Financial Instability, the Sovereign-Bank Nexus and Eurobonds:
a Post-Keynesian Stock Flow Consistent Model.

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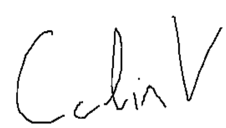

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Abstract

This master thesis discusses the implication of the joint issuance of public debt in the Eurozone in the form of eurobonds on the financial stability of the European Monetary Union (EMU). More precisely, this thesis relies on the important literature on the existence of destabilizing dynamics in the EMU financial system, notably at play during the European sovereign debt crisis, creating a negative feedback loop between a sovereign and its domestic public sector, often referred as *sovereign-bank nexus* or *diabolic loop*. The mechanisms go as follows: an increase in the sovereign risk translates into a devaluation of the public debt held by private banks, increasing their leverage and pushing them to reduce their provision of credit to the economy, further weakening government finances. We try to introduce these dynamics in a theoretical stock-flow consistent model of the EMU featuring two countries: a northern, Germany-like country, and a southern Greece-like one, with distinct dynamics of credit rationing by banks as a consequence of variations in the sovereign risk of the southern country. Our results, although only a preliminary step towards a fully satisfying and more sophisticated version of the model, display some of these dynamics, and suggest that the issuance of eurobonds has a positive effect on financial stability, and reduces the credit rationing of banks. The inquiry presented here has reinforced our opinion that significant work remains and deserves to be done on this matter, to which we hope this development can be of some use.

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1 Introduction

The mutualization of part or all of the Eurozone members sovereign debt and the consequence issuance of "eurobonds", made or derived of it, has been discussed as the next important new feature of the European Union architecture. It has often been presented as a missing piece in the faulty or incomplete design of the Eurozone, and its absence, as well as the absence of other stabilizing mechanisms, such as intra-zone transfers, as responsible for the vulnerability of the Eurozone as a whole, and of its peripheral members, in particular (see, for example, De Grauwe, 2012). The vulnerability of the Eurozone has been made particularly clear by the so-called European sovereign debt crisis, which saw the integrity and the very existence of the European Monetary Union challenged by the difficulties experienced by its peripheral members, mostly, among which Greece, Ireland, Italy, Portugal and Spain, forming the acronym GIIPS, and which was characterized by the worsening conditions of the European financial and banking sectors, in the aftermath of the Subprime crisis.

In that regard, the main question that this master thesis offers to discuss regards the impact of a eurobonds issuance in the Eurozone on the destabilizing dynamics existing and persisting in its financial system, and in particular the instabilities caused by the so-called sovereign-bank nexus, or diabolic loop, and their damaging effect on Europeans economies.

The sovereign bank-nexus describes the intertwining of the health a government's public finances and the health its domestic banking sector, which was particularly noticeable during the European sovereign debt crisis, during which banks and sovereigns ended up "joined at the hip" (Mody and Sandri, 2012). More precisely, the European sovereign debt crisis saw banking sectors prospects further decline after the Subprime crisis as expectations regarding sovereign default risks seemed to increase in the Eurozone's periphery. The mechanisms at play behind this common fate involves the existence of a negative feedback loop between sovereign risk and the state of the banking sector, often referred to as "doom loop" or "diabolic loop" in the literature (see, for example, Brunnermeier et al., 2016; Farhi and Tirole, 2018). This diabolic loop can be divided in different channels (see

Dell'Ariccia et al., 2018), but its core principle revolves around the domestic sovereign exposure of the banking sector and the negative feedback loop caused by an increase in the sovereign risk and by the consequent reduction of credit supply by banks, as a reaction to the devaluation of the public bonds present in their balance sheet. Eurobonds have been mentioned as a device to break the loop, effectively replacing, in the balance sheet of domestic banks, sovereign bonds subject to changes in value as the sovereign risk is reassessed. These dynamics are still at play in the current architecture of the Eurozone, and, if the European sovereign debt crisis seems to have reached its end, the very recent crisis linked to the Coronavirus pandemic shows a return of increasing sovereign yields and high debt to GDP ratios.

An important literature provides quantitative evidence of the existence of such a relation and of its detrimental impact on the supply of credit money by banks, especially in the case of the European sovereign debt crisis (Battistini et al., 2014; Becker and Ivashina, 2018; Fontana and Langedijk, 2019; Mody and Sandri, 2012, for a non-exhaustive selection). The question of the implementation of Eurobonds is also the subject of an extensive literature, with eurobonds proposals varying in their degree of solidarity between participants, in their institutional features and in their objectives. Indeed, if Brunnermeier et al. (2011) focus on the role of newly issued eurobonds as euro-wide safe assets, with no guarantee whatsoever between participating countries, Delpla and Von Weizsäcker (2010) propose an issuance scheme with joint liability of participants, as does De Grauwe and Moesen (2009) and Palley (2011), who proposes the use of the funds to finance the bailouts of troubled governments. However, few papers discuss the potential impact of a eurobonds issuance in a complete model, especially in heterodox and post-Keynesian literature. An important step in this regard is the recent model by Duwicquet et al. (2018), who offer a two-country stock-flow coherent (SFC) model of the EMU and discuss, among other things, the impact of the implementation of a eurobonds scheme. Nevertheless, this model does not focus on the financial dynamics involved in the diabolic loop, and offer no clear and distinct mechanism of credit rationing by banks.

We hence propose a 4-sectors, two-country model of the EMU with credit rationing resulting from movements in the prices of public bonds, thus displaying some of the diabolic loop's features.

Although incomplete, our model helps to analyse and explain the dynamics at play between the banking sector and the government sector, their impact on the rest of the economy, the role of intra-zone financing and the effect of the issuance of eurobonds as a stabilizing mechanism. Our results show that, in such a model of the EMU, the negative effects on the supply of credit by banks and on economic activity of a negative shock on the sovereign risk of the southern country (country S) can be suppressed by the issuance of eurobonds. Indeed, the presence of eurobonds in the balance sheets of banks reduces the domestic sovereign exposure of the banking sector and thus decreases the impact of variations in the interest rate on Treasury bills on the banking sector leverage ratio, thus reducing credit rationing.

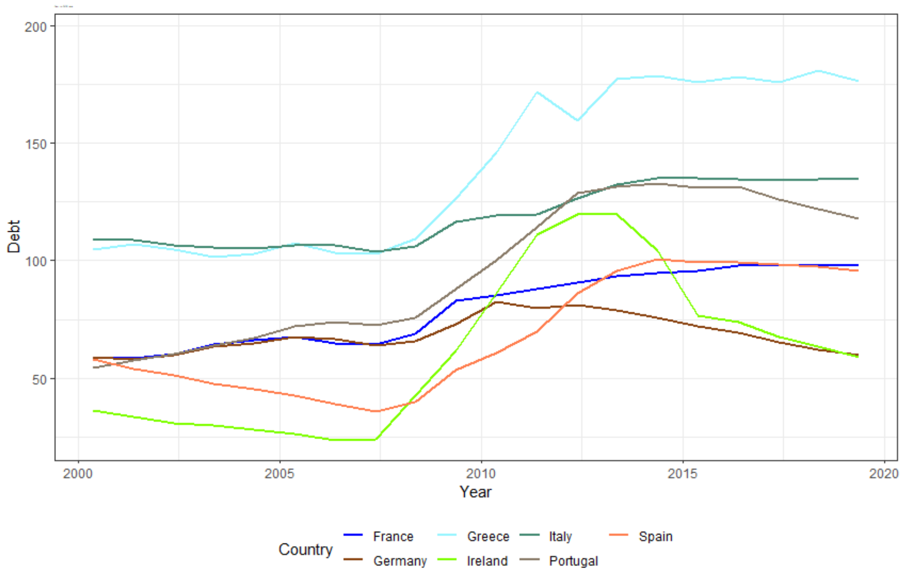
Our master thesis is structured as follows. The next section offers a literature review of the discussions around the European sovereign debt crisis and the existence of a sovereign-bank nexus in the Eurozone. The structure of the model presented in this paper is displayed in Section 3. Section 4 presents the scenarios used for the simulations, the results of which are discussed in section 5. Finally, section 6 offers a discussion of the shortcomings of the model presented here, as well as directions of future improvements. The seventh, and last, section is reserved for the conclusion.

2 Literature review: the European sovereign debt crisis and the sovereign-bank nexus

2.1 Financial instability in the Eurozone: the diabolic loop

The model developed in this paper is very much linked with the important existing literature discussing the European sovereign debt crisis of 2010-2011. The crisis, following by a few years the Global Financial Crisis of 2008-2009, has as its main characteristic an increase in the interest rates paid on their debt by the government of the countries deemed the most fragile of the Eurozone, namely Greece, Ireland, Italy, Portugal and Spain, often referred to as the GIIPS, compared to the interest rates paid by the safest countries, and in particular by Germany. This widening of the spread between sovereign interest rates was accompanied by a contraction of economic activity in the GIIPS, especially, and the rest Eurozone, with credit rationing by banks being seen as one of its main features. Consequently, and backed by an already substantial literature, an important stream of studies has focused on the link between movements in the interest rates on public debt, and variations in the supply of financing by banks in European countries, during the European sovereign debt crisis. More precisely, a number of papers have revealed the existence of reinforcing feedback effects between distress in the banking sector and higher risks of default associated with the sovereign debt of European countries, named the 'diabolic loop'. If the European sovereign debt crisis has shown further light on the economic fragility of the Eurozone, and in particular of its financial system, propositions have been put forward to release market pressures on the sovereign debt of the countries of the Eurozone by mutualising public debt issuance in Eurobonds, which would fulfill the currently empty role of being a euro-wide safe financial asset, and would help as such in breaking the diabolic loop.

Figure 1: *Debt to GDP ratio, Germany, France and the GIIPS, annually, 2000-2019*



Source: Author's own elaboration, Ameco database, European Commission, accessed 25/05/2020.

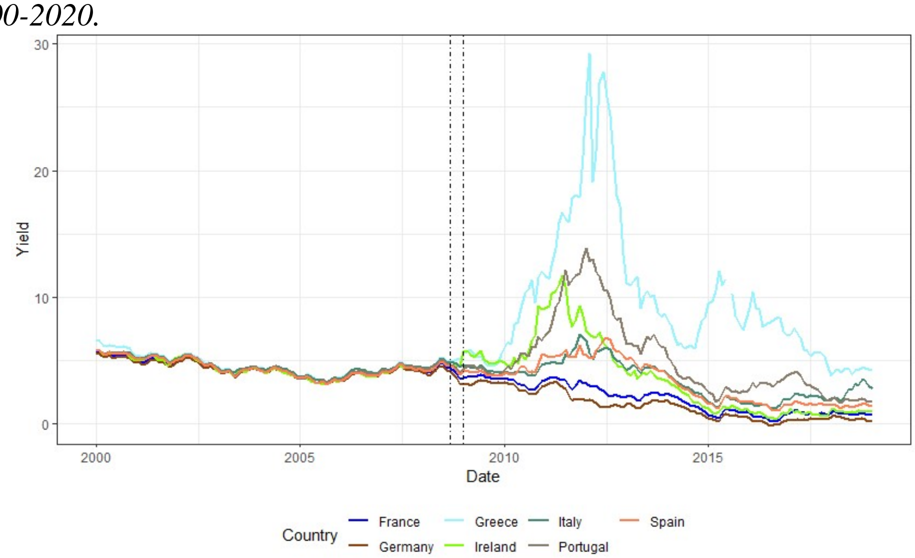
2.1.1 The European sovereign debt crisis: the events

The European sovereign debt crisis refers to the period of economic turmoil which saw the very integrity of the Eurozone questioned as some of its members were shut out of financial markets. Countries of the European Union periphery experienced the effects of the financial crisis, with declining domestic and global demand, substantial credit crunch and capital flight due to important distress in the banking sector, while their previously considered safe public debt levels were beginning to be questioned by financial markets. As a consequence, a few months after the events of the GFC, European countries were the subjects of a second crisis with rising interest rates on some countries public debt, weakened banking sectors and the need for the bailout of a few of them.

Lane (2012) gives an early account of the crisis and the events leading to it. His story goes as follows: after the GFC of 2008-2009 put a stop to a credit boom which lasted form 2003-2007, and during which private and public debt rose jointly in most of peripheral European countries, such as Spain or Italy, question regarding the sustainability of their public debts launched a wave of negative risk reassessment on European public debts (Lane 2012).

In particular, low long-term interest rates internationally, consequences of the securitization boom and the decline of financial risks, created an accumulation of debt by households, the most prominent face of it being the subprime loans in the US (Lane 2012). As the GFC developed, the shortage of liquidity in international banking sectors considerably reduced cross-border financial flows, which impacted more peripheral European countries more reliant on external financing (Lane 2012). Banking sectors heavily dependent on foreign short-term funding, such as the Irish banking sector, were hit the hardest and ultimately required government bailouts. Despite low growth prospects and rising expectations of substantial government intervention, the European sovereign debt market remained relatively stable until late 2009, were yields started to increasingly diverge between countries deemed safe and those deemed unsafe, as visible in Figure 2. This was not only the consequence of rising debt to GDP ratios, as displayed in Figure 1., but also of declining banking sector health which pushed sovereign default expectations upwards. In particular, the announcement in late autumn 2009 of the revision of the Greek budget deficit forecast sent the interest on its debt skyrocketing (Figure 2.). Expectations on the sovereign defaults of the remaining of the GIIPS countries also started to rise from 2010 on.

Figure 2: *Interest rates on 10-year government bonds, France, Germany, Greece, Italy, Spain, monthly, 2000-2020.*



Source: Author's own elaboration, FRED data, accessed 24/05/2020.
Note: The two vertical line correspond to the date of the Bear Stearns bail-out and the Anglo Irish Bank bail-out.

Focusing on the impact of bailouts expectation, Mody and Sandri (2012) offer a complementary narrative of the European sovereign debt crisis events. Indeed, they see as the main cause behind the increase in European sovereign yields the increased probability of the bailouts of bank by sovereigns, with, as a starting point, the bailout of Bear Stearns in March 2008 (Mody and Sandri 2012). Since then, the continuing worsening condition of the banking sector drove sovereign rates upwards, and this became even more pregnant with the nationalization of the Irish bank Anglo Irish: "After Anglo Irish, the crisis evolved into its full-blown phase characterized by highly intertwined financial and sovereign shocks, and this relationship was further strengthened after the Greece bailout" (Mody and Sandri 2012, 203). According to Mody and Sandri (2012), if, after the Bear Stearns bailout, markets started to expect public authorities to intervene and bailout the banking sector, expectations further confirmed for European countries by the Anglo Irish bailout, leading, after it, indicators of the health of the banking sector and of the sustainability of public deficits to move closely along.

2.1.2 Built-in European instability

Concerns had been raised previously concerning the underlying vulnerabilities of the European Monetary Unions, and the inherent fragility of the Eurozone were reassess in light of the European Sovereign Debt crisis (Lane 2012; De Grauwe 2012; 2013). De Grauwe (2013) argues that the EMU exacerbates, instead of taming, the destabilizing dynamics of capitalism and its 'boom-bust' cycles. The accumulation of risk and debt as a normal feature of capitalist economies, with especially the endogenous build-up of financial instabilities, as theorised notably by Minsky and Kindleberger (Aliber and Kindleberger, 2015; Minsky, H. P., 1986), requires the existence of institutional 'buffers', such as a lender of last resort central bank and automatic stabilizers in the government expenditures' determination (De Grauwe 2013). As De Grauwe (2013) explains, with economic policies staying largely in the hands of national governments, booms and bust cycles remain a national phenomenon, exacerbated by the monetary union, not allowing interest rates to move nationally to stabilize business cycles, especially in the Southern countries of the Eurozone, which accumulated, as a consequence, large current account deficits. Also, with the ECB not acting as a true lender of last resort, governments were not able to guarantee payments of their issued debt via a their national central banks, and experienced violent capital outflows and flights to safety out of their sovereign debt, putting them at risk of default (De Grauwe 2013). With financial markets risk assessment pushing interest rates of peripheral European countries to punitive levels, governments were constrained to implement austerity measures, further compressing domestic demand and worsening the economic crisis, trapping southern European countries in a bad equilibrium of high interest rates, high debt to GDP ratios and economic recession, while central European countries, with public debt deemed safe, enjoy low interest rates and more fiscal room, thus creating a multiple equilibria monetary union (De Grauwe, 2013, 2012, 2011; Lane, 2012). If the ECB could and did try to act as the lender of last resort and guarantee liquidity in exchange for European countries public debt, especially in a time of crisis, it did so, at first, in the "worst possible way" (De Grauwe 2013, 16) by announcing the limitation in time and size of its debt repurchasing programs, before partially releasing some if these restrictions, and remains only ambiguously committed to this role and the survival of the Eurozone (De Grauwe 2013). De Grauwe (2011; 2012) thus assimilates the situation of peripheral European sovereign with regards to financial markets to the one of developing countries.

In particular, De Grauwe (2012; 2013) point out the fact that when peripheral European countries are forced in higher debt to GDP ratios in their fight against the recession, and are then constrained into pursuing austerity policies to reduce financial markets attacks on their debt, there is no monetary union level mechanism to encourage central European countries with lower public debt levels to pursue expansionist fiscal policies and boost demand. Instead, quite the opposite happened with central European country focusing on achieving a balanced government budget, compressing European demand even more (De Grauwe 2013). Responsibility for the European sovereign debt crisis can thus be imputed to both the original architecture of the EU at the time of the crisis and to the inappropriate response of the EU institutions and economic leadership, or, as Lane (2012) puts it:

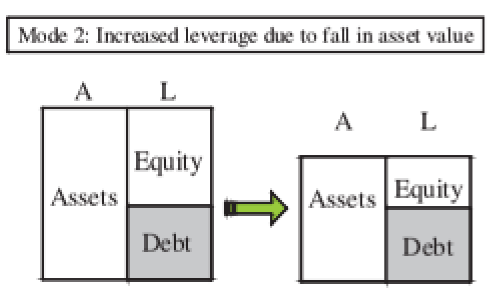
> "In conclusion, the origin and propagation of the European sovereign debt crisis

can be attributed to the flawed original design of the euro. In particular, there was an incomplete understanding of the fragility of a monetary union under crisis conditions, especially in the absence of banking union and other European-level buffer mechanisms. Moreover, the inherent messiness involved in proposing and implementing incremental multicountry crisis management responses on the fly has been an important destabilizing factor throughout the crisis." (Lane 2012, 65).

2.1.3 Sovereign exposure and credit rationing in the Eurozone

If the pressure on the public debt of some European countries in the European sovereign debt crisis was fuelled by higher public debt levels aggravated by national automatic stabilizers and expectations of a bailing out of the banking sector, movements of the interest rates on public debt also had an effect on the banking sector. Indeed, a large literature identifies and discusses the two-way link between the health of the banking sector and perceived default risks of their domestic sovereign debt (Altavilla, Pagano, and Simonelli 2017; De Marco 2019; Popov and Van Horen 2015; Gennaioli, Martin, and Rossi 2014; Mody and Sandri 2012; Acharya, Drechsler, and Schnabl 2014; Reinhart and Rogoff 2011). The existence of a negative effect of a deterioration of the perspective of default of a sovereign on its debt for the banking sector and banks' activities is, for a large part, based on evidences of a negative impact of a devaluation of a bank's balance sheet on its supply of credit money (Adrian and Shin 2014; 2010; Huizinga and Laeven 2019; Popov and Udell 2012; Chava and Purnanandam 2011; Popov and Van Horen 2015).

Figure 3: *Increased leverage due to fall in asset value.*

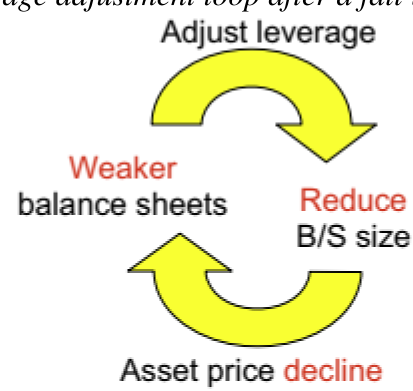


Source: Adrian and Shin (2014, figure 1)

In particular, Adrian and Shin (2010) show that, when balance sheets are continuously marked to market (MTM), a decline in the value of the assets present in the balance sheets will cause agents' net worth to decline, and thus their leverage ratio, the ratio of their equity capital to total debt, to increase, as illustrated in Figure 4. As it is in the nature of banks and other financial intermediaries to be highly leveraged firms (Fullwiler 2013), these agents are very sensible to fluctuations in assets prices and their leverage ratio tends to vary in the same direction as the prices of the assets composing their balance sheets (Adrian and Shin 2010).

What's more, because financial agents adjust their leverage ratio actively along the business cycle, rendering their leverage ratio procyclical, that is, high during booms and low in slowdowns, negative shocks affecting the assets of their balance sheets will drive them to reduce the size of their balance sheet to protect their leverage ratio and, by that, their credit rating, and thus their lending activities (Adrian and Shin 2010; 2014). As Adrian and Shin show that commercial banks seem to target a fixed leverage ratio, any movement in the prices of the assets present in their balance sheet will result in a similar movement in the size of their balance sheet. In a macroeconomic downturn affecting most of financial agents, this reaction to assets' prices decline generates a deflationary loop of falling assets' prices and shrinking balance sheets in the financial sector, as shown in Figure 5 (Adrian and Shin 2010; 2014).

Figure 4: *Leverage adjustment loop after a fall in assets' prices.*



Source: Adrian and Shin (2010, figure 6)

As adjustments of the balance sheets' sizes are even stronger due to the procyclicality of leverage, this creates the "possibility of feedbacks . . . the adjustment of leverage and price changes will reinforce each other in an amplification of the financial cycle . . . there is the potential for a feedback effect in which stronger balance sheets feed greater demand for the asset, which in turn raises the asset's price and lead to stronger balance sheets" (2010, 423), or, in this case, weaker balance sheets feed lower demand for the asset, reducing its price and further weakening the agent's balance sheet (Adrian and Shin 2010). Similarly, Huizinga and Laeven (2019) find that loan loss provisions of banks show a procyclical behaviour, with provisions being lower in good times and higher at the lows of the business cycle, creating a procyclical credit supply. In the particular context of the Eurozone:

> "Provisioning procyclicality is particularly problematic in a monetary union where a single monetary policy is ill equipped to absorb shocks transmitted through financial linkages and divergent domestic economic and financial cycles, and the burden of adjustment falls primarily on fiscal and (macro)prudential policies" (Huizinga and Laeven 2019, 5).

Popov and Udell (2012) and Chava and Purnanandam (2011) find that shocks on the balance sheets of banks affect their supply of credit, and in particular for medium and small enterprises, with domestic and foreign negative financial shocks affecting banks' lending. Popov and Van Horen (2015) further discuss the impact of sovereign stress on banks lending via their sovereign exposure in the context of the European sovereign debt crisis. They find that over-exposed European banks reduced their supply of credit as a consequence of an increased risk of default of their sovereign due to, on the one hand, the direct weakening impact of falling government bonds prices if they are MTM in their balance sheet, or, on the other hand, the heightened difficulty to secure short term liquidity via the use of these public bonds as collateral, even if they are not MTM (Popov and Van Horen 2015). This effect of a negative shock on the prices of government bonds on the domestic banking sector lending activities is even stronger in the Eurozone, as banks seem to present an important home bias, and so for a number of reasons, often divided between hypotheses of a 'carry trade' behaviour by banks and a 'moral suasion' by their sovereign (Battistini, Pagano, and Simonelli 2014; Acharya and Steffen 2015).

During the European sovereign debt crisis, this home bias was increased, even, and maybe more surprisingly, for countries for which the risk of sovereign default was the greatest. Acharya and

Steffen (2015) find that not only did banks chose to hold more government bonds from the EU's peripheral countries as the spread widened, between Marc and December 2010, but they did partly by selling French and German bonds, some of the safest at the time in the EMU. They find three reasons for this: badly capitalized banks looking for high-return low-risk assets were driven towards high interest rates government bonds to meet their capital requirements at a time when these bonds were still given a zero risk weight in the regulations; a home bias of banks motivated by a bet on the sustainability of their own sovereign, as its default would put their own survivability at risk anyway; and suasion by their domestic government to purchase more of its bonds in order to support demand and keep yields low (Acharya and Steffen 2015). Battistini, Pagano and Simonelli (2014) find that, since the GFC, and during the European sovereign debt crisis, banks home bias towards their domestic sovereign debt and the Credit Default Swap (CDS) premia on this debt, indicative of its risk of default, have moved accordingly, with banks increasing their sovereign exposure when the risk of default appears to be higher. By decomposing sovereign risk into its country-specific component and a systemic risk component regarding the stability of the whole union, they find that not only peripheral countries' banks tend to increase their sovereign exposure when the country-specific risk of their sovereign increases, but also that banking sectors in both central and peripheral countries increase sovereign exposure 'turn back home' in response to an increase in the EMU-wide risk (Battistini, Pagano, and Simonelli 2014). In the case of the European sovereign crisis, both government intervention, under the hypothesis of a 'moral suasion', and banks strategic decisions, under the hypothesis of a 'carry trade', seemed to have played a role in increasing the home bias of European banks in their holding of sovereign debt.

The link between sovereign debt and banking sector lending activities created a vicious loop as worsening conditions in financial markets saw sovereign default risks increase, which further damaged the situation of banks. Weakened banks further ration credit, slowing down even more economic activity and reducing income of the government, aggravating the prospects for its finances. This dynamics of a co-degradation of public finances and the banking sector is referred to in the literature as the *doom loop* or *diabolic loop*.

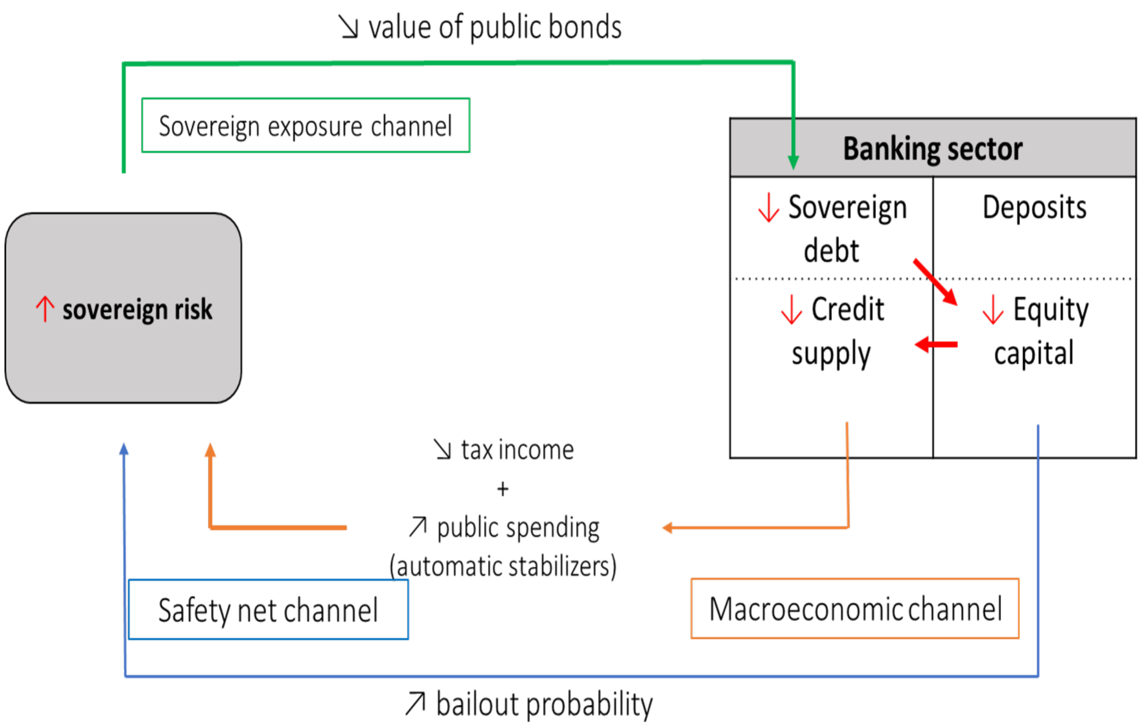
2.1.4 Dynamics of the diabolic loop

On these bases, a substantial literature has developed regarding the possible feedback loops between sovereign stress and credit rationing by banks in the Eurozone. This literature calls these dynamics the "diabolic loop", and its mechanism is can be described as follows:

> "First, the increase in bank leverage raises the probability that the home sovereign will bail-out the bank's bondholders ... Second, in response to their increase in leverage, banks shed assets in an attempt to return to their target leverage ratio ... This includes cuts in loans to firms and households; the attendant credit crunch reduces economic activity ... These two channels—through government bail-outs and the real economy— respectively increase the public debt stock and reduce tax revenue, exacerbating the initial rise in sovereign risk and completing the diabolic loop." (Brunnermeier et al. 2017, 180)

Dell'Ariccia et al. (2018) offer a rather comprehensive discussion of the sovereign-bank nexus and its transmission channels, identifying three: a "sovereign exposure channel", a "safety net channel", and a "macroeconomic channel" (Dell'Ariccia et al. 2018, 5). For different reasons explored above, banks, and in particular European banks, display a large exposure to their domestic sovereign debt, making them very sensitive to shocks in the domestic sovereign risk, with substantial consequences for their provision of credit to the economy and to their sovereign. The safety net channel concerns the role of lender or investor of last resort that central banks and, in particular in the Eurozone, governments play with regard to the banking sector. This channel works both ways: an increase in the sovereign risk reduces the government's capacity to bailout fragilized banks and thus worsens the prospects for the financial sector, while a decline in the health of the financial sector implies a potential or actual bailout by public authorities and thus important additional public expenditures, aggravating the expectations regarding sovereign default. Finally, the macroeconomic channel relates to the negative impact on economic activity of the decline in the banking sector's health and of the increase in the sovereign risk, which imply lower supply of financing to the private sector because of credit rationing by banks, and lower support to the economy by the state, as austerity policies are undertaken to secure public finances (Dell'Ariccia et al. 2018). Figure 5 displays a summary of these dynamics, and thus of the diabolic loop between sovereign risk and banking sector.

Figure 5: *The diabolic loop*



Source: Author's own elaboration from Brunnermeier et al. (2017, figure 1)

2.1.5 European policies of financial instability

Discussing political action regarding sovereign debt in the Eurozone wouldn't be possible without presenting the institutional changes consequential to the European sovereign debt crisis. The flawed architecture of the Eurozone and its vulnerability to crises was highlighted during the European sovereign debt crisis, and, as a response, some institutional features were added to the design of the EMU. In particular, between 2010 and 2012, the members of the EU agreed on the creation of a series of stability funds (like the European Financial Stability Facility and the European Financial Stabilization Mechanism) aimed mainly at ensuring emergency funding to states or financial actors of the Eurozone during the crisis, some of them later made permanent (like the European Stability Mechanism).

The joint IMF-EU bailouts of mainly Greece, Ireland and Portugal, who found themselves unable of borrowing on financial markets, sparked the creation of two institutions: the European Financial Stability Facility (EFSF), capable of issuing debt up to €440 billion backed by the German Finance Agency to provide financing to members of the EMU, and the European Financial Stabilization Mechanism (EFSM), issuing debt guaranteed by the European Commission up to €60 billion. The three years funding granted to Greece, Ireland and Portugal were conditioned on the implementation of structural reforms and austerity policies. This, among other things, posed several problems threatening the success of the funding programs, as explained by Lane (2012). The programs were too short, spreading only over three years while the adjustment needed for the beneficiaries to be able to sustainably fund themselves on financial markets would take much longer, the austerity measures planned in the program was likely to threaten their banking sectors by rising the private sector's risk of default, the fiscal targets contained in the program were not conditional on the Eurozone economic performances, making them impossible to obtain in the case of a euro-wide economic slowdown, the penalty premium on the IMF part of the loans made it harder for these countries to repay them, and, finally, the program relied on the government to bailout the domestic banking sector, increasing the sovereign-bank nexus (Lane 2012). And, for Lane (2012) to conclude: "it may be fair to characterize Europe's efforts to address its sovereign debt problem as makeshift and chaotic, at least through the middle of 2012" (Lane 2012, 60).

The EFSF and the EFSM were later merged into a single institution, the European Stability Mechanism (ESM), which now serves as the permanent provisioner of financing to distress Eurozone countries, although the EFSF is still in existence but doesn't grant any additional loan. The ESM can loan up to €500 billion, it finances itself on financial markets guaranteed by its capital of up to €700 billion made of the contributions of the countries of the EMU. The access to the ESM funding program is, as for the EFSF, conditional on the undertaking of policy measures negotiated in a 'Memorandum of Understanding' (MoU) between the beneficiary and the European Commission, and aimed at ensuring that the beneficiary regains lasting access to financial markets. Hence, the ESM funding program does not escape the critic made by Lane (2012), and, as De Grauwe (2013) argues, steams from a misunderstanding of the causes of the European sovereign debt crisis, which are not to be found in having allowed excessively large public deficits but rather the accumulation of private debt, the explosion of which in the GFC forced sovereign to increase let their debt to GDP ratio grow (De Grauwe 2013).

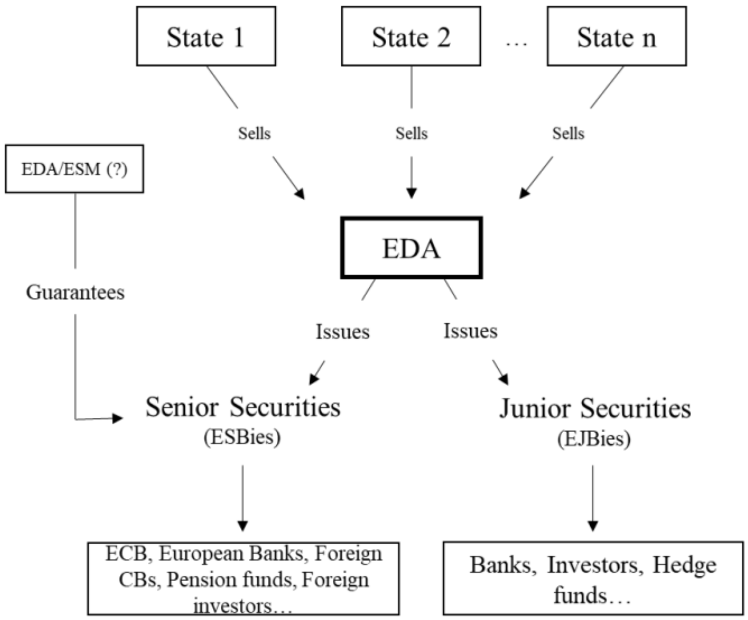
2.2 Breaking the diabolic loop: Eurobonds as an European safe asset

During and in the aftermath of the European sovereign debt crisis, a number of eurobonds propositions have been put forward, with varying degrees of solidarity between participating countries, different institutional setup and different objectives. Indeed, while some propositions do not feature any sort of solidarity mechanism, or joint liability, between participants (Brunnermeier et al., 2011; Junker and Tremonti, 2010; Ubide, 2015), other eurobonds scheme include the joint guarantee of part, or the entirety of the debt issued as eurobonds (De Grauwe and Moesen 2009; Delpla and Von Weizsäcker, 2010; Palley, 2011). Also, if some eurobonds proposals require the introduction of dedicated and new institutional features in the current design of the Eurozone, or the revision of the European treaties (see, for example, Palley, 2011), an important number of them hope to be able to rely on the existing architecture of the EU for the issuance of eurobonds (Brunnermeier et al. 2011; Ubide 2015). Lastly, while some eurobonds propositions rely on eurobonds to ease up market pressures on some European countries public debt, allowing them more fiscal space and capacities to deal with the problems they might be facing, or to bail them out, in times of crisis (De Grauwe and Moesen, 2009; De Palley 2011), other see eurobonds as a missing institutional feature in the normal architecture of the Eurozone (Brunnermeier et al. 2011; Ehnts 2016; Ehnts and Höfgen, 2019).

Among the latter, a substantial amount of papers focus on the role eurobonds would play as a euro-wide 'safe asset' in the Eurozone's financial and banking system (Brunnermeier et al. 2011, 2016, 2017; ESRB 2018). Brunnermeier et al. (2011, 2016, 2017) proposition, proposes the issuance of European Safe Bonds (ESBies), or Sovereign Bond-Backed Securities (SBBS) (see, ESRB 2018), notably as a mean to fight the destabilizing dynamics persisting in the Eurozone's financial system, as described in the diabolic loop. The idea behind the ESBies proposal is to have a institution, sometimes referred to as the 'European Debt Agency' (Brunnermeier et al. 2011), buy sovereign bonds from the governments of the Eurozone at some fixed weight (such as the share of their GDP in the Eurozone's GDP), and to use these bonds as collateral to issue two types of securities: the safer and senior ESBies and a riskier junior one (see. Financial actors would then buy these securities according to their desired level of risk and return for their investment, as displayed in Figure 6. ESBies would be issued up to 60 percent of the Eurozone's GDP, and their safeness would be based on the pooling of assets with different risks and the 'tranching' of the securities, along with the capital guarantee of the senior tranches (from an initial capital contribution of the member states), making the ESBies "considerably safer than German bonds" (Brunnermeier et al., 2011, 11). The ESBies thus issued would progressively replace domestic sovereign bonds in the balance sheets of financial actors, especially banks, reducing their domestic sovereign exposure and thus weakening the mechanisms at play in the diabolic loop. This mechanism, as well as the role played by eurobonds as a safe asset in stabilizing the Eurozone's financial system, will be the one of the main subjects of our inquiry and of the model presented in the next section[1].

[1] A more comprehensive presentation and discussion of eurobonds proposals, including the ESBies proposal, from which this development was partially inspired, can be found in Quero, Tsolakidis and Vuilletet (2019)

Figure 6: *The ESBies issuance scheme*



Source: Quero, Tsolakidis and Vuilletet (2019, figure 1)

3 A post-Keynesian stock-flow consistent model of the sovereign-bank nexus

In this section, we model and analyze the emergence of a diabolic loop between a degradation of banks' balance sheets and the public debt of the banks' sovereign in a stock-flow coherent framework[2]. An SFC model describing these dynamics would need to include two countries in a monetary union, a smaller or peripheral one and a larger and central one, commercial banks purchasing public bonds from both governments and rationing credit following movements in their balance sheet. We find a good basis for such a model in the two-country models developed in Duwicquet and Mazier (2008, 2012) and Duwicquet et al. (2016, 2018)[3].

[2]The complete set of equations of the model, the balance sheet and transaction flow matrices, as well as a description of each variable and parameter of the model, is available in the appendix.

[3]A complete version of this base model is to be found in Duwicquet et al. (2016)

3.1 The fundamental structure of the model

The model presented in this paper and used for the simulations below is largely inspired by the model displayed in Duwicquet et al. (2018, hereafter DMS 2018). The DMS 2018 model is a two-country model of a monetary union with exchange rate misalignments and credit rationing discussing the impact of the introduction of eurobonds and other international intra-union solidarity mechanisms between a larger and a smaller country. If our model will make good use of these features, it will ignore exchange rate and competitivity issues as it is not directly related to our inquiry and will instead take some of the features of the model from an earlier version of the model DMS 2018 (Duwicquet et Mazier, 2012).

3.1.1 Households

Income

$$y_n = c_n + inv_n + gn_n + x_n - im_n \tag{1}$$

$$y_s = c_s + inv_s + gn_s + x_s - im_s \tag{2}$$

with y the national income in real term, c households consumption, inv investment made by firms, gn national government expenditures, x the exports and im the imports

Real disposable income

$$ydh_n = w_n + id * bd_n(-1) + divh_n^n + divh_n^s + bp_n * (1 - \delta_{bn}) - t_n \tag{3}$$

$$ydh_s = w_s + id * bd_s(-1) + divh_s^s + divh_s^n + bp_s * (1 - \delta_{bs}) - t_s \tag{4}$$

where *ydh* is the real disposable income of households, *w* the wage share, *id* the interest rate on bank depostis, *bd* households bank deposits, *divh* the dividends distributed by firms to households, *bp* are bank profits, δ_b the rate of undistributed bank's profit so that $bp*(1-\delta_b)$ is the amount of banks' profit received by households, *t* the personal income tax

Imports

$$log(im_n) = \mu_{0n} + \mu_{1n} log(y_n) \tag{5}$$

$$log(im_s) = \mu_{0s} + \mu_{1s} log(y_s) \tag{6}$$

with *im* the imports and *y* the national income in real term

Exports

$$x_n = im_s \tag{7}$$

$$x_s = im_n \tag{8}$$

with *x* the exports and *im* the imports

As in the DMS 2018 model, households from both countries consume from their income and a portion of their wealth, and allocate their savings between deposits, cash money, public bonds and equities from both countries. The disposable income of households is thus composed of wages paid by firms, interest on households' deposits, interest on the public bonds owned, dividends received from their ownership of equities and a share of banks' profits, as banks retain only a fraction of their profits and distribute the rest to households who own them in. The ownership of banks by households is featured in a very simple manner in our model and completely absent of the DMS 2018 model. Households have claims on the profits of the commercial banks of their country, in proportions determined exogenously and for reasons developed below. As in the DMS 2018 model, households in our model also pay taxes from their income and from wages, but they do not receive social benefits. Indeed, in order to simplify the model, and focus its structure on the dynamics we propose to investigate in this paper, we simplified the tax structure of the model compared to the DMS 2018 model, and as found in earlier version of it (Duwicquet and Mazier, 2012). Our model also presents the same portfolio behaviour of households than the DMS 2018 model, following the arbitrage method developed by Godley (1999) and Tobin (1969), and described in Godley and Lavoie (2007). In this regard, the matrix form of the portfolio behaviour of our households can be written as follows:

$$\begin{bmatrix} bd_n \\ b_n^n \\ b_n^s \\ eh_n^n \\ eh_n^s \end{bmatrix} = \begin{bmatrix} v_{0nnd} \\ v_{0nnb} \\ v_{0nsb} \\ v_{0nne} \\ v_{0nse} \end{bmatrix} .vh_n + \begin{bmatrix} v_{1nnd} & v_{2nnd} & v_{3nnd} & v_{4nnd} & v_{5nnd} \\ v_{1nnb} & v_{2nnb} & v_{3nnb} & v_{4nnb} & v_{5nnb} \\ v_{2nsb} & v_{1nsb} & v_{3nsb} & v_{4nsb} & v_{5nsb} \\ v_{1nne} & v_{2nne} & v_{3nne} & v_{4nne} & v_{5nne} \\ v_{2nse} & v_{1nse} & v_{3nse} & v_{4nse} & v_{5nse} \end{bmatrix} \cdot \begin{bmatrix} id \\ rb_n \\ rb_s \\ re_n \\ re_s \end{bmatrix}$$

with b the demand for bonds by households and eh the demand for firms' equities by households

This gives the equations (17) to (26) determining the allocation of households savings between financial assets and deposits, with the latter being written as a residual of households savings (equations (25) and (26)) after the purchasing of financial assets and the demand of cash money, determined as a share of total households consumption. As often seen in SFC models, only the demand for assets is written here, the supply of assets is assumed to perfectly adjust to demand (Godley and Lavoie, 2007). As the prices of bonds and equities can change between periods, households realize capital gains (equations (29) and (30)), which increases (or decreases, if households make capital losses) their purchasing power as defined by their Haig-Simons disposable income (equations (9) and (10)).

Haig-Simons disposable income

$$yh_n = ydh_n + cgh_n \tag{9}$$

$$yh_s = ydh_s + cgh_s \tag{10}$$

where *yh* is the Haig-Simons real disposable income of households, *cgh* the capital gains of households and *ydh* is the real disposable income of households

Personal income tax

$$t_n = \theta_n[w_n + id * bd_n(-1) + bp_n * (1 - \delta_b n) + b_n^n + b_n^s + divh_n^n + divh_n^s] \tag{11}$$

$$t_s = \theta_s[w_s + id * bd_s(-1) + bp_s * (1 - \delta_b n) + b_s^s + b_s^n + divh_s^s + divh_s^n] \tag{12}$$

with *t* the personal income tax,*w* the wage share, *id* the interest rate on bank depostis, *bd* households bank deposits, *divh* the dividends distributed by firms to households, *bp* are bank profits, δ_b the rate of undistributed bank's profit so that *bp*(1-*δ_b*)* is the amount of banks' profit received by households

Households consumption

$$c_n = a_{0n} + a_{1n} yh_n + a_{2n} vh_n(-1) \tag{13}$$

$$c_s = a_{0s} + a_{1s} yh_s + a_{2s} vh_s(-1) \tag{14}$$

with *vh* the net wealth of households, *c* households consumption and *yh* is the Haig-Simons real disposable income of households

Cash held by households

$$hh_n = \lambda_0 c_n \tag{15}$$

$$hh_s = \lambda_0 c_s \tag{16}$$

with *hh* the cash held households and *c* households consumption

Demand for equities by households

$$eh_n^n = ([(v_{0nne} - v_{1nnb} rb_n - v_{2nnb} rb_s - v_{3nne} * id + v_{4nne} re_n - v_{5nne} re_s) vh_n])/(pe_n) \tag{17}$$

$$eh_n^s = ([(v_{0nse} - v_{1nsb} rb_s - v_{2nsb} rb_n - v_{3nne} * id - v_{4nse} re_n + v_{5nse} re_s) vh_n])/(pe_s) \tag{18}$$

$$eh_s^s = ([(v_{0sse} - v_{1ssb} rb_s - v_{2ssb} rb_n - v_{3nne} * id - v_{4sse} re_n + v_{5sse} re_s) vh_s])/(pe_s) \tag{19}$$

$$eh_s^n = ([(v_{0sne} - v_{1snb} rb_n - v_{2snb} rb_s - v_{3nne} * id + v_{4sne} re_n - v_{5sne} re_s) vh_s])/(pe_n) \tag{20}$$

Demand for public bonds by households

$$b_n^n = \frac{[(v_{0nnb} + v_{1nnb} rb_n - v_{2nnb} rb_s - v_{3nnb} id - v_{4nnb} re_n - v_{5nnb} re_s) vh_n]}{pb_n} \tag{21}$$

$$b_n^s = \frac{[(v_{0nsb} + v_{1nsb} rb_s - v_{2nsb} rb_n - v_{3nsb} id - v_{4nsb} re_n - v_{5nsb} re_s) vh_n]}{pb_s} \tag{22}$$

$$b_s^s = \frac{[(v_{0ssb} + v_{1ssb} rb_s - v_{2ssb} rb_n - v_{3ssb} id - v_{4ssb} re_n - v_{5ssb} re_s) vh_s]}{pb_s} \tag{23}$$

$$b_s^n = \frac{[(v_{0snb} + v_{1snb} rb_n - v_{2snb} rb_s - v_{3snb} id - v_{4snb} re_n - v_{5snb} re_s) vh_s]}{pb_n} \tag{24}$$

with *b* the demand for bonds by households and *eh* the demand for firms' equities by households, *rb* the interest rate of public bonds, *pb* the price of public bonds, *pe* the price of equities and *re* the rate of return on equities

Variations of bank deposits held by households

$$\Delta bd_n = ydh_n - c_n - pb_n * \Delta b_n^n - pb_s * \Delta b_n^s - pe_n * \Delta eh_n^n - pe_s * \Delta eh_n^s - \Delta hh_n \tag{25}$$

$$\Delta bd_s = ydh_s - c_s - pb_n * \Delta b_s^n - pb_s * \Delta b_s^s - pe_s * \Delta eh_s^s - pe_n * \Delta eh_s^n - \Delta hh_s \tag{26}$$

with *bd* households bank deposits*, ydh* is the real disposable income of households, *c* households consumption, *pb* is the price of public bonds and *b* the public bonds held by households, *pe* is the price of equities and *eh* the demand for firms' equities by households, *hh* the cash held households

Households wealth

$$vh_n = bd_n + pb_n * b_n^n + pb_s * b_n^s + pe_n * \Delta eh_n^n + pe_s * \Delta eh_n^s + hh_n \quad (27)$$

$$vh_s = bd_s + pb_n * b_s^n + pb_s * b_s^s + pe_s * \Delta eh_s^s + pe_n * \Delta eh_s^n + hh_s \quad (28)$$

with *vh* the net wealth of households, *bd* households bank deposits, *pb* is the price of public bonds and *b* the public bonds held by households, *pe* is the price of equities and *eh* the demand for firms' equities by households, *hh* the cash held households

Households capital gains

$$cgh_n = \Delta pb_n * b_n^n(-1) + \Delta pb_s * b_n^s(-1) + \Delta pe_n * eh_n^n(-1) + \Delta pe_s * eh_n^s(-1) \quad (29)$$

$$cgh_s = \Delta pb_n * b_s^n(-1) + \Delta pb_s * b_s^s(-1) + \Delta pe_n * eh_s^n(-1) + \Delta pe_s * eh_s^s(-1) \quad (30)$$

with *cgh* the capital gains of households, *pb* is the price of public bonds and *b* the public bonds held by households, *pe* is the price of equities and *eh* the demand for firms' equities by households

3.1.2 Firms

In the DMS 2018 model, firms accumulate both real and financial assets. Because it does not relate directly to the questions this master thesis proposes to discuss, and because it helps simplifying the model, contrary to the DMS 2018 model, here firms do not pay taxes, and instead behave as described in an earlier version of the model (Duwicquet and Mazier, 2012). Their real investment decisions are driven by retained profits determining their internal financing capacities, by the rate of growth of demand, with negative impacts of their own indebtedness and of the cost of external financing. As in Duwicquet and Mazier (2012), we distinguish between desired and restricted investment: firms have a certain desired rate of growth of capital which may or may not be within their financing capabilities. The *realized* investment is thus the minimum between the level of investment firms desire, and the level of investment they can finance (equations (39) and (40)). Investment is financed externally through loans from banks and equities issued, and internally by retained earnings. Actual investment is determined as the minimum between desired and restricted investment. A particularity of our model with regard to the DMS 2018 model is that the supply of credit money that firms are able to foster is not always equal to their demand for credit money. The latter is the residual finance required on top of retained earnings and after the issuance of equities to finance desired investment, while the former is the demand for credit money rationed by banks (for the determination of credit rationing, see section 3.2 and equations (116) and (117)). As in the DMS 2018 model, firms can address their credit demand to banks of both countries, with banks from the larger country being fully financed nationally, but in our model the share of the total of credit demanded addressed to banks from country N by firms from country S is determined by a fixed parameter (ε) representing the international status of firms from country S and their ability to demand foreign credit. This simplification was useful in order to introduce credit-flow specific lender's risks as defined below in equations (113) to (121).

Financial investment by firms is again determined by the portfolio allocation method of Godley (1999) and Tobin (1969), with a positive impact of the rate of return on equities and the rate of profit, reflecting the global state of affairs, and an arbitrage between domestic and foreign equities ((Duwicquet and Mazier, 2012). As in the DMS 2018 model, the price of equities grows exogenously, the rate of return on equities is determined by both dividends and capital gains and issuance of new equities responds fully to the demand from firms and households of both countries. Dividends distributed are the residual of total profits not retained by firms, as determined by the rate of undistributed profits (sf). Income distribution is assumed to be exogenously determined as the wage share is a fixed share of total income.

Retained earnings

$$up_n = [y_n - w_n - rl_n bl_n^n(-1) - rl_s bl_s^n(-1) - div_n + dive_n^n + dive_n^s] \tag{31}$$

$$up_s = [y_s - w_s - rl_s bl_s^s(-1) - rl_n bl_n^s(-1) - div_s + dive_s^s + dive_s^n] \tag{32}$$

where *up* are firms' retained earnings, *bl* the loans supplied by private banks to firms, *rl* the interset rate of bank loans to firms, *div* the dividends distributed by firms, *dive* the dividends received by firms on their holding of equities

Accumulation rate

$$g_n = k_{0n} + k_{1n}\frac{up_n(-1)}{k_n(-2)} + k_{2n}\frac{(\Delta y_n)}{y_n(-1)} - k_{3n}\frac{bl_n(-1)}{k_n(-1)} - k_{4nn} rl_n^n - k_{4sn} rl_s^n \tag{33}$$

$$g_s = k_{0s} + k_{1s}\frac{up_s(-1)}{k_s(-2)} + k_{2s}\frac{(\Delta y_s)}{y_s(-1)} - k_{3s}\frac{bl_s(-1)}{k_s(-1)} - k_{4ss} rl_s^s - k_{4ns} rl_n^s \tag{34}$$

where *g* the accumulation rate, *k* is firms' fixed capital stock, *bl* the loans supplied by private banks to firms, *rl* the interset rate of bank loans to firms, *up* are firms' retained earnings

Investment (desired)

$$ind_n = g_n k_n(-1) \tag{35}$$

$$ind_s = g_s k_s(-1) \tag{36}$$

with *ind* firms' desired investment, *g* the accumulation rate, *k* is firms' fixed capital stock

Investment (restricted)

$$inr_n = \Delta bl_n + up_n + pe_n * \Delta e_n - pe_n * \Delta ee_n^n - pe_s * \Delta ee_n^s \tag{37}$$

$$inr_s = \Delta bl_s + up_s + pe_s * \Delta e_s - pe_n * \Delta ee_s^n - pe_s * \Delta ee_s^s \tag{38}$$

with *inr* firms' restricted investment, *e* the equities issued by firms, *ee* demand for equities by firms, *bl* the loans provided to firms by banks, *up* are firms' retained earnings, *pe* is the price of equities

Investment realized

$$inv_n = min(inr_n, ind_n) \tag{39}$$

$$inv_s = min(inr_s, ind_n) \tag{40}$$

with *inv* investment made by firms, *inr* firms' restricted investment, *ind* firms' desired investment

Variations of firms' fixed capital stock

$$\Delta k_n = inv_n - \delta_n k_n(-1) \tag{41}$$

$$\Delta k_s = inv_s - \delta_s k_s(-1) \tag{42}$$

where k is firms' fixed capital stock, *inv* investment made by firms, k is firms' fixed capital stock

Loans (demanded)

$$l_n = bl_n(-1) + inv_n - up_n - pe_n \Delta e_n + pe_n \Delta ee_n^n + pe_s \Delta ee_n^s \tag{43}$$

$$l_s = bl_s(-1) + inv_s - up_s - pe_s \Delta e_s + pe_s \Delta ee_s^s + pe_n \Delta ee_s^n \tag{44}$$

$$\Delta l_n^n = \Delta l_n - \Delta l_s^n \tag{45}$$

$$\Delta l_s^s = \Delta l_s - \Delta l_n^s \tag{46}$$

$$l_s^n = 0 \tag{47}$$

$$l_n^s = \varepsilon * l_s \tag{48}$$

where l are the loans demanded by firms to private banks, ee is demand for equities by firms, pe is the price of equities, k is firms' fixed capital stock, e the equities issued by firms, up are firms' retained earnings, bl the loans provided to firms by banks, *inv* investment made by firms

Demand for equities by firms

$$ee_n^n = \frac{[(f_1 nnre_n - f_2 nnre_s + f_3 nn(up_n)/(k_n(-1)) + f_0 nn)(k_n + pe_n ee_n^n + pe_s ee_n^s)]}{pe_n} \tag{49}$$

$$ee_n^s = \frac{[(f_1 nsre_s - f_2 nsre_n + f_3 ns(up_n)/(k_n(-1)) + f_0 ns)(k_n + pe_n ee_n^n + pe_s ee_n^s)]}{pe_s} \tag{50}$$

$$ee_s^n = \frac{[(f_1 snre_n - f_2 snre_s + f_3 sn(up_s)/(k_s(-1)) + f_0 sn)(k_s + pe_n ee_s^n + pe_s ee_s^s)]}{pe_n} \tag{51}$$

$$ee_s^s = \frac{[(f_1 ssre_s - f_2 ssre_n + f_3 ss(up_s)/(k_s(-1)) + f_0 ss)(k_s + pe_n ee_s^n + pe_s ee_s^s)]}{pe_s} \tag{52}$$

where *ee* is demand for equities by firms, *pe* is the price of equities, *k* is firms' fixed capital stock and *up* are firms' retained earnings

Prices of equities

$$pe_n = \sigma_n pe_n(-1) \tag{53}$$

$$pe_s = \sigma_s pe_s(-1) \tag{54}$$

where *pe* is the price of equities

Rate of return of equities

$$re_n = \frac{\Delta pe_n}{pe_n(-1)} + \frac{div_n}{pe_n(-1)e_n(-1)} \tag{55}$$

$$re_s = \frac{\Delta pe_s}{pe_s(-1)} + \frac{div_s}{pe_s(-1)e_s(-1)} \tag{56}$$

with *re* the rate of return on equities, *pe* the price of equities, *e* the equities issued by firms, *div* the dividends distributed by firms

Number of equities

$$e_n = eh_n^n + ee_n^n + eh_s^n + ee_s^n \tag{57}$$

$$e_s = eh_n^s + ee_n^s + eh_s^s + ee_s^s \tag{58}$$

where *ee* is demand for equities by firms, *e* the equities issued by firms, *eh* the demand for firms' equities by households

Dividends distributed by firms

$$div_n = (1 - sf)[y_n(-1) - w_n(-1) - rl_n bl_n^n(-2) - rl_s bl_s^n(-2)] \tag{59}$$

$$div_s = (1 - sf)[y_s(-1) - w_s(-1) - rl_s bl_s^s(-2) - rl_n bl_n^s(-2)] \tag{60}$$

$$dive_n^n = div_n(\frac{ee_n^n(-1)}{e_n(-1)}) \tag{61}$$

$$divh_n^n = div_n(\frac{eh_n^n(-1)}{e_n(-1)}) \tag{62}$$

$$dive_s^n = div_n(\frac{ee_s^n(-1)}{e_n(-1)}) \tag{63}$$

$$divh_s^n = div_n(\frac{eh_s^n(-1)}{e_n(-1)}) \tag{64}$$

$$dive_s^s = div_s(\frac{ee_s^s(-1)}{e_s(-1)}) \tag{65}$$

$$divh_s^s = div_s(\frac{eh_s^s(-1)}{e_s(-1)}) \tag{66}$$

$$dive_n^s = div_s(\frac{ee_n^s(-1)}{e_s(-1)}) \tag{67}$$

$$divh_n^s = div_s(\frac{eh_n^s(-1)}{e_s(-1)}) \tag{68}$$

with *div* the dividends distributed by firms, *dive* the dividends received by firms on their holding of equities, *divh* the dividends distributed by firms to households, *ee* demand for equities by firms, *e* the equities issued by firms, *eh* the demand for firms' equities by households, *bl* the loans provided to firms by banks, *rl* the interest rate on bank loans

Firms' capital gains

$$cge_n = \Delta pe_n ee_n^n(-1) + \Delta pe_s ee_n^s(-1) \tag{69}$$

$$cge_s = \Delta pe_n ee_s^n(-1) + \Delta pe_s ee_s^s(-1) \tag{70}$$

where *cge* is the capital gains of firms, *ee* demand for equities by firms, *pe* the price of equities

Firms wealth

$$v_n = k_n + pe_n ee_n^n + pe_s ee_n^s - bl_n - pe_n e_n \tag{71}$$

$$v_s = k_s + pe_n ee_s^n + pe_s ee_s^s - bl_s - pe_s e_s \tag{72}$$

where v is firms' net wealth, k is firms' fixed capital stock, ee demand for equities by firms, pe the price of equities, e the equities issued by firms, bl the loans provided to firms by banks

Wage share

$$w_n = r_0 y_n \tag{73}$$

$$w_s = r_0 y_s \tag{74}$$

where w is the wage share and y is national income in real term

3.1.3 Banks

In the DMS 2018 model, banks hold the deposits of households, of which they also hold a share in cash money, reflecting reserve requirements, and pay an interest on them determined by banks' mark-up on the interest on central bank advances (equation (77)). They provide loans to firms without restriction at an interest rate varying with 'financial conditions' determined by the interest rate of treasury bills issued by their domestic government. The interest rate on loans (equations (78) and (79)) made by private banks move with a lag with the interest rate on domestic Treasury bills. They also retain all of their profits after having paid some of it in taxes to their domestic government, and refinance themselves to the central bank, if necessary to finance their operations. In our model, however, things are different. Banks do not supply all of the credit demanded by firm but instead ration credit in terms of quantities, the details of which are the subject of the next section. Also, in the model detailed here, banks do not retain all of their profits, but instead distribute an exogenously determined share of it to domestic households who own them. This transformation was necessary in order to allow the diabolic loop dynamics to work, as, in the original version of the DMS 2018 model, the net value of banks tends to grow too rapidly and continuously.

Cash held by banks

$$h_n = \lambda_n bd_n \tag{75}$$

$$h_s = \lambda_s bd_s \tag{76}$$

where h is the cash held by banks (capital requirements) and bd the bank depostis of households

Interest rate on deposits

$$id = ib - m_2 b \tag{77}$$

where ib is the interest rate on central bank advances to banks and id the interest rate on bank deposits

Interest rate on loans

$$rl_n = rl_n(-1) * (1 - a) + a * r_n(-1) \tag{78}$$

$$rl_s = rl_s(-1) * (1-a) + a * r_s(-1) \tag{79}$$

where r is the interest rate on Treasury bills and rl the interest rate on bank loans

Banks' profits

$$\begin{aligned} bp_n = (1-\theta_{bn})[rl_n bl_n^n(-1) + rl_n bl_n^s(-1) + r_n bt_n^n(-1) + r_s bt_n^s(-1) \\ - id.bd_n(-1) - ib.rf_n(-1)] \end{aligned} \tag{80}$$

$$bp_s = (1-\theta_{bs})[rl_s bl_s^s(-1) + r_s bt_s^s(-1) + r_n bt_s^n(-1) - id.bd_s(-1) - ib.rf_s(-1)] \tag{81}$$

where bp is bank's profit, bt the Treasury bills held by banks, rf the central bank advances made to private banks, bl the loans provided to firms by banks, rl the interest rate on bank loans, r the interest on T-bills, id the interest rate on bank deposits, ib the interest rate on central banks advances, bd the bank depostis of households

Banks' net wealth

$$vb_n = h_n + bl_n^n + bl_n^s + bt_n^n + bt_n^s - rf_n - bd_n \tag{82}$$

$$vb_s = h_s + bl_s^s + bt_s^s - rf_s - bd_s \tag{83}$$

where vb is the net wealth of banks, bt the Treasury bills held by banks, bl the loans provided to firms by banks, rf the central bank advances made to private banks, bd the bank depostis of households, h is the cash held by banks

Change in bank's wealth

$$\Delta vb_n = \delta_b n * bp_n \tag{84}$$

$$\Delta vb_s = \delta_b s * bp_s \tag{85}$$

Taxes on banks

$$\begin{aligned} tb_n = \theta_{bn}[& rl_n bl_n^n(-1) + rl_n bl_n^s(-1) + r_n bt_n^n(-1) + r_s bt_n^s(-1) \\ & - id.bd_n(-1) - ib.rf_n(-1)] \end{aligned} \tag{86}$$

$$tb_s = \theta_{bs}[rl_s bl_s^s(-1) + r_s bt_s^s(-1) + r_n bt_s^n(-1) - id.bd_s(-1) - ib.rf_s(-1)] \tag{87}$$

where *tb* are the taxes paid by private banks, *bt* the Treasury bills held by banks, *rf* the central bank advances made to private banks, *bl* the loans provided to firms by banks, *rl* the interest rate on bank loans, *r* the interest on T-bills, *id* the interest rate on bank deposits, *ib* the interest rate on central banks advances, *bd* the bank depostis of households

Central bank advances made to private banks

$$\Delta rf_n = \Delta h_n + \Delta bl_n^n + \Delta bl_n^s + \Delta bt_n^n + \Delta bt_n^s - bp_n - \Delta bd_n \tag{88}$$

$$\Delta rf_s = \Delta h_s + \Delta bl_s^s + \Delta bt_s^s - bp_s - \Delta bd_s \tag{89}$$

where *rf* the central bank advances made to private banks, *bp* is bank's profit, *bt* the Treasury bills held by banks, *bl* the loans provided to firms by banks, *bd* the bank depostis of households, *h* is the cash held by banks

3.1.4 Government and Central Bank

As in the DMS 2018 model, in our model the government has a relatively reduced role. Its expenditures grow at an exogenous rate. It receives taxes from households, firms, banks and the central bank, who redistributes all its profits as taxes to both governments. After having responded to the demand for public bonds, the remaining deficit is entirely financed by the issuance of Treasury bills purchased by banks, with only the smaller country selling T-bills to banks of both countries. In the DMS 2018 model, the interest rate on public bonds is equal to the interest rate on T-bills, which depends on the quantity of T-bills issued, as it has to equal the demand and supply of T-bills, and on the interest rate on the T-bills of the country in the case of country S T-bills. In our model however the variations in the interest rate on bonds are smoothed by introducing a lag in its reaction with regards to the rate on T-bills, as found in Duwicquet and Mazier (2012), because strong variations in the interest rate on bonds destabilize the model. The interest rate on Treasury bills was also changed with regard to the DMS 2018 model. Because we were able to introduce distinct credit rationing features, we chose to relax the assumption that interest rates on public debt is a positive function of the quantity of T-bills issued, and instead assume that the interest rates on T-bills are exogenous, as in Duwicquet and Mazier (2012), with the interest rate on the T-bills of the southern country being equal to the interest rate on the T-bills of the northern country plus a risk premium (z_{rs}, in equation (99)) representative of the spread in interest rates on public debt between countries of the EMU.

National government expenditure

$$gn_n = a_{gg1} gn_n(-1) \tag{90}$$

$$gn_s = a_{gg1} gn_s(-1) \tag{91}$$

where *gn* are the national government expenditures

T-bills issued

$$\Delta bt_n = gn_n + r_n bt_n(-1) + b_n(-1) - t_n - tb_n - teb_n - pb_n \Delta b_n \tag{92}$$

$$\Delta bt_s = gn_s + r_s bt_s(-1) + b_s(-1) - t_s - tb_s - teb_s - pb_s \Delta b_s \tag{93}$$

where *gn* are the national government expenditures, *r.bt* the interest paid by the government on T-bills issued, *b* the interest paid on public bonds, *t the* personal income tax, *tb* the taxes on banks, *teb* the taxes paid by the central bank, *pb.*■*b* the income received from the new issuance of public bonds

*T-bills issued by * held by banks **

$$\Delta bt_n^n = \Delta bt_n \tag{94}$$

$$\Delta bt_s^s = \Delta bt_s - \Delta bt_n^s \tag{95}$$

where *bt* are the T-bills issued by the government

*T-bills issued by * held by banks °*

$$bt_s^n = 0 \tag{96}$$

$$bt_n^s = (a_{1ns} r_s - a_{2ns} r_n) y_n \tag{97}$$

where bt are the T-bills issued by the government

Rates on T-bills

$$r_n = r \tag{98}$$

$$r_s = r_n + z_{rs} \tag{99}$$

where r is the interest rate on T-bills issued by the government

Variations in public bonds

$$\Delta b_n = \Delta b_n^n + \Delta b_s^n \tag{100}$$

$$\Delta b_s = \Delta b_s^s + \Delta b_n^s \tag{101}$$

where b are the public bonds issued by the government

Prices of bonds

$$pb_n = \frac{1}{rb_n} \tag{102}$$

$$pb_s = \frac{1}{rb_s} \tag{103}$$

where *pb* is the price of public bonds and *rb* the interest rate on public bonds

Rates on bonds

$$rb_n = rb_n(-1) * (1-a) + a * r_n(-1) \tag{104}$$

$$rb_s = rb_s(-1) * (1-a) + a * r_n(-1) \tag{105}$$

with *rb* the interest rate on public bonds and *r* the interest rate on Treasury bills

Public debt

$$d_n = bt_n + pb_n b_n \tag{106}$$

$$d_s = bt_s + pb_s b_s \tag{107}$$

where *d* is the public deficit of the governemnt, *bt* the T-bills issued and *pb.b* value of the public bonds issued

High-powered money

$$h = hh_n + hh_s + h_n + h_s \tag{108}$$

where h is total HPM in the monetary union, hh the cash held by households, $h_n$and h_s the cash held by banks in both countries

Taxes on Central bank advances made to private banks

$$teb = ib[rf_n(-1) + rf_s(-1)] \tag{109}$$

$$teb_n = teb(\frac{y_n}{y_n + y_s}) \tag{110}$$

$$teb_s = teb(\frac{y_s}{y_n + y_s}) \tag{111}$$

where *teb* is the taxes paid by the central bank to governments, *ib* the interest rate on central bank advances and *rf* the central bank advances to private banks

Net value of central bank (not to be written)

$$\Delta h = \Delta rf_n + \Delta rf_s \tag{112}$$

[4]where *rf* the central bank advances to private banks and h is total HPM in the monetary union

[4]The truthfulness of this equality, which is a condition for the stock-flow coherence of the model, can be verified in the Appendix for the 3 scenarios of our model.

3.2 Generating credit rationing

The most important amendment to the DMS 2018 model made by us is the introduction of more specific credit rationing dynamics by including a lender's risk (*LR*) as found in Le Héron and Mouakil (2008)[5]. Extending liquidity preference to banks in a context of endogenous money, Le Héron and Mouakil (2008) define a lender's risk determined by the gap between firms' indebtedness and the banking sector convention regarding it, the market valuation of firms as entailed in the Tobin's Q (*q*) and the cost of accessing high powered money, the interest on central bank advances (*ib*). In our model we add in the Lender's risk (*LR*) a new component: the leverage ratio of banks (*BLR*), which is the ratio of the sum of the assets held by banks on the net wealth of banks, corrected for the risk associated with Treasury bills, acting a proxy for equity capital, the details of which are the subject of the next section. As in Le Héron and Mouakil (2008), our lender's risk takes value between 0 and 1, with a lender's equal to 1 meaning that banks completely ration credit and provide no loan to firms, and a lender's risk of 0 meaning that banks provide all the credit money demanded by firms, as in the horizontalist case. The loans actually provided by banks (*bl*) is then always less or equal to the demand for credit money, depending on the values taken by the lender's risk (*LR*).

Lender's risk (loans)

$$LR_n^n = \rho_1(lev_n(-1) - lev_n^c) + \rho_3(BLR_n(-1) - BLR_n^t) - \rho_4.q_n(-1) + \rho_6.ib \tag{113}$$

$$LR_n^s = \rho_1(lev_s(-1) - lev_s^c) + \rho_3(BLR_n(-1) - BLR_n^t) - \rho_4.q_s(-1) + \rho_6.ib \tag{114}$$

$$LR_s^s = \rho_1(lev_s(-1) - lev_s^c) + \rho_3(BLR_s(-1) - BLR_s^t) - \rho_4.q_s(-1) + \rho_6.ib \tag{115}$$

[5] See also (Le Heron, 2012, 2011) for similar developments.

with LR the lender's risk of banks, lev the leverage ratio of firms, BLR the leverage ratio of banks, q Tobin's Q and ib the interest rate on central bank advances

Loans actually provided by banks

$$\Delta bl_n = \Delta l_n(1 - LR_n^n) \tag{116}$$

$$\Delta bl_s = \Delta l_s^s(1 - LR_s^s) + \Delta l_n^s(1 - LR_n^s)$$

which gives

$$\Delta bl_s = \Delta l_s[(1-\varepsilon)(1 - LR_s^s) + \varepsilon(1 - LR_n^s)] \tag{117}$$

with bl the actual loans provided by private banks to firms, LR the lender's risk of banks, l the loans demanded by firms to private banks

Leverage ratio of firms

$$lev_n = (bl_n/k_n) \tag{118}$$

$$lev_s = (bl_s/k_s) \tag{119}$$

where lev is the leverage ratio of firms, bl the loans provided by banks to firms, k the fixed capital stock of firms

Tobin's Q

$$q_n = pe_n e_n/k_n \tag{120}$$

$$q_s = pe_s e_s / k_s \tag{121}$$

where q is Tobin's Q, $pe.e$ the value of the equities issed by firms, k the fixed capital stock of firms

3.3 Banks' leverage ratio and modeling the diabolic loop

The diabolic loop, as described in Dell'Ariccia et al. (2018), entails the existence of a specific credit-rationing response from banks to a negative shock on the public debt of their sovereign. To generate this effect in our model, we define a bank leverage ratio (*BLR*) and a targeted bank leverage ratio (BLR^t), with banks rationing credit more as their actual leverage ratio departs from its target. We find precedents for such a ratio in an SFC framework in Godley (1999) and Godley and Lavoie (2007), who introduce a 'Bank liquidity ratio' (*BR*, in Godley 1999, and *BLR*, in Godley and Lavoie 2007) defined as "the ratio of defensive assets ([Treasury bills]) to liabilities" (Godley 1999, 408). Banks have a 'norm' or target for this ratio, and will then increase the rate of interest whenever the ratio falls below the target, and reduce it when the ratio exceeds its norm (Godley 1999). Our *BLR* behave in a similar way, and is introduced in the lender's risk of banks (equation (113) to (115)) in the same manner Le Héron and Mouakil (2008) introduced the leverage ratio of firms (*lev*) in their equation of the lender's risk. The idea is that, in times of crisis, faced with a devaluation of the asset side of their balance sheets, banks see their equity capital absorb the shock and their leverage ratio increase above their leverage ratio and reduce their holding of assets and thus their credit supply to the economy (Adrian and Shin, 2014). Because banks only hold Treasury bills in terms of public debt, and because public debt do not have a price as they are redeemed at the end of each period, we had approximate what would be a change in price as a result of an increase in the interest rate of Treasury bills by correcting the net wealth of banks for the risk associated with Treasury bills (*risk*, in equations (122) and (123)). Thanks to this transformation, an increase in the interest rate on Treasury bills results in a reduction of the net wealth of banks in our bank leverage ratio, increasing the leverage of banks and thus the lender's risk, which initiates the credit rationing dynamics of our model.

$$BLR_n = \frac{Total\ assets}{Net\ wealth\ of\ banks} = \frac{h_n + bl_n^n + bl_n^s + bt_n^n + bt_n^s}{vb_n - bt_n^n.risk_n - bt_n^s.risk_s} \tag{122}$$

$$BLR_s = \frac{Total\ assets}{Net\ wealth\ of\ banks} = \frac{h_s + bl_s^s + bt_s^s}{vb_s - bt_s^s.risk_s} \tag{123}$$

$$risk_n = r_n(1 + \gamma_{riskn}) \tag{124}$$

$$risk_s = r_s(1 + \gamma_{risks}) \tag{125}$$

where *h* is the cash held by banks, *bl* the loans provided by banks to firms, *bt* the Treasury bills held by banks, *vb* the net value of banks, *bt.risk* the T-bills held by banks corrected for the risk, *r* the interest rate on T-bills

As a consequence, a negative shock on the public debt of country S, that is, a temporary increase of the interest rate on its debt because, for example, of a sudden loss of confidence by markets, will increase the risk associated with Treasury bills and thus the net wealth of banks, and especially of banks from the country S who are biased towards their sovereign in their demand for T-bills, decrease, increasing the ratio *BLR*, and hence the lender's risk *LR*, generating credit rationing.

4 The scenarios: sovereign risk shock and eurobonds issuance

In order to discuss the effects of the diabolic loop, or sovereign-bank nexus, on a monetary union like the Eurozone, our model will go through a selection of scenarios as follows. A baseline scenario will let the model run without changing any of the initial variables, giving us the 'normal' trajectory of the two economies composing our model. From this baseline scenario, a second scenario introducing a negative shock on the interest rate of the peripheral country's public debt (Country S), thus increasing the interest rate on public bonds, as well as reducing their prices, will be executed. Finally, the last scenario will display the impact of a eurobonds issuance in the conditions of the second scenario, that is, with a similar shock on the interest rate of the public debt of the peripheral country. This scenario will let us assess to what extent a eurobonds issuance reduces the sovereign-bank nexus, and the following effect on the economy of Country S.

The DMS 2018 model, on which our own model is largely built, also offers a scenario with eurobonds following this rule for the issuance of the eurobonds:

$$If\ \frac{d_n}{y_n} > 60\%\ then$$

$$\Delta bte_n = (gn_n + r_n bt_n(-1) + b_n(-1) - t_n - tb_n - teb_n - pb_n \Delta b_n - tf_n) + ge_n$$

$$If\ \frac{d_s}{y_s} > 60\%\ then$$

$$\Delta bte_s = (gn_s + r_s bt_s(-1) + b_s(-1) - t_s - tb_s - teb_s - pb_s \Delta b_s - tf_s) + ge_s$$

$$bte = bte_n + bte_s$$

$$reuro = a_{0e} + a_{1e}(\frac{bte}{y_e})$$

where *gn* are the national government expenditures, *r.bt* the interest paid by the government on T-bills issued, *b* the interest paid on public bonds, *t the* personal income tax, *tb* the taxes on banks, *teb* the taxes paid by the central bank, *tf* the taxes paid by firms, *pb.■b* the income received from the new issuance of public bonds, *ge* federal government expenditures, *bte* eurobonds, *reuro* the interest rate on eurobonds

In the scheme displayed above, eurobonds are issued in place of the treasury bills of a country to finance its deficit when its public debt to GDP ratio exceeds a threshold of 60 percent. It is unclear in the DMS 2018 model if such an issuance scheme refers to an already existing proposition for a eurobonds issuance in the literature or not, but it does not, to the extent of our knowledge, correspond to one of the main eurobonds scheme currently discussed in the literature. Indeed, even among the more ambitious schemes actively discussed such as De Grauwe and Moesen (2009) and Delpla and Von Weizsäcker (2010), the issuance structure tends to be issuing eurobonds for the safest part of the domestic public debt, up to 60 percent of debt to GDP, in order to achieve complete safeness for the eurobonds, and having the remainder of domestic public debt issued as 'normal' domestic public debt. This kind of propositions also have the benefit of being relatively close to the rules encompassing fiscal policy in the Eurozone, encouraging sound finance and punishing 'excessive' spending above the threshold of 60 percent of debt to GDP. If maybe less appealing politically, the scheme proposed in the DMS 2018 model presents the advantage of resorting to the issuance of eurobonds when public debt might become less sustainable for the two countries, especially under the assumption that interest rates on public debt increase with the issuance of Treasury bills, and thus making eurobonds act as a stabilizing mechanism in the Eurozone.

For our model, this issuance scheme will be maintained and this for two main reasons: it has the benefit of simplicity, especially as such a scheme was used and proven to work in a model very similar to ours, and it will keep the quantity of eurobonds issued in the model relatively low, in particular compared to an issuance scheme with eurobonds issuance below the 60 percent of debt to GDP threshold, thus only impacting the balance sheet of banks in a limited, though noticeable, way. This will allow to reduce the impact of a change in the prices of public bonds on the supply of credit of banks, instead of completely canceling and concealing it, which we consider a better ground for future discussion[6].

[6]Although, it is our opinion that future discussion from our model would benefit from relying on existing and more sophisticated eurobonds proposal, such as Brunnermeier et al. (2011) or Delpla and Von Weizsäcker (2010).

Hence, in this second scenario the equations for the issuance of Treasury bills will be revised as follows:

$$If\ \frac{d_n}{y_n} < 60\%\ then$$

$$\Delta bt_n = (g_n^n + r_n bt_n(-1) + b_n(-1) - t_n - tb_n - teb_n - pb_n \Delta b_n - tf_n) + reuro.bte_n(-1)$$

$$If\ \frac{d_s}{y_s} < 60\%\ then$$

$$\Delta bt_s = (g_s^s + r_s bt_s(-1) + b_s(-1) - t_s - tb_s - teb_s - pb_s \Delta b_s - tf_s) + reuro.bte_s(-1)$$

where *gn* are the national government expenditures, *r.bt* the interest paid by the government on T-bills issued, *b* the interest paid on public bonds, *t the* personal income tax, *tb* the taxes on banks, *teb* the taxes paid by the central bank, *tf* the taxes paid by firms, *pb.*■*b* the income received from the new issuance of public bonds, *ge* federal government expenditures, *bte* eurobonds, *reuro* the interest rate on eurobonds

If each country issues its own set of eurobonds, and pays the interest on it, these bonds have a common yield which is expected to be lower than the interest on the public debt of the peripheral country, granting it a kind of fiscal relief. Nevertheless, eurobonds will not be reinvested in a specific manner by the countries issuing them, they will simply be used to finance part of the public deficit of the issuer, with no consequence on the exogenous rate of increase of public expenditures. Instead, the expected effect of this issuance scheme is to see eurobonds partly replace Treasury bills in the balance sheet of banks, reducing the impact of the country-specific risk of T-bills in the leverage ratio of banks[7].

[7]Eurobonds will be assigned a euro-wide risk, depending on the interest rate on eurobonds, that will be introduced in equations (122) and (123) of the model under scenario 2, as can be found in the complete set of equations of the model in the appendix

5 The simulation: diabolic loop dynamics in a monetary union

The calibration of the model follows relatively closely the one in the DMS 2018 model, in particular for the starting values of the stocks, and most of the parameters, which were calibrated in the original model to fit the structure of the EMU[8]. We ran the model for 40 periods through our 3 scenarios: the baseline scenario (Scenario 0), in which the model runs without any shocks, and without any issuance of eurobonds, the sovereign risk shock scenario (Scenario 1), in which the interest rate on the Treasury bills of country S, the southern country, is shocked with a 5 percentage points increase for 4 periods, between period 5 and period 8, and finally, the scenario with eurobonds issuance (Scenario 2), in which a issuance scheme, as described above, is added to the model, on top of the sovereign risk shock. It is important to note that, for lack of a better method, Scenario 2 was launched separately in a different model which included a eurobonds issuance scheme. If this model does not differ in any other way from the model used for scenario 0 and scenario 1, the issuance of eurobonds changes slightly the trajectory of some of the variables, even in the baseline scenario, which might explain some of the unexpected differences between scenario 0 and scenario 2 in our results. The simulations and programming of the model are done using the software Eviews 11 University Edition[9].

Figure 7 displays the trajectories of the output and disposable income for both countries over the periods simulated. There is not observable substantial change in output across the scenarios, both countries follow a stable low-growth path, with only a limited negative impact of the sovereign risk shock for country S (Figure 7.1), and a seemingly positive impact for the eurobonds issuance (Scenario 2) in country S, most clearly, and in country N. Such a weak effect of the sovereign risk shock in Scenario 1 is disappointing, as our paper wishes to feature, among other things, the negative impact of such a shock on economic activity, and is due to the also weak effect on credit rationing of our shock, as discussed below (Figure 9).

[8]see Duwicquet and Mazier (2010, 2012) and Duwicquet et al. (2016, 2018) for more details on the calibration method

[9]The EViews codes used for the simulations are available, from the author upon request

Figure 7: *Evolution of output and disposable income.*

Figure 7.1: *Output and disposable income of country S*

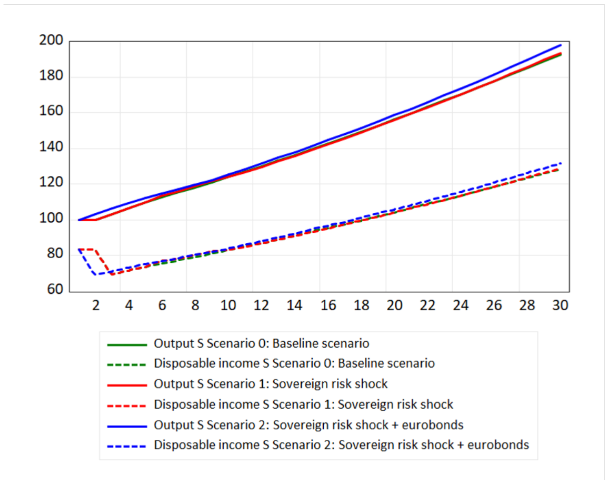
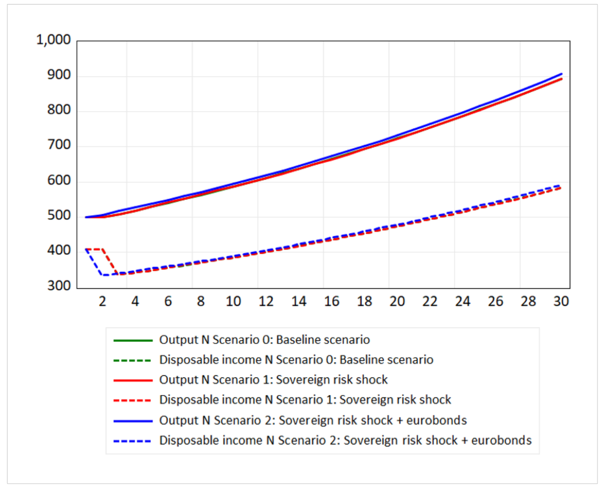


Figure 7.2: *Output and disposable income of country N*



Source: Author's own calculations.

The effect of the issuance of eurobonds can be clearly observed in Figure 8, which displays the evolution of the public debt to GDP ratios for both countries. If the sovereign risk shock (Scenario 1) as a negative impact on the public debt of the southern country, this impact is, as expected, more than compensated in the case of a eurobonds issuance (Scenario 2). Because of the threshold set in our model for the eurobonds issuance scheme only country S issues eurobonds, and thus the issuance of eurobonds has little impact on the trajectory of the debt to GDP ratio of the northern country. It is nevertheless unclear, at this point, why scenario 2 causes on the long run a higher debt to GDP ratio for country N.

Figure 8: *Evolution of the public debt to GDP ratios.*

Figure 8.1: *Public debt to GDP ratio of country S*

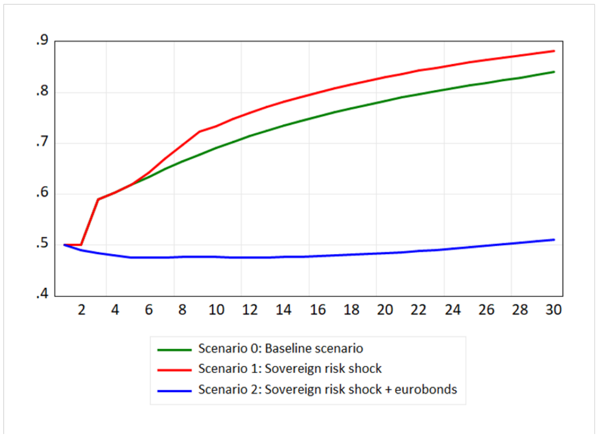
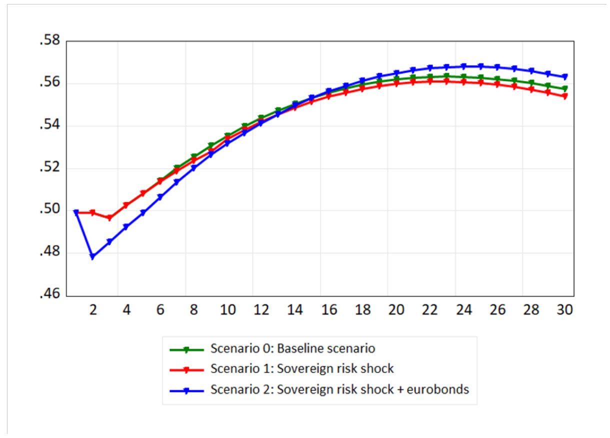


Figure 8.2: *Public debt to GDP ratio of country N*



Source: Author's own calculations.

More relevant to our inquiry, the effect of the different scenario on the credit rationing dynamics included in our model are visible in Figure 9, which shows the variations in the loans actually provided by banks, as defined in equations (120) and (121). In particular, as seen in Figure 9.1, in the periods following the shock on the sovereign risk of country S in scenario 1, the loan provided to firms S decreases compared to the baseline scenario, indicating a stronger rationing of credit by banks, mainly as a response to the increase in the lender's risk of banks S following the shock (see Figure 10.1). The key variables of the mechanisms of credit rationing at play here, defined in equation (117) to equation (133), are summarized in Figure 10.

Figure 9: *Evolution in the loans actually provided by banks to firms.*

Figure 9.1: *Loans actually provided by banks to firms S*

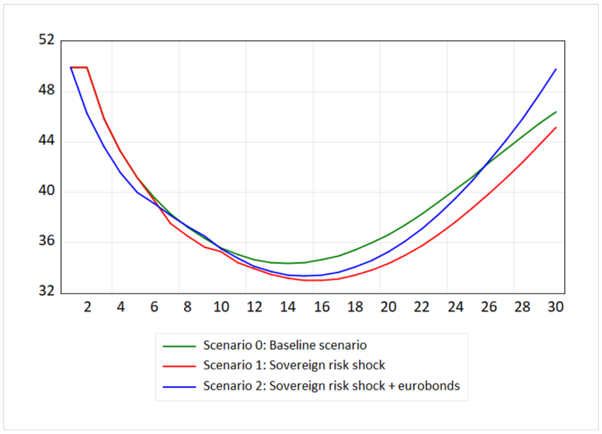
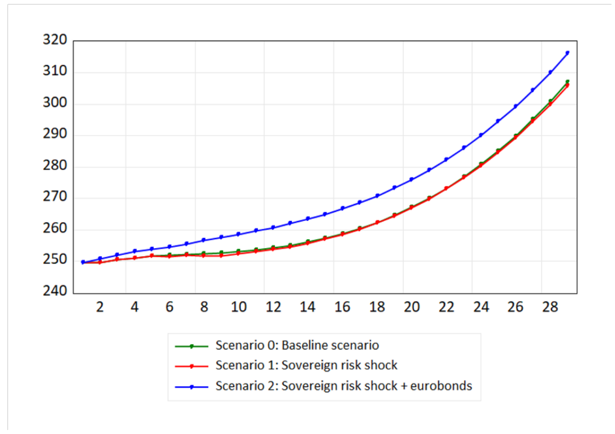


Figure 9.2: *Loans actually provided by banks to firms N*



Source: Author's own calculations.

The effects of the shock in the sovereign risk of country S are clearly visible. In Figure 10.1, an increase in the interest rate paid by country S on its public debt increases the lender's risk banks S face when lending to the firms of country S. The transmission channels work as follows: an increase in the interest rates on Treasury bills S increases the risk associated with the Treasury bills of country S present in the balance sheet of its banks, thus reducing their net value, a proxy of their equity capital, which increases the leverage ratio of banks S, as seen in Figure 10.4, and hence increasing the lender's risk of banks S. The shock on the sovereign risk of the southern country also has an impact on credit rationing by banks of the country N because of their cross-border holding of Treasury bills, both in the lender's risk they face while lending to their own domestic firms (Figure 10.2), and while lending to firms of the southern country (Figure 10.3). We are thus able to replicate part of the dynamics involved in the diabolic loop, with a higher risk of sovereign default being translated, via the holding of public debt by banks, to increased leverage ratios for banks and thus to credit rationing.

It is also noticeable in Figure 10 (and in particular on Figure 10.2, 10.3 and 10.5) that the effect of the shock on the sovereign risk of country S has a longer lasting effect on the credit rationing variables of country N, which is surprising considering banks present a home bias in their holding of Treasury bills, and thus country N holds less Treasury bills from country S than the banks from country S. We believe it to be caused by the positive effect of an increase in the interest rate on the public debt of country S on the demand for public bonds from country S by households. Because, after the shock, the demand for public bonds S increases, the quantity of Treasury bills issued by S is reduced (see equations (96) and (97)) and thus the total of the T-bills from country S held by banks, as well as their leverage ratio, decrease. Because T-bills S are mostly held by banks S, this effect is stronger for banks S than for banks N, reducing the lender's risk faster for the former than for the latter.

Figure 10: *Evolution of the key variables of credit rationing by banks.*

Figure 10.1: *Lender's risk for bank S lending towards country S*

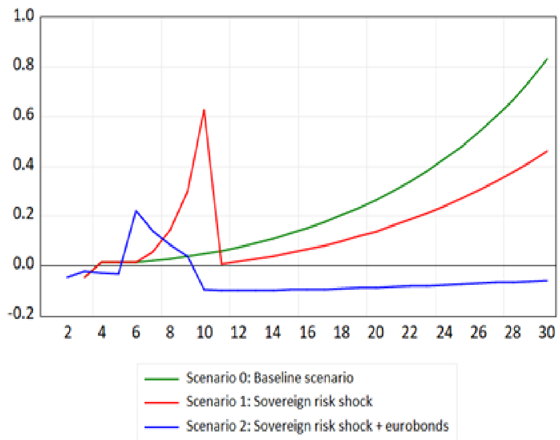


Figure 10.2: *Lender s risk for bank N lending towards country N*

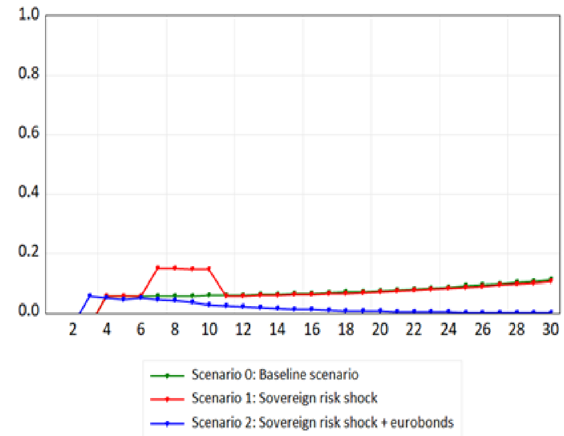


Figure 10.3: *Lender's risk for bank N lending towards country S*

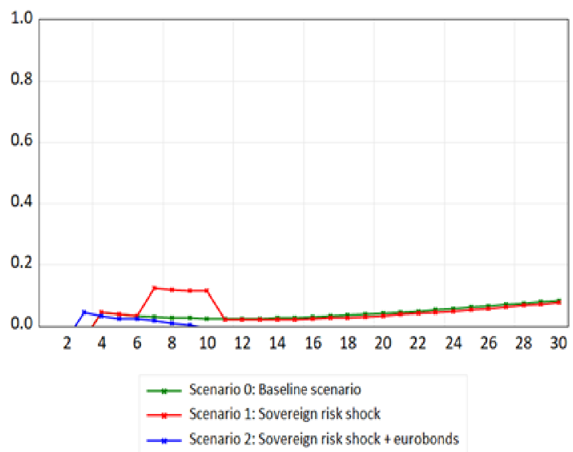


Figure 10.4: *Bank leverage ratio, Banks S*

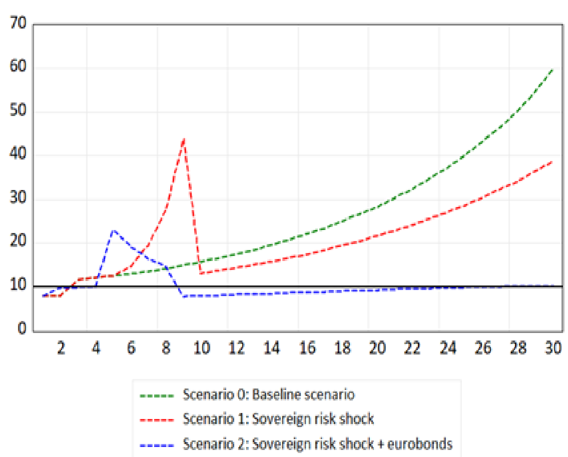
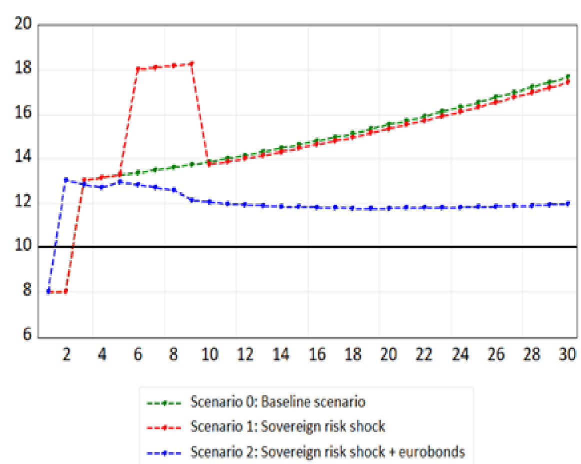


Figure 10.5: *Bank leverage ratio, Banks N*

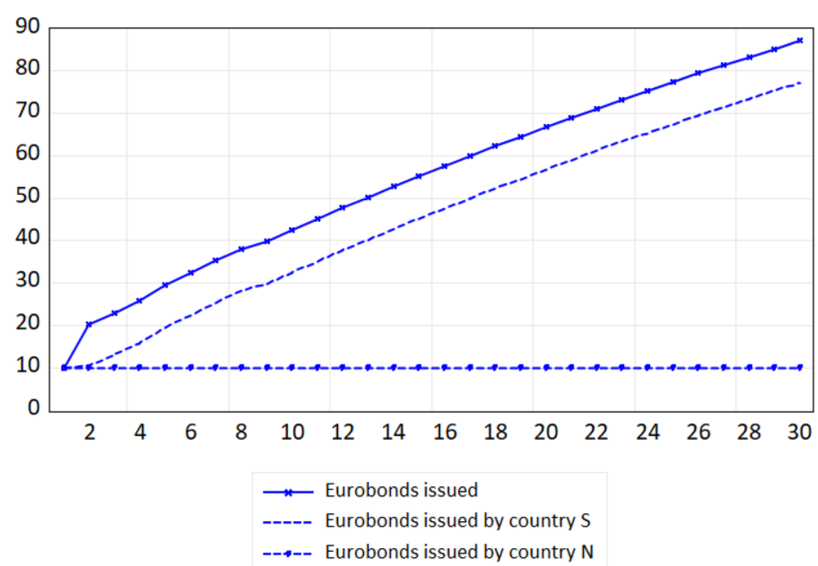


Source: Author's own calculations.

The impact of the issuance of eurobonds on the sovereign-bank nexus discussed above is also displayed in Figure 10. Under scenario 2, that is, with eurobonds issuance, the impact of a shock on the sovereign risk of the southern country on credit supply is much weaker, in the case of the banks of country S, as visible in Figure 10.1, or completely suppressed, in the case of the banks of country N, as can be seen in Figure 10.2 and Figure 10.3. We can thus argue that eurobonds indeed play the role of a euro-wide safe asset for the Eurozone's financial system, shielding the balance sheets of banks against the sovereign-bank nexus by reducing their sovereign exposure, and swapping domestic public debt for a safer euro-wide debt asset. In the case of a negative reassessment by financial markets of the risk of sovereign default of the peripheral country, the presence of eurobonds in the balance sheets of this country's banking sector reduces the impact of the dynamics of the diabolic loop and the consequent credit rationing by banks, as argued in Brunnermeier et al. (2017) and in ESRB (2018), both domestically and in the rest of the union.

Figure 11: *Pattern of issuance of eurobonds.*

Figure 11: *Pattern of issuance of eurobonds in Scenario 2*



Source: Author's own calculations.

Figure 11 shows the pattern of the issuance of eurobonds under the scenario 2 of our model. Because of the level of the threshold, only the southern country issues eurobonds during the periods of simulation, although, as both countries have, at the beginning of the model, each issued a certain quantity of eurobonds, country N has issued a non-null fixed stock of eurobonds, held by its banking sector.

6 Limits of the model: the work ahead

The model presented in this paper allowed us to show and discuss some of the destabilizing dynamics at play in the Eurozone's financial and banking systems, the so-called sovereign-bank nexus, and the consequent credit rationing by banks and its impact on economic activity. Nonetheless, our successful modeling of some of the diabolic loop dynamics in an SFC framework in this paper is not to be considered sufficient, and should rather be a starting point for further work on the matter, and in particular at fixing what we consider to be significant insufficiencies in our model.

6.1 A word on our results

As explained in section 5, if we were able to build a model showing some of the dynamics of the diabolic loop, and in particular credit rationing by banks as a result of a sovereign risk negative shock, our simulations only show relatively weak movements in our variables. Especially, there is close to no impact of the shock introduced in scenario 1 on output and disposable income, which indicates a failure from our part in building and calibrating the model and assuring the transmission of higher lender's risks for banks to lower economic activity. This could be corrected by choosing higher values for some of the parameters involved these dynamics, which unfortunately, at this stage of the model, was too destabilizing, but could be introduced in further versions. Also, the general long term trends of the model, and in particular those of country N, are somewhat incoherent, and show a overall lack of control of the model in the long run, which should be corrected in later versions of the model. Finally, the longer lasting effect of the shock of scenario 1 on the credit rationing variables of country N is rather dissatisfying, and the dynamics of the demand for public bonds by households, as well as their effect on the quantity of Treasury bills held by banks, should be revised. Compared to the credit rationing dynamics present in Le Héron and Mouakil (2008), we only introduced in our model credit rationing on *quantities*, and left out rationing through prices, that is, a distinct lender's risk variable in the determination of the interest rates on loans, such as follows:

Interest rate on loans

$$rl_n^n = ib + lr_n^n + \gamma_r ln$$

$$rl_n^s = ib + lr_n^s + \gamma_r lns$$

$$rl_s^s = ib + lr_s^s + \gamma_r ls$$

Lender's risk (interest rate)

$$lr_n^n = \rho_2(lev_n(-1) - lev_n^c) + \rho_5(BLR_n(-1) - BLR_n^t) - \rho_7 q_n(-1)$$

$$lr_n^s = \rho_2(lev_s(-1) - lev_n^c) + \rho_5(BLR_n(-1) - BLR_n^t) - \rho_7 q_s(-1)$$

$$lr_s^s = \rho_2(lev_s(-1) - lev_s^c) + \rho_5(BLR_s(-1) - BLR_s^t) - \rho_7 q_s(-1)$$

If, mainly for lack of time, these equations were left out of the model presented in this paper, such features should be included in future versions of the model.

6.2 Treasury bills, public bonds and the diabolic loop

Another shortcoming of the model presented here is the reliance on Treasury bills, which are only held for a period and thus are not subjected to changes in price, as the only form of public debt held by banks, and thus as the only channel for asset side devaluation. This choice was made because it is how the DMS 2018 model is built, and attempt at introducing new elements such as public bonds in the balance sheet of banks proved to require a important redesign of the model, which exceeded the purpose of this paper. Consequently, future works on the matter would demand a complete redesign of the model, or the construction of a new model, featuring a banking sector behaving as a financial investor, making portfolio allocation decisions over a large panel of financial assets, including different type of public assets, based on financial returns and risk. This would allow us to see more clearly and with less manipulations the impact of changes in the yields and prices of those assets on the balance sheet structure of banks, and on their leverage ratio. What's more, a discussion of the impact of the issuance of eurobonds for the Eurozone's financial system would benefit from a larger discussion on the role of safe assets for banks and financial actors, and thus on introducing in the behaviour of the financial and banking sector of a future model a distinct feature linked to this discussion. Finally, regarding the modeling of the diabolic loop, our model only explicitly features the link between a shock on the interest rate on the public debt of a country, and the credit rationing by the banks who hold this debt, the *sovereign exposure channel* according to Dell'Ariccia et al. (2018) , but does not clearly include the feedback on sovereign debt via economic activity, the *macroeconomic channel*, nor via bailout expectations, the *safety net channel*. An improvement of the model could thus include in the behaviour of public expenditures the bailout of banks, or its probability in the determination of the sovereign risk.

6.3 Eurobonds issuance schemes

The eurobonds issuance scheme included in the model presented here could as well be the subject of some improvements. In particular, while we decided to rely on the issuance structure already present in the DMS 2018 model, using a more sophisticated issuance structure close to an existing proposition of eurobonds, such as Brunnermeier et al. (2017) or Delpla and Von Weizsäcker (2010), would an interesting step towards being able to assess specific eurobonds propositions.

7 Conclusion

With regard to the questions we proposed to address in this master thesis, the model and simulations presented here, extended from Duwicquet et al. (2016, 2018), show some encouraging although preliminary results, and much remains to be done for later works.

The question at hand here was to assess the impact on financial stability in the Eurozone, especially with respect to the destabilizing dynamics identified under the names of *sovereign-bank nexus*, or *diabolic loop*, (Brunnermeier et al., 2017, Dell'Ariccia et al., 2018) of the joint issuance of the public debt of euro-area countries, or eurobonds. Indeed, the European sovereign debt crisis highlighted some of the vulnerabilities of the EMU, and in particular the existence of a negative feedback loop that peripheral countries, such as the GIIPS, face between the risk associated to the sovereign debt of these countries and the health of their banking sector (see, for example, Modi and Sandri, 2012). The mechanism goes as follows: an increase in the sovereign risk of a country decreases the value of the assets associated with it, these assets being disproportionately held by domestic banks because of a home bias in there purchasing of public debt, the consequent devaluation of the asset side of their balance sheet decreases their equity capital, increasing their leverage ratio, to which bank respond by reducing the size of their balance sheet to return to their target leverage ratio, decreasing their supply of credit to the economy (Adrian and Shin 2010, 2014, Brunnermeier et al. 2017). This has damaging impacts on economic activity and growth, as private actors, and especially firms, are less and less able to access credit money from private banks. In response to these destabilizing dynamics, eurobonds have been presented as a euro-wide safe asset able to break, at least in part, the sovereign-bank nexus by replacing domestic sovereign debt in the balance sheet of banks (Brunnermeier et al. 2011, 2016, 2017, ESRB, 2018).

To discuss these problems, the chosen method was to introduce in a two-country SFC model of the EMU some of the dynamics of the diabolic loop, and more precisely to include distinct credit rationing dynamics in the behaviour of the banking sector, as in Le Héron and Mouakil (2008), responsive to changes in the value of the assets, and in particular public debt, present in its balance sheet and in its leverage ratio. We were only partially successful in this regard. If our model and our simulations do show some credit rationing as a consequence of a negative sovereign risk shock in the southern country, we had to rely on less than satisfactory transformations in the definition of some of the variables involved. Like, for example, in the definition of our Bank Leverage Ratio (*BLR*) and the introduction of a risk parameter in place of a proper price variation of the public debt held in the balance sheet of banks. This is largely due to the decision to keep to the original structure of the model from Duwicquet et al. (2016, 2018) and have T-bills, which are not subject to change in price, as the only public debt asset held by private banks. In this respect, it is our opinion that later versions of the model would greatly benefit from a more sophisticated banking sector, with specific portfolio allocation equations over a larger set of assets, including different public assets varying by their maturity and risk. Such a transformation would require to rewrite a large part of the original model and is set out of the scope of this paper to respect the time allowed for the writing of this dissertation. Further versions of the model should also feature the other channels of the sovereign-bank nexus, such as the safety net channel, that is, the negative feedback of a rise in the leverage ratio of banks on the sovereign risk due to the actual or expected bailout of the banking sector by the government.

Nonetheless, our results give relatively clear indications of the positive effect the issuance of eurobonds could have with regard to these credit rationing dynamics, with credit rationing by banks as a response to a negative sovereign risk shock in the southern country being substantially suppressed in the scenario introducing a eurobonds issuance scheme (Scenario 2). This is linked to the fact that, with the issuance of eurobonds by the southern country, private banks hold less Treasury bills with a country-specific risk, and hold instead more eurobonds associated with a euro-wide risk parameter, with hence a lesser impact of the interest rate on T-bills on the leverage ratio, and thus the lender's risk, of banks. Again, for the model presented in this paper we relied on the issuance scheme featured in Duwicquet et al. (2016, 2018) which does not relate to a specific eurobonds proposition, although introducing instead an issuance structure linked to existing proposals in later versions of the model would be of significant interest. Nevertheless, these early results suggest that the introduction of eurobonds would have beneficial effects for the Eurozone's financial sector and should, if political oppositions inside the Eurozone can be overcome, be implemented, especially as the Eurozone faces a new crisis with the Coronavirus pandemic.

Further extensions of the model would thus include the introduction of clearer credit rationing dynamics, with the risk assessment of banks impacting both the quantity of loans supplied and the interest rate on these loans, a redesign of the banking sector and of its balance sheet structure, with banks holding a variety of public debt assets of different type, maturity and risk, and the introduction of existing eurobonds issuance scheme in the scenarios of the model, with the possible addition of other monetary policies, such as the repurchasing by the central bank of the eurobonds issued.

Overall, the inquiry presented here has reinforced our opinion that significant work remains and deserve to be done on this matter, to which we hope this development can be of some use.

16242 words

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9 Appendix

Main parameters used for the simulations

Main parameters				
		Investment made by firms	**N**	**S**
k_{0n}	k_{0s}	Autonomous component	0.057356	0.055
k_{1n}	k_{1s}	Marginal impact of firm's profit	0.525000	0.525000
k_{2n}	k_{2s}	Accelerator effect	0	0
k_{3n}	k_{3s}	Marginal impact of firms' indebtedness	0.1	0.1
k_{4nn}	k_{4ss}	Marginal impact of rate on loans granted by banks	0.375	0.375
k_{4sn}	k_{4ns}	Marginal impact of rate on loans granted by banks	0.125	0.025
δ_n	δ_n	Rate of depreciation	0.05	0.05
		External trade	**N**	**S**
μ_{0n}	μ_{0s}	Autonomous component	-3.00234009	-1.39290218
μ_{1n}	μ_{1s}	Income elasticity	1	1
ε		Financial openness parameter	0.24835	
		Consumption	**N**	**S**
a_{1n}	a_{1s}	Marginal propensity to consume out of disposable income	0.75	0.75
a_{2n}	a_{2n}	Marginal propensity to consume out of wealth	0.04	0.04
		Cash held by households	**N**	**S**
λ_{0n}	λ_{0s}	Cash to consumption ratio	0.15	0.15
		Rate of interest on T-bills and eurobonds		
z_{rs}		Risk premium on T-bills of country S	0	
a_{0e}		Autonomous component	0.013	
a_{1e}		Marginal impact of supply of T-bills in percent of GDP	0.03	
		Correction for risk factor in BLR	**N**	**S**

γ_{riskn}	γ_{risks}	Impact of rate of interest parameter	1	4
		Lender's risk components		
ρ_1		Marginal effect of leverage of firms	1	
ρ_3		Marginal effect of banks' leverage ratio	0.02	
ρ_4		Marginal effect of Tobin's Q	0.05	
ρ_6		Marginal effect of interest rate on CB advances	1.5	
		Rate of interest on public bonds and loans		
a		Marginal impact of the rate on T-bills	0.01	
		High Powered Money (HPM)	**N**	**S**
λ_s	λ_s	HPM-bank deposit ratio	0.05	0.05
m_{2b}		Banks margin	0.005	
		Tax rates	**N**	**S**
θ_{bn}	θ_{bs}	Banks	0.175730	0.175730
θ_n	θ_s	Personal income tax	0.127700	0.125107
sf_n	sf_s	Rate of undistributed firm's profit	0.419112	0.419112
δ_n	δ_s	Rate of undistributed bank's profit	0.35	0.35
r_{0n}	r_{0s}	Wage share	0.645719	0.645719
		Demand of bonds by households		
v_{0nnb}		Autonomous demand	0.086773	
v_{1nnb}		Marginal impact of rate on country N bonds	0.1	
v_{2nnb}		Marginal impact of rate on country S bonds	2.0	
v_{3nnb}		Marginal impact of rate on bank deposits	0.2	
v_{4nnb}		Marginal impact of rate of return on country N equities	0.1	
v_{5nnb}		Marginal impact of rate of return on country S equities	0.1	
v_{0nsb}		Autonomous demand	0.046773	
v_{1nsb}		Marginal impact of rate on country N bonds	0.1	

v_{2nsb}		Marginal impact of rate on country S bonds	2.0	
v_{3nsb}		Marginal impact of rate on bank deposits	0.2	
v_{4nsb}		Marginal impact of rate of return on country N equities	0.1	
v_{5nsb}		Marginal impact of rate of return on country S equities	0.1	
v_{0ssb}		Autonomous demand	0.08264	
v_{1ssb}		Marginal impact of rate on country N bonds	0.1	
v_{2ssb}		Marginal impact of rate on country S bonds	2.0	
v_{3ssb}		Marginal impact of rate on bank deposits	0.2	
v_{4ssb}		Marginal impact of rate of return on country N equities	0.1	
v_{5ssb}		Marginal impact of rate of return on country S equities	0.1	
v_{0snb}		Autonomous demand	0.059591	
v_{1snb}		Marginal impact of rate on country N bonds	0.1	
v_{2snb}		Marginal impact of rate on country S bonds	2.0	
v_{3snb}		Marginal impact of rate on bank deposits	0.2	
v_{4snb}		Marginal impact of rate of return on country N equities	0.1	
v_{5snb}		Marginal impact of rate of return on country S equities	0.1	
		Demand of equities by households		
v_{0nne}		Autonomous demand	0.476411	
v_{1nne}		Marginal impact of rate on country N bonds	0.001	
v_{2nne}		Marginal impact of rate on country S bonds	0.01	
v_{3nne}		Marginal impact of rate on bank deposits	0.2	
v_{4nne}		Marginal impact of rate of return on country N equities	0.02	
v_{5nne}		Marginal impact of rate of return on country S equities	0.02	
v_{0nse}		Autonomous demand	0.213072	
v_{1nse}		Marginal impact of rate on country N bonds	0.001	
v_{2nse}		Marginal impact of rate on country S bonds	0.01	

v_{3nse}		Marginal impact of rate on bank deposits	0.2	
v_{4nse}		Marginal impact of rate of return on country N equities	0.02	
v_{5nse}		Marginal impact of rate of return on country S equities	0.02	
v_{0sse}		Autonomous demand	0.624967	
v_{1sse}		Marginal impact of rate on country N bonds	0.001	
v_{2sse}		Marginal impact of rate on country S bonds	0.01	
v_{3sse}		Marginal impact of rate on bank deposits	0.2	
v_{4sse}		Marginal impact of rate of return on country N equities	0.02	
v_{5sse}		Marginal impact of rate of return on country S equities	0.02	
v_{0sne}		Autonomous demand	0.031492	
v_{1sne}		Marginal impact of rate on country N bonds	0.001	
v_{2sne}		Marginal impact of rate on country S bonds	0.01	
v_{3sne}		Marginal impact of rate on bank deposits	0.2	
v_{4sne}		Marginal impact of rate of return on country N equities	0.02	
v_{5sne}		Marginal impact of rate of return on country S equities	0.02	
		Demand of equities by firms		
f_{0nn}		Autonomous demand	0.210210	
f_{1nn}		Marginal impact of rate of return on country N equities	0.2	
f_{2nn}		Marginal impact of rate of return on country S equities	0.2	
f_{3nn}		Marginal impact of firms' profit	0.6	
f_{0ns}		Autonomous demand	0.072521	
f_{1ns}		Marginal impact of rate of return on country S equities	0.2	
f_{2ns}		Marginal impact of rate of return on country N equities	0.2	
f_{3ns}		Marginal impact of firms' profit	0.6	
f_{0ss}		Autonomous demand	0.274680	
f_{1ss}		Marginal impact of rate of return on country S equities	0.2	

f_{2ss}	Marginal impact of rate of return on country N equities	0.2	
f_{3ss}	Marginal impact of firms' profit	0.6	
f_{0sn}	Autonomous demand	0.020855	
f_{1sn}	Marginal impact of rate of return on country N equities	0.2	
f_{2sn}	Marginal impact of rate of return on country S equities	0.2	
f_{3sn}	Marginal impact of firms' profit	0.6	
	Price of firms' equities	**N**	**S**
σ_n σ_s	Growth rate	1.003	1.003
	Government expenditures		
a_{gg1}	Growth rate	1.018	

List of variables

Variable	Name
Endogenous variables	
y_n, y_s	National income in real term
ydh_n, ydh_s	Real disposable income
yh_n, yh_s	Haig-Simons real disposable income
t_n, t_s	Personal income tax
c_n, c_s	Households consumption
bd_n, bd_s	Bank deposits held by households
cgh_n, cgh_s	Households capital gains
vh_n, vh_s	Households wealth
b	Demand of public bonds by households (for bonds and equities, the subscript corresponds to the country where the demand is originating, and the superscript the origin country of the asset)
eh	Demand of equities by households
ee	Demand of equities by firms
hh_n, hh_s	Cash held by households
up_n, up_s	Firms' retained earnings
g_n, g_s	Accumulation rate
inv_n, inv_s	Investment made by firms
k_n, k_s	Firms' fixed capital stock
l_n, l_s	Loans demanded to private banks by firms
bl_n, bl_s	Loans supplied by private banks to firms
re_n, re_s	Rate of return on equities
e_n, e_s	Number of equities
v_n, v_s	Firms' wealth

cge_n, cge_s	Firms' capital gains
w_n, w_s	Wage share
div_n, div_s	Dividends distributed by firms
$dive$	Dividends distributed to firms
$divh$	Dividends distributed to households
bt_n, bt_s	Treasury bills held by banks
b_n, b_s	Bonds held by households
pb_n, pb_s	Prices of bonds held by households
d_n, d_s	Public debt
bp_n, bp_s	Banks' profit
tb_n, tb_s	Taxes on banks
rf_n, rf_s	Central banks advances made to private banks
h_n, h_s	Cash held by private banks
h	High Powered Money (HPM)
vb_n, vb_s	Private banks' wealth
teb, teb_n, teb_s	Taxes on CB advances made to private banks
im_n, im_s	Imports
x_n, x_s	Exports
id	Interest rate on banks deposits
LR	Lender's risk
BLR	Bank leverage ratio
BLR^t	Targeted bank leverage ratio
q	Tobin's Q
lev	Leverage of firms
lev^c	Conventional leverage of firms
bte, bte_n, bte_s	Eurobonds

reuro	Interest rate on Eurobonds
Exogenous variables	
r_n, r_s	Interest rate on treasury bills
rb_n, rb_s	Interest rate on public bonds
rl_n, rl_s	Interest rates on loans
gn_n, gn_s	National government expenditures
pe_n, pe_s	Price of equities
m_{2b}	Private banks' margin on banks deposit
ib	Interest rate on central bank advances

The complete model

Income

$$y_n = c_n + inv_n + g_n^n + x_n - im_n \tag{1}$$

$$y_s = c_s + inv_s + g_s^s + x_s - im_s \tag{2}$$

Real disposable income

$$ydh_n = w_n + id * bd_n(-1) + divh_n^n + divh_n^s + bp_n * (1 - \delta_b n) - t_n \tag{3}$$

$$ydh_s = w_s + id * bd_s(-1) + divh_s^s + divh_s^n + bp_s * (1 - \delta_b s) - t_s \tag{4}$$

Imports

$$log(im_n) = \mu_0 n + \mu_{1n} log(y_n) \tag{5}$$

$$log(im_s) = \mu_0 s + \mu_{1s} log(y_s) \tag{6}$$

Exports

$$x_n = im_s \tag{7}$$

$$x_s = im_n \tag{8}$$

Haig-Simons disposable income

$$yh_n = ydh_n + cgh_n \tag{9}$$

$$yh_s = ydh_s + cgh_s \tag{10}$$

Personal income tax

$$t_n = \theta_n [w_n + id * bd_n(-1) + bp_n * (1 - \delta_b n) + b_n^n + b_n^s + divh_n^n + divh_n^s] \tag{11}$$

$$t_s = \theta_s [w_s + id * bd_s(-1) + bp_s * (1 - \delta_b n) + b_s^s + b_s^n + divh_s^s + divh_s^n] \tag{12}$$

Households consumption

$$c_n = a_{0n} + a_{1n} yh_n + a_{2n} vh_n(-1) \tag{13}$$

$$c_s = a_{0s} + a_{1s} yh_s + a_{2s} vh_s(-1) \tag{14}$$

Cash held by households

$$hh_n = \lambda_0 c_n \tag{15}$$

$$hh_s = \lambda_0 c_s \tag{16}$$

Demand for equities by households

$$eh_n^n = ([(v_0 nne - v_{1nnb} rb_n - v_{2nnb} rb_s - v_3 nne * id + v_4 nnere_n - v_5 nnere_s) vh_n])/(pe_n) \tag{17}$$

$$eh_n^s = ([(v_0 nse - v_{1nsb} rb_s - v_{2nsb} rb_n - v_3 nne * id - v_4 nsere_n + v_5 nsere_s) vh_n])/(pe_s) \tag{18}$$

$$eh_s^s = ([(v_0 sse - v_{1ssb} rb_s - v_{2ssb} rb_n - v_3 nne * id - v_4 ssere_n + v_5 ssere_s) vh_s])/(pe_s) \tag{19}$$

$$eh_s^n = ([(v_0 sne - v_{1snb} rb_n - v_{2snb} rb_s - v_3 nne * id + v_4 snere_n - v_5 snere_s) vh_s])/(pe_n) \tag{20}$$

Demand for public bonds by households

$$b_n^n = \frac{[(v_{0nnb} + v_{1nnb} rb_n - v_{2nnb} rb_s - v_{3nnb} id - v_{4nnb} re_n - v_{5nnb} re_s) vh_n]}{pb_n} \tag{21}$$

$$b_n^s = \frac{[(v_{0nsb} + v_{1nsb} rb_s - v_{2nsb} rb_n - v_{3nsb} id - v_{4nsb} re_n - v_{5nsb} re_s) vh_n]}{pb_s} \quad (22)$$

$$b_s^s = \frac{[(v_{0ssb} + v_{1ssb} rb_s - v_{2ssb} rb_n - v_{3ssb} id - v_{4ssb} re_n - v_{5ssb} re_s) vh_s]}{pb_s} \quad (23)$$

$$b_s^n = \frac{[(v_{0snb} + v_{1snb} rb_n - v_{2snb} rb_s - v_{3snb} id - v_{4snb} re_n - v_{5snb} re_s) vh_s]}{pb_n} \quad (24)$$

Variations of bank deposits held by households

$$\Delta bd_n = ydh_n - c_n - pb_n * \Delta b_n^n - pb_s * \Delta b_n^s - pe_n * \Delta eh_n^n - pe_s * \Delta eh_n^s - \Delta hh_n \quad (25)$$

$$\Delta bd_s = ydh_s - c_s - pb_n * \Delta b_s^n - pb_s * \Delta b_s^s - pe_s * \Delta eh_s^s - pe_n * \Delta eh_s^n - \Delta hh_s \quad (26)$$

Households wealth

$$vh_n = bd_n + pb_n * b_n^n + pb_s * b_n^s + pe_n * \Delta eh_n^n + pe_s * \Delta eh_n^s + hh_n \quad (27)$$

$$vh_s = bd_s + pb_n * b_s^n + pb_s * b_s^s + pe_s * \Delta eh_s^s + pe_n * \Delta eh_s^n + hh_s \quad (28)$$

Households capital gains

$$cgh_n = \Delta pb_n * b_n^n(-1) + \Delta pb_s * b_n^s(-1) + \Delta pe_n * eh_n^n(-1) + \Delta pe_s * eh_n^s(-1) \quad (29)$$

$$cgh_s = \Delta pb_n * b_s^n(-1) + \Delta pb_s * b_s^s(-1) + \Delta pe_n * eh_s^n(-1) + \Delta pe_s * eh_s^s(-1) \quad (30)$$

Retained earnings

$$up_n = [y_n - w_n - rl_n bl_n^n(-1) - rl_s bl_s^n(-1) - div_n + dive_n^n + dive_n^s] \quad (31)$$

$$up_s = [y_s - w_s - rl_s bl_s^s(-1) - rl_n bl_n^s(-1) - div_s + dive_s^s + dive_s^n] \quad (32)$$

Accumulation rate

$$g_n = k_{0n} + k_{1n}\frac{up_n(-1)}{k_n(-2)} + k_{2n}\frac{(\Delta y_n)}{y_n(-1)} - k_{3n}\frac{bl_n(-1)}{k_n(-1)} - k_{4nn} rl_n^n - k_{4sn} rl_s^n \quad (33)$$

$$g_s = k_{0s} + k_{1s}\frac{up_s(-1)}{k_s(-2)} + k_{2s}\frac{(\Delta y_s)}{y_s(-1)} - k_{3s}\frac{bl_s(-1)}{k_s(-1)} - k_{4ss} rl_s^s - k_{4ns} rl_n^s \quad (34)$$

Investment (desired)

$$ind_n = g_n k_n(-1) \quad (35)$$

$$ind_s = g_s k_s(-1) \quad (36)$$

Investment (restricted)

$$inr_n = \Delta bl_n + up_n + pe_n * \Delta e_n - pe_n * \Delta ee_n^n - pe_s * \Delta ee_n^s \quad (37)$$

$$inr_s = \Delta bl_s + up_s + pe_s * \Delta e_s - pe_n * \Delta ee_s^n - pe_s * \Delta ee_s^s \quad (38)$$

Investment realised

$$inv_n = inr_n \tag{39}$$

$$inv_s = inr_s \tag{40}$$

Variations of firms' fixed capital stock

$$\Delta k_n = inv_n - \delta_n k_n(-1) \tag{41}$$

$$\Delta k_s = inv_s - \delta_s k_s(-1) \tag{42}$$

Loans (demanded)

$$l_n = bl_n(-1) + inv_n - up_n - pe_n \Delta e_n + pe_n \Delta ee_n^n + pe_s \Delta ee_n^s \tag{43}$$

$$l_s = bl_s(-1) + inv_s - up_s - pe_s \Delta e_s + pe_s \Delta ee_s^s + pe_n \Delta ee_s^n \tag{44}$$

$$\Delta l_n^n = \Delta l_n - \Delta l_s^n \tag{45}$$

$$\Delta l_s^s = \Delta l_s - \Delta l_n^s \tag{46}$$

$$l_s^n = 0 \tag{47}$$

$$l_n^s = \varepsilon * l_s \tag{48}$$

Demand for equities by firms

$$ee_n^n = \frac{[(f_1 nnre_n - f_2 nnre_s + f_3 nn(up_n)/(k_n(-1)) + f_0 nn)(k_n + pe_n ee_n^n + pe_s ee_n^s)]}{pe_n} \tag{49}$$

$$ee_n^s = \frac{[(f_1 nsre_s - f_2 nsre_n + f_3 ns(up_n)/(k_n(-1)) + f_0 ns)(k_n + pe_n ee_n^n + pe_s ee_n^s)]}{pe_s} \tag{50}$$

$$ee_s^n = \frac{[(f_1 snre_n - f_2 snre_s + f_3 sn(up_s)/(k_s(-1)) + f_0 sn)(k_s + pe_n ee_s^n + pe_s ee_s^s)]}{pe_n} \tag{51}$$

$$ee_s^s = \frac{[(f_1 ssre_s - f_2 ssre_n + f_3 ss(up_s)/(k_s(-1)) + f_0 ss)(k_s + pe_n ee_s^n + pe_s ee_s^s)]}{pe_s} \tag{52}$$

Prices of equities

$$pe_n = \sigma_n pe_n(-1) \tag{53}$$

$$pe_s = \sigma_s pe_s(-1) \tag{54}$$

Rate of return of equities

$$re_n = \frac{\Delta pe_n}{pe_n(-1)} + \frac{div_n}{pe_n(-1)e_n(-1)} \tag{55}$$

$$re_s = \frac{\Delta pe_s}{pe_s(-1)} + \frac{div_s}{pe_s(-1)e_s(-1)} \tag{56}$$

Number of equities

$$e_n = eh_n^n + ee_n^n + eh_s^n + ee_s^n \tag{57}$$

$$e_s = eh_n^s + ee_n^s + eh_s^s + ee_s^s \tag{58}$$

Dividends distributed by firms

$$div_n = (1-sf)[y_n(-1) - w_n(-1) - rl_n bl_n^n(-2) - rl_s bl_s^n(-2)] \tag{59}$$

$$div_s = (1-sf)[y_s(-1) - w_s(-1) - rl_s bl_s^s(-2) - rl_n bl_n^s(-2)] \tag{60}$$

$$dive_n^n = div_n(\frac{ee_n^n(-1)}{e_n(-1)}) \tag{61}$$

$$divh_n^n = div_n(\frac{eh_n^n(-1)}{e_n(-1)}) \tag{62}$$

$$dive_s^n = div_n(\frac{ee_s^n(-1)}{e_n(-1)}) \tag{63}$$

$$divh_s^n = div_n(\frac{eh_s^n(-1)}{e_n(-1)}) \tag{64}$$

$$dive_s^s = div_s(\frac{ee_s^s(-1)}{e_s(-1)}) \tag{65}$$

$$divh_s^s = div_s(\frac{eh_s^s(-1)}{e_s(-1)}) \tag{66}$$

$$dive_n^s = div_s(\frac{ee_n^s(-1)}{e_s(-1)}) \tag{67}$$

$$divh_n^s = div_s(\frac{eh_n^s(-1)}{e_s(-1)}) \tag{68}$$

Firms' capital gains

$$cge_n = \Delta pe_n ee_n^n(-1) + \Delta pe_s ee_n^s(-1) \tag{69}$$

$$cge_s = \Delta pe_n ee_s^n(-1) + \Delta pe_s ee_s^s(-1) \tag{70}$$

Firms wealth

$$v_n = k_n + pe_n ee_n^n + pe_s ee_n^s - bl_n - pe_n e_n \tag{71}$$

$$v_s = k_s + pe_n ee_s^n + pe_s ee_s^s - bl_s - pe_s e_s \tag{72}$$

Wage share

$$w_n = r_0 y_n \tag{73}$$

$$w_s = r_0 y_s \tag{74}$$

Cash held by banks

$$h_n = \lambda_n bd_n \tag{75}$$

$$h_s = \lambda_s bd_s \tag{76}$$

Interest rate on deposits

$$id = ib - m_2 b \tag{77}$$

Interest rate on loans

$$rl_n = rl_n(-1) * (1-a) + a * r_n(-1) \tag{78}$$

$$rl_s = rl_s(-1) * (1-a) + a * r_s(-1) \tag{79}$$

Banks' profits

$$\begin{aligned} bp_n = (1-\theta_{bn})[rl_n bl_n^n(-1) + rl_n bl_n^s(-1) + r_n bt_n^n(-1) + r_s bt_n^s(-1) \\ - id.bd_n(-1) - ib.rf_n(-1)] \end{aligned} \tag{80}$$

$$bp_s = (1-\theta_{bs})[rl_s bl_s^s(-1) + r_s bt_s^s(-1) + r_n bt_s^n(-1) - id.bd_s(-1) - ib.rf_s(-1)] \tag{81}$$

Banks' net wealth

$$vb_n = h_n + bl_n^n + bl_n^s + bt_n^n + bt_n^s - rf_n - bd_n \tag{82}$$

$$vb_s = h_s + bl_s^s + bt_s^s - rf_s - bd_s \tag{83}$$

Change in bank's wealth

$$\Delta vb_n = \delta_b n * bp_n \tag{84}$$

$$\Delta vb_s = \delta_b s * bp_s \tag{85}$$

Taxes on banks

$$\begin{aligned} tb_n = \theta_{bn}[&rl_n bl_n^n(-1) + rl_n bl_n^s(-1) + r_n bt_n^n(-1) + r_s bt_n^s(-1) \\ &- id.bd_n(-1) - ib.rf_n(-1)] \end{aligned} \tag{86}$$

$$tb_s = \theta_{bs}[rl_s bl_s^s(-1) + r_s bt_s^s(-1) + r_n bt_s^n(-1) - id.bd_s(-1) - ib.rf_s(-1)] \tag{87}$$

Central bank advances made to private banks

$$\Delta rf_n = \Delta h_n + \Delta bl_n^n + \Delta bl_n^s + \Delta bt_n^n + \Delta bt_n^s - bp_n - \Delta bd_n \tag{88}$$

$$\Delta rf_s = \Delta h_s + \Delta bl_s^s + \Delta bt_s^s - bp_s - \Delta bd_s \tag{89}$$

National government expenditure

$$gn_n = a_{gg1} gn_n(-1) \tag{90}$$

$$gn_s = a_{gg1} gn_s(-1) \tag{91}$$

Issuance of Treasury bills and eurobonds

$$If\ \frac{d_n}{y_n} < 60\%\ then$$

$$\Delta bt_n = (g_n^n + r_n bt_n(-1) + b_n(-1) - t_n - tb_n - teb_n - pb_n \Delta b_n) + reuro.bte_n(-1) \tag{92}$$

$$If\ \frac{d_s}{y_s} < 60\%\ then$$

$$\Delta bt_s = (g_s^s + r_s bt_s(-1) + b_s(-1) - t_s - tb_s - teb_s - pb_s \Delta b_s) + reuro.bte_s(-1) \tag{93}$$

$$If\ \frac{d_n}{y_n} > 60\%\ then$$

$$\Delta bte_n = (g_n^n + r_n bt_n(-1) + b_n(-1) - t_n - tb_n - teb_n - pb_n \Delta b_n) \tag{94}$$

$$If\ \frac{d_s}{y_s} > 60\%\ then$$

$$\Delta bte_s = (g_s^s + r_s bt_s(-1) + b_s(-1) - t_s - tb_s - teb_s - pb_s \Delta b_s) \tag{95}$$

$$bte = bte_n + bte_s \tag{96}$$

Interest rate on eurobonds

$$reuro = a_{0e} + a_{1e}(\frac{bte}{y_e}) \tag{97}$$

*T-bills issued by * held by banks **

$$\Delta bt_n^n = \Delta bt_n \tag{98}$$

$$\Delta bt_s^s = \Delta bt_s - \Delta bt_n^s \tag{99}$$

*T-bills issued by * held by banks °*

$$bt_s^n = 0 \tag{100}$$

$$bt_n^s = (a_{1ns} r_s - a_{2ns} r_n) y_n \tag{101}$$

Rates on T-bills

$$r_n = r \tag{102}$$

$$r_s = r_n + z_{rs} \tag{103}$$

Variations in public bonds

$$\Delta b_n = \Delta b_n^n + \Delta b_s^n \tag{104}$$

$$\Delta b_s = \Delta b_s^s + \Delta b_n^s \tag{105}$$

Prices of bonds

$$pb_n = \frac{1}{rb_n} \tag{106}$$

$$pb_s = \frac{1}{rb_s} \tag{107}$$

Rates on bonds

$$rb_n = rb_n(-1) * (1-a) + a * r_n(-1) \tag{108}$$

$$rb_s = rb_s(-1) * (1-a) + a * r_n(-1) \tag{109}$$

Public debt

$$d_n = bt_n + pb_n b_n \tag{110}$$

$$d_s = bt_s + pb_s b_s \tag{111}$$

High-powered money

$$h = hh_n + hh_s + h_n + h_s \tag{112}$$

Taxes on Central bank advances made to private banks

$$teb = ib[rf_n(-1) + rf_s(-1)] \tag{113}$$

$$teb_n = teb(\frac{y_n}{y_n + y_s}) \tag{114}$$

$$teb_s = teb(\frac{y_s}{y_n + y_s}) \tag{115}$$

Net value of central bank (not to be written)

$$\Delta H = \Delta rf_n + \Delta rf_s \tag{116}$$

Lender's risk (loans)

$$LR_n^n = \rho_1(lev_n(-1) - lev_n^c) + \rho_3(BLR_n(-1) - BLR_n^t) - \rho_4.q_n(-1) + \rho_6.ib \tag{117}$$

$$LR_n^s = \rho_1(lev_s(-1) - lev_s^c) + \rho_3(BLR_n(-1) - BLR_n^t) - \rho_4.q_s(-1) + \rho_6.ib \tag{118}$$

$$LR_s^s = \rho_1(lev_s(-1) - lev_s^c) + \rho_3(BLR_s(-1) - BLR_s^t) - \rho_4.q_s(-1) + \rho_6.ib \tag{119}$$

Loans actually provided by banks

$$\Delta bl_n = \Delta l_n(1 - LR_n^n) \tag{120}$$

$$\Delta bl_s = \Delta l_s^s(1 - LR_s^s) + \Delta l_n^s(1 - LR_n^s)$$

which gives

$$\Delta bl_s = \Delta l_s[(1-\varepsilon)(1-LR_s^s)+\varepsilon(1-LR_n^s)] \tag{121}$$

Bank leverage ratio (revised for risk of Treasury bills)

$$BLR_n = \frac{Total\ assets}{Net\ wealth\ of\ banks} = \frac{h_n + bl_n^n + bl_n^s + bt_n^n + bt_n^s}{vb_n - bt_n^n.risk_n - bt_n^s.risk_s - bte_n.risk_e} \tag{122}$$

$$BLR_s = \frac{Total\ assets}{Net\ wealth\ of\ banks} = \frac{h_s + bl_s^s + bt_s^s}{vb_s - bt_s^s.risk_s - bet_s.risk_e} \tag{123}$$

Risk parameter associated to Treasury bills

$$risk_n = r_n(1+\gamma_{riskn}) \tag{124}$$

$$risk_s = r_s(1+\gamma_{risks}) \tag{125}$$

$$risk_e = reuro(1+\gamma_{riske}) \tag{126}$$

Leverage ratio of firms

$$lev_n = (bl_n/k_n) \tag{127}$$

$$lev_s = (bl_s/k_s) \tag{128}$$

Tobin's Q

$$q_n = pe_n e_n/k_n \tag{129}$$

$$q_s = pe_s e_s / k_s \tag{130}$$

Hidden equation

	H_0	H_TH_0	H_1	H_TH_1	H2_1	H_TH2_1
1	77.58625	77.58625	77.58625	77.58625	77.58625	77.58625
2	77.58625	77.58625	77.58625	77.58625	82.26263	82.26263
3	82.44558	82.44558	82.44558	82.44558	83.71206	83.71206
4	83.95924	83.95924	83.95924	83.95924	85.26466	85.26466
5	85.55425	85.55425	85.55425	85.55425	86.81967	86.81967
6	87.13829	87.13829	87.34773	87.34773	88.36258	88.36258
7	88.73986	88.73986	88.99608	88.99608	90.00638	90.00638
8	90.37831	90.37831	90.75222	90.75222	91.69299	91.69299
9	92.06140	92.06140	92.57235	92.57235	93.42823	93.42823
10	93.79146	93.79146	94.13627	94.13627	95.26249	95.26249
11	95.56918	95.56918	95.94405	95.94405	97.06813	97.06813
12	97.39490	97.39490	97.75460	97.75460	98.91501	98.91501
13	99.26888	99.26888	99.62390	99.62390	100.8080	100.8080
14	101.1914	101.1914	101.5440	101.5440	102.7503	102.7503
15	103.1626	103.1626	103.5139	103.5139	104.7434	104.7434
16	105.1828	105.1828	105.5334	105.5334	106.7880	106.7880
17	107.2521	107.2521	107.6028	107.6028	108.8845	108.8845
18	109.3705	109.3705	109.7223	109.7223	111.0334	111.0334
19	111.5382	111.5382	111.8921	111.8921	113.2348	113.2348
20	113.7549	113.7549	114.1123	114.1123	115.4894	115.4894
21	116.0208	116.0208	116.3830	116.3830	117.7973	117.7973
22	118.3354	118.3354	118.7043	118.7043	120.1588	120.1588
23	120.6987	120.6987	121.0761	121.0761	122.5744	122.5744
24	123.1101	123.1101	123.4984	123.4984	125.0442	125.0442
25	125.5690	125.5690	125.9711	125.9711	127.5685	127.5685
26	128.0748	128.0748	128.4942	128.4942	130.1475	130.1475
27	130.6264	130.6264	131.0672	131.0672	132.7816	132.7816
28	133.2226	133.2226	133.6901	133.6901	135.4709	135.4709
29	135.8615	135.8615	136.3624	136.3624	138.2156	138.2156
30	138.5407	138.5407	139.0837	139.0837	141.0160	141.0160

Source: Author's own calculations.

H_0 and H_TH_0 corresponds to the baseline scenario, H_1 and H_TH_1 to scenario 1, and H2_1 and H_TH2_1 to scenario 2.

Table A1. *The balance sheet matrix*

	Country N						*Country S*				
	Households	**Firms**	**Government**	**Banks**	**Federal Budget**	**ECB**	**Households**	**Firms**	**Government**	**Banks**	Σ
Capital		$+k_n$						$+k_s$			+k
Deposits	$+bd_n$			$-bd_n$			$+bd_s$			$-bd_s$	0
Cash	$+hh_n$			$+h_n$		$-h$	$+hh_s$			$+h_s$	0
Credit		$-bl_n$		$+bl^n{}_n$							0
				$+bl^s{}_n$				$-bl_s$		$+bl^s{}_s$	0
Reserves				$-rf_n$		$+rf_n+rf_s$				$-rf_s$	0
Bonds	$+pb_nb^n{}_n$		$-pb_nb_n$				$+pb_nb^n{}_s$				0
	$+pb_sb^s{}_n$						$+pb_sb^s{}_s$		$-pb_sb_s$		0
Eurobonds				$+bte_n$	$-bte_n$					$+bte_s$	0
Tbills			$-bt_n$	$+bt^n{}_n$							0
				$+bt^s{}_n$					$-bt_s$	$+bt^s{}_s$	0
Equities	$+pe_neh^n{}_n$	$+pe_nee^n{}_n$					$+pe_neh^n{}_s$	$+pe_nee^n{}_s$			0
		$-pe_ne_n$									0
	$+pe_seh^s{}_n$	$+pe_see^s{}_n$					$+pe_seh^s{}_s$	$+pe_see^s{}_s$			0
								$-pe_se_s$			0
Wealth	$-vh_n$	$-v_n$	$-d_n$	$-vb_n$	$-de_n$		$-vh_s$	$-v_s$	$-d_s$	$-vb_s$	-k
Σ	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	0

Table A2. *The transaction flow matrix*

	Country N							Country S					
	Households	**Firms**		**Government**	**Banks**	**Federal Budget**	**ECB**	**Households**	**Firms**		**Government**	**Banks**	Σ
Goods N	- c_n	+ y_n	- inv_n	- gn_n				-x_n + im_n					0
Goods S	- x_s + im_s							- c_s	+ y_s	- inv_s	-gn_s		0
Wages	+w_n	- w_n						+ w_s	- w_s				0
Interest on loans		- rl_n_n(-1)*bl_n			+rl_n_n(-1)*bl_n_n				- rl_s_s(-1)*bl_s_s(-1)			+rl(-1)*bl_s	0
					+rl_n_s(-1)*bl_n_s				- rl_n_s(-1)*bl_n_s(-1)				
Interest on deposits	+ id(-1)*bd_n(-1)				- id(-1)*bd_n(-1)			+ id(-1)*bd_s(-1)				- id(-1)*bd_s(-1)	0
Interest on refinancing					- ib(-1)*rf_n(-1)		+ ib(-1)*(rf_n(-1) + rf_s(-1))					- ib(-1)*rf_s(-1)	0
Interest on Bonds	+b_n_n(-1)			- b_n(-1)				+b_s_n(-1)					0
	+b_n_s(-1)							+b_s_s(-1)			- b_s(-1)		0
Interest on T-bills				-r_n(-1)*bt_n(-1)	+r_n(-1)*bt_n_n(-1)						-r_s(-1)*bt_s_s(-1)	+r_s(-1)*bt_s_s(-1)	0
					+r_s(-1)*bt_n_s(-1)						-r_s(-1)*bt_n_s(-1)		

Table A2. *Continued*

	Country N									*Country S*						
	Households	**Firms**		**Government**	**Banks**		**Federal Budget**	**ECB**	**Households**	**Firms**		**Government**	**Banks**		Σ
Dividends		$+dive\_n\_n - div\_n$			$+divb\_n\_n$					$+dive\_s\_n$			$+divb\_s\_n$		0
		$+dive\_n\_s$			$+divb\_n\_s$					$+dive\_n\_s - div\_s$			$+divb\_s\_s$		0
Tax	$-t\_n$			$+t\_n$					$-t\_s$			$+t\_s$			0
				$+tb\_n$	$-tb\_n$							$+tb\_s$	$-tb\_s$		0
		$-tf\_n$		$+tf\_n$						$-tf\_s$		$+tf\_s$			0
Profit		$-up\_n$	$+up\_n$							$-up\_s$	$+up\_s$				0
	$+bp\_n*(1-\delta\_bn)$				$-bp\_n$	$+bp\_n*\delta\_bn$			$+bp\_s*(1-\delta\_bs)$				$-bp\_s$	$+bp\_s*\delta\_bs$	0
Deposits	$-\Delta bd\_n$					$+\Delta bd\_n$			$-\Delta bd\_s$					$+\Delta bd\_s$	0
Currency	$-\Delta hh\_n$					$-\Delta h\_n$		$+\Delta h$	$-\Delta hh\_s$					$-\Delta h\_s$	0
Loans			$+\Delta bl\_n$			$-\Delta bl\_n\_n$					$+\Delta bl\_s\_s$			$-\Delta bl\_s\_s$	0
						$-\Delta bl\_n\_s$					$+\Delta bl\_n\_s$				0
Refinancing						$+\Delta rf\_n$		$-\Delta rf$						$+\Delta rf\_s$	0
Bonds	$-pb\_n*\Delta b\_n\_n$			$+pb\_n*\Delta b\_n$					$-pb\_n*\Delta b\_s\_n$						0
	$-pb\_s*\Delta b\_n\_s$								$-pb\_s*\Delta b\_s\_s$			$+pb\_s*\Delta b\_s$			0

Table A2. *Continued*

	Country N									*Country S*					
	Households	**Firms**		**Government**	**Banks**		**Federal Budget**	**ECB**	**Households**	**Firms**		**Government**	**Banks**		Σ
Treasury Bills				+Δbt_n		-Δbt_n_n						+bt_s_s		-bt_s_s	0
						-Δbt_n_s						+bt_n_s			0
Equities			-pe_n*Δee_n_n +pe_n*Δe_n			-pe_n*Δeb_n_n					-pe_n*Δee_s_n			-pe_n*Δeb_s_n	0
			-pe_s*Δee_n_s			-pe_s*Δeb_n_s					_pe_s*Δee_s_s +pe_s*Δe_s			-pe_s*Δeb_s_s	0
Σ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0