UNIVERSITA' DEGLI STUDI DI PADOVA

DIPARTIMENTO DI SCIENZE ECONOMICHE ED AZIENDALI "M.FANNO"

CORSO DI LAUREA MAGISTRALE IN ECONOMICS AND FINANCE

TESI DI LAUREA

"A safe sovereign asset for the EU banks: an assessment"

RELATORE:

CH.MO PROF. Bruno Maria Parigi

LAUREANDO/A: Aurora De Gaspari

MATRICOLA N. 1203537

ANNO ACCADEMICO 2019 – 2020

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Firma dello studente

Alla mia famiglia e ad Alberto.

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1. Introduction

The European Union faces one of the greatest challenges in its existence. The European sovereign debt crisis is almost history, yet the next challenge is looming. The global economic downturn triggered by the global pandemic is a new burden for the still weak eurozone.
During the years several measures have been taken to strengthen the EU.[1] However, notwithstanding the important steps toward market integration, greater efficiency, and economic recovery, one crucial feature remains missing. The euro area does not supply a union-wide safe asset. In particular, the European Monetary Union is characterized by a scarce and asymmetric supply of euro-denominated safe assets. Taken together these two characteristics create two severe problems. First, capital flows from the periphery countries to the core countries in time of crisis and from the core to the periphery countries in boom periods. These capital flights triggered by changes in perceptions about vulnerabilities of specific countries destabilize the whole system. The second severe problem is the vicious link between banks and their sovereigns. European banks tend to take excessive exposure to their sovereign debt. On the other hand, sovereigns face the risk of having to bail out their banks, which increases the riskiness of government bonds. This situation leads to a doom loop whereby sovereign risk and bank weakness reinforce each other. Many analysts, commenters, and policymakers view an area-wide safe sovereign asset as a solution to these problems and several proposals have been put forward during the years.

After a comparison of the various ideas, I will perform empirical analysis to prove that the introduction of a well-designed safe sovereign asset in the EU bank's balance sheets is capable of de-risking banks' sovereign portfolios and, as a consequence, mitigating the risk transmission mechanism in place between sovereign and banks. To break the sovereign-bank vicious circle is an essential requirement for the euro area financial stability and further financial integration inside the union.
In conducting my empirical analysis I focused on the proposal by Brunnermeier et al. (2011, 2017), recently undergoing a subject of an extensive review by a High-Level Task Force of the European Systematic Risk Board (ESRB, 2018). The idea is to create a multi-tranche sovereign bond-backed security (SBBS) with the most senior tranche (European Safe Bonds, EBSies)

[1] Further information at European Commission (2017), pg. 32-33; and at https://ec.europa.eu/info/live-work-travel-eu/health/coronavirus-response_en.

playing the role of a safe asset. In contrast to most other proposals, SBBSs are politically feasible as they do not require any Member State guarantees.

Firstly, I compared the credit risk arising from the current portfolio composition of EU banks (status quo) with that resulting from the introduction of a diversified portfolio of euro-area government bonds (pure pooling). Then, I examined the potential benefits of adding tranching to diversification, which is the potential benefits arising from the introduction of the ESBies into euro-area banks balance sheets. To do that, with the aid of a Monte Carlo simulation I generated the distribution of future portfolio credit losses for the various compositions of EU banks' balance sheets. Then, I used the distribution of losses to calculate and conduct analysis on the credit risk. The credit risk measures adopted in the study are the Value at Risk (VaR) and the Expected Shortfall (ES).

To preview my main results, the simulation analysis will demonstrate that the introduction of ESBies in banks' portfolios is capable of reducing unexpected loss rates of banks' sovereign portfolios, thus reducing their credit risk, even at very low thicknesses of the junior tranche. Moreover, both tranching and diversification are key to ESBies' safety. Precisely, results show that countries which in the status quo owned a safe government bond composition experience an increase in their credit risk when a diversified portfolio of government bonds replace their sovereign bond composition. In other words, diversification alone is not beneficial for the safest EU banks, namely German and French banks. Increasing the diversification of government bonds positively reduces credit risk only of those banks that currently hold a riskier portfolio composition. Conversely, when the diversified portfolio of euro-area sovereign bonds is tranched into a senior component (ESBies) and a junior component (ESBies), with banks holding only the senior tranche, results indicate that the credit risk of all banks examined is reduced compared to the current situation and pure diversification security design, even when very low subordination levels are considered. Moreover, simulation results show that when banks' exposure to the senior bonds increases also the benefit in terms of credit risk reduction increases. To conclude, such an instrument would effectively remove the sovereign risk from all EU banks' balance sheets and thus, break the risk transmission mechanism in place between governments and banks. As a result, my empirical analysis supports the creation of a safe sovereign asset, in the ESBies form, to strengthen financial stability and the euro area as a whole.

The remainder of this thesis is organized as follows. Chapter two briefly examines the problems caused by the lack of an area-wide safe asset and discusses the main benefits that such an instrument could bring to the euro area. Chapter three provides an overview of the most relevant proposals for a safe sovereign asset. Chapter four presents the methodology adopted for conducting the empirical analysis, reports the data used for the simulation, and presents the results of the research. The final one concludes.

2. A euro-area wide safe asset

2.1 The lack of an area-wide safe asset and the resulting problems

Modern financial systems rely heavily on safe assets. A safe asset can be defined as an asset that is liquid, which has a minimal default risk, and that is denominated in a currency with stable purchasing power over time. Brunnermeier and Haddad (2014) argue that similar to a good friend who is around when needed, a safe asset is valuable and liquid exactly when one needs it. Like gold, a safe asset holds its value or even appreciates in times of crisis. The authors refer to this feature as the "good friend analogy". Safe assets meet investment needs, as well as being used as collateral for REPOs, central bank REPOs and over-the-counter derivatives transactions. In financial markets, they serve as a benchmark for pricing, hedging, and evaluation of risky assets. In the case of banks, in addition to playing a key role in daily asset-liability management, the high demand for safe assets is related to prudential regulation. To comply with Basel III requirements, banks need to hold risk-free securities to meet their financing needs in different scenarios, in particular adverse ones. Finally, the central bank, in conducting conventional monetary policy, should exchange money for safe bonds (Brunnermeier et al., 2011).

To meet this great demand, there is very little supply of safe assets. The euro area does not supply a safe asset on par with the United States, despite the two economies having a similar size and financial markets at a similar stage of development. According to Leandro and Zettelmeyer (2019), only about €1.5 trillion in euro area central government debt securities are rated AA+/Aa1 or higher (€3.2 trillion if AA/Aa2 rated French bonds are included), with Germany supplying around 83% of top-rated euro-denominated sovereign debt. This has to be compared to almost US$15 trillion in US Treasuries. The relative scarcity and asymmetric supply of euro-denominated safe assets create two severe problems, namely the flight to safety phenomenon and the so-called "diabolic loop".

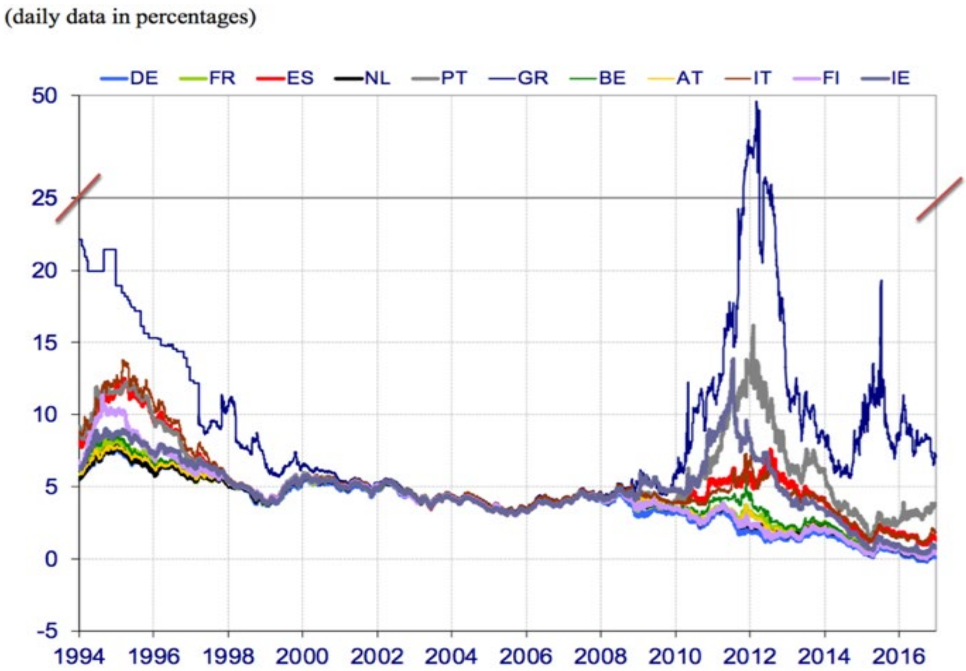
2.1.1 Flight to safety

The Eurozone is a monetary union without a fiscal union. Monetary policy for the Eurozone is set by the European Central Bank (ECB), while economic and fiscal policy is set on the national level. In other words, the functioning of EMU is characterized by a fragmented sovereign bond landscape, where only national financial instruments are available to underpin the architecture and, at the same time, countries no longer have their national central banks to ultimately assist them in case of liquidity stress in sovereign debt markets denominated in their currency. This exposes sovereign debt in the euro area to credit risk in a way other advanced economies are not, which in turn exposes the euro area to sudden capital flights triggered by changes in perceptions about vulnerabilities of specific countries (Giudice, 2019). All this leads to a situation in which national sovereign bond markets can be hit by self-fulfilling crises: investors distrusting the capacity of a government to continue to service its debt sell the bonds, thereby raising the yields and making it more difficult for that government to roll over its debt. Investors will sell bonds of those governments perceived to be the riskiest and acquire bonds issued by sovereigns perceived to be less risky. As a result, massive capital flows within the euro area are activated destabilizing the whole system. In other words, since only a few European countries issue public debt which rating companies and savers regard as risk-free, crises trigger capital flights in search of security, which makes the situation of the countries in crisis even worse. This was exactly what happened during the euro area sovereign debt crisis 2009-2012.

In particular, before the major financial crisis, euro area government bonds were perceived as safe assets, irrespective of the Member State issuing them. This contributes to the so-called "Great Convergence" of sovereign bond yields (Figure 1) and facilitated substantial capital flows from the core to periphery countries[2]. As national economies continued to grow, investors perceived sovereign bonds across the euro area as liquid and high-quality assets. After 2009 investors began to question the solvency of some Eurozone sovereigns. Government bonds from euro area countries were no longer considered equally risky: German bonds became the safest asset in the Eurozone, as was the case before the creation of the European Monetary Union (EMU). This reassessment triggered a rapid reversal of capital flows as investors sought safety above all else. Cross-border flight-to-safety compressed core countries' borrowing costs, allowing them to enjoy a "safety premium", while it raised stressed sovereigns' borrowing costs correspondingly, and thereby further hurt their fiscal solvency (Van Riet, 2017). This resulted in a deep financial fragmentation along national lines of creditworthiness, which in turn hampered the even transmission of monetary policy throughout the eurozone.

[2] Greece, Italy, Ireland, Portugal, and Spain are considered the peripheral countries (or GIIPS Countries).

Figure 1. Government bond yields of the euro area countries, 1994-2016. *Source*: Van Riet (2017).



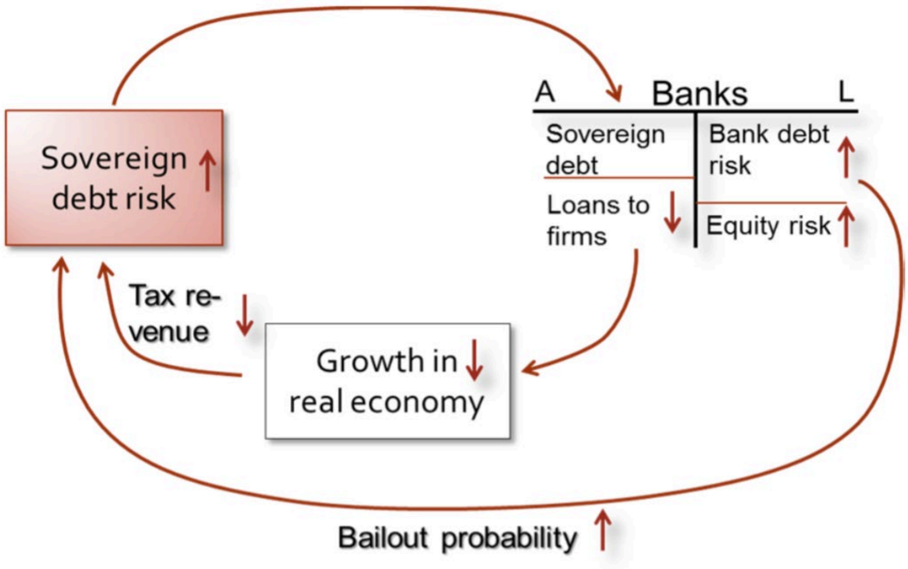
2.1.2 Diabolic loop

The instability of the government bond markets is aggravated by the doom loop between banks and sovereigns. Following the Basel Framework, banks can use sovereign debt to comply with prudential regulation irrespective of the credit quality of the government, treating sovereign debt essentially as risk-free. In other words, in calculating capital requirements, bank regulators assign a zero risk weight to banks' claims on any European Union (EU) Member State. Moreover, they allow banks to use sovereign debt to satisfy their liquidity ratios regardless of the creditworthiness of the government. Encouraged by the absence of any regulatory discrimination among bonds, European banks tend to take on excessive exposure to their national debts, even if they are risky. On the other hand, sovereigns face a constant risk of having to rescue their banks which increases the riskiness of their bonds. A substantial body of evidence indicates that "home bias" forges the potential for an adverse link between sovereign risk and bank risk, often referred to as "diabolic loop", "doom loop", and "feedback loop".[3] The sovereign-bank vicious circle consists of the transmission of risks from governments to banks and vice versa. In particular, a shock to the market value of sovereign bonds causes banks' book and market equity value to fall and activates two propagation channels. The first

[3] See e.g. Altavilla et al. (2017), Acharya et al. (2018), Brunnermeier et al. (2011, 2016, 2017), Cooper and Nikolov (2018), Farhi and Tirole (2018), Leonello (2018).

loop operates via a bailout channel, the reduction in banks' solvency raises the probability that banks would have to be bailed out by their government, increasing sovereign risk and government bonds depreciation. The second loop operates via the real economy. In response to the reduction in their solvency, banks curtail their lending activity which in turn reduces real activity, lowering tax revenues and increasing sovereign risk further. In this way a circle is created, where the crisis of the state aggravates that of the banks and the crisis of the banks aggravates that of the state (Figure 2).

Figure 2. The sovereign-bank diabolic loop. *Source*: Brunnermeier et al. (2011).

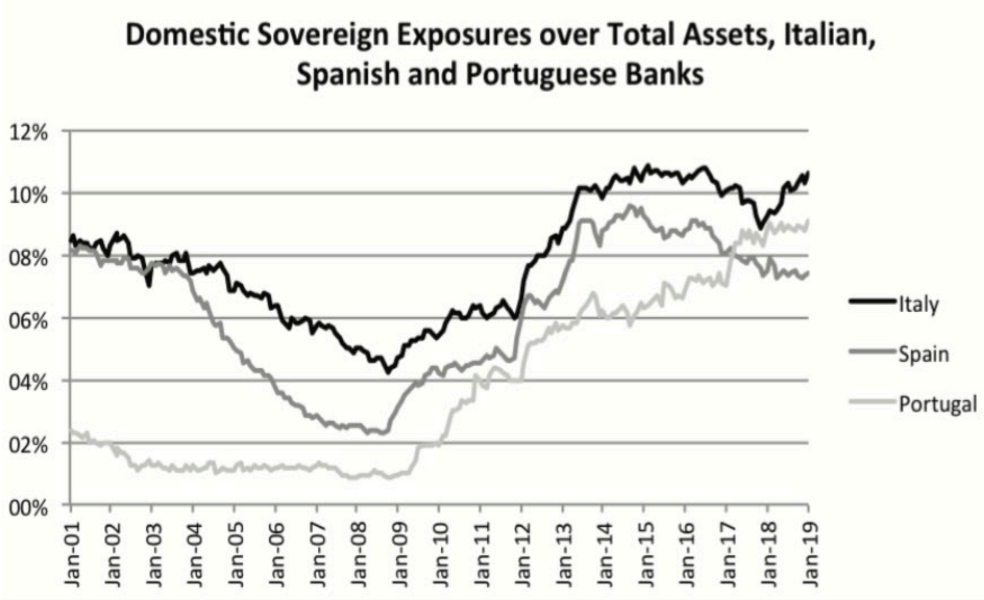


The diabolic loop was the hallmark of the 2009-2012 sovereign debt crisis in the periphery countries. It was and still is one of the major threats to European financial stability. In some countries, such as Greece, Italy, and Portugal, the stress arose from a worsening in the sovereign creditworthiness. Long-run public debt accumulation and slow growth alarmed investors about the possibility of default. As a consequence, the sharp widening in the government bond yields harmed the domestic banks' balance sheets, which in turn amplified the sovereign risk further. In other countries, such as Ireland and Spain, the direction of causality was different, with the stress arising from the widespread bank insolvencies which threatened the sustainability of sovereign debt dynamics (Brunnermeier et al. 2017).

Pagano (2019) points out that sovereign risk on banks' balance sheets is still very concentrated. The domestic sovereign exposure of Italian banks, after peaking at 10.8% of total assets in 2015-16 and a drop to 8.9% at the end of 2017, bounced back near their historical peak by January 2019 (10.6%). Portuguese banks' domestic exposure rose continuously from below 2%

in 2002-09 to 9.1% in January 2019. Those of Spanish banks in January 2019 were to 7.3% (Figure 3).

Figure 3. Monthly domestic sovereign exposures of Italian, Spanish, and Portuguese banks. *Source*: Pagano (2019).



The current structure of the sovereign bond market and the excessive exposure of European banks to their national sovereign credit risk amplify market volatility, affecting the stability of the financial sector, which in turn impacts negatively the real economies of the euro area Member States. Furthermore, these features limit the ability of the euro area to develop the international role of the euro and challenge the conduct of the single monetary policy. This situation has stimulated an intense debate and proposals on a European safe asset. A European safe asset could create numerous benefits for the euro area economy, which will be discussed in the next section.

2.2 An area-wide safe asset: main benefits

A union-wide safe asset could serve several different purposes. The main benefits can be classified into four broad categories: strengthening financial stability, improving financial markets' functioning in the eurozone, enhancing the international role of the euro, and facilitating the transmission of monetary policy.

2.2.1 Strengthening financial stability

The introduction of a European safe asset can make a considerable contribution to strengthening financial stability in the euro area. First, by storing the value in safe sovereign bonds rather than holding home-biased sovereign debt portfolios, banks would weaken the vicious link between their solvency and that of their domestic government. Regulatory treatment of sovereign exposures has to be changed for banks to find it attractive to reallocate their portfolios in favor of an area-wide safe asset. In fact, the absence of any capital charge leads financial institutions to hold risky sovereign bonds rather than other assets of similar riskiness. One option would be to set positive risk-weights on all single-name sovereign holdings. Without a European safe asset, this could generate a capital flow from the periphery to core countries. A union-wide safe asset would preclude this outcome as banks would be incentivized to reinvest in it to minimize their capital requirements. Reforming the regulatory treatment of sovereign exposures and the introduction of a European safe asset are jointly necessary to break the bank-sovereign link (Alogoskoufis & Langfield, 2019). Secondly, a union-wide safe asset could contribute to reinforcing financial stability reducing the scope for cross-countries' destabilizing capital flows triggered by shifts in market sentiments. In turn, it could facilitate more consistent pricing of debt developments, creating better conditions and stronger incentives for conducting sounder fiscal policies, resulting in strengthened public finances. Overall, by creating a more stable euro area, European safe assets would contribute to reducing risk premia in euro area assets, thereby easing financial conditions over the medium term. By lowering the cost of capital, the result would be higher potential economic growth (Ubide, 2015).

2.2.2 Improving financial markets' efficiency

In its "Green Paper on the Feasibility of Introducing Stability Bonds" published in 2011, the European Commission acknowledges that a union-wide safe asset would promote efficiency in the euro area sovereign bond market and the European financial system as a whole. In particular, it would provide the euro area with a deep and highly liquid market, characterized by a single benchmark yield curve contrary to the current situation of many country-specific benchmarks. Benchmark yields would be low, given the high credit quality of the risk-free assets and their liquidity which would be manifested by lower credit and liquidity risk premiums. In other words, a euro risk-free yield curve would be generated. A single set of European safe asset benchmark yields across the maturity spectrum - being the benchmark for pricing other assets - would help to expand the bond market, stimulating issuance by the private sector, such as financial firms, corporations, and municipalities. Moreover, it would improve the functioning of many euro-denominated derivates markets. In a nutshell, the introduction of a euro-area wide safe asset could lower financing costs for both the public and the private sector and thereby underpin the growth potential of the economy in the long term.

2.2.3 Enhancing the international role of the euro

In terms of size, the US sovereign bond market and the total sovereign bond market of all European sovereign bonds are comparable, but the fragmented sovereign bond landscape in the euro area means that much larger volumes of US Treasury bonds are available compared to those of any other European state. High liquidity is one of the factors that provide the US Treasuries with a privileged role in the global financial system, attracting institutional investors. A euro-area wide safe asset would guarantee a deep and highly liquid European bond market and would attract the interest of institutional investors, increasing the attractiveness of the euro as a reserve currency in the international market. In other words, over time, a greater supply of safe assets from Europe would stimulate portfolio investment in euro and favor a more balanced global financial system, thereby supporting a stronger international role of the euro and underpinning the euro as a global currency.

2.2.4 Facilitating the transmission of monetary policy

A union-wide safe asset would facilitate the transmission of the single monetary policy across the euro area. The transmission of monetary policy to euro area Member States is currently impaired due to large financial market fragmentation along national lines across the credit spectrum. Individual national issuers in the euro area face different borrowing costs, in large part due to concern about the riskiness of national banking systems and sovereigns, which generated highly volatile markets with highly divergent government bond yields. To strengthen the transmission of the monetary policy, the ECB has intervened with unconventional monetary policies, which however only minimized the most adverse consequences of shocks, but not brought financial conditions back to normal (Claessens, Mody, & Vallée, 2012). A European safe asset would ease the conduct of open market operations and allow the ECB to use its policy toolkit more effectively. In particular, it would contribute to restoring the proper functioning of financial markets to allow for proper transmission of monetary policy by providing the euro area with a deep and high liquid market for euro sovereign securities. This would grant monetary policies conducted by the ECB to pass from the government bond market uniformly and to translate adequately into changes in local lending and funding conditions, and ultimately into aggregate demand. Moreover, such a safe instrument could also be the preferred monetary policy tool for the ECB to engage in non-standard large scale open market operations in government bonds, without concerns for the distributional effects or consequences for its balance sheet (Van Riet, 2017).

In summary, a union-wide safe asset would reinforce the financial market and its stability, support the smooth functioning of the EU economies, underpin the euro as a global reserve currency and allow for a proper monetary policy transmission, both in normal times and in the face of a crisis. The sooner the functioning of sovereign bond markets can evolve, the sooner the EMU architecture can become stronger. Several proposals have been put forward over the last decade on how a European safe asset could be created. The issue is intensifying as a result of the crisis caused by the global pandemic that has shaken the whole world and, in particular, the euro area, still weak from the financial crisis of 2008 and the subsequent sovereign debt crisis. The next chapter aims to review some of the most significant proposals, which, indicatively, complete the range of categories proposed.

3. Proposals for a safe sovereign asset

The proposal for a safe sovereign asset was addressed for the first time around the beginning of the new millennium when the Giovannini Group (2000) published a report presenting several viable alternatives for coordinating the issuance of euro-area sovereign debt. The argument has re-emerged strongly between academics and financial operators with the intensification of the sovereign debt crisis. In 2011, the European Commission opened a public consultation on Stability Bonds through the publication of a Green Paper, and several other bodies, think-tanks, and academics developed proposals on that topic. The idea has regained momentum with the triggering of the economic crisis that the global pandemic is generating throughout Europe.
The focus has shifted several times. Earlier proposals on a European safe asset were thought to offer a possible avenue of further integrating EMU and reinforce the role of the euro as a reserve currency. Then, during the euro area sovereign debt crisis, proposals were intended to represent a possible crisis resolution tool. The concreate goal was to bring the extraordinary yield spreads back down and stabilize public finances and government debt markets in the euro area. Sometime after the moments of the peak of the crisis, and before the economic crisis caused by the coronavirus pandemic, the focus changed again. Proposals primarily aimed to increase the supply of euro-denominated safe assets. The main objectives were to promote financial integration, support monetary policy transmission, prevent self-fulfilling liquidity runs, and replace national sovereign bonds on banks' balance sheets to break the sovereign-bank vicious circle. Since the beginning of this year, due to the crisis caused by the COVID-19, other proposals have emerged to effectively tackle the health and economic emergency in all countries and trigger the rebirth, creating at the same time that safe asset that Europe and its financial system desperately need (Boitani & Tamborini, 2020).

The proposals for a safe sovereign asset are numerous and although some are very similar to each other, others have different characteristics. Several ideas for the creation of a euro-area safe asset envisage some form of mutual guarantee that would ensure the safety of these assets, but could also lead to redistribution and moral hazard effects if not properly accompanied by varying degrees of closer and stricter fiscal surveillance to ensure budgetary discipline. These types of proposals also require a European Union Treaty change. Other ideas try to dispense with mutualization by achieving safety by some combination of diversification and seniority. The most relevant proposals will be reviewed in the following sections. Table 1 provides a summary that indicates the main characteristics of the analyzed proposals and highlights the differences to the European Safe Bonds (ESBies).

Table 1. Comparison of the proposals.

Proposals	Main Features	Tranching and pooling	Guarantees	Differences with ESBies
Eurobonds	▪ Issued by a European institution or directly by euro area countries' governments. ▪ Participation of each country fixed based on its equity shares in the EIB. ▪ Payoffs equal to the joint payoffs of the bonds in the underlying portfolio. ▪ Require a revision of European Treaties.	▪ No tranching. ▪ Pooling.	▪ Joint and several guarantees.	▪ Joint and several guarantees → require a significant revision of European Treaties.
Blue-Red Bonds	▪ Strict governance mechanism. ▪ National tranching: (1) Blue debt up to 60% of each member's GDP; (2) Red debt above 60%. ▪ Red bonds: issued by the sovereign. ▪ Blue Bonds senior to Red Bonds. ▪ Price signals on Red debt. ▪ Gradual or big bang introduction. ▪ Require a revision of European Treaties.	▪ Tranching and pooling	▪ Blue Bonds: joint and several guarantees. ▪ Red Bonds: no guarantees.	▪ Blue-Red Bonds proposal: national tranching + pooling. ESBies proposal: pooling + tranching (reversed order). ▪ Blue Bonds entail joint and several liabilities → require a significant revision of European Treaties.
Purple-Red Bonds	▪ In the beginning, the entire debt stock becomes Purple. ▪ Year after year: (1) Purple debt: debt consistent with the Fiscal Compact's annual limit; (2) Red debt: any debt issued above the permitted ceiling. ▪ Purple Bonds: no-limits and zero-capital weighting. ▪ No change of the Maastricht Treaty. ▪ Amendment of the ESM Treaty.	▪ No tranching. ▪ Pooling.	▪ No restructuring clause on Purple Bonds. ▪ Red Bonds: no guarantees.	▪ No tranching of the existing debt stock. ▪ Purple debt backed by a no restructuring guarantee → amendment of the ESM Treaty.
Eurobills	▪ Issuance entrusted to a debt management office (DMO). ▪ Replace existing short-term debts. ▪ Countries cannot issue new short-term debt. ▪ Participation conditioned on compliance with the criteria of economic governance and budgetary discipline. ▪ Senior to all other liabilities issued by countries. ▪ No changes to either the European Treaties or the Constitution of individual Member States.	▪ No tranching. ▪ Pooling.	▪ Joint and several guarantees up to 10 percent of a country's GDP.	▪ Pooling up to 10% of each country's GDP. Limited to short-term debt. ▪ Joint and several guarantees on Eurobills.
E-Bonds	▪ Issued by a senior, publicly-owned financial intermediary. ▪ Backed by a diversified portfolio of sovereign debt. ▪ Lending to each country does not exceed a given level of its' GDP (equal for all countries). ▪ Debt not covered by this mechanism financed through national government debt. ▪ No changes to the Maastricht Treaty. ▪ Amendment of the ESM Treaty could be required.	▪ Pooling. ▪ No tranching. ▪ Seniority is applied at the level of the issuer.	▪ No joint and several guarantees.	▪ Issued in a single tranche. ▪ Seniority applies at the level of the intermediary.
European Safe Bonds (ESBies)	▪ A Special Purpose Vehicle (SPV) purchases a diversified portfolio of sovereign bonds. ▪ ECB capital key or GDP weights. ▪ The SPV issues two types of Sovereign-Bond-Backed Securities (SBBSs): (1) European Safe Bonds (ESBies); (2) European Junior Bonds (EJBies). ▪ ESBies are senior to EJBies. ▪ 30% subordination level sufficient to ensure ESBies' safety. ▪ Regulatory reform to "promote" ESBies. ▪ Official Handbook. ▪ No changes to the European Treaties.	▪ Pooling and tranching.	▪ No joint and several guarantees.	

Table 1- Cont.

Synthetic Eurobonds	▪ A new European debt mutual fund purchases a diversified portfolio of sovereign bonds based on ECB capital key or GDP weights and issues synthetic bonds. ▪ Payoffs equal to the joint payoffs of the bonds in the underlying portfolio. ▪ No changes to the European Treaties.	▪ Pooling. ▪ No tranching.	▪ No joint and several guarantees.	▪ No tranching: single-tranche SBBS.
Structured Eurobonds	▪ A SPV buys a diversified portfolio of sovereign bonds and issues Eurobonds. ▪ Several subordinated tranches. ▪ Trust fund as an additional layer of protection. ▪ No changes to the European Treaties.	▪ Pooling and tranching.	▪ EU participating countries partially liable via the trust fund.	▪ Partial joint liability among nation-states. ▪ Several tranches with different ratings (not only two).
Safe Market Bonds	▪ Created by the private sector. ▪ Backed by a diversified portfolio of euro-area sovereign bonds based on GDP weights. ▪ Several subordinated tranches. ▪ The ECB assigns risk weights to each euro area country sovereign debt and sets up a registration scheme. ▪ ECB's announcements: (1) it will purchase only the senior 60% tranche of the synthetic bond; (2) only the senior tranche of the synthetic bond could be counted as risk-free for the risk weighting and liquidity coverage ratio calculations. ▪ No changes to the European Treaties.	▪ Pooling and tranching.	▪ No joint and several guarantees.	▪ Created by the private sector.
Coronabonds	▪ Common debt issued by a group of euro area countries. ▪ Mutualization of interest rates on the new debt.	▪ Pooling. ▪ No tranching.	▪ Mutualization of interest rates on the new debt issued.	▪ Expansion of debt on the market. ▪ Mutualization of interest rates → require a revision of European Treaties.

3.1 Eurobonds, by De Grauwe and Moesen

As early as May 2009, De Grauwe and Moesen suggested the issue of euro-denominated bonds, Eurobonds, that would be guaranteed collectively by the euro area governments. The authors point out that Eurobonds could be issued by a European institution, like the European Investment Bank (EIB), or directly by the euro area Member States' governments.

Common debt would avoid diverging borrowing costs, with the adverse consequences for debt sustainability and risks of propagation. However, the joint and several guarantees would require a significant revision of European Treaties and are opposed by a very large part of the European countries. In particular, Germany and the Countries of Northern Europe (Finland, the Netherlands, Austria) have opposed the issue of common bonds from the outset. The reason for the contrariety of these euro area Member States is clear: they do not want to guarantee the debt of the GIIPS countries. In particular, they fear that common debt will create an incentive for countries with higher yields to conduct unsustainable fiscal policies. As a result, they may be forced to bail-out the government of the undisciplined countries in case of default. To balance these risks and the core countries' fears, strict conditions would need to apply. Because of this, De Grauwe and Moesen (2009) define a series of characteristics for the Eurobond issue. First, the participation of each country in the issue is fixed based on its equity shares in the European Investment Bank (EIB). Second, the interest rate on the euro-denominated bonds would be a weighted average of the yields observed in each government bond market at the moment of issue. Third, the proceeds of the Eurobond issue would be channeled to each government based on each country's weight. Finally, the interest rate paid by each government on its part of the bond would be equal to the national interest rate used to compute the average interest rate on the Eurobond. Even if countries' interest rate on debt does not change compared to the situation in which they issue bonds on their own, stressed countries would benefit from the fact they can access funding more easily. Moreover, Eurobonds would be more liquid than the euro area countries' national bonds and they would reinforce the financial market stability.

3.2 Blue-Red Bonds, by Depla and von Weizsäcker

In May 2010, Depla and von Weizsäcker published their "Blue-Red Bonds" proposal. The idea put forward by Bruegel Think Tank proposes splitting the sovereign debt of the euro area Member States into two parts. The first part, up to the Maastricht debt limit of 60 percent of each member's GDP, should be pooled as "Blue" bonds with senior status, to be jointly and severally guaranteed by participating countries. Any residual borrowing by a sovereign, i.e. debt above 60 percent, would have to be financed through purely national "Red" bonds with junior status. This remaining junior tranche consists of more risky assets at a marginal cost reflecting the country's creditworthiness, thus maintaining price signals. Given their characteristics, Blue Bonds will likely enjoy a triple-A rating and, as argued by Depla and von Weizsäcker (2010), they would be considered even safer than German Bunds. The Blue Bonds would constitute an extremely liquid and safe asset that could compete with the US Treasury Bonds since they would be more attractive for both central banks and large investors. On the other hand, borrowing costs for Red Bonds would be high for countries in breach of the Stability and Growth Pact (SGP). The higher price paid for the Red Bonds potentially creates an incentive to limit debt issuance, thereby encouraging Member States to adopt appropriate fiscal discipline and to fall within the limits of the SGP. Furthermore, according to Depla and von Weizsäcker, Red debt should be largely kept out of the banking system and cannot be guaranteed by another country or be bailed out by the EU mechanism. The no bail-out rule would apply only and strictly to the Red debt.

The authors set out a strict governance mechanism under which an independent stability council would propose the annual allocation of Blue Bonds, according to principles of the SGP and notions of general fiscal sustainability. This allocation would subsequently be approved by the national parliaments of participating Member States. Any country voting against the proposed allocation would thereby decide neither to issue any Blue Bonds in the coming year nor to guarantee any Blue Bonds of that particular vintage.

Concerning the introduction of Blue-Red Bonds, this could take place either gradually, with the progressive replacement of sovereign bonds at maturity, or in a big bang through the replacement of all sovereign debt in circulation. Gradual is more attractive to establish credibility and gain political support. However, a big bang would create a deeply liquid pool of Blue debt overnight and could potentially be used for a comprehensive debt restructuring.

Finally, the Blue-Red Bonds proposal, by providing for joint responsibility between the Member States, would require the amendment of the existing regulatory framework.

3.3 Purple-Red Bonds, by Bini Smaghi and Marcussen

The Purple-Red Bonds approach suggested by Bini Smaghi and Marcussen (2018) is based on the Blue-Red Bonds proposal by Depla and von Weizsäcker (2010). A potential problem related to the original proposal is that it would force all countries with debt above 60 percent of GDP to issue new debt as subordinated Red Bonds. Then, countries with debt over 60 percent could find new bond issuance very expensive or even lose market access (Leandro & Zettelmeyer, 2018). The Purple-Red Bonds scheme tries to solve this problem. In particular, Bini Smaghi and Marcussen propose a 20-year transition period that levers on the Fiscal Compact's requirement according to which countries would be asked to reduce the excess general government debt above 60 percent of GDP by 1/20 every year. At the beginning of the program, the entire debt stock would become Purple, thus entailing no tranching of the existing debt stock. Year after year, the debt consistent with the Fiscal Compact's annual limit, the so-called "Purple debt limit", would be Purple. Conversely, any debt issued above the permitted ceiling would be Red.

The Purple debt would be backed by a guarantee that protects it from any debt restructuring demands under an eventual European Stabilization Mechanism (ESM) program, while the Red debt would enjoy no guarantees. In particular, the latter would be issued with a clause making it clear that it falls outside the no restructuring and could also contain other clauses on debt restructuring to facilitate this, if necessary. The higher cost of Red Bonds and the motivation for governments to avoid an ESM program would limit moral hazard and encourage the Member States to pursue fiscal discipline. Moreover, under the Purple-Red Bonds proposal, the no-limits and zero-capital weighting on the sovereign debt would only apply to Purple Bonds, while banks' holding of Red Bonds would be subject to limitations. In this way, banks' holdings of the riskiest part of sovereign debt will be gradually reduced.

According to the authors, at the end of the 20-year transition period, the Purple Bonds would be equivalent to 60 percent of GDP, and they could be converted into Blue Bonds, as set out in the original Blue-Red proposal by Depla and von Weizsäcker (2010). Beyond this period, any debt above 60 percent would still be financed in Red Bonds.

To conclude, Bini Smaghi and Marcussen's proposal entails no joint and several guarantees. As such it does not require the amendment of the Maastricht Treaty. However, to be implemented it requires the ESM Treaty to be amended to reflect the no restructuring clause on Purple Bonds and to include the clauses related to the Red Bonds.

3.4 Eurobills, by Hellwig and Philippon

In November 2011, Hellwig and Philippon proposed a variant of the Blue-Red Bonds proposal by Depla and von Weizsäcker (2010) limited to debt of maturities less than a year, Eurobills. The Eurobills proposal involves joint and several guarantees which are limited only to a portion of each country's debt stock, up to 10 percent of a country's GDP. Issuance of Eurobills is entrusted to a debt management office (DMO) set up by the Eurozone countries. Before the beginning of each quarter, the Treasuries of the members would submit demand schedules for issuances based on which the DMO would, using auctions, issue Eurobills to cover the needs of all the countries over the quarter, subject to the condition that no country can have more than 10 percent of its GDP in Eurobills outstanding at any point in time. If there is any unbid amount, the European Central Bank (ECB) would retain the Eurobills remaining outside the auction, just like the Bundesbank who steps in to retain any unsold Bund issuance. If this should happen, the Member States must repurchase the Eurobills retained by the ECB within one quarter. Should a country be unable to fulfill its obligations, other Member States are required to intervene and increase their repurchase.

The participation of the EU countries in Eurobills emission will be conditional on compliance with the criteria of economic governance and budgetary discipline. Moreover, Eurobills issuance will not lead to an expansion of the overall amount of short-term debt on the market, since they will simply replace existing short-term debts. Member States will be not allowed to issue new debt of fewer than two years of maturity. Giving up the right to issue short-term debt is, according to Hellwig and Philippon, the only credible way to make Eurobills effectively senior to all other liabilities that countries issue. Limit on the size of the issuance together with credible seniority is critical for convincing strong countries to accept the joint-and-several liability. Indeed, participation will not be binding and the exit is feasible if a country pays off its claims or lets them mature.

Even if the participation is not mandatory, all euro area countries should take part in it for two reasons. First, strong countries must participate otherwise a stigma could arise and the market could unravel. Secondly, harmful competition between strong countries' government bonds and Eurobills is undesirable.

This type of common debt would require no changes to either the European Treaties or the Constitution of individual Member States and it can be phased in as soon as the DMO is created. According to the authors, fully transferring the issuing power of Eurobills to a Community body would ensure their credibility and contribute to a reduction in the cost of servicing the debt. Moreover, the issuance of these securities would oblige states to correct budgetary policies, minimizing moral hazard, and would provide the banking system with a safe asset.

3.5 E-Bonds, by Monti and by Juncker and Tremonti

Proposed in a report to the President of the European Commission by Monti (2010) and in the Financial Times by Juncker and Tremonti (2010), the E-Bond approach consists to create a European Debt Agency (EDA) that would issue euro area bonds backed by a diversified portfolio of sovereign debt purchased at market price or face value directly from national issuers. Such an agency could be created, according to Junker and Tremonti (2010), by the European Council.

The E-Bonds would be issued in a single tranche and they would be made safe through a combination of diversification and seniority applied at the level of the intermediary issuing the European sovereign bonds, which would be a preferred creditor. The preferred creditor status could be established contractually, by indicating in future euro area sovereign bond contracts that the bond is subordinated to debt claims held by the intermediary. Alternatively, the legal foundation could be established through an EU regulation or an amendment of the ESM Treaty. Following the E-Bond proposal, lending to the Member States would not exceed a given level of a country's GDP, set out equal for all countries. Member States' financing needs not covered with this mechanism should be financed through national government debt, for which countries remain individually responsible. Due to the preferred creditor status of the intermediary issuing the E-Bonds, the market pressure and yields on the sovereign debt not held by the EDA should increase. In turn, this would create a stronger incentive for the Member States to quickly reduce such debt through sound fiscal policies.

The E-Bonds mechanism could include all euro area countries. The larger the number of Member States participating, the larger the issuance of E-Bonds by the European entity, and the greater the benefits in terms of liquidity and depth of the European bond market (Monti, 2010).

The E-Bond proposal ensures that fiscally-responsible countries are not forced to bail-out the undisciplined Member States, thus ensuring the respect of the no-bailout clause in the European Treaty.

3.6 European Safe Bonds (ESBies), by Euro-nomics, a group of European Academics[4]

Starting October 2011, the Euro-nomics group, a group of European Academics, has proposed the creation of a European Safe Bond based on a combination of diversification and tranching. The analysis of the European Safe Bonds presented in this section will be detailed, as these are the euro area safe sovereign assets analyzed in my empirical analysis developed in Chapter 4.

Following the Euro-nomics group's proposal, to create a European safe asset, a Special Purpose Vehicle (SPV), which could be administrated by a public or private special purpose entity (or entities), purchases a diversified portfolio of euro-area sovereign bonds according to some fixed weights. In particular, portfolio weights should be set according to nation-states' relative contributions to the euro-area economy. This could be done by weighting the sovereign bonds of Member States according to a moving average of euro area countries' relative GDPs or in proportion to national central banks' contribution to European Central Bank (ECB) capital. The use of GDP or ECB capital key weights is strictly better than setting weights according to nation-states' outstanding public debt since it ensures that countries could not increase their share in the securitization by issuing more debt. The SPV would buy only a certain fraction of each country's outstanding central government debt securities at market price. This framework allows for limiting moral hazard problems.

[4] The proposal was put forward by Brunnermeier, Garicano, Lane, Pagano, Reis, Santos, Thesmar, Van Nieuwerburgh and Vayanos (2011). It was then reanalyzed by the authors in 2016 and then improved in 2017.

To finance the diversified portfolio of euro-area sovereign bonds, the debt agency (or agencies) would issue two types of Sovereign Bond-Backed Securities (SBBSs), i.e. two tranches. The first tranche, the European Safe Bonds (ESBies), would be senior on interest and principal repayments of bonds held by the agency. The second tranche, the European Junior Bonds (EJBies), would be a junior claim on these payments. That is, it would be the first to absorb losses arising from the pool of sovereign bonds that back these issues. Together, the ESBies and EJBies would be fully collateralized by the underlying portfolio. In other words, the combined face value of ESBies and EJBies would be equal to the sum of the face values of the national sovereign bonds against which ESBies and EJBies are issued.

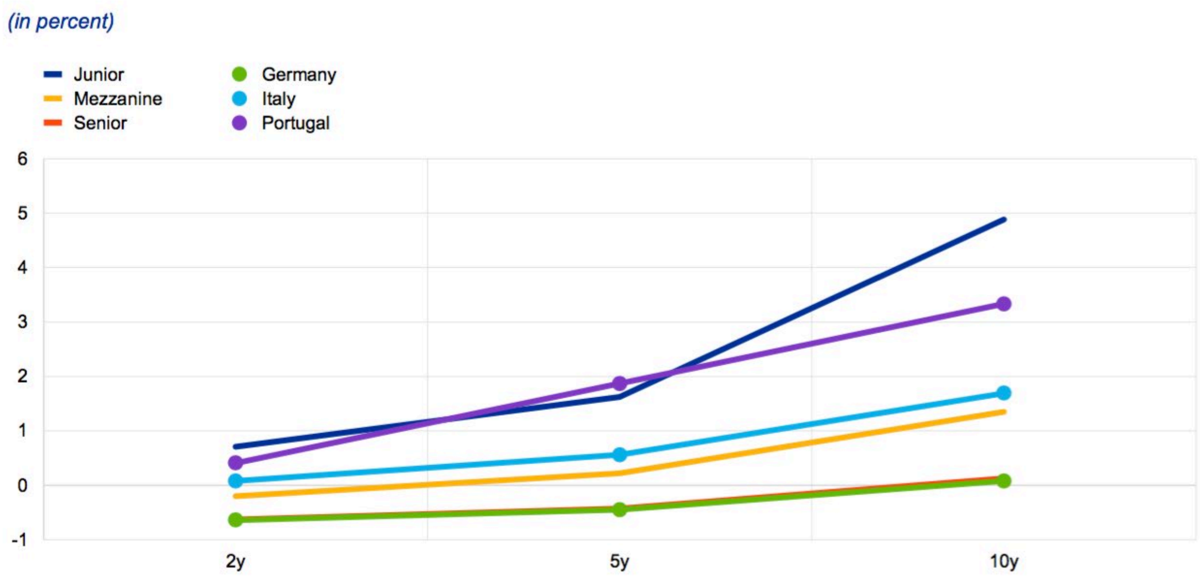
Both tranching and diversification are key to ESBies' safety. Any losses on the debt agency's diversified portfolio of national government bonds would reduce payments to junior tranche holders but leave payments to the senior tranche holders unaffected. Only if losses are large enough to exceed the subordination level, such that EJBies are entirely wiped out, ESBies begin to take any losses.

Brunnermeier et al. (2011) proposed a third layer of protection for the ESBies, to be added to diversification and seniority. In particular, the authors envisaged a capital guarantee, according to which the euro area Member States could pay in some capital upfront and, if the losses arising from the diversified portfolio of government bonds were to ever exceed the size of the junior tranche, these assets would cover the losses on the outstanding ESBies, until being exhausted. However, according to Brunnermeier et al.'s (2017) simulations, this additional level of protection is unnecessary to ensure the safety of the senior bond. Thus, ESBies need not encompass any public guarantee. The riskiness of the senior tranche will depend on the "thickness" of subordinated tranches, i.e. the subordination level. The higher the subordination level, the larger the cushion protecting the senior tranche from sovereign default. In this regard, using a two-level default simulation model, Brunnermeier et al. (2017) demonstrate that a subordination level of 30 percent, such that the junior bond represents 30 percent, and the senior bond 70 percent of the underlying face value, would be sufficient to ensure a five-year expected loss rate for the senior tranche slightly lower than that of the German Bund. Moreover, at this subordination level, ESBies could substantially increase the supply of safe assets relative to the status quo. On the other hand, the five-year expected loss for the junior tranche would be similar to those for bonds issued by the periphery euro area Member States.

Brunnermeier et al.'s proposal has been the subject of an extensive review by a High-Level Task Force of the European Systematic Risk Board (ESRB, 2018). According to the latter, SBBSs could be issued in three tranches: senior, mezzanine, and junior (i.e. first-loss equity).

In particular, the ESRB report envisages a seniority structure comprised of 70%-thick senior SBBS, 20%-thick mezzanine SBBS, and 10%-thick junior SBBS. In other words, the subordinated tranche envisaged by the Euro-nomics group, i.e. the EJBies, would be divided into two subordinated tranches: a mezzanine tranche and an equity tranche. The mezzanine tranche would be subordinated to the senior tranche, while the equity tranche would be subordinated to both the senior and mezzanine tranche. The High-Level Task Force argues that the 30 percent subordination level is large enough as a buffer to take potential losses on the underlying sovereign bonds so as to make the senior tranche risk-free, thus confirming Brunnermeier et al.'s (2017) results. Moreover, it calculates yields on SBBS using Monte Carlo simulations and shows that the senior tranche would present returns similar to those of German Bunds (Figure 4).

Figure 4. Estimated yields on 10-year SBBS compared with Germany, Italian and Portuguese bonds. *Source*: ESRB (2018).



The presence of the mezzanine tranche allows the reduction of the nominal value of the junior tranche, which may be too large to be placed with those investors who require high rates of return. In particular, the 20 percent mezzanine tranche would have risk characteristics similar to sovereign bonds with BBB- or higher rating for Standard and Poor's, or with Baa3 rating or higher for Moody's. The remaining 10 percent of junior SBBS would be riskier, with expected losses equal to those of sovereign bonds with the worst credit ratings in the euro area, and thus offset by a higher rate of return.

One might worry that the safety of the senior tranche comes at the expense of a very risky junior tranche that no investor wants to buy. The Euro-nomics group argues that the worry is fundamentally misguided, indeed investors who hold sovereign bonds would have no reason not to hold synthetic securities backed by these bonds. The EJBies would be desirable to investors seeking to leverage their exposure to sovereign risk because, unlike a portfolio of sovereign bonds, they provide embedded leverage that is fixed over time. Besides, the authors suggest to sub-tranche or repackage the EJB component in ways that make them more attractive to investors with different risk preferences. They advise to sub-tranche the junior tranche into a first-loss equity tranche and a mezzanine tranche, just as envisioned by the High-Level Task Force of the ESRB. Risk-averse investors, like insurance companies and pension funds, would desire the mezzanine bond. On the other hand, investors specialized in high-yield debt, such as hedge funds would be attracted to the equity tranche.

As already mentioned, regulatory reform which entails assigning capital charges as a function of risk to government debt is necessary. SBBSs would preclude a regulatory-driven flight to safety from the periphery to the core nation-states, as banks could satisfy liquidity requirements by holding risk-weighted ESBies, backed by all countries' bonds. In this regard, policymakers should also define the treatment of the SBBSs' tranches, i.e. of the ESBies and EJBies. Under current regulation, their creation is stymied. They would be treated as securitizations, thereby attracting a harsh treatment relative to that of sovereign bonds. To overcome this regulatory roadblock, regulatory reform should define ESBies as quasi safe-sovereign debt to reflect their safety. On the other hand, it should treat EJBies as risky securities. Otherwise, banks would be able to arbitrage regulation by holding EJBies rather than ESBies or government bonds, and the sovereign-bank doom loop would not break.

Following Brunnermeier et al. (2017), an official Handbook would define the guidelines according to which authorized issuers should create the securities. These guidelines include the definition of the subordination level and underlying portfolio composition, as well as the institution licensed to issue them. The securities thus created will be assigned a license number that certificates them as legitimate SBBSs. This process would ensure homogeneity and transparency in the different SBBSs issued and would convey confidence to investors.
More precisely, as already mentioned, the subordination level should be set at 30 percent and weights could be derived from relative GDP or the ECB's capital key. The SBBS Handbook also includes the "market access criterion", according to which a country that loses primary

market access should be excluded from the new issues of SBBSs. Indeed, SBBSs issuers purchase government debts at market prices, then price discovery of national sovereign bonds is required. When a country loses market access, there is no liquid market for its debt and it would be difficult to establish the right market price. In the absence of such prices, purchases cannot happen. Moreover, the inclusion in the diversified portfolio of a country without market access makes it difficult to sell junior bonds. Exclusion of central government bonds without active secondary market access also reinforces fiscal discipline. However, for the SBBSs' benefits to be maximized, all the other euro-area countries should be included in the portfolio underlying the SBBSs.
The entities authorized to issue the SBBSs should also be defined in the official Handbook. Brunnermeier et al. point out that the most likely candidates could be either the securitization vehicles of private financial institutions, such as large banks or asset managers, or a public institution, such as the European Stability Mechanism (ESM), or even a combination of the two. As regards the SBBSs issuance, at first SBBSs could be limited to allow market participants to learn about the new securities and contracts' details to be refined. Then, the issuance could be gradually incremented. In particular, after the limited issuance in the early years, the authors suggest deepening the market for ESBies by arranging a centralized auction mechanism, whereby investors submit a price schedule for sovereign bonds, ESBies, and EJBies. After the auction, SBBSs' issuers would have the diversified portfolio of sovereign bonds, banks would hold ESBies, and the other market participants would acquire primarily EJBies. When the market for ESBies achieves a critical mass, the new regulatory reform could be introduced gradually, allowing banks to comply within a transition period. Moreover, the ECB could promote the growth of the European Safe Bonds market, either by announcing that it would accept ESBies as collateral in monetary policy operations or by using senior bonds as its preferred security for open market operations or quantitative easing.

The SBBSs design would break the vicious link between banks and their sovereign and would ensure that flight-to-safety capital flows would no longer occur across national boundaries, but rather across the two tranches produced by securitization, i.e. from EJBies to ESBies. Moreover, this proposal does not imply any joint liability by the euro-area Member States. Hence, there would be no substantial political obstacle to the creation of SBBSs, and no changes to European Treaties are required. Finally, as pointed out by Brunnermeier et al. (2011), the new regulatory reform favoring ESBies would come naturally in a fast-tracked revision of the Basel standards.

3.7 European safe assets proposals similar to ESBies

3.7.1 Synthetic Eurobonds, by Beck, Wagner, and Uhlig

Beck, Wagner, and Uhlig (2011) proposed the creation of synthetic European safe assets similar to Brunnermeier et al.'s (2011) ESBies, just before the latter proposal was published.

The authors envision the creation of a European debt mutual fund, which holds a diversified portfolio of sovereign bonds based on ECB capital key or GDP weights. This fund is entrusted to issue synthetic Eurobonds whose payoffs are the joint payoffs of the bonds in its portfolio. Such a security is not completely risk-free, any default in one of the underlying bonds would lead to a loss. However, the beneficial effects of diversification would make a drastic reduction in payments unlikely. Indeed, sovereign exposure would be less concentrated compared to the portfolios of government bonds held by most euro area banks today, and the synthetic Eurobond would be safer than the portfolios held by many banks. Moreover, such security would ensure the respect of the no-bailout clause in the European Treaty, without requiring any other type of guarantee. This is in effect a single-tranche SBBS, which entails pure diversification without tranching. However, it is important to emphasize here that my simulations in Chapter 4 show that tranching is critical to ESBies' safety, just as demonstrated by Brunnermeier et al. (2017).

3.7.2 Structured Eurobonds, by Hild, Herz, and Bauer

Hild, Herz, and Bauer (2014) propose to use asset-backed security (ABS) structure to implement a structured Eurobond. An independent Special Purpose Vehicle (SPV) buys a portfolio of euro-area sovereign bonds and issues Eurobonds with several subordinated tranches. So, instead of issuing one bond with a given risk, rating, and yield, the SPV issues different tranches with different priorities, creditworthiness, and thickness. Investors could buy these securities according to their risk preferences. The role of the SPV could be taken over by an existing independent institution such as the ESM or a newly created entity.

To increase the stability and the credibility of the structure, in addition to pooling and tranching, the authors propose a third layer of protection for the structured Eurobonds, a trust fund. Participating countries transfer 10 percent of the credit sum to the trust fund, which thereby constitutes their maximum loss. The trust fund collateralizes the structure, by covering initial losses in case of a country default before the lowest rating tranche is affected. As long as the amount transferred to the trust fund is sufficient to cover the losses, a default does not affect the investors. However, as soon as investors' claims exceed the available funds, market participants suffer financial losses. Notice that subordinated tranches receive cash flows only after the senior tranche is fully served.

By pooling euro area Member States' government bonds, tranching the new product, and introducing the trust fund, the structured Eurobonds' credit quality increases above that of the underlying portfolio of sovereign bonds. The authors' simulations show that all euro area Member States could benefit from the new product, by getting cheaper access to the capital markets compared to the current situation of national borrowing. The EU participating countries are only partially liable via the trust fund.[5]

By limiting liability, Hild et al.'s approach may be easily implemented and legally practicable, as no changes to the European Treaties are required.

3.7.3 Safe Market Bonds, by Garicano and Reichlin

Garicano and Reichlin (2014) propose to create a euro-area sovereign safe asset through securitization, as Brunnermeier et al. (2011, 2017) have proposed. However, they prefer a private sector initiative to create synthetic European safe assets. Differently from Brunnermeier et al.'s proposal, no European Debt Agency or any other intermediary needs to be involved.[6]

The ECB could lead the markets to create a synthetic risk-free asset by regulatory intervention. In particular, the authors suggest that the ECB announces that it will purchase for its operations exclusively "Safe Market Bonds", where the Safe Market Bonds would be the senior 60 percent tranche of a synthetic bond formed of euro area countries debt, in fixed proportions to their GDPs. Moreover, the ECB and the Single Supervisory Mechanism (SSM) would announce that only the senior tranche of the synthetic bond produced, i.e. only the Safe Market Bonds, could be counted as risk-free for the risk weighting and liquidity coverage ratio calculations.

The ECB should assign risk weights to each euro area country sovereign debt. The risk weights would be assigned according to each country's fiscal position and a debt sustainability exercise. Then, as pointed out by Corsetti et al. (2016), the ECB should set up a registration scheme to encourage the private sector to create the synthetic bond backed by a portfolio of risk-weighted sovereign bonds issued by euro area countries. Under the scheme, sovereign debt-backed synthetic bonds could be divided into tranches with different credit risk characteristics. As already mentioned, only the most senior tranche, i.e. Safe Market Bonds, would attract a zero

[5] This is one of the differences with the ESBies proposal by Brunnermeier et al. (2017), which does not include any joint liability. The other difference is that the Euro-nomics group only envisages two tranches in its proposal, while Hild et al. (2014) allow for several tranches with different ratings.

[6] For a similar proposal see also Corsetti et al. (2015, 2016).

risk weight, while the others would attract more. Finally, a small ECB office would verify the compliance of the senior synthetic bonds and would declare them as “conforming Euro-Safe Bonds” when they fulfill the indicated characteristics.
The Safe Market Bonds would not involve any risk sharing among different governments or any debt mutualization. Each euro area government would continue to issue its debt and face its interest rates in the market, and the junior tranches would reflect default risk.

3.8 Coronabonds, by Chancel

Several proposals for special Eurobonds, called “Coronabonds” or “COVID-bonds”, have emerged since the beginning of the crisis caused by the global pandemic. In this section, the approach proposed by Chancel is analyzed.[7]
Chancel (2020) explores the rationale and the way forward for a small group of European countries, such as France, Italy, Spain, and Belgium, to group together and issue common debt, Coronabonds, even without the support of all euro area Member States. Indeed, the proposal envisages the possibility that any country willing to join the group can participate, including Germany and the Netherlands, but it could work effectively even without the support of these countries, which have proven to be the most critical of the establishment of Coronabonds.
A new European Solidarity Treasury Agency is established by the participating countries, in charge of issuing a new debt called “Coronabonds-1”. The debt emitted would represent around 5 percent of participating euro area countries’ GDP in 2020, which would be equal to around €250 billion if only France, Italy, Spain, and Belgium participate.
In the first version of the proposal, related to the current emergency, participating countries mutualize interest rates on the new debt. The result is that countries continue to repay the debt they contract, but without facing exorbitant borrowing costs if the market bets against them. The agreement is limited to new debt issued to face the pandemic. However, it can be subsequently revised with an agreement between the parties to gradually mutualize the interest rate in the entire debt stock. Debt mutualization would have positive impacts on yields and has the potential to do away with the rising spreads between Southern and Northern European countries.
Finally, the author proposes a debt repayment scheme via a novel European Solidarity Tax on Multinational Corporate Profits which could reimburse the debt issued in 2020 in 4-5 years.

[7] For other proposals see e.g. Boitani and Tamborini (2020).

This tax would be justified by the fact that the euro area countries are largely intervening in their economies to support businesses. Therefore, it is legitimate that, in turn, corporate actors contribute to the financing of Member States expenses. The corporate tax would affect all euro area countries, therefore also those countries that do not want to issue Coronabonds by participating in the initiative. Non-participating countries' tax revenues would accrue to participating Member States. For this reason, the European Solidarity Tax on Multinational Corporate profits would represent a political and economic incentive for non-participating countries to join the program.

Chancel (2020) points out that the EU Treaties do not prevent countries neither from establishing the European Solidarity Treasury Agency nor from pooling their debt, even absent the support of all Eurozone countries.

In this chapter, I described the most relevant proposals for a safe sovereign asset which are likely to reinforce the financial market and its stability, give some relief to the weak euro area economy, and strengthen the EMU architecture. In the following chapter, I will perform empirical analysis to demonstrate that a union-wide safe asset, in the ESBies form, could be effectively beneficial for all euro area Member States and their banks.

4. Empirical analysis

The European Safe Bonds (ESBies) could benefit financial stability by breaking the negative feedback loops between euro-area sovereigns and their domestic banking sector. To assess the ESBies intended benefits, in this chapter I will evaluate and measure the credit risk of this type of instrument with Monte Carlo simulations. In particular, I will compare three security designs. First, the status quo where sovereign bonds are neither pooled in a single portfolio nor tranched for safety. Second, pure pooling, in which sovereign bonds are pooled across nation-states, with weights corresponding to euro-area countries' relative GDPs over 2003-2018. In conclusion, pooling and tranching, where the diversified portfolio of euro-area sovereign bonds is tranched into a senior component (ESBies) and a junior component (EJBies) with a given subordination level. In the analysis, I examined the ESBies at a subordination level of 30% – so that the junior bond represent 30%, and the senior bond 70% of the underlying face value – as suggested by Brunnermeier et al. (2017) and by the European Systematic Risk Board report (2018). In other words, the EJBies would absorb the first 30% of losses. The size of the junior tranche is a key policy variable since it affects the senior bond's safety and the volume of safe assets generated. A subordination level of 30% is a reasonable middle ground between minimizing expected loss rates and maximizing safe asset supply. At this level, ESBies are slightly safer than the untranched German Bund, and the safe asset multiplier is maximized. Moreover, in the analysis it is assumed that banks hold only the senior component of the diversified portfolio of euro-area sovereign bonds, otherwise the beneficial effect of tranching fades away.
The scope of this chapter is to determine whether the introduction of a well-designed common safe asset into EU banks' balance sheets, in the ESBies form, is capable of de-risking banks' sovereign portfolios and, as a consequence, of mitigating the risk transmission mechanism in place between sovereigns and banks.

4.1 Credit risk and Vasicek single factor model

Credit risk is the risk of losses due to credit events, i.e. resulting from a borrower's failure to repay its debt (default) or from a downgrade of the credit rating assigned to an issuer or counterparty (Bindseil et al., 2007). Measurement of credit risk is based on three fundamental parameters: Probability of Default (PD), Loss Given Default (LGD), Exposure at Default (EAD). Firstly, the probability of default (PD) expresses the likelihood that the counterparty will default on its obligation either over the life of the obligation or over some specified horizon. Secondly, loss given default (LGD) returns the fraction of the exposure that may not be recovered in the case of default, which is: $1 - Recovery\ Rate$. Finally, the exposure at default (EAD) represents the amount that a bank is exposed to at the time of default of the obligor.

To see whether and how the safety properties of the three security designs differ, one needs to compare the distribution of potential losses under each approach, particularly in the risk tail. In general, credit losses are characterized by a large probability of small gains and, on the other hand, a low probability of high losses which generate a fat-tailed and skewed distribution of credit losses. A standard measure to describe this distribution is the Value at Risk (VaR). The VaR is defined as the maximum amount expected to be lost over a given time horizon, at a pre-defined confidence level. In other words, the VaR at probability α describes the maximum loss occurring with probability α or higher. Since small losses are more likely than large losses, the VaR declines as the threshold probability increases. Even though VaR is widely used as a risk indicator, there is also criticism in its use. One of the biggest drawbacks of VaR is that it does not consider losses occurring with probabilities lower than α. When the tail distribution looks normal, VaR should give a good picture of the risk. However, it can create a false sense of security when there is a big possibility of loss much higher than the VaR level. For this reason, I decided to consider an additional risk measure, the Expected Shortfall (ES). The ES calculates the average of all losses exceeding the VaR level, thus taking into consideration the high probability losses, if any, in the tails. By construction, the ES is always larger (or at most equal) than the VaR.

As can be noted, two parameters are relevant for the calculation of the VaR and the ES: the time horizon and the confidence level. Indeed, if these parameters vary, the corresponding values of the VaR and the ES also vary. The confidence level and the time horizon used in the analysis correspond to those imposed by the Basel framework for credit risk, 99.9%, and one year respectively.

The risk in a portfolio depends not only on the risk in each element of the portfolio but also on the dependence between these sources of risk. Vasicek's (2002) model has been used to derive the loss distribution functions of EU banks' portfolios. The remaining of this section aims to describe the derivation of Vasicek's single factor limiting loss distribution and its underlying assumption, to properly understand the steps of the analysis I conducted.

In the banking industry, portfolio models of credit risk are mostly based on the conditional independence framework. According to these models, defaults of individual borrowers rest on a set of common systematic risk factors describing the general economic conditions.
Using a conditional independence framework, Vasicek (2002) derives a limiting distribution of portfolio losses with a systematic risk factor, which is the basis of Basel's risk-weighted assets formula. According to Vasicek, the portfolio loss distribution has several important applications, including the measurement of portfolio risk and the measurement of the capital necessary to support a loan portfolio.[8]
The individual loss due to the obligor i is given by the product of the Exposure at Default (EAD), the Loss Given Default (LGD), and a Bernoulli random variable D_i that takes the value of one if the obligor default and zero otherwise:

$$L_i = EAD_i \times LGD_i \times D_i$$

This specification implicitly assumes that EAD_i and LGD_i are time-invariant for each obligor. Considering a portfolio consisting of n loans and denoting the portfolio loss rate by L, it follows that:

$$L = \frac{\sum_{i=1}^{n} L_i}{\sum_{i=1}^{n} EAD_i} = \sum_{i=1}^{n} w_i \times LGD_i \times D_i \qquad (1)$$

where w_i represents the portfolio weight of the ith loan ($w_i = \frac{EAD_i}{\sum_{i=1}^{n} EAD_i}$).
Assume that the size of EAD_i and LGD_i are the same for all obligors, and, let $LGD_i = 1$. Then, the portfolio loss rate can be written as follows:

$$L = \frac{\sum_{i=1}^{n} D_i}{n}$$

[8] The portfolio loss distribution, which is used in this paper for the calculation of the Value at Risk (VaR) and the Expected Shortfall (ES), according to Vasicek (2002), can also be used in regulatory reporting, portfolio optimization, as well as structuring and pricing debt portfolio derivatives such as collateralized debt obligations (CDOs).

The return of each asset in the portfolio is determined by the following equation:

$$X_i = Y\sqrt{\rho} + Z_i\sqrt{1-\rho} \qquad (2)$$

where $Y, Z_1, Z_2, \dots, Z_n$ are identically and independently distributed standard normal variables. The variable Y can be interpreted as a portfolio systematic or common factor that drives the correlations between assets, while Z_i variables are asset-specific or idiosyncratic risk factors. The terms $Y\sqrt{\rho}$ and $Z_i\sqrt{1-\rho}$ represent the exposure to the common and to the idiosyncratic risk factors respectively. Note that the asset returns are jointly standard normal with equal pairwise correlations ρ.

Vasicek assumes that the credit portfolio is characterized by a large number of relatively low exposures. If this assumption holds, the asset-specific idiosyncratic risk factor will cancel out and only the systematic risk factor will affect the portfolio value and loss rate.

Following Merton's approach (1974), Vasicek assumes that the *i*th obligor defaults if the value of its assets, A_i, at loan maturity T, falls below the contractual value, B_i. Assuming that all obligors have the same probability of default (PD), it follows that:

$$D_i = \begin{cases} 1, & X_i < \Phi^{-1}(PD) \\ 0, & otherwise \end{cases} \qquad (3)$$

where $\Phi(.)$ is the cumulative normal distribution function. The value corresponding to $\Phi^{-1}(PD)$ can be defined as the "point of default". Indeed, when the return of the asset i is lower than $\Phi^{-1}(PD)$, D_i takes the value of one, which means that the obligor default.

D_i depends on the common factor Y that affects the asset returns Xi as follows:

$$\begin{aligned} p(y) &= \\ &= \mathrm{P}\,(D_i = 1 | Y = y) \\ &= \mathrm{P}\,(Xi < \Phi^{-1}(PD) | Y = y) \\ &= \mathrm{P}(\sqrt{\rho}\,Y + \sqrt{1-\rho}\,Z_i < \Phi^{-1}(PD) | Y = y) \\ &= \mathrm{P}\left(Z_i < \frac{\Phi^{-1}(PD) - Y\sqrt{\rho}}{\sqrt{1-\rho}} \lceil Y = y\right) \\ &= \Phi\left(\frac{\Phi^{-1}(PD) - y\sqrt{\rho}}{\sqrt{1-\rho}}\right) \end{aligned}$$

which is the probability of default conditional on the value of Y. When the common factor is fixed, the conditional probability of loss on anyone loan is:

$$p(Y) = \mathrm{P}[D_i = 1|Y] = \Phi\left(\frac{\Phi^{-1}(PD) - Y\sqrt{\rho}}{\sqrt{1-\rho}}\right)$$

The quantity p(Y) provides the loan default probability under the given scenario. The unconditional default probability (PD) is the average of the conditional probabilities over the scenarios.

Vasicek shows that the portfolio loss conditional on Y converges, by the law of large numbers, to its expectation p(Y) as $n \rightarrow \infty$. This means that, if the portfolio is large, by the law of large numbers, the fraction of obligors that default is equal to the individual default probability. Then, the cumulative distribution function of loan losses on a very large portfolio is in the limit:

$$F(x; PD, \rho) = \mathrm{P}(L \leq x) = \Phi\left[\frac{\sqrt{1-\rho}\,\Phi^{-1}(x) - \Phi^{-1}(PD)}{\sqrt{\rho}}\right]$$

So, the portfolio loss is described by the probability of default (PD) and the asset correlation (ρ).[9]

In the summary of his paper, Vasicek reports the results of Monte Carlo simulations of an actual bank portfolio and shows that the limiting probability distribution of portfolio losses, derived under the assumption that all loans in the portfolio have the same maturity, the same probability of default, and the same pairwise correlation of the borrower assets, provides a reasonably good fit to the tail of the loss distribution also for more general portfolios.

In the next section, I will present in detail how the distribution of EU banks' portfolios credit losses was derived, aiming at measuring each portfolio's credit risk, and so how my analysis was conducted.

[9] The convergence of the portfolio loss distribution to the limiting form holds even for portfolios with unequal weights. Let the portfolio weights be $w_{1,} w_2, \ldots., w_n$ with $\sum w_i = 1$. The portfolio loss: $L = \sum_{i=1}^{n} w_i L_i$ conditional on Y converges to its expectation p(Y) whenever (necessary and sufficient condition): $\sum_{i=1}^{n} w_i^2 \rightarrow 0$. In other words, if the portfolio contains a sufficiently large number of loans without it being dominated by a few loans much larger than the rest, the limiting distribution provides a good approximation for the portfolio loss.

4.2 Research method

The one-year portfolio credit loss distribution is generated via a Monte Carlo simulation, based on Vasicek's (2002) single-factor model, following the study conducted by Touvras (2019). Then, I used the distribution of portfolio credit losses to measure and conduct analysis on the Value at Risk (VaR) and the Expected Shortfall (ES) of EU banks.

The Monte Carlo approach allowed me to overcome drawbacks related to the scarcity of data over risk factors returns. Indeed, with the aid of Monte Carlo simulations, once the risk factors influencing the position are identified, it is possible to generate a high number of scenarios of the variables to be estimated, without having timely data about their returns. The generic knowledge of the distribution of risk factors returns is necessary and sufficient. As the scenarios generated increase, the accuracy of the estimate increases as well because it increases the probability that the expected value of the generated distribution coincides with the "actual" or "real" distribution. However, as the values simulated increase, the complexity of the simulation, and the difficulty of managing the operations conducted on these numbers increase as well. This implies that, when choosing the number of scenarios, it is necessary to select a number of values that makes the estimate reliable, without thereby affecting the accuracy of the operations carried out. My simulation uses a total of 20,000 draws. According to the sensitivity study conducted by Andersson et al. (2000) concerning the number of scenarios, 20,000 scenarios are sufficient to estimate VaR and ES with sufficient precision.

After generating the pseudo-random values that each risk factor assumes in each draw, the value of the individual positions can be calculated for every scenario j (j = 1,2,…,n). More precisely, knowing that the risk factors that influence the value of bank portfolio assets follow the standard normal distribution, I generated a vector Y_i for the systematic risk factor and a matrix $Z_{j,i}$ for the idiosyncratic risk. The systematic risk, Y, is common to all assets, so it will differ for each scenario j, but it will be equal for all assets i in every scenario j. Differently, the idiosyncratic risk will be different for all assets i in every scenario j. Then, following equation (2) presented in the previous section, the matrix $X_{j,i}$ was generated. $X_{j,i}$ gives the returns of all assets i for every scenario j.

After calculating the value of each asset for each generated scenario, it is necessary to calculate the losses incurred by each position. Following Vasicek (2002), losses result only from an obligor's failure to repay its debt, so due to default, and not from a downgrade in the quality of the credit. Since I know that the asset returns are jointly standard normal, and I have the

probabilities of default of each asset i, the point where each asset defaults can be determined. In particular, obligor i default, that is $D_i = 1$, when $X_{j,i} < \Phi^{-1}(PD_i)$.
Therefore, when the default incident occurs, losses of each asset i for every scenario j are given by:

$$L_{j,i} = EAD_i \times LGD_i \times D_i$$
$$L_{j,i} = EAD_i \times LGD_i$$

Finally, following equation (1) presented in the analysis of the Vasicek's (2002) model, the portfolio loss rate, for each scenario j, is given by the sum of losses occurred from all assets in the portfolio, where each asset is multiplied by its portfolio weight (w_i). The histogram of the L vector thus generated returns the distribution of portfolio losses.
To measure the Value at Risk and the Expected Shortfall, the L vector can be sorted in increasing order, from the lowest to the highest loss. Then, to calculate the VaR, it is sufficient to "cut" the distribution at the chosen confidence level. For example, in the case of 20,000 scenarios generated, and assuming a confidence level equals to 99.9%, as imposed by the Basel framework, the 99.9% VaR would be the twentieth worst result. Instead, for the computation of the ES, it is necessary to calculate the average of the losses exceeding the VaR level.

The analysis of EU banks' portfolios credit risk required some simplifications. In particular, I considered a simplified version of bank's assets, characterized by a large number of small size loans, specifically five hundred loans, and a small number of high size government bonds, five different types of government bonds distinct by rating. By changing the summed exposure to government bonds from 15% to 50%, and so the summed exposure to loans from 85% to 50%, I examined the effect of changing exposure to government bonds on the Value at Risk (VaR) and Expected Shortfall (ES).

Using the above method, I compared three security designs: the status quo, pure pooling, pooling and tranching (ESBies). I conducted the analysis considering two states of the economy: a Benchmark Calibration, and an Adverse Calibration. In the Benchmark Calibration, I selected the parameters such that the annual default probabilities were consistent with market prices. To check the sensitivity of these results to parameter uncertainty I subjected the study to an Adverse Scenario, thus adopting a pessimistic approach. Besides, I tested how ESBies would perform relative to the other security designs when subordination levels other than 30% are considered.

4.3 Data Estimation

4.3.1 Loss Given Default (LGD)

Assumptions on Loss Given Default are crucial inputs to the credit risk evaluation. Indeed, it is one of the fundamental parameters, together with the Probability of Default and the Exposure at Default, needed to measure credit risk. However, sovereign defaults are rare events, implying considerable uncertainty regarding true LGD rates. In line with the market convention for LDGs when pricing sovereign CDS contracts, in my analysis LGDs are set equal to 60%. This choice allowed me to be appropriately conservative without being unreasonably large. Indeed, empirical evidence shows that the LGD tends to be well below 60%, and even under most distressful economic, financial, and fiscal conditions, it is estimated to have been approximately 65%.[10]

4.3.2 Credit ratings, government bonds probabilities of default and weights for the pooled portfolio of government bonds

Credit ratings

For the analysis purpose, the euro-area countries are classified according to their rating class. In particular, the credit rating class assigned to each euro-area country reflects the "prevailing" rating assigned to them by the most influential rating agencies, i.e. S&P, Moody's, and Fitch, from the 2008 financial crisis to the present day. I built five credit rating classes and assigned each class a number from 1 to 5, where 1 represents the safest and 5 the riskiest class. In Table 2 the number attached to each credit rating class is indicated, while columns 1 and 2 of Table 3 show, for each EU country, the corresponding credit rating value.

[10] Further information: Giudice et al. (2019), pg. 16-18.

Table 2. Credit rating classes and Credit rating values.

Credit rating class	Credit rating value
AAA	1
AA+ to AA-	2
A+ to A-	3
BBB+ to BBB-	4
BB+ to B-	5

Government bonds probabilities of default

Data on 5-year sovereign CDS spreads and the probability of default assigned to each credit rating class by S&P was collected to infer sovereigns' probabilities of default over a 1-year horizon from CDS spreads.

More precisely, data reported by Giudice et al. (2019) are used for sovereign CDS spreads (Column 3 of Table 3). Sample dates range from 2001 to 2006 and run until November 2018.[11] Assuming a constant LGD rate of 60%, and therefore a recovery rate of 40%, I inferred sovereign PDs from CDS spreads. Then, the probabilities of default of sovereigns with rating value 1 are summed and are divided by the number of countries belonging to class 1 to obtain the average PDs by rating value. This procedure is repeated for each category, that is to say, rating 2, 3, 4, and 5. However, the values thus obtained, reflect a 5-year default probability (Column 4 of Table 3). Since my study aims to measure one-year portfolio credit risk, I converted the 5-years probabilities of default into 1-year probabilities of default. To do that, I made an approximation using the probabilities of default, at one and five years, assigned to each credit rating class by S&P. First, I converted each rating class to its credit rating value (as described in the previous section). Secondly, I calculated the average PDs by rating category. This procedure was adopted to compute the average PDs by rating at both one and five years, using S&P data. Then, I calculated the PDs at one year implied by CDS spreads using the following approximation:

$$5years\ PD\ by\ CDS\ Spreads : 5years\ PD\ by\ S\&P = x : 1year\ PD\ by\ S\&P$$

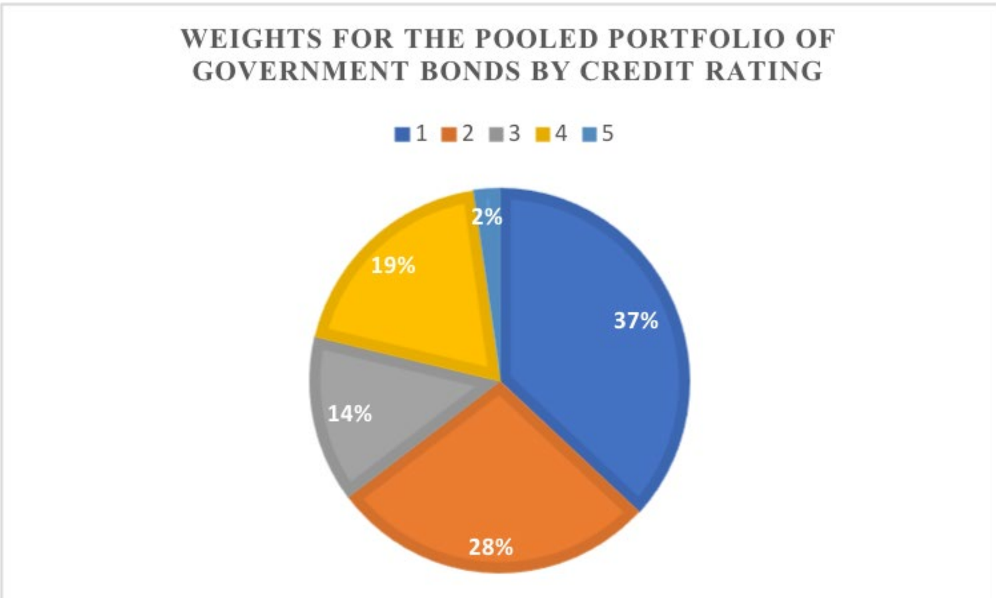
[11] Further information: Giudice et al. (2019), pg. 16.

where x returns the PDs at one year implied by CDS spreads. Approximations thus obtained are reported in Column 5 of Table 3. These annual default probabilities, consistent with market prices (i.e. CDS), are used to analyze the Benchmark Scenario. The probabilities of default used for the Adverse Scenario, are the 1-year PDs increased by 1000% (Column 6 of Table 3).

Weights for the pooled portfolio of government bonds

The weights values used to create the pooled portfolio of euro-area sovereign bonds correspond to euro-area countries' relative GDPs over 2003-2018. Historical GDP series by country were collected from the World Bank Data.[12] The calculated weights values are reproduced in the last column of Table 3. Figure 5 represents the weights for the pooled portfolio of government bonds by credit rating. Euro-area sovereign bonds with rating 1 represent 37% of the diversified portfolio. Those rated 2, 3, 4, and 5 represent the 28%, 14%, 19%, and 2%, respectively.

Figure 5. Weights for the pooled portfolio of government bonds by credit rating.



Notes: AAA = 1; AA+ to AA- = 2; A+ to A- = 3; BBB+ to BBB- = 4; BB+ to B- = 5.

[12] https://data.worldbank.org/

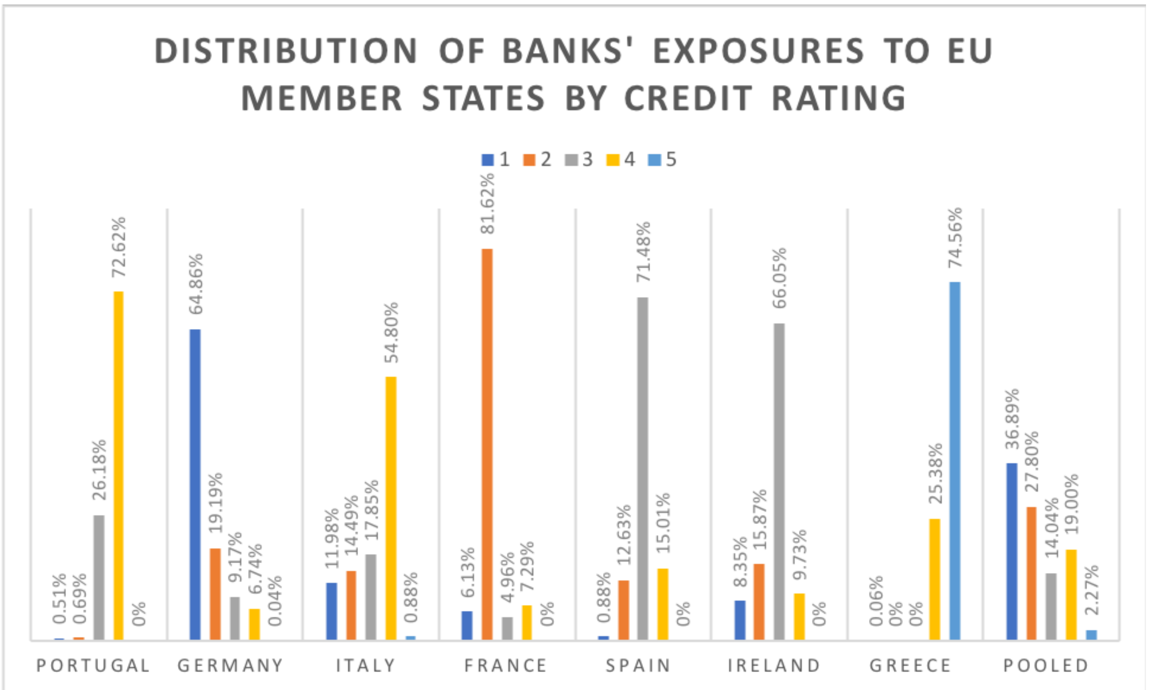
Table 3. EU countries by credit rating, CDS spreads, probabilities of default and pooled portfolio weights.

EU countries	Credit rating values	Average sovereign CDS spreads	5-year PDs by CDS spreads	1-year PDs (Benchmark Scenario)	1-year PDs (Adverse Scenario)	Pooled portfolio weights
Germany	1	0.23%	0.45%	0.01%	0.13%	27.85%
Netherlands	1	0.32%	0.45%	0.01%	0.13%	6.61%
Luxemburg	1	0.32%	0.45%	0.01%	0.13%	0.43%
Finland	1	0.21%	0.45%	0.01%	0.13%	2.00%
Austria	2	0.39%	0.72%	0.04%	0.42%	3.15%
France	2	0.41%	0.72%	0.04%	0.42%	20.85%
Belgium	2	0.49%	0.72%	0.04%	0.42%	3.80%
Estonia	3	1.07%	1.84%	0.22%	2.19%	0.17%
Slovakia	3	0.67%	1.84%	0.22%	2.19%	0.69%
Ireland	3	1.36%	1.84%	0.22%	2.19%	2.06%
Malta	3	1.30%	1.84%	0.22%	2.19%	0.08%
Slovenia	3	1.22%	1.84%	0.22%	2.19%	0.37%
Spain	3	0.99%	1.84%	0.22%	2.19%	10.68%
Lithuania	4	1.44%	2.73%	0.30%	3.02%	0.31%
Latvia	4	1.92%	2.73%	0.30%	3.02%	0.21%
Italy	4	1.14%	2.73%	0.30%	3.02%	16.68%
Portugal	4	2.06%	2.73%	0.30%	3.02%	1.80%
Cyprus	5	5.08%	14.01%	5.34%	53.39%	0.18%
Greece	5	11.73%	14.01%	5.34%	53.39%	2.09%

4.3.3 Distribution of banks' exposures to EU Member States by credit rating

The analysis of EU banks' portfolios requires the distribution of banks' exposures to EU Member States by rating category to be known. The Annual Report 2018/19 of the German Council of Economic Experts reports data on the exposure of Portuguese, German, Italian, French, Spanish, Irish, and Greek banks to government bonds by credit rating. These are the EU countries on which the analysis focuses. The sovereign exposures of the EU banks examined are drawn in Figure 6. I also showed the composition of the pooled portfolio.

Figure 6. Distribution of Banks' Exposures to EU Member States by credit rating. *Sources*: German Council of Economic Experts (2018), own calculations.



Notes: AAA = 1; AA+ to AA- = 2; A+ to A- = 3; BBB+ to BBB- = 4; BB+ to B- = 5.

4.3.4 Probabilities of default of EU banks' loans

The simplified version of banks' assets is characterized by five hundred small size loans and five different types of government bonds already described. To analyze the credit risk of the EU banks portfolios, the probability of default of loans that banks in each country have in their portfolio has to be known. Since data over the probability of default of banks' loans are hard to come by, I considered it appropriate to use the Non-performing loans ratio of each country analyzed as a proxy of banks' loans PD. Indeed, NPL ratios are indicative of the overall performance of loans in each economy. Data obtained from the ECB Supervisory Banking Statistics (2019) for the fourth quarter of 2018 are shown in the following table:

Table 4. Non-performing loans (NPL) ratio. *Source*: European Central Bank (ECB) (2019).

	Portugal	Germany	Italy	France	Spain	Ireland	Greece
NPLs	12.21%	1.30%	8.26%	2.76%	3.74%	6.65%	41.24%

4.3.5 Confidence level, time horizon, rho, scenarios

To comply with the Basel framework, the confidence level and the time horizon are set to be 99.9% and one year, respectively. The correlation coefficient, ρ, takes a value of 20%. Besides, as already mentioned, the number of scenarios generated is equal to 20,000 for each variable to be estimated.

4.4 Results

The empirical analysis I conducted aims to determine whether the introduction of a well-designed common safe asset into EU banks' balance sheets, in the ESBies form, is capable of de-risking banks' sovereign portfolios. First, I will report in the following sections the results I obtained from the Benchmark Scenario. Secondly, as an additional control, I conducted again the whole analysis for the Adverse Scenario. The presentation of the results obtained for the robustness check will follow the outcomes obtained for the Benchmark Calibration. As will be shown, the overall result obtained for the Benchmark Scenario is comparable to the one arising under the robustness check. Moreover, I will report the outcomes about the test on how ESBies would perform relative to the other security designs when subordination levels other than 30% are considered, which will confirm the results obtained in the main analysis.

In a nutshell, the results of the empirical study are robust to changes in the model set up - in particular the data on government bonds probabilities of default, and the thickness of the junior tranche.

4.4.1 Benchmark Scenario

4.4.1.1 Status quo

In the status quo, sovereign bonds are neither pooled in a single portfolio nor tranched for safety. EU banks' portfolios are composed of 500 loans and 5 types of government bonds distinct by rating. First, the distribution of banks' exposures to the different types of sovereign bonds is collected from the 2018/19 Annual Report of the German Council of Economic Experts (Table 5). Secondly, I made an approximation to infer the 1-year government bonds probabilities of default from CDS spreads. Finally, each country's NPLs ratio is used as a proxy of banks' loan probability of default. Germany has the lowest level of NPLs equal to 1.30%, as opposed to Greece which has the highest amount of NPLs, which corresponds to 41.24%. Finally, France, Spain, Ireland, Italy, and Portugal have PD of loans at 2.76%, 3.74%, 6.65%, 8.26%, and 12.21%, respectively.

Table 5. Distribution of banks' exposures to EU Member States by credit rating. *Sources*: German Council of Economic Experts (2018), own calculations.

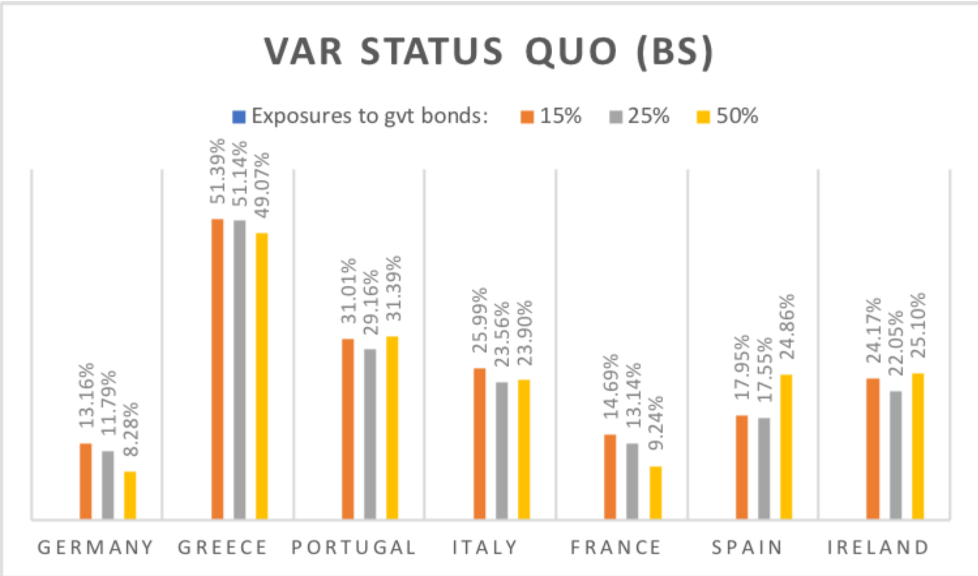
	Rating 1	Rating 2	Rating 3	Rating 4	Rating 5
Portugal	0.51%	0.69%	26.18%	72.62%	0%
Germany	64.86%	19.19%	9.17%	6.74%	0.04%
Italy	11.98%	14.49%	17.85%	54.80%	0.88%
France	6.13%	81.62%	4.96%	7.29%	0%
Spain	0.88%	12.63%	71.48%	15.01%	0%
Ireland	8.35%	15.87%	66.05%	9.73%	0%
Greece	0.06%	0%	0%	25.38%	74.56%
Pooled	36.89%	27.80%	14.04%	19.00%	2.27%

Notes: AAA = rating 1; AA+ to AA- = rating 2; A+ to A- = rating 3; BBB+ to BBB- = rating 4; BB+ to B- = rating 5.

I examined how the Portuguese, German, Italian, French, Spanish, Irish, and Greek banks' exposure to each type of government bonds affect the Value at Risk (VaR) and the Expected Shortfall (ES). This assessment has been performed by changing the summed exposure to government bonds from 15% to 50%, and so the summed exposure to loans from 85% to 50%. For example, looking at Italian banks, data in Table 5 show that the Italian banks' portfolio of government bonds consists of government bonds with rating 1, 2, 3, 4, and 5 respectively for 11.98%, 14.49%, 17.85%, 54.80%, and 0.88%. The sum of banks' exposures to the EU Member States by credit rating equals 100%. When I assume a summed exposure to government bonds of 50%, it means that government bonds with credit rating from 1 to 5 would have portfolio weights equal to 5.99% (i.e. 11.98% x 50%), 7.24%, 8.93%, 27.4%, and 0.44%, respectively. On the other hand, each loan's portfolio weight would be equal to 0.1%, i.e. (1/500) x 50%. The same reasoning can be applied to the different summed exposures to government bonds.

Looking at the results, Figure 7 depicts the VaR for each level of exposure to government bonds.

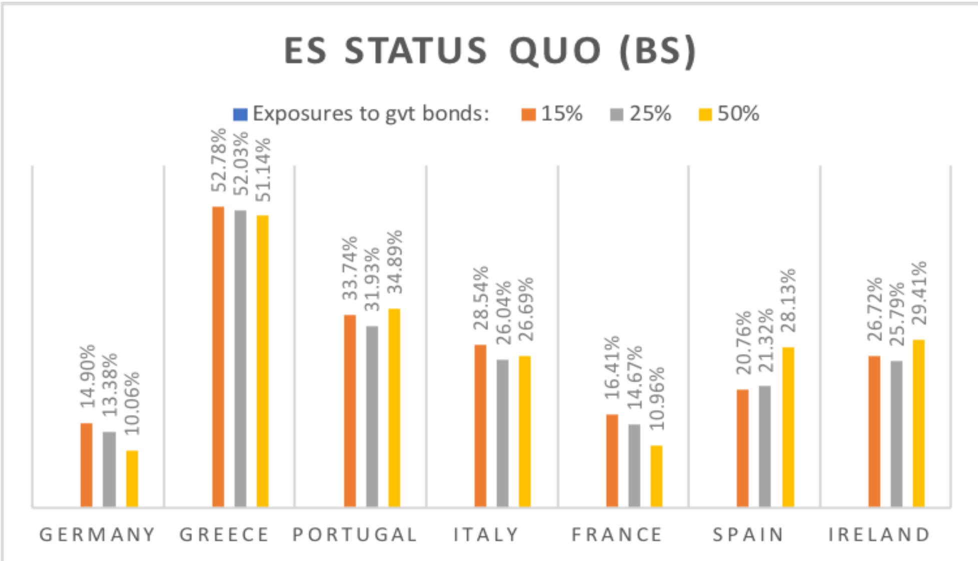
Figure 7. Value at Risk for countries' banks, status quo (BS). *Source*: own calculations.



As can be seen in Figure 7 the riskiest government bond composition is that of Greek and Portuguese banks. Italian, Irish and Spanish banks have lower levels of VaR, but still high compared to the safest government bond composition, that of French and German banks, with Germany be the safest. The increase of the summed exposure to government bonds in German and French banks significantly reduce their VaR. Indeed, when the total exposure to government bonds goes from 15% to 50%, the VaR of both countries banks decreases in percentage terms by about 60%. In particular, German banks' VaR drops from 13.16% to 8.28%, while that of French banks from 14.69% to 9.24%. These findings are justified by the fact that German and French banks hold predominantly safe sovereign bonds. In particular, the German banks' exposure to rating 1 and rating 2 government bonds is about 85%, and that of French banks equals 88%, that is to say, they have a safe government bonds composition (see Table 5). The increase of the summed exposure to sovereign bonds decreases VaR also for Greek banks since their bank loans have a huge default probability. However, in the case of Greece, the increased exposure has a low impact on the reduction of risk, about 5% when the summed exposure goes from 15% to 50%, since Greek banks' government bond composition is also very risky. In contrast, increasing the exposure to sovereign bonds in Portuguese, Italian, Spanish, and Irish banks has a different effect. At first, when the exposure passes from 15% to 25% the VaR decreases. Instead, increasing the exposure to 50%, the credit risk increases. Indeed, the banks' composition of government bonds in these countries is mainly concentrated in quite risky sovereign bonds, rating 3 and 4.

Concerning the other risk measure I examined, the Expected Shortfall (ES), the results are represented in the following figure:

Figure 8. Expected Shortfall for countries' banks, status quo (BS). *Source*: own calculations.



The overall result is equal to that presented for the VaR, except for Spain whose credit risk, when ES risk indicator is used, also increases when exposure to government bonds goes from 15% to 25%. By construction, values are higher when the risk is measured using the ES.

4.4.1.2 Pure Pooling

In the pure pooling security design, sovereign bonds are pooled across nation-states, with weights corresponding to euro-area countries' relative GDPs over 2003-2018 (Column 7 of Table 3 and Figure 5). This security design implies that banks in all countries have the same government bonds composition. Therefore, what differentiates the credit risk is the probability of default of banks' loans. I examined how Portuguese, German, Italian, French, Spanish, Irish, and Greek banks' exposure to each type of government bonds, in the diversified portfolio composition, affects the Value at Risk (VaR) and the Expected Shortfall (ES). As for the status quo analysis, I changed the summed exposure to the pooled portfolio from 15% to 50% to see the effect on credit risk. Figure 9 shows the level of VaR for each level of exposure to government bonds, while figure 10 depicts the ES.

Figure 9. Value at Risk for countries' banks, pure pooling (BS). *Source*: own calculations.

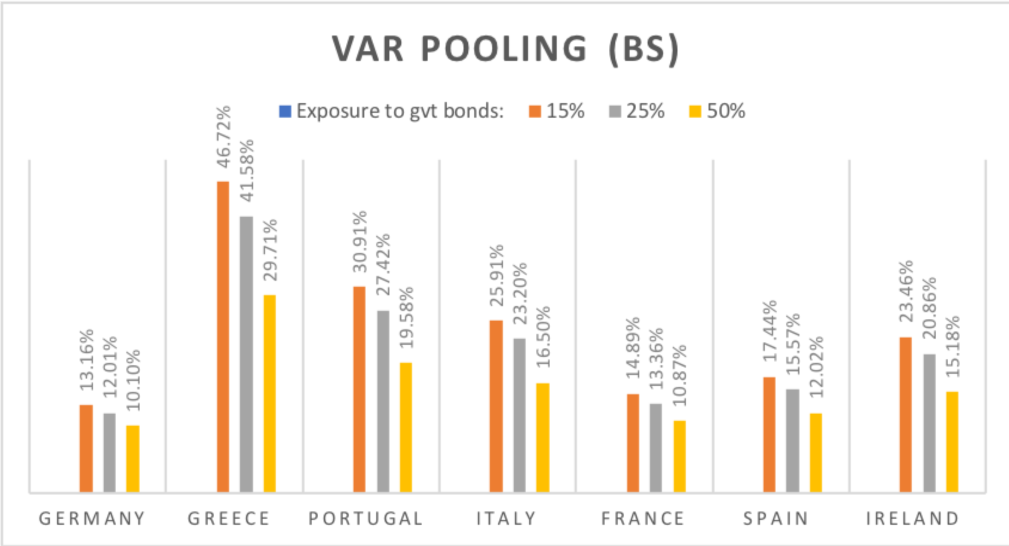
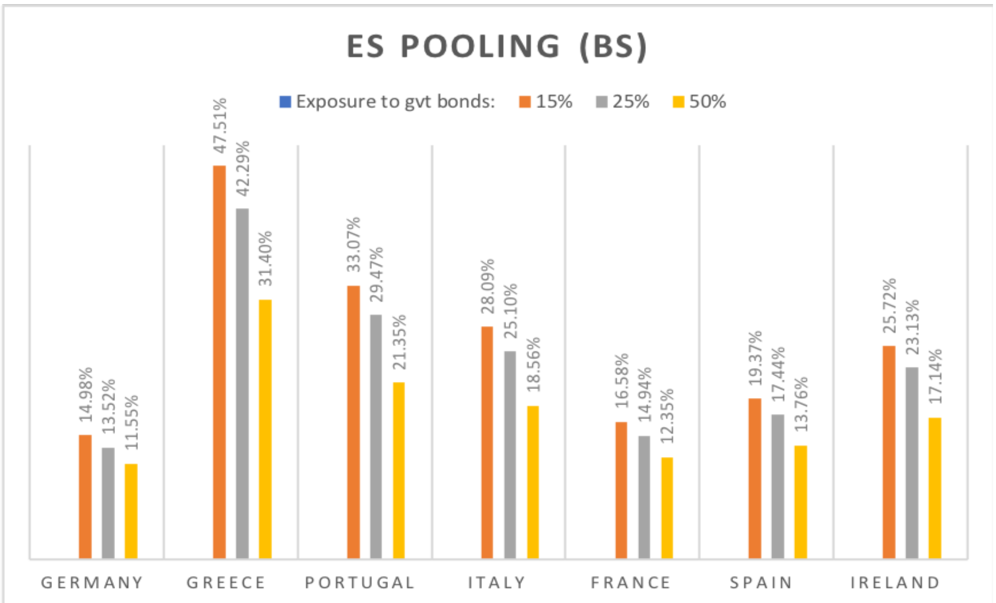


Figure 10. Expected Shortfall for countries' banks, pure pooling (BS). *Source*: own calculations.



Both results on Value at Risk and Expected Shortfall show that increased exposure to the pooled portfolio and credit risk are negatively related in all banks of the countries examined.

Again, as in the status quo, when the risk is measured using the ES as risk indicator, the values are higher. However, as can be seen by comparing the two graphs the difference between the %Var and the %ES is minimal. Therefore, it seems that the tails follow normal distribution so that there is no big possibility of loss much higher than the VaR level. In other words, the VaR seems to give a good picture of the examined banks' risk.

To check if the introduction of the pooled portfolio of government bonds into banks' balance sheets is beneficial for all countries, I compared the credit risk resulting from the analysis of the status quo with the one of the pure pooling. The results I obtained are shown in the following tables, Table 6 reports the % change in VaR from the pooled portfolio compared with the status quo, while Table 7 shows the % change in ES. A negative sign indicates that the pooled portfolio of government bonds leads to an increase in credit risk compared to the status quo. Conversely, a positive sign indicates that credit risk decreases.

Table 6. Change (%) in VaR from pooled portfolio compared with status quo. *Source*: own calculations.

Exposure	Germany	Greece	Portugal	Italy	France	Spain	Ireland
15%	0.00%	9.09%	0.33%	0.30%	-1.39%	2.84%	2.96%
25%	-1.83%	18.70%	5.97%	1.53%	-1.64%	11.28%	5.40%
50%	-21.99%	39.45%	37.61%	30.97%	-17.65%	51.65%	39.51%

Notes: (+) VaR reduction; (-) increase in VaR.

Table 7. Change (%) in ES from pooled portfolio compared with status quo. *Source*: own calculations.

Exposure	Germany	Greece	Portugal	Italy	France	Spain	Ireland
15%	-0.57%	9.99%	2.01%	1.55%	-1.09%	6.70%	3.76%
25%	-1.04%	18.71%	7.70%	3.60%	-1.85%	18.20%	10.31%
50%	-14.85%	38.61%	38.81%	30.46%	-12.62%	51.07%	41.72%

Notes: (+) ES reduction; (-) increase in ES.

In Greek, Portuguese, Italian, Spanish and Irish banks, increased exposure to the pooled portfolio of government bonds manages to reduce credit risk. Greek banks, which in the status quo had the riskiest government bond composition (about 75% in rating 5 sovereign bonds), show a quite high VaR and ES reduction, 9%, and 10% respectively, even at low exposure levels. By contrast, French and German banks, countries which in the status quo presented the safest government bond composition, experience an increase in their credit risk when a diversified portfolio of government bonds, with weights equal to euro-area countries' relative GDP, replace their government bonds composition. In other words, the pooled portfolio is not beneficial for these countries. In particular, German banks suffer an increase in the VaR level from 0% to 22%, depending on the level of summed exposure to the government bonds, and an increase in the ES from 0.6% to 15%. On the other hand, French banks experience an increase in the VaR from 1.4% to 17.7% and a growth in the ES from 1% to 13%.

4.4.1.3 Pooling and Tranching: Sovereign bond-backed securities (SBBS)

In the pooling and tranching security design, the previously analyzed diversified portfolio of euro-area sovereign bonds is tranched into a senior component (ESBies) and a junior component (EJBies) with a given subordination level. In this section, the ESBies are examined at a subordination level of 30%. In other words, the EJBies absorb the first 30% of losses. Later on in this paper, I will test the sensitivity of the results taking into account different "thicknesses" of the junior tranche: 10%, 20%, 40%.

It is assumed that banks hold only the senior tranche (ESBies), otherwise the beneficial effect of tranching fades away. Losses arising from sovereign defaults, i.e. losses incurred from government bonds, would first be borne by EJBies holders. Only if these losses exceed the subordination level, such that junior bonds are fully wiped out, ESBies begin to take any losses. In other words, ESBies are fully protected against an individual or multiple defaults by euro area Member States as long as aggregate losses in the underlying bond portfolio do not exceed the size of the subordinated SBBS tranches. Once this cushion is depleted, however, holders of ESBies bear the full cost of any further defaults.

As can be seen in Figure 11 and Figure 12, introducing ESBies to banks' balance sheets manages to reduce the credit risk of all analyzed countries' banks. For example, looking at the safest banks, the German ones, when the exposure to government bonds rises from 15% to 25%, their VaR drops from 13.16% to 11.61%, thus decreasing by around 12%. The reduction is even more evident when the total exposure rises from 15% to 50%. In this case, German banks' VaR drops from 13.16% to 7.74%, thus declining by around 41%. The same percentage reduction occurs when the ES is used as a risk measure. On the other hand, looking at the riskiest banks, i.e. the Greek banks, the overall result does not change. Indeed, when the exposure to government bonds rises from 15% to 25%, their VaR and ES decline by about 12%, while when the exposure goes from 15% to 50%, their VaR and ES drop by about 41%.

Figure 11. Value at Risk for countries' banks, pooling and tranching (BS). *Source*: own calculations.

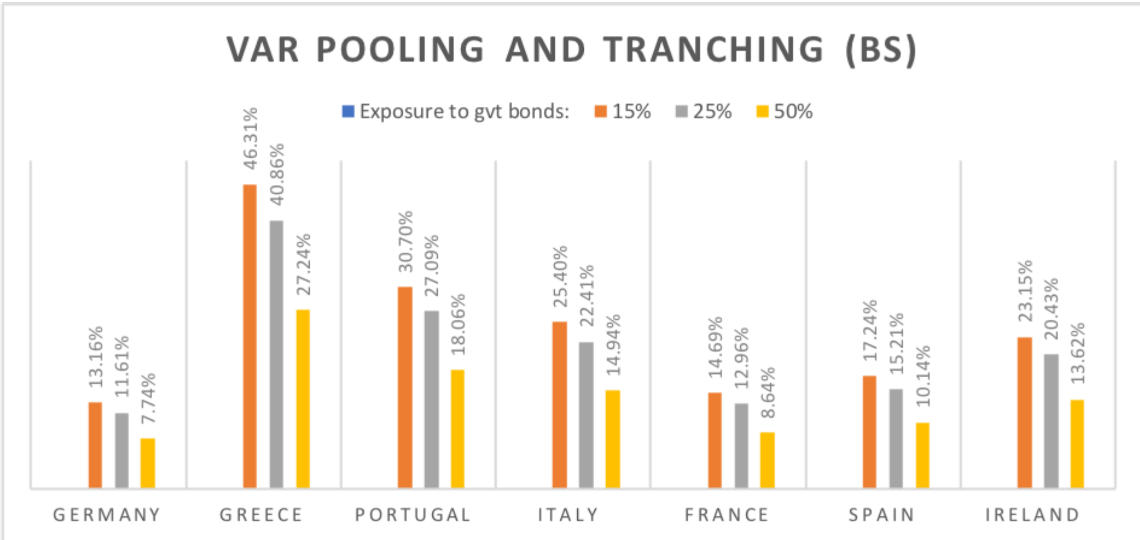
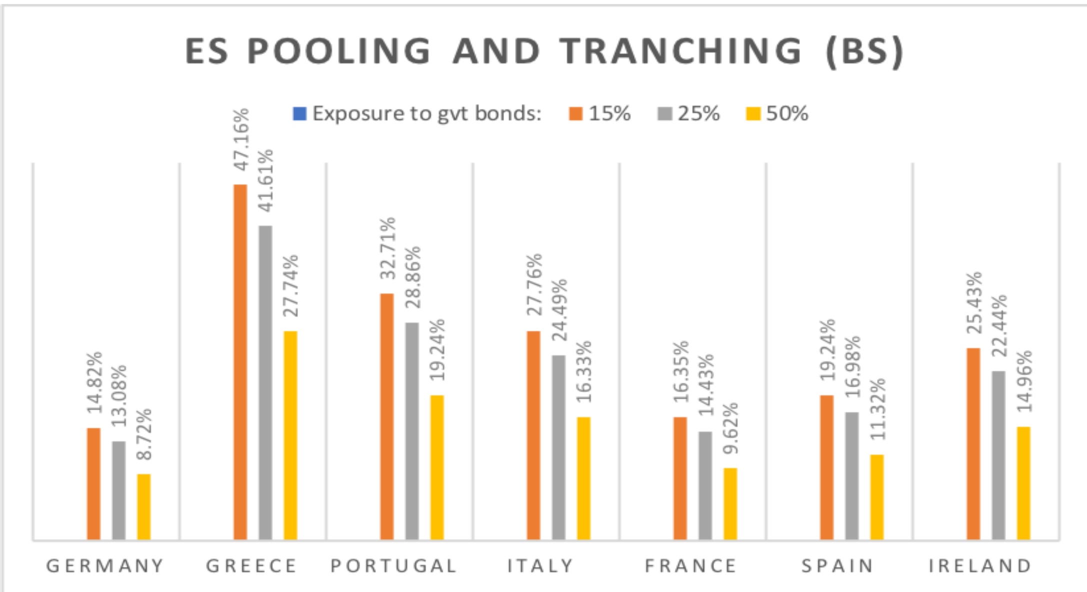


Figure 12. Expected Shortfall for countries' banks, pooling and tranching (BS). *Source*: own calculations.



The beneficial effects of the ESBies

To check if the introduction of the senior bonds (ESBies) in banks' balance sheets is beneficial for all countries, I compared the credit risk resulting from the analysis of the pooling and tranching security design with that of the status quo. When the diversified portfolio of euro-area sovereign bonds is tranched into a senior component (ESBies) and a junior component (ESBies), with banks holding only the senior tranche, results indicate that the credit risk of all banks examined is reduced compared to the status quo (Table 8 and Table 9). Unlike pure pooling security design, when adding tranching to diversification, even the safest banks, French and German, show a benefit in terms of risk reduction.

Table 8. Reduction (%) in VaR from pooling and tranching compared with status quo. *Source*: own calculations.

Exposure	Germany	Greece	Portugal	Italy	France	Spain	Ireland
15%	0.00%	9.88%	0.99%	2.27%	0.00%	3.98%	4.22%
25%	1.53%	20.11%	7.10%	4.89%	1.37%	13.33%	7.35%
50%	6.52%	44.49%	42.46%	37.50%	6.49%	59.22%	45.73%

Table 9. Reduction (%) in ES from pooling and tranching compared with status quo. *Source*: own calculations.

Exposure	Germany	Greece	Portugal	Italy	France	Spain	Ireland
15%	0.51%	10.64%	3.07%	2.72%	0.34%	7.34%	4.84%
25%	2.27%	20.03%	9.63%	5.94%	1.66%	20.38%	12.99%
50%	13.30%	45.76%	44.86%	38.83%	12.27%	59.77%	49.14%

In particular, looking at the VaR, German and French banks, at exposure to government bonds of 15%, are indifferent between the status quo and the pooling and tranching security design. When the summed exposure increases, the credit risk starts to decline, reaching a VaR reduction of 6.52% and 6.49% in Germany and France, respectively. On the other hand, when risk is measured by the ES, results show a credit risk reduction for German and French banks compared to the status quo also for the smallest exposure to sovereign bonds, 15%. These results reveal that both tranching and diversification are key to ESBies' safety, just as found by Brunnermeier et al. (2017). Indeed, as seen in the pure pooling security design analysis, for German and French banks, diversification alone is not beneficial. In other words, the safest banks are better off by holding the current portfolio composition of government bonds rather than the pooled portfolio of sovereign bonds. This is because German and French banks already hold predominantly safe sovereign bonds in their balance sheets. The pooled portfolio would increase their exposure to riskier government bonds and thus, worsen their position. Conversely, as seen in Tables 8 and 9, when tranching is added to diversification, and the senior tranche is introduced into EU banks' balance sheets, all euro banks see their credit risk shrinking. The ESBies reduce the credit risk of all euro area banks, even the safest, i.e. German and French banks. Besides, simulation results show that junior bonds absorb all losses incurred from government bonds. In other words, losses do not exceed the subordination level and thus, the number of junior bonds that are wiped out equals zero. As a result, the ESBies, which are held by banks, do not take any losses.

Additionally, to check the benefits provided by tranching, I compared the credit risk resulting from pooling and tranching security design with that resulting from pure pooling. The following tables show the results:

Table 10. Reduction (%) in VaR from pooling and tranching compared with pure pooling. *Source*: own calculations.

Exposure	Germany	Greece	Portugal	Italy	France	Spain	Ireland
15%	0.00%	0.87%	0.66%	1.97%	1.37%	1.17%	1.30%
25%	3.30%	1.73%	1.20%	3.41%	2.96%	2.31%	2.06%
50%	23.38%	8.32%	7.77%	9.45%	20.52%	15.65%	10.28%

Table 11. Reduction (%) in ES from pooling and tranching compared with pure pooling. *Source*: own calculations.

Exposure	Germany	Greece	Portugal	Italy	France	Spain	Ireland
15%	1.08%	0.73%	1.08%	1.19%	1.41%	0.69%	1.12%
25%	3.28%	1.62%	2.08%	2.43%	3.45%	2.66%	2.99%
50%	24.51%	11.65%	9.89%	12.04%	22.10%	17.77%	12.72%

The EU banks that benefit most from the tranching are French and German banks. Indeed, these banks are the ones that did not benefit from diversification alone. In particular, pooling and tranching manage to reduce the VaR of German and French banks, at 50% exposure to government bonds, by 23.38% and 20.52%, respectively. On the other hand, it reduces their ES by 24.51% and 22.10%, respectively. Also Greek, Portuguese, Italian, Spanish, and Irish banks are better off when tranching is added to pooling, so when ESBies are introduced in banks' balance sheets.

4.4.2 A Robustness check: Adverse Scenario

4.4.2.1 Robustness check: Status quo

To check the sensitivity of results obtained for the Benchmark Scenario, I subjected the study to an adverse scenario, a bad state of the economy where the government bonds probabilities of default are increased by 1000% compared to the 1-year government bonds PDs consistent with market prices (Column 6 of Table 3). Changing the probabilities of default to the Adverse Scenario values, I obtained the following results for the status quo:

Figure 13. Value at Risk for countries' banks, status quo (AS). *Source*: own calculations.

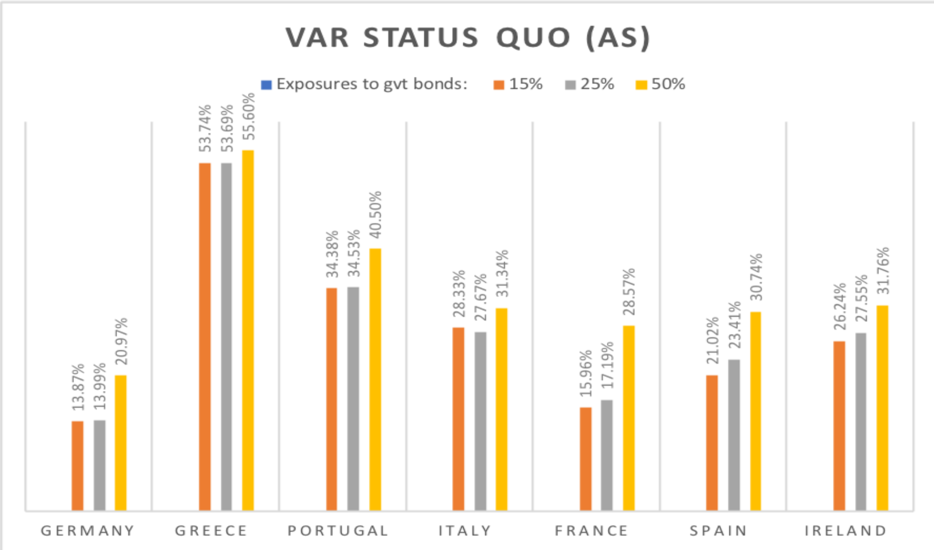
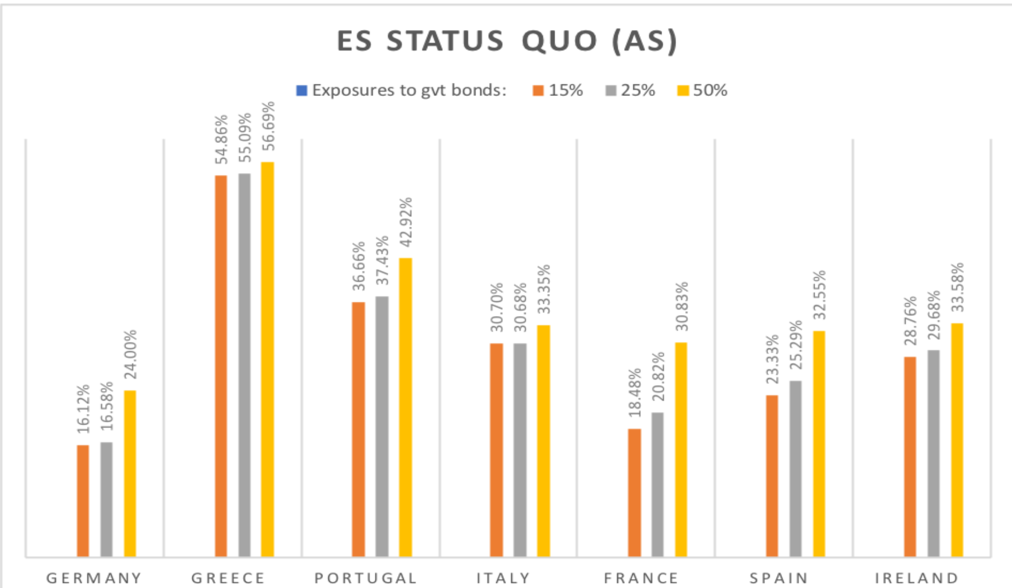


Figure 14. Expected Shortfall for countries' banks, status quo (AS). *Source*: own calculations.



Overall, increasing the total exposure to government bonds from 15% to 50% increases banks' credit risk. This is also true for banks that hold safe government bonds composition, French and German banks, that in the status quo of the Benchmark Scenario, as exposure to government bonds increased, they saw their credit risk decrease. However, their credit risk is still lower than that of other banks. The increase in credit risk comparted to the Benchmark Scenario is much evident at a high exposure to government bonds. Moreover, the difference is higher for the safest banks. Indeed, at an exposure level of 50%, the VaR of both German and French banks increased in percentage terms compared to the Benchmark Scenario by about 153% and 209%, respectively. On the other hand, German and French banks ES increased by 139% and 181%, respectively. For Greek banks, those with the riskiest government bond composition, the increase in credit risk compared to the Benchmark Scenario is much less evident. The VaR level grew by 13%, while the ES increased by 11%. This is due to the fact that, even in the Benchmark Scenario, where the government bonds PDs was 1000% lower than those of the Adverse Scenario, the credit risk of Greek banks was very high. Looking at the other EU banks, the VaR for Portugal, Italy, Spain, and Ireland, increased by 29%, 31%, 24%, 27%, while the ES grew by 23%, 25%, 16%, and 14%, respectively. The increase in credit risk in these countries' banks is higher than that of Greek banks, but still much lower than that of German and French banks.

4.4.2.2 Robustness check: Pure Pooling

All countries have the same government bonds composition. In other words, what differentiates the credit risk is the probability of default of banks' loans. Changing the government bonds PDs to the Adverse Scenario values and increasing the summed exposure to the pooled portfolio from 15% to 50% the effect on credit risk is different from that obtained in the Benchmark Scenario. In the good state of the economy, increased exposure to the pooled portfolio and credit risk were negatively related in all banks of the EU countries. For the Adverse Scenario, this is not true. Indeed, increased exposure to the pooled portfolio reduces the credit risk of Greek, Portuguese, Italian, and Irish banks, but increases the risk of German and French banks. This is because German and French banks' loans, relative to the other countries, have a low probability of default. Increasing the summed exposure to government bonds, so decreasing the summed exposure to loans, the credit risk in these banks increases. Conversely, the reduction of credit risk is evident for those banks with a high loan probability of default, which is for Greek, Portuguese, Italian and Irish banks which have a NPLs ratio of 41.24%, 12.21%, 8.26%, 6.65%, respectively. Results for the Var are reported in Figure 15, while those for the ES in Figure 16.

Figure 15. Value at Risk for countries' banks, pure pooling (AS). *Source*: own calculations.

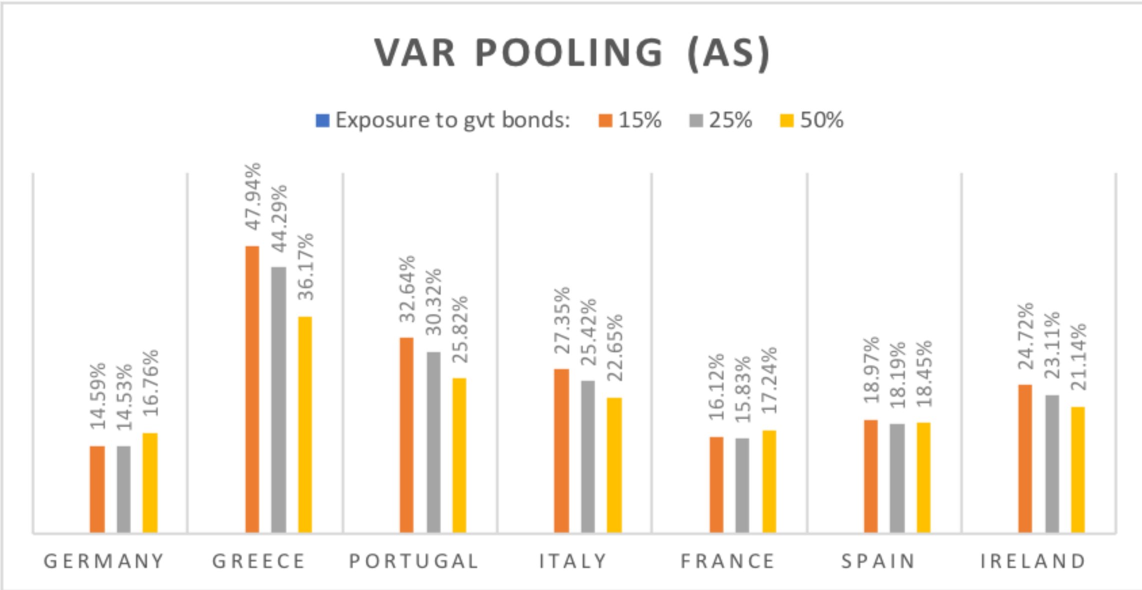
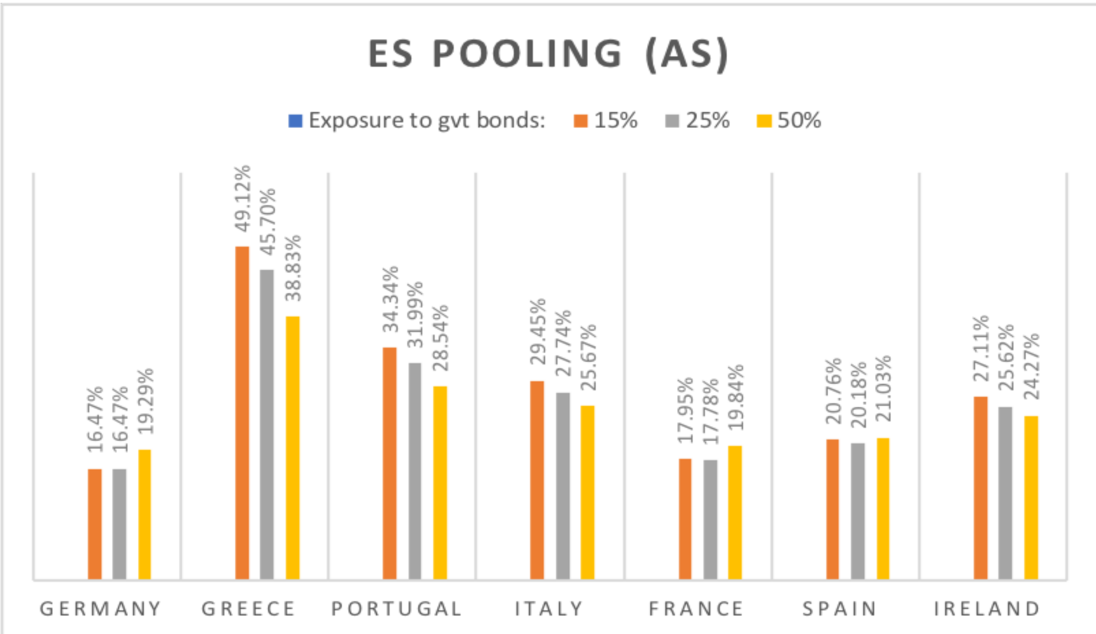


Figure 16. Expected Shortfall for countries' banks, pure pooling (AS). *Source*: own calculations.



Comparing the credit risk resulting from the analysis of the status quo with the pure pooling, I obtained the results reported in Table 12 and Table 13. A negative sign indicates that the pooled portfolio of government bonds leads to an increase in credit risk compared to the status quo. Conversely, a positive sign indicates that credit risk decreases.

Table 12. Change (%) in VaR from pooling compared with status quo. *Source*: own calculations.

Exposure	Germany	Greece	Portugal	Italy	France	Spain	Ireland
15%	-5.18%	10.79%	5.07%	3.46%	-1.00%	9.74%	5.79%
25%	-3.90%	17.51%	12.20%	8.14%	7.95%	22.30%	16.11%
50%	20.08%	34.95%	36.21%	27.71%	39.65%	39.98%	33.42%

Notes: (+) VaR reduction; (-) increase in VaR.

Table 13. Change (%) in ES from pooling compared with status quo. *Source*: own calculations.

Exposure	Germany	Greece	Portugal	Italy	France	Spain	Ireland
15%	-2.17%	10.46%	6.33%	4.07%	2.88%	11.02%	5.71%
25%	0.67%	17.06%	14.52%	9.59%	14.59%	20.22%	13.69%
50%	19.64%	31.51%	33.49%	23.02%	35.65%	35.38%	27.73%

Notes: (+) ES reduction; (-) increase in ES.

Unlike the Benchmark Scenario, for German and French banks, the introduction of the pooled portfolio of government bonds in the banks' balance sheets is not disadvantageous at all exposure levels. Looking at the VaR (Table 12), French banks begin to benefit in terms of risk reduction already at 25% exposure to the pooled portfolio. For German banks, the threshold raises to 50%. When the ES is used to measure credit risk, results change. French banks always benefit from the introduction of the pooled portfolio in their balance sheets, while German banks do not benefit from it only at an exposure level of 15%. When exposure to the pooled portfolio grows to 25% and 50% even the safest banks, the German ones, are better off. At these exposure levels, diversification benefits would ensure that a drastic reduction in payments would be unlikely relative to the status quo.

4.4.2.3 Robustness check: Pooling and Tranching. Sovereign bond-backed securities (SBBS)

Assuming that banks hold only the senior component of the diversified portfolio of euro-area sovereign bonds, and changing the government bonds PDs to the Adverse Scenario values, results show that there are six scenarios, on 20,000 scenarios generated, in which junior bonds are wiped out. In other words, there are six cases in which losses incurred from government bonds exceed 30% of the sovereign bonds portfolio's value and ESBies start suffering losses for the amount greater than 30%. The effect on credit risk due to losses incurred by ESBies is shown in Figures 17 and 18.

Figure 17. Value at Risk for countries' banks, pooling and tranching (AS). *Source*: own calculations.

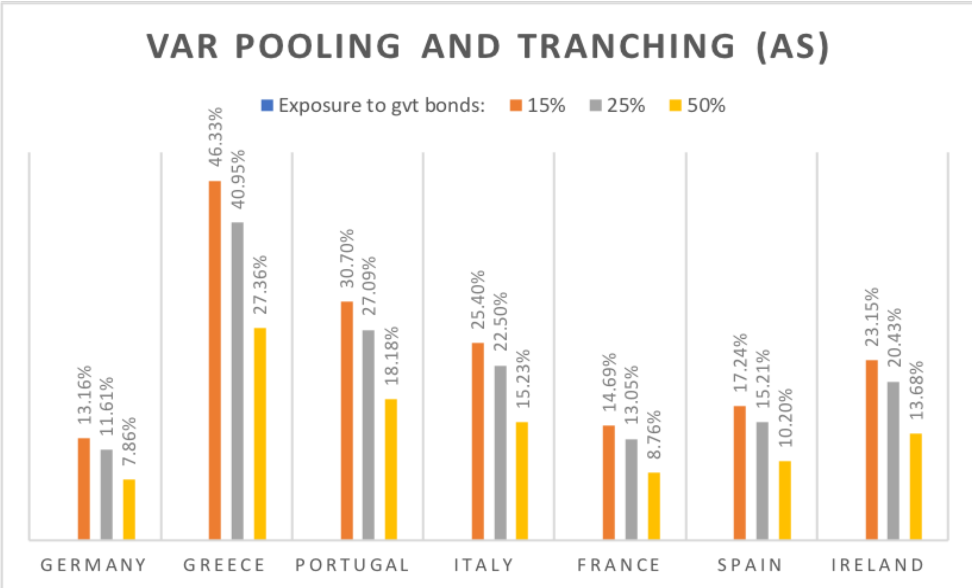
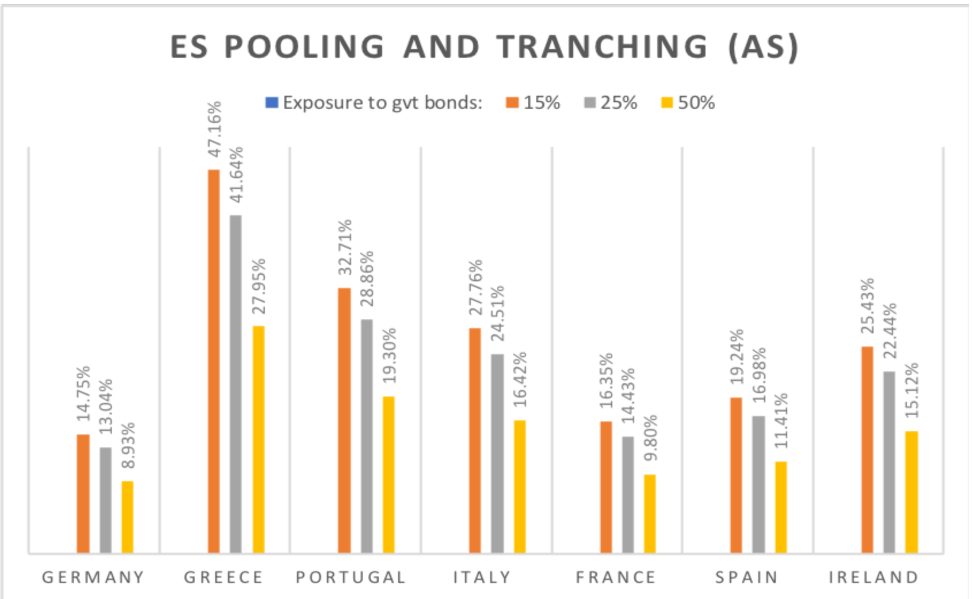


Figure 18. Expected Shortfall for countries' banks, pooling and tranching (AS). *Source*: own calculations.



As for the Benchmark Calibration, introducing ESBies into banks' balance sheets manages to reduce the credit risk of EU countries' banks. Increasing the exposure to the ESBies from 15% to 25%, both VaR and ES decrease by about 13% in each country's banks. Moreover, when the exposure grows from 25% to 50% and from 15% to 50%, the credit risk declines by around 50% and 70%, respectively, in every bank.

Table 14 compares the VaR levels in the Benchmark Scenario with those of the Adverse Scenario. The credit risk variation will be caused by the losses suffered by the ESBies in the six scenarios in which the EJBies are wiped out. Results show some very small increases in the credit risk in the Adverse Scenario, about 0.4% on average.

Table 14. Var (%) for countries' banks, pooling and tranching (SBBS). Benchmark and Adverse scenarios. *Source*: own calculations.

	Benchmark Scenario							Adverse Scenario						
Exp.	**Germany**	**Greece**	**Portugal**	**Italy**	**France**	**Spain**	**Ireland**	**Germany**	**Greece**	**Portugal**	**Italy**	**France**	**Spain**	**Ireland**
15%	13.16	46.31	30.70	25.40	14.69	17.24	23.15	13.16	46.33	30.70	25.40	14.69	17.24	23.15
25%	11.61	40.86	27.09	22.41	12.96	15.21	20.43	11.61	40.95	27.09	22.50	13.05	15.21	20.43
50%	7.74	27.24	18.06	14.94	8.64	10.14	13.62	7.86	27.36	18.18	15.23	8.76	10.20	13.68

The beneficial effects of the ESBies

To check whether the introduction of the senior bonds into banks' balance sheets is beneficial for all countries' banks, I compared the credit risk resulting from the analysis of the status quo, with the one of the pooling and tranching. Results demonstrate that, even in the Adverse Scenario, introducing senior bonds to banks' holdings reduces the credit risk of all countries analyzed compared to the status quo (Table 15 and Table 16). When adding tranching in addition to diversification, even the safest banks, French and German, show a benefit in terms of risk reduction. Benefits increase when the exposure to government bonds grows and reach levels even above 60%.

Table 15. Reduction (%) in VaR from pooling and tranching compared with status quo. *Source*: own calculations.

Exposure	Germany	Greece	Portugal	Italy	France	Spain	Ireland
15%	5.12%	13.79%	10.70%	10.36%	7.95%	17.99%	11.77%
25%	16.99%	23.73%	21.55%	18.69%	24.10%	35.03%	25.84%
50%	62.52%	50.79%	55.11%	51.40%	69.33%	66.82%	56.92%

Table 16. Reduction (%) in ES from pooling and tranching compared with status quo. *Source*: own calculations.

Exposure	Germany	Greece	Portugal	Italy	France	Spain	Ireland
15%	8.55%	14.04%	10.79%	9.59%	11.53%	17.54%	11.57%
25%	21.34%	24.42%	22.90%	20.12%	30.67%	32.88%	24.41%
50%	62.81%	50.70%	55.03%	50.77%	68.21%	64.93%	54.97%

To conclude, the following tables show the benefits provided by tranching. As for the Benchmark Scenario, the EU banks that benefit most from the tranching are French and German. In particular, pooling and tranching manage to reduce the VaR of German and French banks, at 50% exposure to government bonds, by 53.11% and 49.19%, respectively. On the other hand, it reduces their ES by 53.72% and 50.60%, respectively. Also Greek, Portuguese, Italian, Spanish, and Irish banks are better off when ESBies are introduced in their balance sheets.

Table 17. Reduction (%) in VaR from pooling and tranching compared with pure pooling. *Source*: own calculations.

Exposure	Germany	Greece	Portugal	Italy	France	Spain	Ireland
15%	9.79%	3.36%	5.94%	7.14%	8.86%	9.14%	6.35%
25%	20.10%	7.54%	10.64%	11.49%	17.54%	16.39%	11.60%
50%	53.11%	24.35%	29.59%	32.78%	49.19%	44.72%	35.29%

Table 18. Reduction (%) in ES from pooling and tranching compared with pure pooling. *Source*: own calculations.

Exposure	Germany	Greece	Portugal	Italy	France	Spain	Ireland
15%	10.49%	3.99%	4.76%	5.75%	8.91%	7.32%	6.21%
25%	20.81%	8.88%	9.80%	11.65%	18.83%	15.87%	12.43%
50%	53.72%	28.08%	32.39%	36.04%	50.60%	45.73%	37.70%

4.4.3 EJBies

The subordination level determines the risk of junior and senior bonds. In particular, EJBies' credit risk rises as the subordination level increases, while the ESBies' credit risk decreases. This is because, at higher subordination levels, the losses that the junior bonds can absorb increases. In my analysis, I used a subordination level of 30%, so that the EJBies absorb the first 30% of losses.

In this section, I test the sensitivity of the results obtained in my analysis taking into account three different subordination levels: 10%, 20%, 40%. First, for each subordination level, I calculated the VaR for the ESBies and the EJBies, and the number of EJBies that are wiped out. The results are shown in Table 19. As the subordination level increases, the number of EJBies that are wiped out decreases drastically, therefore the VaR of the junior component increases. For example, increasing the subordination level from 10% to 20%, the number of EJBies that are wiped out declines from 58 to 1 in the Benchmark Scenario, and from 711 to 70 in the Adverse Scenario. The corresponding VaR increases from 10% to 11.40% in the good state of the economy, and from 10% to 20% in the bad state of the economy. On the other hand, the VaR of the senior component decreases. Indeed, increasing the subordination level from 10% to 20%, the ESBies' credit risk declines from 1.40% to 0% and from 13.50% to 3.50% in the Benchmark and Adverse Scenario, respectively. The senior bonds reach a 0% credit risk when the subordination level equals 20% for the good state of the economy, and when the subordination level equals 30% for the bad state of the economy.

Table 19. VaR (%) EJBies, VaR (%) ESBies, number of EJBies wiped out, for different subordination levels. *Source*: own calculations.

	Benchmark Scenario				Adverse Scenario			
Subordination levels	**10-90**	**20-80**	**30-70**	**40-60**	**10-90**	**20-80**	**30-70**	**40-60**
VaR(%) EJBies	10.00%	11.40%	11.40%	11.40%	10.00%	20.00%	23.50%	23.50%
VaR(%) ESBies	1.40%	0%	0%	0%	13.50%	3.50%	0%	0%
#EJBies wiped out	58	1	0	0	711	70	6	1

In the following subsections, I will test if the introduction of the senior bonds into banks' balance sheets is still beneficial for all EU countries' banks at subordination levels of 10% and 20%, both for the Benchmark and for the Adverse Scenario.[13]

4.4.1.2 Subordination level at 10%

Taking into account a 10% subordination level for the SBBS, I compared the EU banks' VaR obtained in the status quo with that of the pooling and tranching security design. Even lowering the subordination level to 10%, results show that the European Safe Bonds improve the situation of banks, both for the good and for the bad state of the economy. Compared to the 30% subordination level, the reduction in the VaR given by the introduction of ESBies is lower (about 3% and 31% on average for the Benchmark and Adverse Scenario, respectively), but still positive. Benefits are lower since the number of EJBies that are wiped out is higher at the 10% subordination level, so the number of scenarios in which ESBies experience losses increase. Outputs for the Benchmark and the Adverse Scenario are reported in Table 20 and 21, respectively.

Table 20. Reduction (%) in VaR from pooling and tranching compared with status quo – Benchmark Scenario. *Source*: own calculations.

	10% subordination							30% subordination						
Exposure	**Germany**	**Greece**	**Portugal**	**Italy**	**France**	**Spain**	**Ireland**	**Germany**	**Greece**	**Portugal**	**Italy**	**France**	**Spain**	**Ireland**
15%	0.00	9.88	0.97	2.24	0.00	3.98	4.22	0.00	9.88	0.99	2.27	0.00	3.98	4.22
25%	1.53	20.11	6.51	4.51	1.37	13.33	7.35	1.53	20.11	7.10	4.89	1.37	13.33	7.35
50%	5.07	44.12	42.46	37.25	5.19	59.22	45.49	6.52	44.49	42.46	37.50	6.49	59.22	45.73

Table 21. Reduction (%) in VaR from pooling and tranching compared with status quo – Adverse Scenario. *Source*: own calculations.

	10% subordination							30% subordination						
Exposure	**Germany**	**Greece**	**Portugal**	**Italy**	**France**	**Spain**	**Ireland**	**Germany**	**Greece**	**Portugal**	**Italy**	**France**	**Spain**	**Ireland**
15%	2.59	12.69	8.33	6.40	5.39	14.34	10.60	5.12	13.79	10.70	10.36	7.95	17.99	11.77
25%	9.27	21.77	17.62	12.81	18.24	30.29	21.24	16.99	23.73	21.55	18.69	24.10	35.03	25.84
50%	43.92	43.94	48.49	43.00	57.14	56.08	48.00	62.52	50.79	55.11	51.40	69.33	66.82	56.92

[13] The results at a subordination level of 40% coincide with those at 30%, for this reason in the next sections the subordination level at 40% is not deepened.

4.4.1.2 Subordination level at 20%

Considering a 20% subordination level for the SBBS, outputs confirm that the introduction of ESBies in EU banks' balance sheets effectively reduces credit risk. In particular, at 20% and 30% subordination levels for the Benchmark Scenario (Table 22), the reduction in the VaR resulting from the introduction of the senior bonds in banks' balance sheets takes identical values. This is because both at 20% and 30% subordination levels, ESBies have a credit risk equal to 0%. Indeed, the number of EJBies that are wiped out at subordination levels of 20% and 30% equals 1 and 0, respectively. Conversely, in the Adverse Scenario benefits are lower at a 20% subordination level, about 4% on average (Table 23). In fact, 70 junior bonds are wiped out instead of 6. When EJBies are wiped out, ESBies, which are held by banks, start experiencing losses, which leads to higher VaR.

Table 22. Reduction (%) in VaR from pooling and tranching compared with status quo – Benchmark Scenario, 20% subordination. *Source*: own calculations.

	20% subordination							30% subordination						
Exposure	**Germany**	**Greece**	**Portugal**	**Italy**	**France**	**Spain**	**Ireland**	**Germany**	**Greece**	**Portugal**	**Italy**	**France**	**Spain**	**Ireland**
15%	0.00	9.88	0.99	2.27	0.00	3.98	4.22	0.00	9.88	0.99	2.27	0.00	3.98	4.22
25%	1.53	20.11	7.10	4.89	1.37	13.33	7.35	1.53	20.11	7.10	4.89	1.37	13.33	7.35
50%	6.52	44.49	42.46	37.50	6.49	59.22	45.73	6.52	44.49	42.46	37.50	6.49	59.22	45.73

Table 23. Reduction (%) in VaR from pooling and tranching compared with status quo – Adverse Scenario, 20% subordination. *Source*: own calculations.

	20% subordination							30% subordination						
Exposure	**Germany**	**Greece**	**Portugal**	**Italy**	**France**	**Spain**	**Ireland**	**Germany**	**Greece**	**Portugal**	**Italy**	**France**	**Spain**	**Ireland**
15%	5.12	13.45	10.11	8.56	6.67	17.99	11.38	5.12	13.79	10.70	10.36	7.95	17.99	11.77
25%	15.70	23.40	20.69	17.39	23.05	34.65	25.51	16.99	23.73	21.55	18.69	24.10	35.03	25.84
50%	60.52	50.15	54.52	50.79	68.04	65.85	55.22	62.52	50.79	55.11	51.40	69.33	66.82	56.92

The results of the analysis show that the introduction of the ESBies into EU banks' balance sheets is capable of reducing unexpected loss rates of banks' sovereign portfolios, thus reducing their credit risk, for each subordination level analyzed. At a 30% subordination level ESBies have a zero credit risk both for the Benchmark and for the pessimistic scenario. However, results show that even at lower subordination levels, the number of EJBies that are wiped out is sufficiently low to ensure the ESBies' safety. Comparing the credit risk resulting from the introduction of ESBies into EU banks' balance sheet with that resulting from the status quo, results confirm that, even at subordination levels lower than 30%, the ESBies reduce unexpected loss rates of banks' sovereign portfolios. To summarize, the introduction of such an instrument into EU banks' balance sheet would effectively remove the sovereign risk from banks' balance sheets and, in turn, break the risk transmission mechanism in place between governments and banks.

5. Conclusions

The global pandemic reveals once again the incompleteness of the European Monetary Union. A lot has been done over the years, but a crucial feature remains missing. One of the missing building blocks of the EMU is a euro-area wide safe asset.
The introduction of a well-designed safe sovereign asset could bring reprieve from current financial instability, by weakening the sovereign-banks doom loop and reducing the scope for cross-countries' destabilizing capital flows triggered by shifts in market sentiments. Moreover, it would support the smooth functioning of the EU economies, underpin the euro as a global reserve currency and allow for a proper monetary policy transmission.

The empirical analysis in this paper examines the benefits of the introduction of a safe sovereign asset, the one suggested by Brunnermeier et al. (2011, 2017), into EU banks' balance sheets. The authors' idea is to create a multi-tranche sovereign bond-backed security (SBBS) with the most senior tranche (European Safe Bonds, EBSies) playing the role of a safe asset. The authors point out that at a 30% subordination level, i.e. thickness of the junior tranche, ESBies are slightly safer than German Bunds, and the safe asset multiplier is maximized.
I examined the impact of banks' exposure to government bonds for seven EU countries: Portugal, Germany, Italy, France, Spain, Ireland, and Greece. With the aid of a Monte Carlo simulation, I generated the distribution of future portfolio credit losses for different compositions of EU banks' balance sheets. Then, I used the distribution of losses to calculate the credit risk. The credit risk is measured using the Value at Risk (VaR) and the Expected Shortfall (ES) as risk indicators. The simulation study shows that the introduction of ESBies in banks' portfolios would effectively remove the sovereign risk from banks' balance sheets in all EU economies examined, even when considering a reduced thickness of the junior tranche. Moreover, the analysis reveals that both tranching and diversification are key to ESBies' safety. Diversification alone would be not beneficial for all euro area Member States. More precisely, compared to the current situation, more diversification increases the credit risk of those Member States perceived to be safe, namely Germany and France. These countries are better off by holding the current portfolio composition of government bonds rather than the pooled portfolio of sovereign bonds. This is because German and French banks already hold predominantly safe sovereign bonds in their balance sheets. The pooled portfolio would increase their exposure to riskier government bonds and thus, worsen their position. Increasing the diversification of

government bonds positively reduces credit risk only of those banks that currently hold a riskier portfolio composition, such as Greek, Portuguese, Italian, Spanish and Irish banks. Conversely, when the diversified portfolio of euro-area sovereign bonds is tranched into a senior component (ESBies) and a junior component (ESBies), and the ESBies are introduced into EU banks' balance sheets, the results show that all euro area banks see their credit risk shrinking. Moreover, credit risk reduction increases when the exposure to ESBies grows and reaches levels even around 60%. This is because at a 30% subordination level no EJBies are wiped out. In other words, ESBies do not take any losses and so they have a zero credit risk. However, results show that, even at lower subordination levels, the number of EJBies that are wiped out is sufficiently low to ensure the ESBies' safety and thus to reduce unexpected loss rates of banks' sovereign portfolios compared with the current situation.
To summarize, the empirical analysis in this paper shows that the introduction of the ESBies into EU banks' balance sheets would effectively remove the sovereign risk from banks' balance sheets in all the EU economies examined and, in turn, mitigate the risk transmission mechanism in place between governments and banks. Such a union-wide safe asset would strengthen financial stability and the euro area as a whole.

One of the reasons why this type of financial instrument has not yet been implemented is the unfavorable treatment it would receive under the current regulatory framework, compared to sovereign exposures. Therefore, the change in the treatment of sovereign exposures is crucial to the development of the SBBS market, insofar as this affects the attractiveness of synthetic securities. Moreover, regulatory reform which entails assigning capital charges as a function of risk to government debt or which limits the concentration of sovereign exposure is necessary. Indeed, such a reform would increase demand for European Safe Assets (ESBies), as they would be used to mitigate the resulting impact on capital requirements.
The current regulation is not the only obstacle to the development of the SBBSs. The biggest obstacle is related to the mutualization of public debts. In general, Germany and the least vulnerable countries fear that the introduction of a euro area safe asset could be the first step towards the opening to the mutualization of risks and losses between the eurozone countries, and therefore towards the fiscal solidarity between the Member States. However, it is important to stress that the SBBSs are designed so as not to create fiscal solidarity between the countries of the euro area, therefore such a political obstacle should not exist.
While I was conducting my analysis, the European Commission has approved an extraordinary plan for 750 billion to cope with the economic crisis triggered by Coronavirus. The Recovery

Fund is financed through the collection of liquidity given by the issuance of the so-called "Recovery Bonds". The Recovery Bonds are common bonds issued by the Fund with the EU budget guarantee. In this way, risk-sharing is common only for future debt, without a mutualization of past debts. With the signed agreement, the least vulnerable countries have shown a small opening towards debt mutualization. Although the SBBSs do not require debt mutualization, this may be the right time to promote them and to improve the knowledge of the proposal.

Due to the complicated nature of the topic examined, some simplified assumptions are adopted in this paper. First, Vasicek's (2002) model, used in the analysis to derive the distribution of portfolio credit losses, assumes that assets values follow the standard normal distribution. In other words, it assumes that the expected return of a bank's portfolio is equal to zero. Second, a simplified version of banks' assets which consists only of government bonds and loans is examined. Finally, the choice of the right value for some model inputs, e.g. LGD and probabilities of default of EU banks' loans, is not trivial. Although the decision of these parameters was as careful as possible, some assumptions were necessary.
For all the reasons stated, my analysis could be improved by adopting less stringent assumptions and further empirical evidence could support this paper's results. Moreover, future research could test the impact of banks' exposure to government bonds implementing a dynamic model. Lastly, the empirical analysis conducted in this thesis should be periodically updated to reflect changes in euro-area countries' credit ratings, government bonds probabilities of default, GDP weights, distribution of banks' exposures to EU member states, and probabilities of default of EU banks' loans.

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