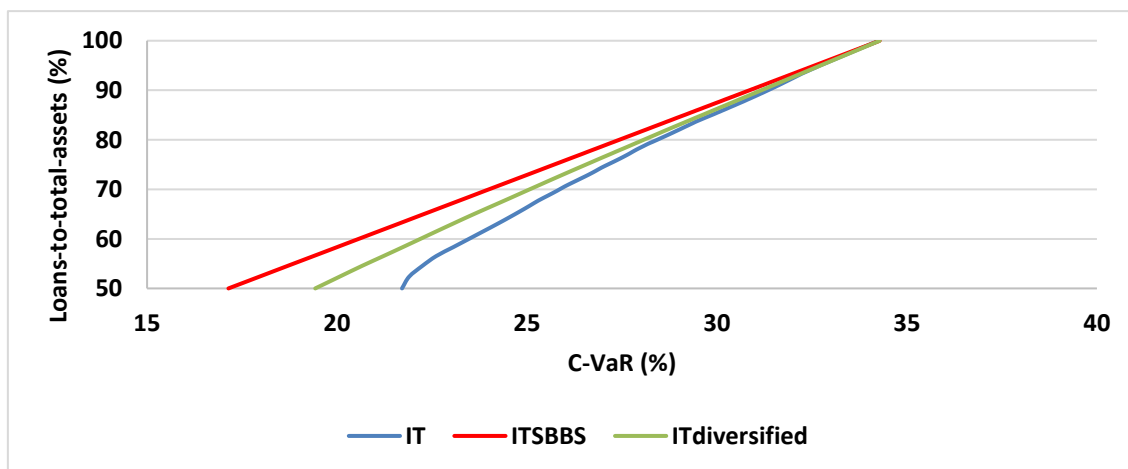


Figure 21. Italian bank's credit risk for different compositions of government bonds

For a constraint set to 26.5% of C-VaR for Spanish banks, the supply of loans for the normal composition is around 89.4%, for the diversified portfolio around 90.05% and for SBBS assets around 91.1%.

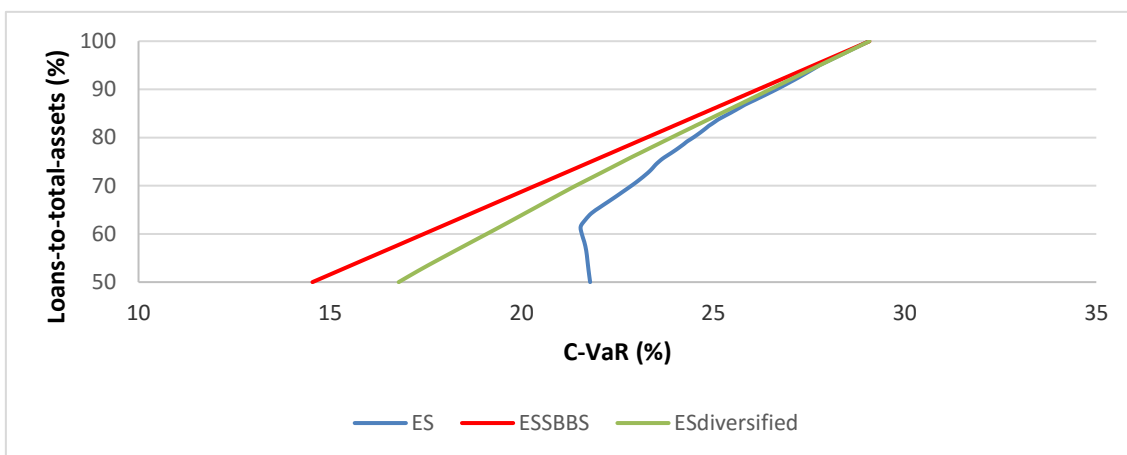


Figure 22. Spanish bank's credit risk for different compositions of government bonds

For Portuguese banks, the normal composition of government bonds is very risky compared to the given riskiness of loans in the country and hence, the improvement from the diversified bundle is very high. For a C-VaR constraint equal to 25.76% and the normal bond composition, the loans to assets ratio is at 94%. With the diversified bundle the level of loans supplied is around 97% and with SBBS the loans to assets ratio reaches 97.2%.

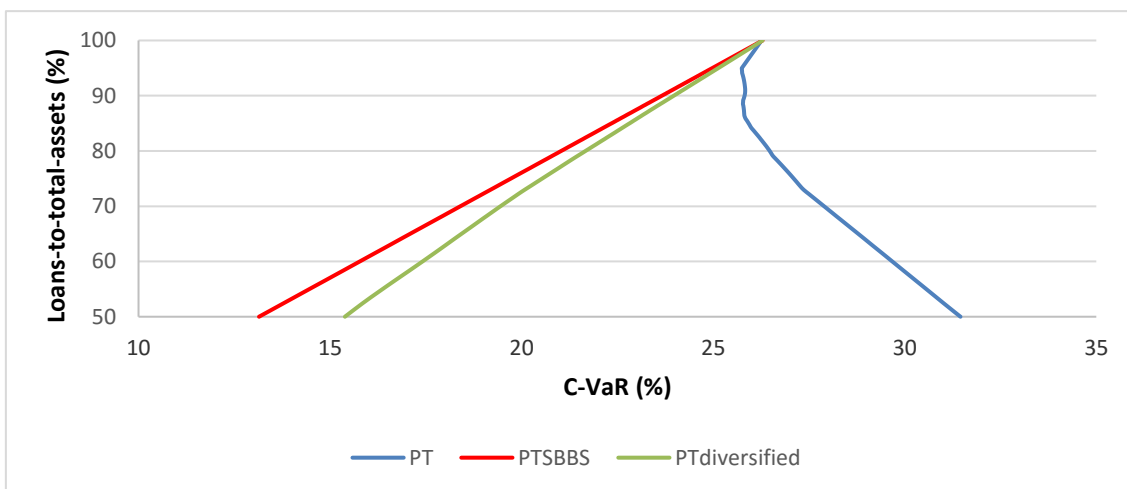


Figure 23. Portuguese bank's credit risk for different compositions of government bonds

Setting a C-VaR constraint of 11.8% for German banks, the normal bundle of bonds leads to 90.65% of loan supply to total assets. The diversified portfolio supplies lower amount of loans, around 90%. The portfolio that contains SBBS assets is again the best portfolio and increases the supply of loans to 92.4% of the total amount of assets that German banks own.

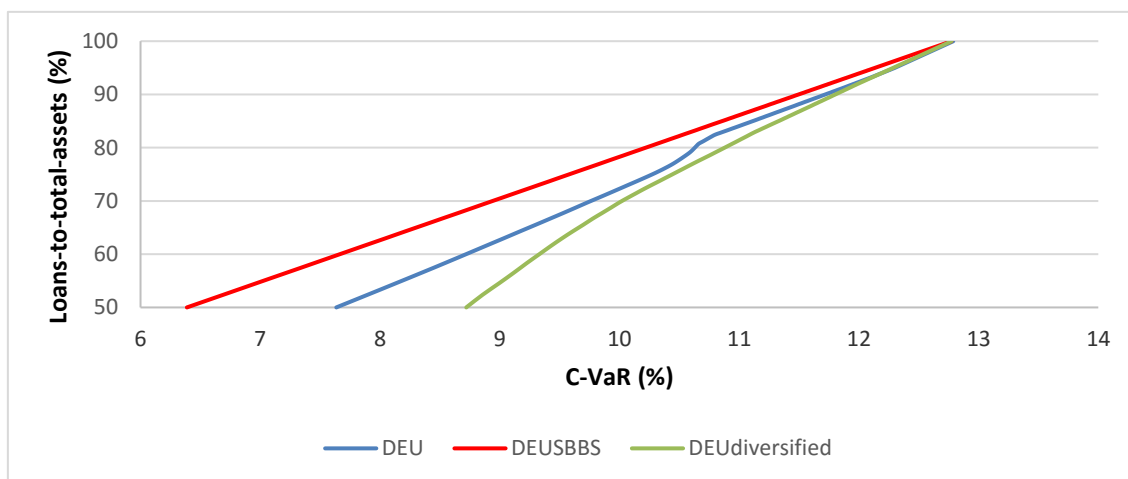


Figure 24. German bank's credit risk for different compositions of government bonds

Lastly, taking into account the increase in loan supply from the analysis above, as well as, the values of consolidated banking assets in each country, the change in supply of loans in each country from the different government bond bundles is reported in table 8 below. The change from government bond composition that banks normally hold in these five countries to a fully diversified portfolio that consists of 19 government bonds from EMU members leads to a 1.58% increase in the loan supply to their economies. Greece and Portugal are the two economies that receive the highest increase in loan supply due to the wide spread between loan supply with normal government bond composition and the diversified portfolio. For Germany the loan supply decreases when banks hold the diversified portfolio by 55 billion euros, a 0.72% decrease of loan supply for the German economy. However, the increase in loan supply from the other 4 countries is high enough to create a 110.2 billion euro increase in the overall loan supply, which translates to a 0.9% increase. For SBBS, the increase in loan supply is more than three times the increase from holding the diversified portfolio, an increase of 336.93 billion euros, a 2.75% increase in the supply of loans. When German bank hold SBBS, their loan supply increases as well which is the reason for the higher increase compared to the diversified approach.

Table 8. Changes in loan supply for three government bond bundles

	C-VaR constraint	Normal	Diversified	SBBS
Greece	41.50%	131.25	237.17	237.56
Italy	31.30%	2365.93	2380.41	2404.11
Spain	26.50%	3161.54	3184.53	3221.66
Portugal	25.76%	358.33	369.76	370.53
Germany	11.80%	6222.31	6177.69	6342.43
Sum		12239.36	12349.56	12576.29
Increase in loan supply			0.90%	2.75%

6 POLICY IMPLICATIONS

One of the main recommendations in the recent literature has been the imposition of a new policy to increase diversification of governments bonds inside the euro area in order to improve bank stability and mitigate the bank-sovereign loop (Arnold, 2012; Bénassy-Quéré et al., 2018). The simulation model of this paper shows evidence that diversification of government bonds can possibly reduce banks' credit risk in countries with high NPL ratios. However, banks that operate in countries within sovereigns that issue government bonds with very low probability of default (e.g. Germany) might experience increase in credit risk when diversification of government bonds is higher. More specifically, banks which already have low-risk government bonds might experience a 1-5% increase in their credit risk if they increase their diversification to government bonds. In the extreme case where, German banks increase their exposure to government bonds up to 50%, the simulation shows that the increase in VaR could be up to 30%. In addition, it is shown that for exposures higher than 6.1% to government bonds the normal bundle of German government bonds results into safer investments compared to the fully diversified bundle.

Furthermore, various scholars (Lenarcic, Mevis & Siklos, 2016; Arnold, 2012) have suggested that government bonds should not be treated differently compared to other assets and that the large exposure framework should be applied to government bonds in a similar manner. While increased exposure to risky government bonds increases credit risk for banks, increased exposure to low risk government bonds might have a neutral effect or even reduce credit risk. This finding suggests that in an environment where there is high freedom for applying zero risk weights for government bonds, a 25% exposure limit to government bonds in the banks' balance sheets would have a positive impact on the reduction of credit risk that occurs from high percentage holdings of risky government bonds.

Consequently, the high exposure framework to government bonds can positively impact banks of countries that suffer from high exposure to risky government bonds and have a very small negative impact, or no impact at all, on banks that hold safe government bond portfolios. This proposition would prohibit banks from increasing exposure to risky government bonds during adverse times, a bank behavior that has been observed previously. However, it should be pointed out that such an approach may increase flight to quality as also argued by Schneider & Steffen (2017).

Lenarcic, Mevis & Siklos (2016) propose that positive risk weights for government bonds diminishes the doom loop. Simulation results of this paper show that applying zero risk-weights to government bonds that have a non-zero probability of default leads to insufficient capital requirements. As it is expected from higher exposure to risky government bonds, the importance of applying proper risk weights also rises. However, one of the important lessons learned from the global financial crisis and the European sovereign debt crisis was that liquidity

squeeze can cause major problems to banks, as well as their sovereign governments. It is thus, essential to determine whether positive risk weights on government bonds would have a negative impact on the ability of governments to receive funding, so they can implement their fiscal policy without issues.

The introduction of LRR is not sufficient to compensate for zero-risk weights. Minimum capital requirement of 8% together with LRR equal to 3% results in a minimum risk weight level for all assets equal to 37.5%. Being as it may, the findings of Kiema & Jokivuolle (2014) state that an LLR of 3% is extremely low and it would not increase bank stability. In the case of a negative shock to low risk loans, bank stability might actually reduce, due to contamination effects. As it is suggested only a higher level of LRR, close to the average level of risk-based capital requirements, would be more successful in increasing bank stability, and as a result reduce the occurrence of twin crises.

The creation of a safe asset in the euro area as proposed by Brunnermeier et al. (2016, 2017) is a feasible solution for the mitigation of doom loop phenomena. Their findings suggest that the senior tranche of SBBS will bear at least the same risks as most low-risk government bonds in the euro area, leading to an increase in the supply of safe assets, so that all EMU members can have access to safe assets and their benefits. Simulation results in this paper support the prospect of removing the sovereign risk from banks' balance sheets, which originates from their government bond holdings. However, this proposal is only going to steer the majority of risk, if not all, to other recipients, the holders of lower seniority tranches of SBBS. Some scholars have raised their concerns that this approach could result in the same adverse effects of the sub-mortgage and sovereign debt crisis. In addition, it has been pointed out that the supply of a safe asset in the euro area can only be increased either through ECB's statement about guaranteed safety for government debt in the region via the shadow banking system (Gabor & Vestergaard, 2018) or through risk sharing between nations (De Grauwe, & Ji, 2018).

Banks are obligated to follow exogenous constraints related to the credit risk of their assets that they hold, such as the propositions of the Basel accord. For this reason, the level of loans supplied to the economy depends on banks' credit risk. If a bank holds riskier assets their loan supply is going to be lower. This paper finds support for the findings of Gennaioli, Martin, and Rossi (2018) that government bond holdings negatively affect the loan supply of banks. In addition, higher exposure to risky government bonds and NPLs further increases credit risk of banks' balance sheets and thus, loan supply reduces further. The introduction of diversification and/or SBBS assets effectively diminishes the negative effect of exposure to government bonds on the supply of loans.

Even though diversification of government bonds can possibly reduce credit risk that emerges from high exposure to government bonds, special attention is needed for those banks that operate in safe countries. The government bond portfolio composition of such banks might be much safer compared to the diversified bundle, so regulators need to take that into account when imposing laws that affect the levels of diversification and exposure of banks to government bonds. Furthermore, the introduction of a safe asset, such as the SBBS has shown

positive results in its ability to reduce credit risk of banks' balance sheets and break the direct linkages that create doom loops, increase home bias and increase loan supply for households and enterprises. Nonetheless, the feasibility of SBBS is subject to many variables that are not examined in this paper thoroughly, for example demand for and regulation of junior and senior SBBS, credit rating given to SBBS and the structure of tranching. Therefore, an initiation of a test phase for such an asset might be the next step to determine whether it will be a feasible solution for eliminating the doom loop and moving forward the market integration in the euro area without mutualizing sovereign risks amongst the members.

7 CONCLUSION

This study examines the impact of banks' exposure to government bonds for five countries in the euro area via a Monte Carlo simulation. The relevance of this connection relates to major issues inside the euro area's financial system, like the vicious cycle of default incidents between banks and their governments, home bias and general instability in the financial system, due to low supply of a safe asset in the area. The simulation study has shown firstly, that diversification of government bonds is effective in reducing credit risk in banks that operate in countries which issue risky government bonds, but can be countereffective in countries whose governments issue safe assets. Secondly, high exposure limits to government bonds can positively affect the composition of banks that operate in risky environments. However, flight to quality, is most likely going to increase in this case which can put further pressure to governments that are already in a bad financial situation. Thirdly, levying zero risk weights to government bonds that are not risk-free makes banks hold lower capital than what would be required for them to be in safe against sovereign defaults. Moreover, the introduction of SBBS in the euro area would effectively remove the sovereign risk from banks' balance sheets and thus, break one of the main linkages that create the vicious cycle of defaults between banks and their sovereign. Finally, the exogenous credit risk constraints that banks have to follow, like the minimum capital requirement of the Basel accord, can possibly impact the level of loan supply to the economy. A government bond composition that has lower credit risk can reduce the overall credit risk of banks' credit risk and provide the opportunity for banks to increase their loan supply. Consequently, a government bond composition that contains all 19 issuers of government bonds in the euro area, manages to increase the loan supply in the euro area overall. Germany is the only country out of the five countries examined, that experiences a loan supply decrease when banks hold the diversified composition of government bonds. Additionally, the introduction of SBBS leads to an increase in loan supply for all five countries, a further positive development that the creation of SBBS has to offer in the euro area.

The research method of this paper is a simulation and therefore the results are indicative. A technique such as a Monte Carlo simulation can provide the means for the researcher to understand issues that otherwise would be extremely difficult to examine and find answers for, due to lack of data or because of the complicated connections between different factors. However, calibration of the model is a difficult task. There can be occasions in which deciding the right value for an input is not a straight forward decision. For this reason, empirical evidence that would further support the findings of this paper would increase the trustworthiness of this study.

Furthermore, due to the complicative nature of this paper's point of focus, some of the assumptions that have been introduced simplify things. Asset values follow the standard normal distribution which causes the expected returns to be

equal to zero. In addition, LGD and PD values are appointed separately. Although, Altman et al. (2004) show that expected and unexpected losses are largely undervalued if PD and LGD are uncorrelated.

Future research can take many different paths. One of those can be testing the role of exposure in government bonds in a dynamic model. A further understanding of the causes of loan supply shocks and their implications can also be examined via a dynamic model to a greater extend. Further empirical evidence that supports the indications of theoretical models has always been a necessity in the literature as well.

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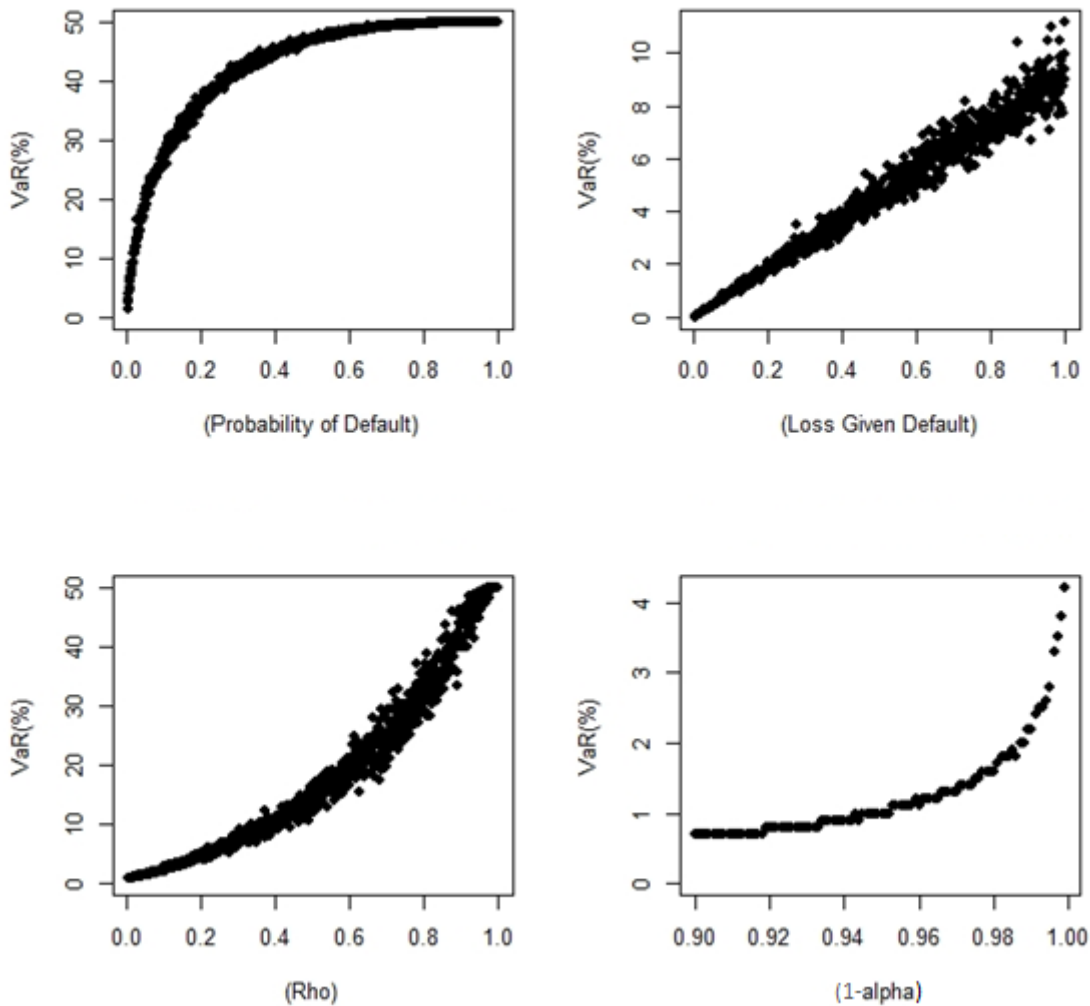
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APPENDICES

Appendix 1: The Reaction of Value at Risk to parameters Probability of Default, Loss Given Default, rho and (1-alpha)



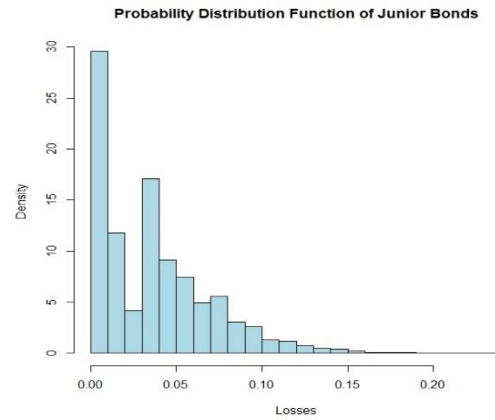
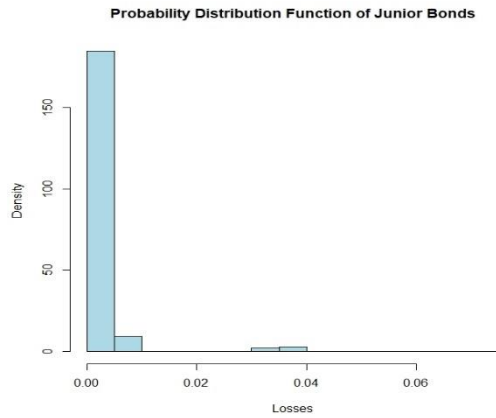
Notes: Upper left graph tests how does VaR react to changes in PD from 0.001 to 1. Upper right graph tests how does VaR react to changes in LGD from 0.001 to 1. Lower left graph tests how does VaR react to changes in Rho from 0.001 to 1. Lower right graph tests how does VaR react to changes in (1-alpha) from 0.9 to 1.

Appendix 2: Probability Distribution Function of Junior bonds in Benchmark and Adverse scenario

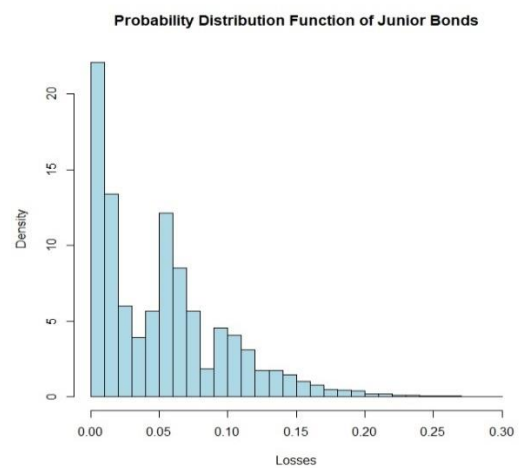
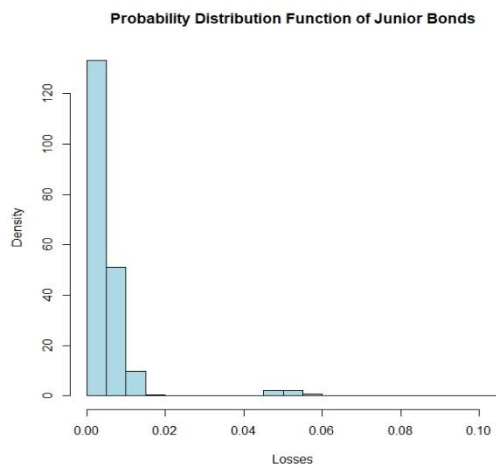
Benchmark scenario

Adverse scenario

LGD=35%



LGD=50%



LGD=75%

