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Abstract

This paper analyses the stabilising properties of a European Banking Union in case of financial shocks in the euro area. We compare output losses under national interventions ('bail-out') with resolution mechanisms included in the banking union, namely resolution via the euro area's Single Resolution Mechanism (SRM), 'bail-in', and a backstop solution with the new European Stability Mechanism's direct recapitalisation instrument for euro area banks. The paper evaluates by how much the output loss associated with the recent financial crisis in the euro area periphery and core could have been reduced had the banking union been in place at the time. The paper finds that with a banking union, GDP losses in the periphery could have been reduced by 30%-40% in the periphery and by 10%-40% in the euro area as whole, depending on which resolution mechanisms were in place. The paper discusses in detail how the individual resolution mechanisms affect the core and the periphery. The SRM is the most powerful for stabilising the periphery but is costly for the core. The 'bail-in' and the ESM backstop arrangements stabilise the periphery less but reduce GDP losses for the core. However, the direct recapitalisation instrument is only applicable under specific circumstances as a measure of 'last resort'.

JEL Classification: C54, E12, E32, E42, E63, F41, G21.
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Executive summary

The euro area's relatively slow recovery from the crisis has highlighted the need to reform its financial sector and create a truly integrated financial system to complement its monetary union. The heavy burden shouldered by national taxpayers to support struggling financial institutions aggravated the impact of the financial crisis within countries, leading to a downward spiral, as the interconnectedness between banking sectors and sovereign risks became apparent to investors. At the height of the crisis, such concerns culminated in speculation about the possible break-up of the euro area.

The EU has pursued a number of initiatives to create a safer and sounder financial sector for the single market. Given their high degree of interdependence, EU lawmakers agreed to pursue the European Commission's roadmap for the creation of a European Banking Union (EBU) for the euro area based on a Single Supervisory Mechanism centred around the European Central Bank and a Single Resolution Mechanism consisting of a Single Resolution Board and a Single Resolution Fund. With such rules and institutions in place, the banking union should end the potential for dangerous feedback loops between public finances and national banking systems and establish clear procedures for dealing with cross border banks.

This paper uses economic modelling to estimate how much the loss associated with the recent financial crisis could have been reduced, had the Banking Union been in place at the time.

According to the analysis, no intervention at all would appear to be a very costly option for both periphery and core countries and would likely lead to sizeable spillover effects. Traditional government bailouts, though stabilising, create vicious feedback loops. The analysis in this paper shows that a European Banking Union would go a long way towards overcoming limited financial market integration. The paper finds that GDP losses could have been reduced by 30%-40% in the periphery and by 10%-40% in the euro area as whole, depending on the resolution mechanisms assumed. Among the three bank resolution mechanisms envisaged under the banking union, 'bailing in' private sector bondholders and ESM loans to banks are preferable in terms of minimising the aggregate economic loss to the euro area as a whole. The euro area Single Resolution Fund appears as the best option from the perspective of the periphery but is less favourable for the core. ESM loans to periphery banks, though less costly for the core, are relatively less attractive for the periphery.

Direct recapitalisation of periphery banks by the European Stability Mechanism, foreseen as an instrument of last resort in the Banking Union, would minimise GDP losses in both the periphery and the core but is less attractive in terms of tax payer involvement and its implications for moral hazard.

Contents

1. Introduction

Six years after the crash of Lehman brothers, the European economy and in particular some countries in the Euro area (EA) are only gradually recovering from the "Great Recession" with the largest contraction of output after World War II. While the U.S. economy recovered relatively quickly and exceeded the pre-crisis level of GDP by 2011, the recovery in the EU/Euro area has lagged behind. It is argued that the reason for the weaker economic condition of the Euro area is the lack of reform of its financial sector and that a mistake was made when creating EMU of neglecting the creation of an integrated financial market alongside a monetary union. Limited risk sharing provided by the financial system aggravated financial shocks within countries, leading to a downward spiral as the interconnectedness between banking sector and sovereign risks became apparent to investors. All this culminated at the depth of the crisis even in speculation about a possible break-up of the euro area.

The EU has pursued a number of initiatives to create a safer and sounder financial sector for the single market. These initiatives, which include stronger prudential requirements for banks, improved depositor protection and rules for managing failing banks, form a single rulebook for all financial actors in the 28 Member States of the European Union. For the highly interdependent euro area countries the EU institutions agreed, on the basis of the European Commission roadmap for the creation of the European Banking Union (EBU), to establish a Single Supervisory Mechanism and a Single Resolution Mechanism for banks. With the instruments of EBU the EU/Euro area would make a decisive step forward to complete the Single Market in financial services.[3] First, EBU should break the diabolic link between sovereign debts (national governments) and bank debt. Second, EBU protects tax payers from bank bail outs by putting them last after bank shareholders and creditors in case of recapitalisation.. And third, EBU would take into account the cross-border externalities of large banks. Normally, national governments concentrated only on the domestic effects of bank failures and ignored cross-border effects.

There are various studies analysing the costs and benefits of financial market regulation. These studies typically contrast the costs of financial market regulation under normal macroeconomic conditions, associated with the fact that certain measures (e.g. DGS - deposit guarantee schemes - and bail-in of

[3] For a discussion of different arguments in favour of a banking union, see the articles in Beck (2012).

certain types of bank debt) increase funding costs for financial intermediaries and thereby capital costs for NFCs, with the benefits of regulation in terms of a lower probability of a financial crisis.[4] By focusing on the reduced probability of a financial crisis, these studies tend to underestimate the net benefits since they do not try to quantify the stabilising effects of regulation once a severe shock has occurred. Since various insurance mechanisms by EBU have the potential of stabilising the economy in case of a large adverse financial shock, such an analysis is warranted and conducted in this paper. Some empirical evidence for this is provided by the US experience. The US economy, which can be regarded as a banking union of US states with common rules and both a federal fiscal backstop plus nationwide deposit insurance, has recovered more quickly from the financial crisis. EBU has various dimensions, the most important ones are first, the prevention of future financial crises, second, a clear resolution mechanism in case of bank failure with the aim of protecting tax payers and, third, preventing large GDP losses in case of an adverse financial shock. This paper concentrates on the third aspect and compares the stabilising properties of the three bank resolution mechanisms stipulated in the Single Resolution Mechanism (SRM), namely bail-in, the single resolution fund and the ESM. This paper does not provide a comprehensive cost benefit analysis, since it only focusses on how EBU proposals reduce costs in terms of GDP losses (in the periphery, the core and in aggregate EA) once a negative financial shock has occurred, and the paper must therefore be seen as complementary to existing cost-benefit analyses (e.g. Schoenmaker and Siegmann, 2013a, 2013b). We also abstract from issues as moral hazard and fear of contagion, which are crucially important and which have been the focus of many other studies. What has received less attention so far is a discussion of stabilising properties of alternative aspects of a banking union and we focus in this paper exclusively on that.

The paper is organised as follows: First, we present in section 2 a few stylised facts about the asymmetric distribution of banking risks across the EA. In section 3 we present the roadmap of a European Banking Union. Section 4 then presents a two region (core-periphery) DSGE model of the Euro area with a banking sector, follwed in section 5 by simulation results for core and periphery countries from six alternative (bank rescue) scenarios, reacting to a financial shock in the periphery. The final section concludes.

[4] See for example BIS (2010) or Miles et al. (2013), European Commission, 2012a; European Commission (2014b) provides a survey of cost-benefit studies.

2. Asymmetric financial sector risks in the Euro area

The Euro crisis has shown that capital markets in EMU are not fully integrated (or can become disintegrated very quickly) and thus only provide limited risk sharing across countries. Adverse financial shocks (e. g. mortgage loan losses in a subset of EA countries as in the case of Ireland and Spain) therefore have effects which are largely confined to countries from which they originate. However, this poses a problem, since it has been demonstrated in the recent financial crisis that because of the size of national banking systems and the size of loan losses this can entail, domestic bail-outs can easily stretch national fiscal capacities to the limit. The implicit and explicit guarantees created strong financial interlinkages between the domestic government and banking system and gave rise to a vicious circle. Since banks hold sizeable amounts of domestic government bonds the value of these assets is further reduced by rising risk premia on govenment bonds in the case of national rescue measures.

The run up to the financial crisis in the Euro area

With the introduction of the euro and the associated elimination of exchange rate risk, the countries in the EA periphery experienced a large decline in interest rates. These countries have responded with substantial borrowing from the core of the euro area, which led to buoyant economic activity and favoured an increase of wages, prices and the real exchange rate. When the capital lenders (banks) after 2008 refused to fund the ever-increasing deficits in the fiscal budgets and current account balances, an inevitable recession in the periphery was the consequence. There is an important link between European banking and the “Euro crisis”. The bank-real sector nexus is at the heart of our analysis.

An analysis of capital flows between 1999 and 2007 shows that the banks in the core of EMU mainly granted credits to the periphery, but hardly invested into foreign direct investments. The market for corporate bonds in Europe is less developed than in the United States. The banking sector (and credit financing) in Europe is therefore a much larger factor than in the United States. Many European banks are so big that their home countries in the event of bankruptcy would have difficulty absorbing them (the “too big to fail” (TBTF) problem).

Additionally, modern banking has changed dramatically in recent decades. On the asset side banks securitize a portion of their loans, including real estate, in principle tradable securities. This process was observed before the crisis, not only in the United States, but also in Ireland and Spain. Banks using such securitization create two risks that are not known in traditional banks: On the one hand, the securitized and tradable assets are subject to the risk of losses in declining market values. Secondly, there is the risk

that the markets for these securitizations are just then illiquid if banks want to sell it. This creates a "wrong signal" of security because banks get the impression that they can sell large quantities of securities at current market prices.

On the liabilities side of their balance sheet, the modern banks have – besides both equity and deposits from households - discovered a further source of funding: the market for short-term borrowings from other financial companies (wholesale funding market). The two main sources of funding are unsecured borrowings and securities sold with repurchase agreement (repo). Banks with access to the wholesale market could grow rapidly in the years before the crisis outbreak.

Performance of Banks in periphery and core

Many analysts regard declining assets on bank balance sheets, associated with non performing loans, in combination with precarious capital adequacy ratios as major reasons for the vulnerability of banks in the periphery. For example Jassaud and Hesse (2013) provide evidence that the share of non-performing loans (NPLs) to total loans is highest in the periphery countries of the EA. A break down of NPLs across core and periphery shows an upward trend in NPLs in the periphery. While non performing loans are high in the periphery, banks in the periphery tend to have low capital buffers (low “leverage ratios”; see also Bolton and Jeanne, (2011).

Furthermore there seems to be a trend to overbanking (“sizable assets”) in small countries. According to ECB data, Luxembourg sticks out with a ratio of bank assets as a share in GDP of 2100%, followed by other EA periphery countries Malta (770%), Ireland (634%), Cyprus (614%). Then comes the bank hub United Kingdom with a ratio of 502%. Germany in contrast has only a ratio of 291%. Spain (323%) and Greece (228%) are below EA average.

The IMF (2013) in its global financial stability report came to the conclusion that the banking sector of the EA periphery needs urgent adaptation. On four bank balance sheet indicators (loss absorption capacity: bank buffers ratio (Basel III: 8%); asset quality: change in impaired loan ratio (share of NPLs); funding: loan-to-deposit ratio; profitability: return on assets) the peripheral countries of the Euro area (Greece, Ireland, Italy, Portugal, and Spain) have the worst scores and therefore need massive adjustment. In preparation for the start of the Single Supervisory Mechanism (SSM) in November 2014, the ECB has conducted a comprehensive assessment of 130 EA banks in which the above mentioned weaknesses of the banks in the EA periphery were confirmed. However, some progress has been made (see also IMF, 2014).

Budgetary costs

Besides the asymmetry in bank risks in the Euro area, after the "Great Recession" 2009 and in the following Euro crisis high public debt was accumulated, primarily in the EA periphery countries. The government interventions to repair the banking sector have been enormous according to recent data from Eurostat (Baciulis, 2013). Government stimulus measures had different forms (direct aid with participation capital, monetary policy operations, overall fiscal support measures and the nationalization of banks). The net cost of the bank bailout programs (the state played the role of a "lender of last resort") are reflected in a cumulative increase in the national debt by 2012 to 690 billion euros in EU-27 (or 5.2% of GDP) and around 520 billion euro in the euro area(or 5.5% of GDP). Both for the EU and the euro area, the net impact was marginally deficit-increasing in 2007, 2008 and 2009, became much more pronounced in 2010 and 2012 and decreased sharply in 2011, largely due to bank recapitalisations and resolutions. The budgetary impact of support for financial institutions was greatest in Ireland, with a deficit of 30% of GDP in 2010, due to the costs of bank nationalization of 20% of GDP. In Greece, the costs amounted to 4% of GDP in 2012, in Spain 3.6% of GDP.

3. Roadmap of a European Banking Union

The Euro crisis that followed the "Great Recession" in 2009 was the result of three crises (see Barroso, 2012a): a public debt crisis, a macroeconomic imbalances crisis and a banking crisis. The first two causes are tackled by the New EMU Economic Governance (see Barroso, 2012b; Van Rompuy, 2012; Breuss, 2013), consisting of a better surveillance of public finance via a reform of the Stability and Growth Pact (plus the "Two-Pack" and the intergovernmental Fiscal Compact) and a better surveillance of macroeconomic imbalances (in the "Six-Pack"). The banking crisis triggered the discussions to establish a European Banking Union (EBU).

In 2014 the EU entered to the first phase of a European Banking Union (EBU). Shortly after the outbreak of the Euro crisis in 2012 the European Commission developed a "Roadmap towards a Banking Union" (European Commission, 2012b; Cesifo, 2012; Breuss, 2012, 2014) in which EBU was designed, resting on three pillars (*Single Supervisory Mechanism – SSM*; *Single Resolution Mechanism – SRM*; and *Single*

Deposit Gurantee Mechanism - SDM) and a solid legal base, called the "Single Rulebook"[5]. The EBU project should lead to a "reformed financial sector for Europe" (European Commission, 2014c).
In analysing the stabilising properties of EBU we focus primarily on the mechanism which provide funding in case of bank distress. That means we derive bank resolution scenarios connected with pillar 2 (SRM) and pillar 3 (SDM) and over a transition period with the European Stability Mechanism (ESM) as a backstop arrangement.

Pillar 1: The *SSM* is - in cooperation with national supervisory authorities and the European Banking Authority (EBA) - responsible for the bank supervision in the Euro area. For the Euro area Member States it is mandatory to participate in the SSM, but it is open for the other EU Member States also to join. Before the SSM became operational on 4 November 2014[6], the ECB had conducted a comprehensive assessment of the 130 largest banks in the Euro area concerning risk assessment, asset quality review (AQR) and lastly a strong stress test, in coordination with EBA[7]. The supervisory arm of EBU, the SSM should reduce the probability of a banking crises à la Lehman Brothers and other banks in Europe during the global financial crisis 2008/09

Pillar 2: The *SRM* is the core of interest in our analysis because it helps to arrange the orderly reorganisation and eventual liquidation of failed or failing banks. The SRM Regulation basically applies the substantive rules (e.g. for "bail in") of the Bank Recovery and Resolution Directive (BRRD) – which is part of the "Single Rule" book and applicable to all EU Member States. The SRM should substitute the present role of the government ("bail out" of banks and hence increasing public debt) through the new rule of "bail in" to resolve banks. Authorities will first bail-in all shareholders and will then follow a pre-determined order ("cascade of shareholders"): creditors who invest in bank capital (such as holders of convertible bonds and junior bonds) will bear losses first, while deposits under EUR 100,000 will never

[5] The "house" of the EBU, resting on the three pillars (SSM, SRM, and SDM) is based on the EU law of the "Single Rulebook" which applies to all EU Member States. Besides a whole variety of new rules re-regulating the financial services of the Single Market in the EU (e.g. Hedge funds, credit rating agencies, short selling, SEA, credit cards etc.; see Breuss, 2014) three basic laws should make the Single Market in financial services more stable (see European Commission, 2014b).
[6] See the new website of the European Central Bank – Banking Supervision: https://www.bankingsupervision.europa.eu/home/html/index.en.html.
[7] On 26 October 2014, the European Central Bank (ECB) has published the results of its thorough year-long examination of the resilience and positions of the 130 largest banks in the euro area as of 31 December 2013 (see: https://www.bankingsupervision.europa.eu/press/pr/date/2014/html/sr141026.en.html.

be touched - they are entirely protected at all times via the recast DGS directive. While resolution will thus be financed in the first place by shareholders and creditors ("bail-in" rule), as a last recourse there will be a Single Resolution Fund (SRF), funded through bank contributions (see European Commission, 2014a, 2014b and 2014c). On 9 December 2014 the Council reached a political agreement on an implementing regulation determining the contributions to be paid by banks to the EU's Single Resolution Fund (SRF) [8]. The fund will be set up under the SRM in order to ensure the orderly resolution of failing banks. The SRF will be built up over a period of eight years to reach a target level of at least 1% of the amount of covered deposits of all credit institutions in all the participating member states. In the end, in 2023, the SRF should then have a capital stock of EUR 55 bn. For member states participating in the banking union, the national resolution funds (NRF) set up under the BRRD as of 1 January 2015 will be replaced by the SRF as of 1 January 2016.

Pillar 3: The SDM at EU level remains a future project. What is in place instead is a harmonized Deposit Guarantee Scheme (DGS) at national level in all EU Member States. According to the new rules on Deposit Guarantee Schemes (DGS Directive, adopted on 15 April 2014) depositors will continue to benefit from a guaranteed coverage of EUR 100.000 (EU law since December 2010) in case of bankruptcy, but access to the guaranteed amount will be easier and faster. Repayment deadlines will be gradually reduced from the current 20 working days to 7 working days in 2024.Although the national deposit guarantee schemes are beneficial for the depositors in case of bank failures, it leads also to considerable economic costs. The target level for ex ante funds of DGS is 0.8% of covered deposits (e.g. about EUR 55 bn) to be collected from national banks over a 10-year period.

ESM: Backstop arrangement in specific circumstances: On 8 December 2014 the Board of Governors of the European Stability Mechanism (ESM) – comprising the 18 euro area finance ministers - adopted the ESM direct recapitalisation instrument (DRI) for euro area financial institutions. The new instrument allows the ESM to recapitalise a systemic and viable euro area financial institution (systemically relevant credit institutions only) directly under specific circumstances as a "last resort" measure. The ESM can recapitalise banks directly only if private investors have been bailed-in, in accordance with the EU Bank Recovery and Resolution Directive (BRRD). In addition, the national resolution funds or, from 2016

[8] The detailed steps towards the SSM can be followed on the Single Resolution Mechanism (SRM) website of the European Commission: http://ec.europa.eu/finance/general-policy/banking-union/single-resolution-mechanism/index_en.htm.

onwards, the Single Resolution Fund (SRF) must contribute. In order to preserve the ESM's high creditworthiness and lending capacity for other instruments, the total amount of ESM resources available for the new instrument is limited to €60 billion[9].

Derived bank resolution scenarios:

From the design and ruling of the EBU we deduce scenarios which represent the different resolution mechanisms. With simulations with a version of the QUEST model which includes a banking sector, we can then determine which EBU measures are best in stabilizing the EA economy as a whole, as well as the periphery and the core countries, in case of financial shocks comparable to those of the global financial crisis in 2008/09.

The EBU discussion in this paper centres on the distribution of financial risks between EA Member States and respective stakeholders (banks, tax payers, borrowers and depositors) in case of a systemic shock, i.e. bank losses of a size which would exceed the capacity of a national resolution scheme. Besides the national intervention to rescue failing banks as was done hitherto, the EBU three rescue scenarios can be envisaged:

- "Bail-in" solution of (mainly) domestic debt holders[10].
- Bank resolution with the SRM at Euro area level.
- ESM as backstop in specific circumstances as a "last resort" measure. .

In our view two dimensions have so far dominated the discussion between these three alternatives, namely moral hazard and fear of contagion. What has received less attention so far is a discussion of *stabilising properties* of these three alternative schemes in the case of adverse financial shocks and the distribution of losses across EA regions once a BU is in place. This is an important aspect, in particular since it is well known that financial crises are costly in the sense of protracted output losses (see Schularick and Taylor, 2012) – and given the observation that the U.S. – which can be regarded as a

[9] For more details on the new DRI see the ESM website: http://www.esm.europa.eu/press/releases/esm-direct-bank-recapitalisation-instrument-adopted.htm. See also ESM (2014) and DRI statements by the Eurogroup (2013a, 2013, 2014).

[10] Note in the model we do not distinguish between secured and unsecured debt, but summarise all non-bank capital items on the liability side of the bank balance sheet as 'deposits'.

federation of states within a BU – has managed to recover more quickly. Therefore the aspect of minimising output losses should find proper attention when selecting particular schemes.

All three BU schemes (plus national bail out) have one important element in common. In all cases the national banking system will be saved (even though individual banks may go bankrupt), but bank resolution may require funds which exceed the funds available to the national resolution authority. The schemes mainly differ in the way the losses are covered, namely either by the domestic government, (mostly) domestic debt holders, an EA wide resolution insurance scheme or by the EA tax payer.

4. A Two-region Euro area model

Because the "Great Recession" was difficult to capture by traditional economic models, new approaches have tried to incorporate the financial sector into macroeconomic models (for example Brunnermeier and Sannikov, 2014). Others consider financial restrictions for business cycle developments à la Bernanke, Gertler, and Gilchrist (1999) or others (e.g. Iacoviello, 2005) into the new macro models, mostly DSGE models. Alpanda and Aysun (2012) investigate the transmission mechanism of financial shocks across large economies (from the U.S. to the Euro area) by estimating a two-region open economy DSGE model. They model the financial side of both economies using the financial accelerator mechanism of Bernanke et al. (1999). Their simulations demonstrate a larger Euro Area response to U.S. shocks and highlight the importance of including frictions in international financial contracts, and not only in domestic financial contracts, for more accurately capturing the international transmission of domestic shocks. A similar exercise for the Euro area was done by Kollmann et al. (2013) with the QUEST model of the European Commission, extended with a banking sector. Bank losses explain about a quarter of the fall in EA GDP and consumption in 2007-2009, and more than three quarter of the fall in private non-residential investment. Government support for banks was an effective tool for stabilizing output and consumption and, especially, physical investment, the component of aggregate demand most adversely affected by the financial crisis.

The financial sector, neglected in most pre-crisis macro and DSGE models, is now increasingly considered important in the interplay of financial and real spheres of the economies. In this regard also the QUEST model of the European Commission has been improved steadily after the financial crisis.

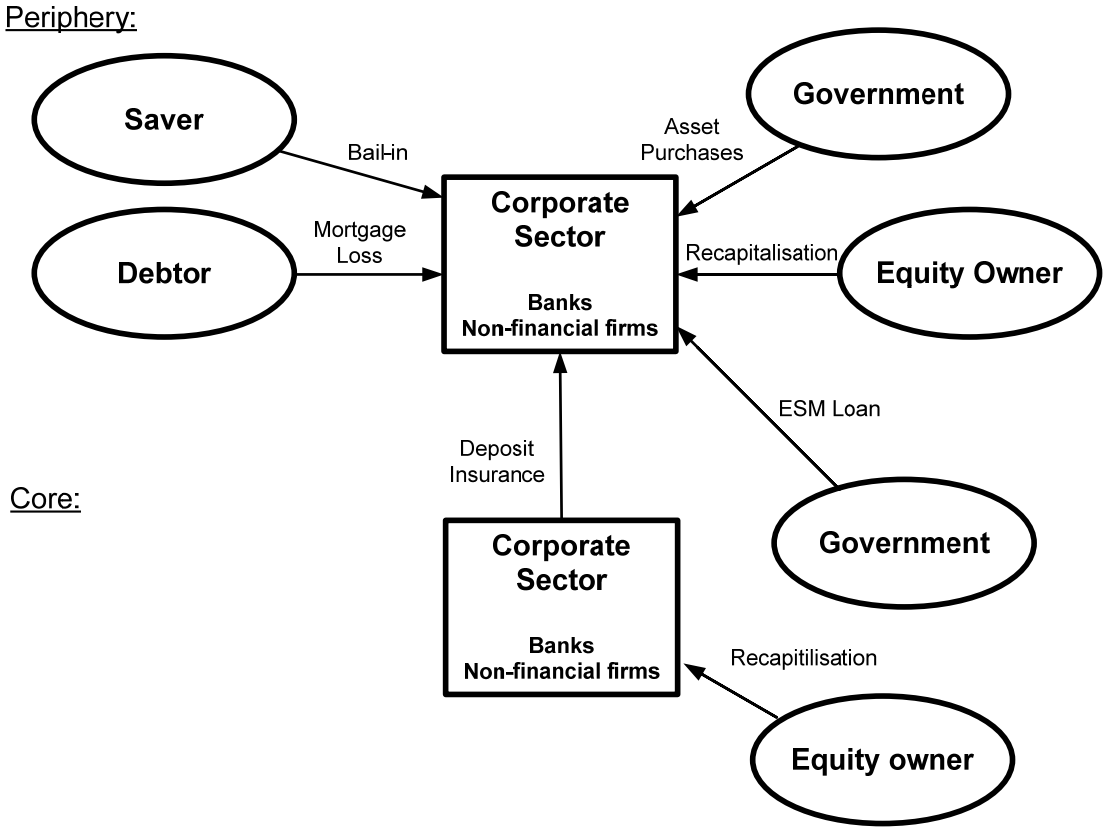
4.1 The QUEST model with a banking sector

This paper uses an extended version of this model. to study the national and Euro area wide effecs of financial shocks. In particular, it features a sovereign risk channel (see Corsetti et al., 2013 and Roeger and In 't Veld, 2013), by allowing banks to hold domestic government bonds. In order to address the stabilising properties of alternative insurance schemes we set up a stylised two region model of the EA economy, where we distinguish between a subset of countries which are hit by a (mortgage) loan shock and the remaining group of countries, which are not directly affected. We call the first group of countries the 'periphery' and the second group of countries the 'core'. We calibrate the periphery to resemble the size of countries in the Euro area which currently suffer from financial shocks (ES, IR, GR, PT and IT).
The QUEST model with a financial sector (see Figure 1)[11] departs from a perfect insurance setting in various ways[12]. The model economy is characterised by two financial market inefficiencies, namely limited risk sharing within a country, and limited ability to borrow from abroad (break down of interbank lending).

Limited risk sharing is introduced by assuming financial market segmentation. Here, segmentation means that certain types of households only trade in specific types of assets. In particular we distinguish between two types of savers, namely risk-averse savers which only save in the form of deposits (and government bonds) and less risk-averse savers which hold equity (of banks and NFCs). Unlike in a standard macro model which does not distinguish between different types of savers there is no general risk sharing arrangement between savers but only deposit insurance provided by equity owners to risk-averse households. Insurance is made credible by providing bank capital.

[11] A detailed description of the QUEST model with a banking sector can be found in Appendix 2.
[12] A macro model without a banking sector and an aggregate household sector implicitly makes the assumption of perfect insurance across households, i.e. financial losses would only lead to redistribution of financial wealth within the household sector and would therefore not have large macroeconomic implications.

Figure 1: Overview of the Two-region EA QUEST model with banking sectors



In case of mortgage losses equity owners are directly affected via a reduction of bank dividends. In case of severe credit losses banks are forced to recapitalise. This is modelled in a simple fashion by introducing a cost for banks from deviating from a target capital to asset ratio. The target capital to asset ratio is set by the regulator and banks can only deviate from this target at an increasing reputatioal cost. Thus, equity owners only have a very limited ability to borrow from other savers in case of bank losses in order to smooth consumption. Similar as in the case of domestic depositors, periphery banks can in principle borrow from the core. However our analysis assumes that periphery banks become cut off from interbank lending in the case of an adverse financial shock (interbank loan supply curve to periphery banks turns vertical).

We believe that these two features are capturing important inefficiencies which characterise financial markets in the EA. There is considerable empirical evidence about the importane of limited particpation

of households in the market for risk capital to explain fluctuations in asset prices (see for example Mankiw and Zeldes (1991), Vissing-Jorgensen (2002) and there is also evidence about the limited stockownership in many countries of the EU (see Guiso et al. (2003)). The importance of financial market segmentation in the current financial crisis has also been stressed by Krishnamurty et al. (2013). This can be called "within country segmentation". We also assume that there is "between country segmentation" of capital markets, i. e. there is considerable home bias in equity holdings and limited cross border lending[13]. These two financial market constraints help to generate large fluctuations in country risk premia in the presence of local loan losses. Both limited domestic stockmarket participation and limited availability of foreign lending to domestic banks, restrict recapialisation efforts to a relatively small pool of domestic shareholders.

This drives a wedge between the return of save and risky assets in the domestic economy and between risky assets in the domestic and foreign economy. It is important to notice that these wedges not only reflect risk differentials but they largely reflect limited supply of domestic and foreign risk capital.

To sum up, financial market shocks lead to macroeconomic effects because segmented financial markets limit arbitrage, i.e. households/firms/banks which are hit by losses are subject to collateral constraints and cannot distributed losses over time by borrowing. This leads to spreads between risky and less risky assets. Within the model, alternative BU schemes can have beneficial effects to the extent in which they overcome funding barriers (or can be used as a substitute) between different types of savers (peripery vs core; depositors vs. equity investors)

We do not model financial market panics and contagion (as a change of beliefs about the solvency of government or bank in the core because of events in the periphery, which go beyond financial losses to financial liabilities of the periphery). Contagion is possibly an important additional spillover effect. However we feel that contagion is currently more important for periphery countries themselves than between periphery and core. Currently negative confidence spillovers between core and periphery could be dominated by safe heaven effects. Some recent empirical evidence for this is provided by Gora and Radev (2013). We may also underestimate the losses inflicted in the no rescue case since we do not model financial market panics or extreme forms of uncerainty aversion, but assume throughout this analysis that

[13] Bignon et al. (2014) analyse in a two-country model context the implications of impediments to credit markets in a segmented EA financial market for the current architecture of the European Banking Union.

all financial market participants have full knowledge about the magnitude of the financial shock (and implicitly there is (effective) national risk sharing in place such that an idiosyncratic shock to an individual national bank is shared by the national banking system. Instead, financial shocks are amplified in this model by certain forms of financial market incompleteness, namely financial market segmentation. It is shown in this paper that with this assumption, the model is able to generate substantial negative GDP effects, for realistic loan loss shocks. The advantage of a clearly spelled out mechanism of shock transmission is that we do not have to make additional assumptions concerning behaviour under alternative EBU regimes.

Because of our extreme assumption about interbank market segmentation in the EA, there are no bank losses from the periphery to the core (either via the interbank market or because of losses of core subsidiaries in the periphery). Though core banks and other investors are still holding assets in the periphery, the Euro area has experienced a significant reversal of financial integration in recent years. As reported in a recent McKinsey study (see Lund et al, 2013) private capital flows within the EA have fallen by about 85% since 2007. For example the exposure of German and French banks to banks in the periphery has fallen to about 2% of GDP. It must nevertheless be conceded that there is still a substantial amount of international diversification of bank asset holdings (see Schoenmaker and Siegman, 2013a, 2013b). Explicitly allowing a direct transmission of losses from the periphery to core banks would generate larger international spillovers of the financial shock, however it would not fundamentally alter the comparison we intend to do in this paper, namely compare the international and spillover effects of financial shocks, since the international losses would be present under all scenarios.

An argument in favour of a simplified approach is that assuming - as we do here - an extreme form of EA financial market fragmentation provides a clear benchmark in the sense that under the status quo there are no direct financial losses from the periphery inflicted on the core but only negative trade spillovers. The baseline scenario (without any form of bank resolution mechanism) could thus be seen as the most favourable constellation for the core. However, section 5 contains a brief discussion of the effects of stronger international bank market integration.

4.2 Calibration

Behavioral and technological parameters are taken from the estimated model for the Euro area in Kollmann *et al.* (2013). I.e. we assume that parameters determining the speed of adjustment of prices,

wages, labor and investment are identical across the two regions. However the two regions differ w. r. t. (bilateral) trade openness, government shares, employment rates and loan-to-value ratios.

Table 1: Model parameters in the QUEST model

	Core	**Periphery**
Rate of time preference (S+E)	1.3% p. a.	1.3% p. a.
Rate of time preference (D)	5.7% p.a.	5.7% p. a.
Output elasticity for labor	0.65	0.65
Openness	4.9	11
Price changes (mean duration)	7Q	7Q
Wage changes (mean duration)	4Q	4Q
Real wage rigidity	0.9	0.9
Frisch labor supply elasticity	0.25	0.25
Income share of borrowers	25%	25%
Net worth equity owners	50%	50%
Mortgage loans (% of GDP)	45%	60%
Bank capital ratio	8%	8%
Sovereign debt (% of bank assets)	7%	15%
Bank capital constraint	0.65	0.65

We set the risk free rate to 1.7% p. a.. This pins down the subjective discount factor of the saver household (0.9994). The steady state loan rate is set at 2.2% (average historical EA real rate). Following Iacoviello and Neri (2010) we set the discount factor of the debtor household at a markedly lower value of 0.960 in order to ensure that the collateral constraint always binds. The subjective discount factor of the equity owner is set at 0.974 which allows to capture the private non-residential capital to GDP ratio of 1.05. The empirical literature on credit constrained households frequently reports that the income share of these households is in the range of 25% and above (see Ratto et al., 2009). We assume that equity owners hold about 50% of net worth[14].

The output elasticity of labor is set equal to 0.65 which corresponds to the (adjusted) wage share in the EA. Depreciation of corporate capital is set to 0.1 (p. a.) and for residential capital to 0.04 (p. a.). The

[14]According to the Luxembourg Wealth Study (Sierminska et al., 2006) the top 10% of the population in the EU own roughly 50% of total net worth (financial assets + dwellings + consumer durables - liabilities).

trade share (goods and services) between periphery and core is set to the following values: Core: 4.9% of core GDP, Periphery: 11% of periphery GDP.

The steady state ratio of mortgage bank loans to GDP is set at 45% (mean ratio of outstanding loans to GDP in EA), while the steady state bank capital ratio is set at 8%. For this exercise it is important to have a good estimate of domestic sovereign debt holdings of domestic banks. Merler and Pisani-Ferry (2012) have calculated sovereign bond holdings of domestic banks for EA countries. They find that these asset holding have increased between 2007 and 2011. Especially domestic banks in countries in Southern Europe tend to hold relatively large shares of domestic sovereign debt as a % of GDP (GR: 16.1%, IR: 9.6%, PT: 20.8%, IT: 16.9%, ES: 15.9%). In 2007 these holdings were below 10% of GDP. For the simulations we assume that domestic banks holdings of sovereign debt amount to 15% of GDP. The curvature parameter of the bank´s cost of deviating from target bank capital implies that a 1 percentage point rise of the bank capital ratio lowers the spread between the loan rate and the deposit rate by 40 basis points. This is a critical parameter in the model, and depends crucially on the degree of risk aversion of depositors.

5. Responses to a financial shock under alternative insurance mechanisms

In order to come up with a realistic financial crisis scenario, we use the case of Spain. As has been shown in In 't Veld et al. (2014), a decline of house prices, associated with collateral tightening and an increase of equity risk premia can explain a substantial part of the Spanish recession. We add to this mortgage losses to the banking sector originating from indebted households. Similar developments can be observed in the case of Ireland. However, Portugal, Greece and Italy have suffered from different financial shocks (soveign debt shocks) plus contagion. Since our intention is not to come up with a crisis scenario which fits all periphery EA Member States, but rather to define a stylised scenario which highlights the financial linkages of borrowers and lenders, we impose the mortgage default on the periphery as a whole.[15]

In order to generate a sizeable recession in the periphery we assume a permanent drop of house prices by 10%[16]. Our choice is dictated by the fact that we want to arrive at a realistic economic downturn for the periphery as a whole. In addition we assume mortgage losses of about 7% of periphery GDP.

[15] Alternatively we could also have opted for an expected sovereign default scenario. However the adopted approach has advantages since it allows us to generate the vicious circle between banks and the government.

[16] This is far less than the real house price decline in Spain and Ireland in 2008/09 (about 50%), but takes into account that house prices in the other countries of the periphery declined less.

While for the periphery it is undisputed that the benefits of moving to a EBU are large, the benefits and costs for core countries are less clear. While on the one hand remaining within the status quo (largely) insulates core countries from periphery asset losses (under the assumption of limited financial market integration), on the other hand there is a sizeable degree of trade integration within the EA (between core and periphery), and thus the core will nevertheless be affected by declining exports. In case a EBU would exist, there would be - under specific variants - direct insurance transfers from the core to the periphery. However these would stabilise the financial system in the periphery and prevent a deep recession. Thus there is the question which of the two options would ultimately be better for the core, when gauging the trade off between direct insurance transfers versus trade losses associated with a financial crisis[17].

5.1 Bank resolution scenarios

We consider the impact of such a financial shock under five alternative insurance arrangements:

Scenarios without EBU:

- *Scenario 1* (No intervention: baseline scenario): Neither the periphery government intervenes, nor is there an international insurance mechanism in place and periphery banks have to recapitalise within a fragmented Euro area financial market.
- *Scenario 2* (National "bail-out": periphery government rescue): Periphery governments take over a substantial fraction of the losses by increasing government debt.

EBU scenarios:

- *Scenario 3* (EBU: "bail-in"): Periphery resident depositors take over a substantial part of the losses.
- *Scenario 4* (EBU: SRM at EU/Euro area level): Core banks become partially but substantially liable for losses occuring at periphery banks. In the eight years transition phase with a network of national resolution mechanism (NRFs and SRF) till the full-fledged operating of the SRM at EU/Euro area level with the SRF in 2023 this scenario overlaps with ingredients of Scenario 3.

[17] Of course a more extensive cost benefit analysis must also consider the case where the core is hit by an adverse financial shock and assess the likelihood of such an event. For a cost-benefit analysis, based on a microeconomic (bottom-up from banks to countries) approach for all EU Member States, see Schoenemaker and Siegman (2013a, 2013b).

- *Scenario 5* (ESM: backstop with loans): Core governments provide loans to periphery banks by issuing government debt via the ESM direct capitalisation instrument (DRI). However, this is only a limited instrument for special cases.

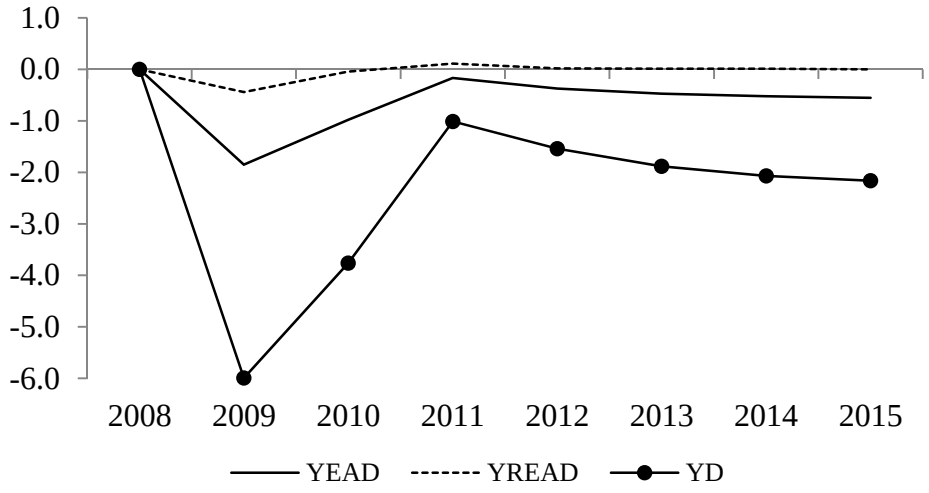
5.2 Simulation results in detail

In the following we describe the effects of these financial shocks under the alternative insurance mechanisms as the result of simulations with the two-regions EA QUEST model with a banking sector. It is important to note that we assume in our simulations that all applied measures to rescue/wind up banks in the EA periphery are implemented immediately. As we have described in Chapter 3, however, the fully-fledged EBU will be implemented only gradually: in 2014 the SSM starts, the SRM will only work fully at EU/Euro area level after the end of a 10-years transitional phase, in which a network of national bank resolution mechanism are at work. In the meantime also the DGS Directive garantees savers deposits up to EUR 100.000 per depositor.

Scenario 1 (No intervention: baseline scenario):

In this baseline scenario it is assumed that there exists no ESM and no banking union; the tax rule is off (for the first 10 years); the sovereign risk channel works. As can be seen from Figure 2 and detailed in Table 1 of Annex 1, the financial shocks generate a recession in the periphery (drop of GDP of nearly 6%) with features typical for a financial crisis. There is a strong increase in the equity premium, since domestic equity owners have to reduce consumption in order to recapitalise domestic banks. This leads to a sharp drop in corporate investment. Residential investment also declines strongly both because of a fall in house prices, which causes a wealth effect and tightens the collateral constraint, and in addition because banks tighten credit due to loan losses. Also private consumption takes a hit, as borrowers suffer from a credit squeeze, because of forced savings of equity owners and because of a decline of both real wages and employment.

Figure 2: GDP effects of the baseline scenario (financial shock in the EA periphery)
(Deviations from unshocked scenario in percentage points)



YEAD = Euro area (EA), YREAD = EA core, YD = EA periphery.

Government debt rises, this is however initially mainly due to a denominator effect, followed by the effects of automatic stabilisation (unemployment insurance, transfers). This adds a negative feedback loop as prices of government bonds further decrease the value of bank assets.

Given the assumptions on financial market fragmentation we are making in this analysis the financial shock is mainly transmitted to the core via the trade channel. GDP in the core falls by about 0.4%, i.e. slightly less than 10% of the loss in the periphery (however significant in absolute terms given the size of the two regions).

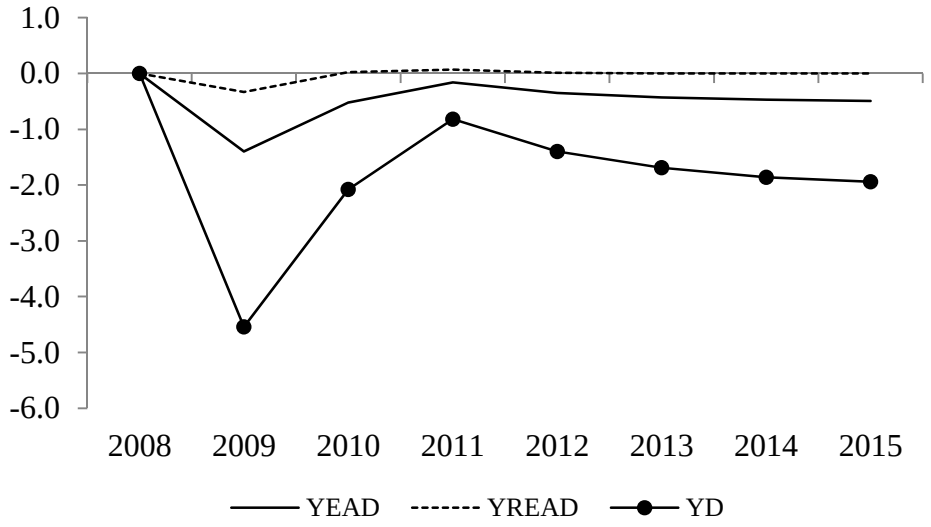
A double dip emerges in all scenarios, namely an initial recession, followed by a recovery and a further slowdown of growth after the 3rd year. This is due to a persistent decline of residential investment which responds sluggishly to the house price decline and gradual deleveraging. Another reason is the fact that sovereign debt is eventually (after 10 years) expected to be stabilised by increasing distortionary labour taxes. One characteristic feature of this baseline scenario is that, apart from house price re-valuation losses, which are borne by all domestic households, financial wealth is shifted from borrowers to periphery equity owners.

Scenario 2 (National "bail-out": periphery government rescue):

The difference between this and the previous scenario is that in this case periphery equity owners only bear 25% of the losses directly, and the rest of the losses are now covered by the government in the form of transfers to banks. This has a stabilising effect, since banks need to raise less capital in the domestic equity market. However, the accompanying increase in government debt partly offsets the positive effects on bank balance sheets because of a stronger decline of government bond prices. Nevertheless, the periphery government rescue measures provide some stabilisation and can reduce the GDP loss to 4.5% in the first year (see Figure 3 and Table 2 in Annex 1).

This additional stabilisation is achieved via a less strong decline of corporate investment and private consumption. By stepping in, in favour of periphery equity owners, which reduces forced savings of periphery shareholders and increases consumption (relative to the first scenario), this frees funds available for other investment projects and slows down the increase in the equity premium. However, the periphery government rescue measure is not self financing but increases the share of government debt (as a % of GDP) by about 3 pps. after 6 years. The additional government debt is financed in the long run and eventually brought back to target levels by higher labour taxes. Because the bail-out stabilises GDP in the periphery, it also reduces the spillover to the core.

Figure 3: GDP effects of the national rescue scenario (bail-out by periphery government)
(Deviations from unshocked scenario in percentage points)



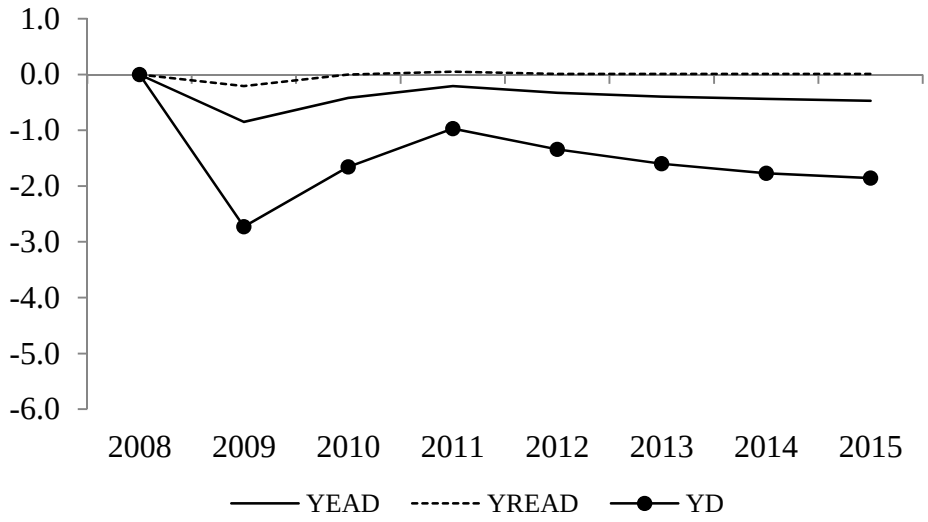
YEAD = Euro area (EA), YREAD = EA core, YD = EA periphery.

Scenario 3 (EBU: "bail-in"):

Now we are moving on to measures foreseen by EBU. In contrast to scenario 2 where worker households (borrowers and risk averse savers) pay for 75% of financial sector repair through higher taxes, in this scenario depositors (risk averse worker households) step in directly and immediately provide a lump sum transfer to the banking sector[18].

The "bail-in" has beneficial effects in this model, which go beyond stabilisation provided by periphery governments, because due to a much lower expected incease of government debt government bond prices decline by less, which further reduces the recapitalisation needs for periphery bank shareholders (see Figure 4 and Table 3 in Annex 1). As a consequence, the equity premium rises less, corporate investment declines less and private consumption is further stabilised. Notice that depositors are modelled as not being financially constrained, thus they are able to smooth consumption. Within the current model, the bail-in solution is an efficient means of stabilisation because it effectively alleviates the limited risk sharing in the economy due to financial market segmentaton. In a less financially segmented market, banks would have been able to shift losses to depositors more easily.

Figure 4: GDP effects of the national rescue scenario (bail-in in EA periphery)
(Deviations from unshocked scenario in percentage points)



YEAD = Euro area (EA), YREAD = EA core, YD = EA periphery.

[18] "Bail-in" is modelled as a contribution of depositors to banks which is based on their existing deposits and not as an expected reduction of the interest received on deposits. I.e. the bail-in measure is associated with an expectation that this is a one-off event. As a consequence there is no behavioural response (bank-run) of depositors.

In terms of the distribution of losses, compared to the previous scenario, risk averse savers now bear most of the losses directly, while borrowers are relieved from the costs of financial sector repair. Equity owners continue to bear 25% of the direct losses, but benefit from a stabilisation of government bond prices. The larger stabilisation provided by the bail-in also benefits the core economy via smaller negative trade effects.

Scenario 4 (EBU: SRM at EU/Euro area level):

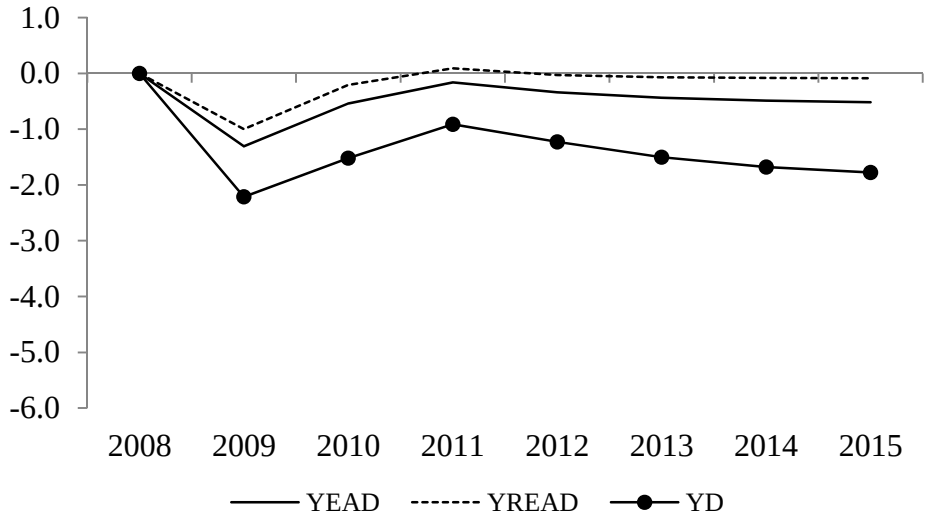
The SRM foresees that all EA banks must pay in the Single Bank Resolution Fund (SRF) as of 1 January 2016. As described in Chapter 3, banks in the EA must pay into the SRF 1% of covered deposits, which after the eight years transition period in 2023 would generate a capital stock corresponding to around EUR 55 billion.

Our simulation assumes the existence of such a fund and excludes the costs of building up such a fund. But it includes the effects of recapitalising the resolution fund after losses have occurred. Losses in the periphery effectively induce a transfer from core banks to banks in the periphery. This transfer covers 75% of total loan losses in the periphery (as before 25% is covered by national deposit guarantees or by individual banks directly). Essentially all the losses occuring in the periphery are now distributed across all (periphery plus core) equity owners in the EA. This has direct positive effects for the periphery since it relieves domestic households and the government from direct payments to periphery banks (see Figure 5 and Table 4 in Annex 1). Compared to all national solutions, the output loss is now reduced because domestic demand is further stabilised. In addition government bond prices decline less, which further reduces recapitalisation efforts of banks and their shareholders with positive multiplier effects on domestic private investment and consumption.

However the burden is now shifted to the EA shareholders in the core. They now have to increase savings in order to recapitalise the insurance funds. This increases the equity premium in the core and lowers investment and economic activity. As a result the net spillover effect to the core increases to a GDP loss of 1% in the first year.

As explained in Chapter 3 agreement of the EBU reached in December 2013 foresees not an immediate start with the SRM at Euro area level. Instead, in the 10-years transition phase there will be a network of national resolution mechanism (resolution funds) until the full-fledged EBU is operational with the SRM at EU/Euro area level. Therefore one could think of a separate scenario which deals with national resolution mechanisms (NRM). The results would probably lie somewhere between the Scenarios 3 and 4.

Figure 5: GDP effects of EBU rescue scenario (SRM at EU level)
(Deviations from unshocked scenario in percentage points)



YEAD = Euro area (EA), YREAD = EA core, YD = EA periphery.

Backstop arrangements in the transition phase towards a fully-fledged EBU:

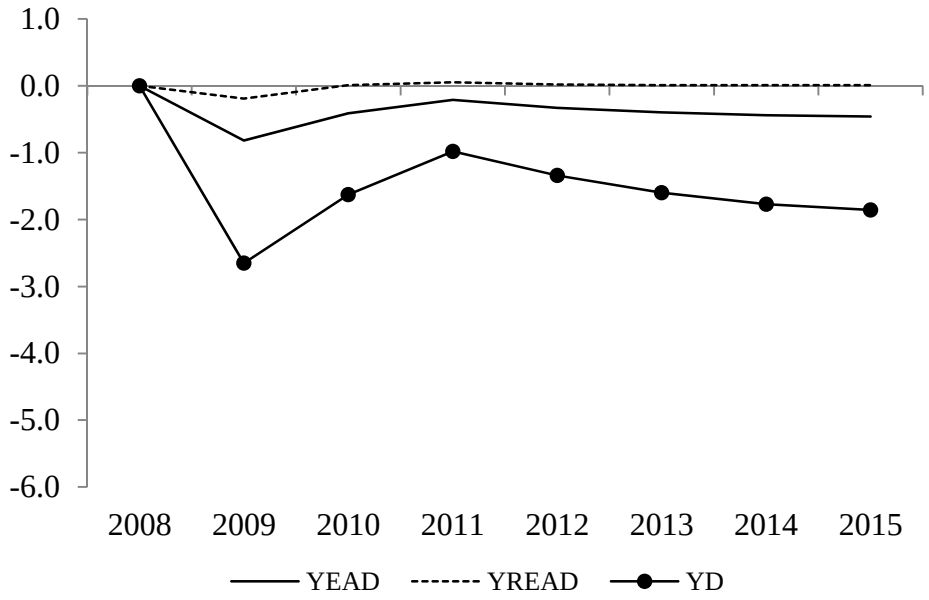
As describe in chapter 3 on 8 December 2014 the Board of Governors of the European Stability Mechanism (ESM) adopted the ESM direct recapitalisation instrument (DRI) for euro area financial institutions. The new instrument allows will be applicable only under specific circumstances as a "last resort" measure and will be limited to €60 billion.

On the one hand, with the new DRI one wants to break the vicious circle between bank and sovereign debt crises (it would avoid an increase of public debt), on the other hand, this "last resort" instrument is an additional measure to the main SRM (SRF) instruments plus "bail-in" mechanism ruled in the BRRD. Current bank aid from the ESM (e.g. in the case of Spain) were executed via the Member States: they received loans from the ESM, which were used to recapitalize banks. However, this operation increased the national sovereign debt which will be avoided by the DRI. In the following Scenario 5 we simulate ESM aid to recapitalize banks directly in the periphery as a backstop instrument.

Scenario 5 (ESM: backstop with loans):

ESM loans to periphery banks provide an alternative international rescue mechanism for the periphery financial sector. This scheme differs from the previous scheme in two respects. First, core shareholders are not providing funding and, second, there is no wealth transfer from the core to the periphery since only long term loans (with infinite duration) are given to periphery banks (it is assumed that these loans are regarded as quasi capital by depositors).

Figure 6: GDP effects of ESM backstop rescue with loans to banks
(Deviations from unshocked scenario in percentage points)



YEAD = Euro area (EA), YREAD = EA core, YD = EA periphery.

Effectively the ESM loan allows periphery banks/shareholders to smooth losses over time and prevents strong forced savings. However, the loan losses are borne by periphery equity owners. In terms of international risk sharing this arrangement is more efficient since it avoids an increase in capital cost in the core and therefore it appears as an effective tool for overcoming between-country financial market segmentation.

It alleviates short term funding pressure because of the long term nature of the loan. However, because it shifts losses to periphery shareholders only, this arrangement cannot overcome the within country capital

market segmentation and is therefore not fully optimal from a stabilisation point of view. The GDP stabilising effect is more concentrated in the core than in the periphery (see Figure 6 and Table 5 in Annex 1).

5.3 Simulation results: ranking w.r.t stabilising EA GDP

5.3.1 Ranking w.r.t stabilising periphery GDP

All rescue measures can stabilise the periphery economy. In terms of a ranking of measures (w. r. t. stabilising 1st year periphery GDP), national government rescue (Scenario 2) is the least efficient method. In this model this is due to the fact that there is a vicious circle between government rescue implying an increase of government debt and asset revaluation effects in balance sheets of periphery banks (see Table 2).

Table 2: First year GDP effects of alternative bank resolution scenarios

Scenarios	**GDP Periphery**	**GDP Core**	**GDP EA average**
1. No intervention: baseline	-5.99	-0.44	-1.85
National measures			
2. National "bail-out": periphery government rescue	-4.54	-0.33	-1.40
European Banking Union (EBU)			
3. National "bail-in"	-2.73	-0.21	-0.85
4. EBU: SRM at EU/Euro area level	-2.21	-1.00	-1.31
5. ESM: backstop with loans	-3.22	-0.19	-0.82
Alternative baselines: More private risk sharing			
Cross border interbank market	-2.35	-1.27	-1.54
Increased within country risk sharing	-3.64	-0.31	-1.16

The three mechanisms envisaged in EBU provide more stabilisation, but there is also a ranking among them. ESM backstop resolution with a loan (Scenario 5) to periphery banks is the least effective EBU mechanism, though it reduces losses considerably. In this scenario, bank owners (equity owners) in the periphery are still bearing the losses. ESM's DRI only provides a possibility for them to distribute the losses over time.

"Bail-in" of periphery depositors (Scenario 3) is slightly less costly. In contrast to the ESM loan scenario (5) it shifts losses away from equity owners to depositors (which can smooth consumption by borrowing

from abroad). Note, however, under our assumption of financial market fragmentation among core and periphery countries, only saver households in the periphery bear financial sector losses.

A fully-fledged EBU with a SRM (Scenario 4) is less costly for the periphery. It shifts losses from periphery investors to core investors.

In general, measures which shift losses away from periphery equity owners reduces the cost for the periphery. The losses for the periphery can further be reduced if losses are shifted to core savers instead of core investors.

5.3.2 Ranking w.r.t GDP losses for the core

An EA wide resolution mechanism (SRM; Scenario 4) is the most costly scenario for the core, since it increases capital cost in the core with detrimental effects on core investment. No response (baseline Scenario 1) is the second worst for the core because of the negative trade effect resulting from the recession in the periphery. National government rescue, "bail-out" (Scenario 2) is the third worst for the core, because of negative trade effect resulting from the relative inefficiency of national government rescue measures.

Bail-in (Scenario 3) as well as the ESM Scenario (5) are the best for the core with a similar GDP loss. These scenarios have in common that they either shift losses to households that can smooth consumption (in Scenario 3) or they allow the periphery investors to smooth consumption (in Scenario 5a).

5.3.3 Ranking w.r.t EA wide GDP losses

No intervention (baseline Scenario 1) is the worst scenario for the EA as a whole because of the large GDP losses inflicted on the periphery with negative trade effects. National government rescue (Scenario 2) is the second worst scenario because of the inefficiency of stabilising the periphery. EA wide resolution solution with the SRM (Scenario 4) is the third worst because of the high costs for the core. Bail-in (Scenario 3) and the ESM scenario (5) are similar best scenarios for stabilising EA wide GDP.

Concerning this ranking, it must be borne in mind that we have evaluated alternative risk sharing mechanisms to financial shocks on their stabilisation aspects only and we have left aside incentive effects for risk taking and risk shifting effects. The bail in option, and even more so the ESM option, could increase the incentive for banks to take on higher risks which is likely to increase the probability of a large financial crisis. The bail in solution could also increase funding costs for banks as risk is shifted

onto providers for bank debt. Higher bank funding costs would at least partly be shifted onto loan rates for NFCs, with adverse effects on investment. The EA wide resolution fund (SRF) is shifting risk to bank shareholders and may increase equity premia for bank capital. This in turn may lead to higher financing cost for NFCs and thus reduce investment and GDP in normal times. The extent in which this is happening is however hotly debated in the literature. While Angeloni et al (2014) stress the macroeconomic cost of increased bank capital, Admati and Hellwig (2010) argue that the redistribution of risk between depositors and bank shareholders has negligible effects on funding cost for banks in normal times.

Our results also depend on the distribution of bank assets across core and periphery. Relaxing the extreme assumption of a completely fragmented market for bank assets, would increase the international spillover effects to the core in the no intervention case. In the bail-out case the core government would take over some of the losses of core banks, however with negative repercussions on the value of bank assets resulting from a fall in government bond prices. However, because of non-linearities, cross ownership of banks would reduce the total cost of the bail out. The periphery bail-in would have higher negative spillover effects to the extent in which core debtors to periphery banks are affected. As long as cross ownership of banks has a home bias our result of a large spillover to the core in the SRM solution does still hold. With cross ownership the ESM loan would affect core shareholders, however less than periphery shareholders under home bias in asset holdings.

The GDP results for alternative assumptions concerning private risk sharing, either in the case of a functioning cross-border interbank market or when within country risk sharing increases, are documented in Table 2 for the first year and in detail in the Tables 6a and 6b in Annex 1. Anyhow, increased risk sharing would diminish output losses in the periphery but would in case of functioning cross-border interbank markets aggravate the recession in the core.

6. Conclusions

The Euro crisis is to a large part due to the unresolved banking problems. On the one hand the European financial sector is highly fragmented because of national rulings. On the other hand cross-border externalities disturb the functioning of the Single Market. Out of the three main causes of the Euro crisis (fragmented competitiveness, sovereign debt and banking crises) the latter two are intermingled in a vicious circle of sovereign debts and bank debt. A European Banking Union (EBU) should first break the diabolic link between sovereign debts (national governments) and bank debt and the vicious circle which lead to rescue banks by taxpayer's money (states as "lender of last resort"). And second, EBU should take into account the cross-border externalities of large banks. National governments concentrated only on the domestic effects of bank failures and ignored cross-border effects.

Our evaluation of EBU concentrates primarily on the stabilising properties of EBU in case of a financial shock comparable to those leading to the "Great Recession" of 2009 and the following Euro crisis. We evaluate three basic scenarios of bank rescues with a two-region EA QUEST model with a banking sector. The Euro Area is partitioned in the periphery and in the core.

Given limited risk sharing both within and across countries, a non-interventionist solution in the case of a severe bank loss shock is very costly for the periphery and has sizeable spillover effects (even under limited financial market integration) to the core. Allowing for cross border ownership of banks would probably make the results more realistic by allowing for even larger spillover of periphery shocks to the core in the no intervention case. Traditional government rescue measures ("bail-out") have a stabilising effect, but are subject to vicious circle feed-back loops. The analysis in this paper shows that an EBU can overcome to a large extent limited financial market integration. Quantitatively, the stabilising effects of an EBU would be large. In the model economy an EBU reduces output losses (in the periphery) by about 2/3 and by about 50% in the core.

Among the three EBU scenarios, namely "Bail-in", EA wide resolution insurance (SRM), and ESM loans to banks, the first and the third option are preferable in terms of minimising the fall of GDP in the EA. The EA wide resolution insurance (SRM) is best from the perspective of the periphery (since it constitutes a transfer from the core banks to the periphery banks) but is worse for the core. ESM loans to the periphery banks are also costly for the periphery. The two last results are due to the fact that in these cases core equity owner or periphery equity owner are ultimately bearing the cost of the rescue measure. However, equity owners will shift these costs onto the macro economy via increases in lending rates. A

low cost solution for the core - in a an environment where financial markets remain segmented - is an EBU which is based on a “bail-in” since it would mostly affect periphery depositors. Nevertheless, this solution largely overcomes the national financial market inefficiency by making all domestic households share the losses. Finally it must be stressed that even though the ESM loan solution has attractive properties in terms of stabilising GDP losses, it violates one important guiding principle of EBU, namely a fair burden sharing of the costs of bank rescue measures with the aim of having tax payer involvement only in exceptional circumstances. Based on this principle the fiscal backstop should only be called upon in exceptional circumstances and after all other measures have been exhausted.

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Annex 1: Detailed simulation results

Table 1: Baseline scenario: No intervention

(No ESM, no banking union, sovereign risk channel)

Year	1	2	3	4	5	6	7
EA GDP	-1.85	-0.98	-0.17	-0.37	-0.47	-0.52	-0.55
- Core GDP	-0.44	-0.04	0.11	0.02	0.01	0.01	0.00
- Periphery GDP	-5.99	-3.76	-1.01	-1.54	-1.88	-2.07	-2.16
Policy rate (bp)	-8.30	-11.38	-7.57	-4.53	-2.41	-0.85	0.23
Periphery:							
GDP	-5.99	-3.76	-1.01	-1.54	-1.88	-2.07	-2.16
Consumption	-9.00	-3.02	0.61	0.50	0.18	0.01	-0.10
Investment	-19.28	-18.64	-14.65	-14.22	-14.34	-14.31	-14.07
Corp. investment	-18.62	-12.26	-4.32	-2.68	-2.65	-2.66	-2.47
Res. Investment	-20.27	-28.21	-30.14	-31.52	-31.88	-31.78	-31.45
Exports	-0.38	0.60	0.72	0.22	-0.22	-0.56	-0.82
Imports	-9.20	-5.60	-1.34	-1.05	-0.85	-0.66	-0.51
GDP deflator	-0.77	-1.17	-0.89	-0.48	-0.06	0.31	0.59
Loans (% GDP)	3.86	-2.03	-7.02	-7.93	-8.84	-9.81	-10.83
Bankcapital-asset ratio	-6.08	-1.45	0.04	-0.07	-0.15	-0.18	-0.18
Loan-deposit spread (bp)	155.39	36.15	-1.01	1.64	3.54	4.11	4.04
Equity spread 5yrs (bp)	733.85	99.51	-32.03	-9.11	3.41	6.70	5.29
House prices	-12.70	-14.09	-13.99	-13.83	-13.65	-13.49	-13.36
Price long term bond	-19.15	-18.50	-18.40	-18.40	-18.31	-18.06	-17.64
Gov debt (% GDP)	6.39	8.46	7.44	8.32	9.31	10.35	11.45
NFA (% GDP)	0.63	1.53	1.82	1.99	2.13	2.23	2.31
Core:							
GDP	-0.44	-0.04	0.11	0.02	0.01	0.01	0.00
Consumption	-0.27	0.17	0.21	0.09	0.05	0.02	-0.01
Investment	0.03	0.62	0.40	0.13	0.05	0.02	-0.01
Corp. investment	0.17	0.47	0.28	0.08	0.02	-0.01	-0.05
Res. Investment	-0.19	0.84	0.59	0.21	0.10	0.07	0.06
Exports	-9.20	-5.60	-1.34	-1.05	-0.85	-0.66	-0.51
Imports	-0.38	0.60	0.72	0.22	-0.22	-0.56	-0.82
GDP deflator	-0.38	-0.46	-0.31	-0.24	-0.20	-0.17	-0.15
Loans (% GDP)	0.29	0.04	-0.06	-0.00	0.01	0.00	0.00
Bankcapital-asset ratio	-0.08	-0.01	-0.01	-0.04	-0.02	-0.01	-0.01
Loan-deposit spread (bp)	1.51	0.23	0.24	0.72	0.43	0.19	0.10
Equity spread 5yrs (bp)	5.65	-5.07	-0.46	2.17	0.96	0.19	0.05
House prices	-12.70	-14.09	-13.99	-13.83	-13.65	-13.49	-13.36
Gov debt (% GDP)	0.51	0.40	0.15	0.13	0.12	0.12	0.13
House prices	-0.25	-0.33	-0.30	-0.28	-0.28	-0.26	-0.25
NFA (% GDP)	-0.20	-0.50	-0.61	-0.67	-0.71	-0.75	-0.78

Note: % (p) difference from base .

Table 2: National "bail-out": periphery government rescue

(Periphery government rescue ,75% of all losses)

Year	1	2	3	4	5	6	7
EA GDP	-1.40	-0.52	-0.16	-0.35	-0.43	-0.47	-0.49
- Core GDP	-0.33	0.02	0.07	0.01	0.00	0.00	0.00
- Periphery GDP	-4.54	-2.08	-0.82	-1.40	-1.69	-1.86	-1.94
Policy rate (bp)	-5.62	-6.84	-4.22	-2.47	-1.18	-0.13	0.65
Periphery:							
GDP	-4.54	-2.08	-0.82	-1.40	-1.69	-1.86	-1.94
Consumption	-6.35	-0.76	1.16	0.69	0.39	0.25	0.16
Investment	-15.42	-14.75	-13.12	-13.56	-13.91	-13.97	-13.79
Corp. investment	-12.57	-5.98	-1.41	-1.27	-1.77	-2.06	-2.04
Res. Investment	-19.69	-27.91	-30.69	-32.00	-32.11	-31.84	-31.41
Exports	-0.28	0.51	0.49	0.13	-0.18	-0.44	-0.65
Imports	-6.81	-2.86	-0.60	-0.73	-0.68	-0.57	-0.46
GDP deflator	-0.55	-0.77	-0.56	-0.27	0.04	0.32	0.55
Loans (% GDP)	2.10	-3.91	-7.23	-8.09	-9.04	-10.03	-11.06
Bankcapital-asset ratio	-5.64	-0.74	0.13	-0.06	-0.12	-0.16	-0.16
Loan-deposit spread (bp)	143.03	18.35	-3.25	1.33	2.82	3.56	3.71
Equity spread 5yrs (bp)	601.97	21.78	-39.72	-11.41	-0.74	3.18	2.42
House prices	-12.65	-13.95	-13.88	-13.76	-13.63	-13.50	-13.39
Price long term bond	-23.41	-22.93	-22.70	-22.45	-22.09	-21.60	-20.96
Gov debt (% GDP)	7.01	9.46	9.83	11.14	12.32	13.48	14.64
NFA (% GDP)	0.47	1.03	1.17	1.28	1.38	1.46	1.52
Core:							
GDP	-0.33	0.02	0.07	0.01	0.00	0.00	0.00
Consumption	-0.18	0.13	0.13	0.05	0.02	0.01	-0.01
Investment	0.06	0.46	0.28	0.12	0.08	0.06	0.04
Corp. investment	0.12	0.30	0.17	0.06	0.02	-0.00	-0.04
Res. Investment	-0.03	0.68	0.44	0.21	0.17	0.16	0.15
Exports	-6.81	-2.86	-0.60	-0.73	-0.68	-0.57	-0.46
Imports	-0.28	0.51	0.49	0.13	-0.18	-0.44	-0.65
GDP deflator	-0.24	-0.24	-0.13	-0.09	-0.07	-0.05	-0.02
Loans (% GDP)	0.22	-0.01	-0.04	-0.01	-0.01	-0.01	-0.02
Bankcapital-asset ratio	-0.07	-0.01	-0.01	-0.03	-0.01	-0.01	-0.00
Loan-deposit spread (bp)	1.38	0.13	0.18	0.48	0.27	0.13	0.08
Equity spread 5yrs (bp)	4.25	-3.30	0.16	1.45	0.45	0.02	0.00
House prices	-0.19	-0.22	-0.20	-0.19	-0.18	-0.17	-0.15
Gov debt (% GDP)	0.36	0.19	0.04	0.03	0.02	0.01	0.01
NFA (% GDP)	-0.15	-0.34	-0.39	-0.43	-0.46	-0.49	-0.51

Table 3: National "bail-in"
(Bail in periphery depositors, 75% of the losses)

Year	1	2	3	4	5	6	7
EA GDP	-0.85	-0.42	-0.21	-0.33	-0.40	-0.44	-0.47
- Core GDP	-0.21	0.00	0.05	0.01	0.01	0.01	0.01
- Periphery GDP	-2.73	-1.66	-0.97	-1.34	-1.60	-1.77	-1.86
Policy rate (bp)	-4.45	-6.39	-5.22	-4.06	-3.01	-2.08	-1.36
Periphery:							
GDP	-2.73	-1.66	-0.97	-1.34	-1.60	-1.77	-1.86
Consumption	-3.34	-0.20	0.91	0.61	0.39	0.26	0.18
Investment	-11.73	-13.23	-12.83	-13.37	-13.78	-13.93	-13.80
Corp. investment	-7.50	-3.35	-0.72	-0.95	-1.62	-2.05	-2.12
Res. investment	-18.07	-28.06	-31.01	-32.01	-32.01	-31.74	-31.33
Exports	-0.07	0.59	0.67	0.43	0.16	-0.08	-0.29
Imports	-4.16	-2.27	-0.97	-0.99	-0.95	-0.86	-0.75
GDP deflator	-0.50	-0.85	-0.81	-0.62	-0.37	-0.12	0.09
Loans (% GDP)	0.02	-4.35	-7.01	-8.07	-9.04	-10.00	-11.00
Bankcapital-asset ratio	-3.30	-0.40	0.08	-0.04	-0.09	-0.14	-0.15
Loan-deposit spread (bp)	85.39	10.08	-2.05	0.82	2.20	3.21	3.48
Equity spread 5yrs (bp)	350.89	-0.32	-33.89	-13.90	-3.46	1.59	1.60
House prices	-12.65	-14.02	-14.02	-13.95	-13.85	-13.74	-13.64
Price long term bond	-14.03	-13.65	-13.60	-13.62	-13.61	-13.51	-13.29
Gov debt (% GDP)	2.81	3.73	3.86	4.68	5.58	6.54	7.52
NFA (% GDP)	0.27	0.66	0.83	0.97	1.11	1.23	1.33
Core:							
GDP	-0.21	0.00	0.05	0.01	0.01	0.01	0.01
Consumption	-0.12	0.10	0.12	0.08	0.06	0.04	0.03
Corp. investment	0.09	0.26	0.19	0.11	0.08	0.05	0.02
Res. investment	0.05	0.61	0.49	0.33	0.27	0.24	0.22
Investment	0.08	0.40	0.31	0.20	0.16	0.13	0.10
Exports	-4.16	-2.27	-0.97	-0.99	-0.95	-0.86	-0.75
Imports	-0.07	0.59	0.67	0.43	0.16	-0.08	-0.29
GDP deflator	-0.18	-0.23	-0.18	-0.16	-0.15	-0.14	-0.13
Loans (% GDP)	0.14	-0.00	-0.03	-0.01	-0.01	-0.01	-0.01
Bankcapital-asset ratio	-0.04	0.00	-0.01	-0.02	-0.01	-0.01	-0.01
Loan-deposit spread (bp)	0.84	0.03	0.14	0.38	0.27	0.17	0.13
Equity spread 5yrs (bp)	2.95	-2.42	-0.09	0.99	0.47	0.18	0.13
House prices	-0.17	-0.22	-0.22	-0.22	-0.23	-0.23	-0.23
Gov debt (% GDP)	0.25	0.17	0.07	0.05	0.04	0.04	0.03
NFA (% GDP)	-0.09	-0.22	-0.28	-0.33	-0.37	-0.41	-0.45

Table 4: EBU: SRM at EU/Euro area level

Year	1	2	3	4	5	6	7
EA GDP	-1.31	-0.54	-0.16	-0.34	-0.44	-0.49	-0.52
- Core GDP	-1.00	-0.21	0.09	-0.03	-0.07	-0.08	-0.09
- Periphery GDP	-2.21	-1.52	-0.91	-1.23	-1.50	-1.68	-1.78
Policy rate (bp)	-11.80	-14.14	-8.21	-4.25	-2.06	-0.85	-0.18
Periphery:							
GDP	-2.21	-1.52	-0.91	-1.23	-1.50	-1.68	-1.78
Consumption	-1.94	0.33	1.17	0.90	0.67	0.51	0.42
Investment	-10.14	-12.28	-12.33	-13.00	-13.48	-13.67	-13.58
Corp. investment	-5.55	-2.19	-0.25	-0.68	-1.45	-1.93	-2.01
Res. investment	-17.01	-27.42	-30.47	-31.47	-31.52	-31.29	-30.93
Exports	-2.26	-0.95	-0.04	-0.10	-0.30	-0.53	-0.72
Imports	-2.67	-1.11	-0.23	-0.42	-0.46	-0.41	-0.32
GDP deflator	-0.37	-0.64	-0.56	-0.32	-0.03	0.25	0.49
Loans (% GDP)	-0.54	-4.42	-6.96	-8.02	-8.96	-9.89	-10.87
Bankcapital-asset ratio	-2.47	-0.35	0.04	-0.05	-0.10	-0.14	-0.15
Loan-deposit spread (bp)	64.60	8.79	-1.06	1.18	2.38	3.34	3.56
Equity spread 5yrs (bp)	258.69	-4.69	-30.51	-12.91	-2.94	2.03	1.97
House prices	-12.20	-13.51	-13.50	-13.40	-13.28	-13.15	-13.04
Price long term bond	-10.40	-10.18	-10.23	-10.34	-10.42	-10.41	-10.27
Gov debt (% GDP)	2.17	2.96	2.98	3.60	4.33	5.13	5.95
NFA (% GDP)	2.24	4.13	4.90	5.29	5.51	5.66	5.77
Core:							
GDP	-1.00	-0.21	0.09	-0.03	-0.07	-0.08	-0.09
Consumption	-1.58	-0.24	0.21	0.07	-0.04	-0.09	-0.13
Investment	-1.59	-0.40	-0.15	-0.29	-0.25	-0.18	-0.15
Corp. investment	-2.12	-1.52	-0.82	-0.56	-0.34	-0.20	-0.14
Res. investment	-0.81	1.28	0.86	0.13	-0.12	-0.16	-0.15
Exports	-2.67	-1.11	-0.23	-0.42	-0.46	-0.41	-0.32
Imports	-2.26	-0.95	-0.04	-0.10	-0.30	-0.53	-0.72
GDP deflator	-0.83	-0.96	-0.55	-0.30	-0.18	-0.12	-0.09
Loans (% GDP)	0.68	0.18	-0.01	0.08	0.10	0.09	0.08
Bankcapital-asset ratio	-0.73	-0.29	-0.08	-0.08	-0.04	-0.02	-0.01
Loan-deposit spread (bp)	13.75	5.43	1.44	1.57	0.84	0.30	0.10
Equity spread 5yrs (bp)	79.41	13.28	3.02	5.28	2.86	1.12	0.59
House prices	-0.42	-0.52	-0.39	-0.31	-0.26	-0.24	-0.22
Gov debt (% GDP)	1.23	1.20	0.74	0.68	0.68	0.71	0.77
NFA (% GDP)	-0.76	-1.39	-1.65	-1.78	-1.85	-1.91	-1.94

Table 5: ESM: backstop with loans

Year	1	2	3	4	5	6	7
EA GDP	-0.82	-0.41	-0.21	-0.33	-0.40	-0.44	-0.46
- Core GDP	-0.19	0.01	0.05	0.02	0.01	0.01	0.01
- Periphery GDP	-2.65	-1.63	-0.98	-1.34	-1.60	-1.77	-1.86
Policy rate (bp)	-4.58	-6.68	-5.63	-4.53	-3.51	-2.61	-1.92
Periphery:							
GDP	-2.65	-1.63	-0.98	-1.34	-1.60	-1.77	-1.86
Consumption	-3.22	-0.21	0.86	0.58	0.36	0.23	0.14
Investment	-11.41	-12.97	-12.66	-13.22	-13.65	-13.82	-13.71
Corp. investment	-7.20	-3.20	-0.73	-1.02	-1.73	-2.17	-2.25
Res. investment	-17.73	-27.63	-30.55	-31.53	-31.54	-31.28	-30.90
Exports	-0.02	0.62	0.70	0.46	0.19	-0.05	-0.26
Imports	-4.05	-2.25	-1.01	-1.03	-0.98	-0.90	-0.79
GDP deflator	-0.48	-0.82	-0.77	-0.57	-0.31	-0.06	0.15
Loans (% GDP)	-0.07	-4.35	-6.96	-8.01	-8.96	-9.92	-10.91
Bankcapital-asset ratio	-3.18	-0.38	0.07	-0.04	-0.10	-0.14	-0.15
Loan-deposit spread (bp)	82.37	9.69	-1.91	0.94	2.31	3.32	3.59
Equity spread 5yrs (bp)	336.41	-2.10	-33.59	-13.66	-3.17	1.93	1.98
House prices	-12.49	-13.83	-13.83	-13.76	-13.65	-13.54	-13.45
Price long term bond	-13.53	-13.16	-13.12	-13.15	-13.16	-13.07	-12.86
Gov debt (% GDP)	2.72	3.62	3.78	4.58	5.46	6.41	7.39
NFA (% GDP)	2.42	4.50	5.28	5.63	5.81	5.90	5.94
Core:							
GDP	-0.19	0.01	0.05	0.02	0.01	0.01	0.01
Consumption	-0.09	0.12	0.13	0.08	0.06	0.05	0.03
Investment	0.08	0.38	0.30	0.21	0.17	0.15	0.13
Corp. investment	0.10	0.26	0.21	0.15	0.12	0.10	0.07
Res. investment	0.06	0.56	0.45	0.30	0.25	0.23	0.23
Exports	-4.05	-2.25	-1.01	-1.03	-0.98	-0.90	-0.79
Imports	-0.02	0.62	0.70	0.46	0.19	-0.05	-0.26
GDP deflator	-0.15	-0.17	-0.11	-0.09	-0.08	-0.07	-0.05
Loans (% GDP)	0.12	-0.01	-0.04	-0.02	-0.02	-0.03	-0.03
Bankcapital-asset ratio	-0.04	-0.01	-0.01	-0.02	-0.01	-0.01	-0.00
Loan-deposit spread (bp)	0.83	0.12	0.18	0.36	0.24	0.14	0.09
Equity spread 5yrs (bp)	2.75	-1.96	0.06	0.92	0.36	0.04	-0.01
House prices	-0.17	-0.21	-0.21	-0.21	-0.21	-0.20	-0.20
Gov debt (% GDP)	0.94	1.44	1.57	1.65	1.67	1.67	1.67
NFA (% GDP)	-0.80	-1.50	-1.77	-1.88	-1.94	-1.97	-1.99

Table 6a: Alternative Baseline – with functioning interbank market

Year	1	2	3	4	5	6	7
EA GDP	-1.54	-0.62	-0.28	-0.37	-0.45	-0.49	-0.52
- Core GDP	-1.27	0.12	0.21	0.02	-0.03	-0.01	0.01
- Periphery GDP	-2.35	-2.80	-1.74	-1.50	-1.67	-1.90	-2.06
Policy rate (bp)	-11.32	-9.87	-4.61	-2.66	-2.01	-1.27	-0.39
Periphery:							
GDP	-2.35	-2.80	-1.74	-1.50	-1.67	-1.90	-2.06
Consumption	-2.73	-1.91	-0.54	0.04	0.17	0.07	-0.09
Investment	-11.79	-16.14	-15.52	-14.92	-14.70	-14.64	-14.51
Corp. investment	-7.98	-7.83	-5.35	-4.09	-3.68	-3.59	-3.48
Res. investment	-17.50	-28.60	-30.79	-31.15	-31.22	-31.22	-31.06
Exports	-2.12	1.23	2.10	1.54	0.82	0.30	-0.03
Imports	-3.72	-4.74	-3.53	-2.49	-1.79	-1.40	-1.22
GDP deflator	-0.69	-1.42	-1.48	-1.13	-0.65	-0.20	0.14
Loans (% GDP)	-0.39	-3.04	-6.11	-7.77	-8.81	-9.71	-10.64
Bankcapital-asset ratio	-1.54	-0.46	-0.18	-0.17	-0.17	-0.18	-0.18
Loan-deposit spread (bp)	39.53	11.41	4.50	4.19	4.06	4.17	4.14
Equity spread 5yrs (bp)	217.64	44.70	2.41	-0.43	2.58	6.14	7.45
House prices	-12.56	-14.07	-14.11	-13.97	-13.77	-13.58	-13.42
Price long term bond	-15.85	-15.22	-14.98	-15.01	-15.07	-15.02	-14.78
Gov debt (% GDP)	2.43	4.95	5.66	6.35	7.21	8.20	9.28
NFA (% GDP)	3.88	4.40	4.07	3.73	3.60	3.58	3.54
Core:							
GDP	-1.27	0.12	0.21	0.02	-0.03	-0.01	0.01
Consumption	-1.85	0.26	0.50	0.16	0.02	0.01	0.02
Investment	-1.54	0.48	0.66	0.33	0.24	0.23	0.21
Corp. investment	-2.23	-0.23	0.75	0.69	0.54	0.42	0.36
Res. investment	-0.50	1.54	0.52	-0.20	-0.21	-0.07	-0.01
Exports	-3.72	-4.74	-3.53	-2.49	-1.79	-1.40	-1.22
Imports	-2.12	1.23	2.10	1.54	0.82	0.30	-0.03
GDP deflator	-0.61	-0.24	0.20	0.26	0.17	0.12	0.12
Loans (% GDP)	0.85	-0.05	-0.11	0.00	0.03	0.01	-0.00
Bankcapital-asset ratio	-1.83	-0.30	0.04	0.03	0.02	0.01	-0.00
Loan-deposit spread (bp)	34.62	5.70	-0.76	-0.53	-0.37	-0.10	0.03
Equity spread 5yrs (bp)	139.82	0.09	-8.35	-1.38	-0.47	-0.60	-0.99
House prices	-0.23	-0.11	0.04	0.05	0.01	-0.00	-0.00
Gov debt (% GDP)	1.38	0.52	-0.02	-0.04	0.01	0.01	-0.01
NFA (% GDP)	-1.30	-1.44	-1.34	-1.23	-1.20	-1.19	-1.18

Table 6b: Alternative baseline – different risk sharing

(Baseline with reduced ALPHAD=0.2: increased risk sharing between EQ and RIC)

Year	1	2	3	4	5	6	7
EA GDP	-1.16	-1.11	-0.31	-0.30	-0.42	-0.50	-0.54
- Core GDP	-0.31	-0.10	0.09	0.05	0.02	0.01	0.01
- Periphery GDP	-3.64	-4.08	-1.49	-1.34	-1.73	-2.01	-2.15
Policy rate (bp)	-7.64	-12.43	-9.48	-5.61	-2.88	-1.12	-0.04
Periphery:							
GDP	-3.64	-4.08	-1.49	-1.34	-1.73	-2.01	-2.15
Consumption	-5.41	-3.49	-0.30	0.56	0.37	0.10	-0.08
Investment	-15.69	-19.14	-15.75	-14.34	-14.28	-14.33	-14.16
Corp. investment	-13.83	-12.72	-6.06	-3.20	-2.74	-2.77	-2.62
Res. investment	-18.48	-28.78	-30.28	-31.06	-31.58	-31.68	-31.46
Exports	-0.10	0.72	0.97	0.50	-0.03	-0.44	-0.72
Imports	-6.12	-6.42	-2.52	-1.18	-0.82	-0.68	-0.58
GDP deflator	-0.79	-1.44	-1.26	-0.76	-0.26	0.15	0.45
Loans (% GDP)	1.08	-1.65	-6.44	-8.04	-8.89	-9.76	-10.72
Bankcapital-asset ratio	-7.47	-3.85	-1.14	-0.42	-0.50	-0.62	-0.63
Loan-deposit spread (bp)	60.56	30.18	8.32	2.57	3.17	4.00	4.06
Equity spread 5yrs (bp)	375.94	115.63	3.02	-10.13	0.64	6.61	6.55
House prices	-12.71	-14.21	-14.16	-13.96	-13.75	-13.57	-13.44
Price long term bond	-17.66	-16.96	-16.82	-16.94	-16.98	-16.84	-16.51
Gov debt (% GDP)	3.82	7.33	6.97	7.37	8.24	9.27	10.36
NFA (% GDP)	0.37	1.22	1.69	1.90	2.04	2.14	2.23
Core:							
GDP	-0.31	-0.10	0.09	0.05	0.02	0.01	0.01
Consumption	-0.22	0.15	0.25	0.14	0.07	0.03	0.01
Investment	0.04	0.60	0.51	0.21	0.08	0.03	0.00
Corp. investment	0.18	0.51	0.38	0.15	0.04	-0.00	-0.04
Res. investment	-0.17	0.75	0.71	0.32	0.13	0.08	0.07
Exports	-6.12	-6.42	-2.52	-1.18	-0.82	-0.68	-0.58
Imports	-0.10	0.72	0.97	0.50	-0.03	-0.44	-0.72
GDP deflator	-0.36	-0.53	-0.41	-0.30	-0.25	-0.22	-0.20
Loans (% GDP)	0.21	0.08	-0.04	-0.01	0.00	0.00	0.00
Bankcapital-asset ratio	-0.04	-0.01	-0.02	-0.04	-0.03	-0.01	-0.01
Loan-deposit spread (bp)	0.82	0.20	0.36	0.74	0.54	0.25	0.11
Equity spread 5yrs (bp)	4.13	-4.75	-1.20	1.98	1.45	0.48	0.09
House prices	-0.25	-0.37	-0.35	-0.33	-0.32	-0.30	-0.29
Gov debt (% GDP)	0.40	0.46	0.21	0.13	0.11	0.11	0.13
NFA (% GDP)	-0.12	-0.40	-0.56	-0.63	-0.68	-0.72	-0.75

Annex 2: A Two-region EA QUEST model with a banking sector: Detailed description

We consider two regions within the Euro area, namely the EA "periphery" (ES, PO, EL and IE) and the remaining "core" countries. If necessary we use the superscript *P* and *C* for these two regions and the superscript *EA* for the EA aggregate. Both regions produce goods which are imperfect substitutes to goods produced in the other region. Households and banks can borrow internationally. We use a New Keynesian model which is an extension of the model presented by Iacoviello (2005), which splits the household sector into borrowers and savers. We build on Iacoviello by further disaggregating saver households into risk-averse savers, who save in the form of deposits and government bonds, and equity-owners who own all shares of banks and non-financial corporations. This disaggregation allows us to distinguish between risky bank capital and insured debt on the liability side of the bank balance sheet. Banks provide loans to households to finance residential investment, while corporate investment is financed via stock and bond markets[19]. In order to distinguish between borrowers and savers in the household sector, we distinguish households by the rate of time preference. Savers with a low rate of time preference supply funds to investors, while households with a high rate of time preference receive loans from banks subject to a collateral constraint. There is a monetary authority, following rules based stabilisation policies.

Corporate Sector

The non-financial corporate sector produces wholesale output with a Cobb Douglas production function which uses capital K_t and labour N_t as inputs

$$(1) \qquad Y_t = K_t^{1-\alpha} N_t^{\alpha} Z_t^{\gamma\alpha}, \qquad \text{with} \quad N_t = \left[\int_0^1 N_t^{i\frac{\theta-1}{\theta}} di \right]^{\frac{\theta}{\theta-1}}.$$

[19] We do not model loan supply to the corporate sector but assume that banks hold a fixed share of corporate shares. Since both non-financial corporations and banks are owned by equity owners the cross ownership of assets between banks and non-financial corporations is not important for our results.

where N_t is a CES aggregate of labour supplied by individual households *i*. The parameter $\theta > 1$ determines the degree of substitutability among different types of labour. There is an economy wide technology shock Z_t^Y and an investment specific technology shock Z_t^J affecting current investment vintages which are priced at p_t^I.[20] The number of outstanding shares of the nonfinancial corporate sector is S_t^{NF}. Dividends are given by

$$(2) \qquad div_t^{NF} = (Y_t - w_t N_t) - p_t^I J_t + q_t^{NF} \Delta S_t^{NF}$$

The nonfinancial corporate sector makes decisions which maximise the present discounted value of dividends and it applies the stochastic discount factor of equity owners $(1 + r_t^E)$

$$(3) \qquad \begin{aligned} Max\ V_0^{NF} &= E_0 \sum_{t=0}^{\infty} \prod_{j=0}^{t} (1 + r_{t+j}^E)^{-1} \left[div_{t+j}^{NF} \right] \\ &\quad - E_0 \sum \lambda_t \beta^t \left[K_t - J_t Z_t^J - (1-\delta) K_{t-1} \right] \end{aligned}$$

The first order condition for physical capital is given by

$$(4) \qquad \frac{p_t^I}{Z_t^J} = Y_{K,t} + E_t \frac{(1-\delta)}{(1+r_t^E)} \frac{p_{t+1}^I}{Z_{t+1}^J},$$

which equates the marginal product of physical capital and the expected capital gain to the required rate of return of investors.

The *banking sector* provides mortgage loans L_t and invests in government bonds $p_t^G B_t^B$ and bonds $e_t F_t^B$ issued by foreign banks. Since bonds are issued in euro the exchange rate e_t is equal to one. Banks use deposits D_t and bank capital $L_t + P_t^G B_t^B + e_t F_t^B - D_t$. Government bonds held by the bank are perpetuities which pay a coupon τ_t each period. And have a price P_t^G. The expected gross rate of return is given by $1 + r_t^G = (\tau_t + E_t p_{t+1}^G)/p_t^G$. There is an

[20] All prices are expressed relative to the final goods deflator.

international interbank market between domestic and foreign bonds. If F_t^B is positive, then the domestic banks are net lenders to foreign banks and vice versa. The bank respects a regulatory constraint which makes it costly for the bank if deposits exceed a fraction Γ^L of total loans. This constraint may reflect a legal requirement, or market pressures. The bank can hold less capital than the required level, but this is costly. Let $x_t = (D_t - \Gamma^L(L_t + p_t^G B_t^B + e_t F_t^B))$ denote the bank's 'capital shortfall' or excess leverage. The bank bears a quadratic cost from a capital shortfall. The bank also tries to stay close to its government bond and foreign net asset target Γ^B and Γ^F respectively. This could be justified by a liquidity preference motive of the bank. Bank shares are held by equity owners. Banks pay dividends div_t^B to share holders. Dividends are equal to the cash flow of banks which is made up of revenues from mortgage loans, holdings of government and foreign bonds and increases of the stock of deposits. Interest payments for deposits, increases of the stock of loans, government and foreign bonds reduce the cash flow. The bank also bears a real operating cost for managing deposits and loans, $\Gamma(D_t + L_t)$, where $\Gamma > 0$ is a constant. The cash flow of banks is also negatively affected by loan losses from periphery borrowers Λ_t^{CC}. In the case of a banking union, periphery banks only bear a share s^{BU} of the loan losses. The remaining losses are borne by banks in the core. Under ESM, periphery banks receive a loan L_t^{ESM} from core governments at an interest rate r_t^{ESM}The corporate banking sector issues shares at price q_t^B, and the number of outstanding shares is denoted by $S_{t-1}^B = S_{t-1}^{BP} + S_{t-1}^{BG}$. Shares are held by private equity owners and by the government.

$$
\begin{aligned}
div_t^B(S_{t-1}^{BP} + S_{t-1}^{BG}) = {} & (1+r_{t-1}^L)L_{t-1} + \tau_{t-1}B_{t-1}^B + p_t^G B_{t-1}^B + (1+r_{t-1}^{F,B})e_t F_{t-1}^B - (1+r_{t-1}^D)D_{t-1} \\
& - L_{t+j} - e_t F_t^B - p_t^G B_t^B + D_t - (1+r_{t-1}^{ESM})L_{t-1}^{ESM} + L_t^{ESM} \\
& - \phi/2(D_t - \Gamma^L(L_t + p_t^G B_t^B + e_t F_t^B))^2 - \theta/2(p_t^G B_t^B - \Gamma^B)^2 - \\
& \psi/2(e_t F_t^B - \Gamma^F)^2 - s^{BU}\Lambda_t^{CC} + q_t(\Delta S_t^{BP} + \Delta S_t^{BG})
\end{aligned} \tag{5}
$$

The banking sector makes decisions which maximises the present discounted value of dividends and it applies the stochastic discount factor of equity owners $1/(1+r_t^E)$

(6) $$\underset{\{L,B^B,F,D\}}{Max} V_0^B = E_0 \sum_{t=0}^{\infty} \prod_{j=0}^{t} (1 + r_{t+j}^E)^{-1} \left[div_{t+j}^B \right].$$

The FOCs w. r. t. D_t, L_t, B_t^B and F_t^{IB} are given by

(6a) $$\frac{\partial V_t^B}{\partial D_t} = \frac{1 + r_t^D + \Gamma}{1 + r_{t+1}^E} - 1 + \phi(D_t - \Gamma^L(L_t + p_t^G B_t^B + e_t F_t^B)) = 0$$

(6b) $$\frac{\partial V_t^B}{\partial L_t} = \frac{1 + r_t^L - \Gamma}{1 + r_{t+1}^E} - 1 + \phi(D_t - \Gamma^L(L_t + p_t^G B_t^B + e_t F_t^B))\Gamma^L = 0$$

(6c) $$\frac{\partial V_t^B}{\partial F_t^B} = \frac{1 + r_t^{F,B}}{1 + r_{t+1}^E}\left(\frac{e_{t+1}}{e_t}\right) - 1 - \psi(e_t F_t^B - \Gamma^F)^2 + \phi(D_t - \Gamma^L(L_t + p_t^G B_t^B + e_t F_t^B))\Gamma^L e_t) = 0$$

According to (6a) the bank sets an optimal capital shortfall (excess leverage) such that the marginal cost of excess leverage is equal to the interest differential between deposits and equity. For ROE exceeding the deposit rate the bank wants to undershoot the bank capital target. Eq (6b) states that loan supply of banks is restricted by excess leverage. Equation (6c) gives the interest parity condition. We do not model the risk and liquidity considerations of banks determining the holding of government bonds and take the stock of government bonds as given. We only consider how bond valuation effects affect loan supply and refinancing decisions of banks. From these FOCs we obtain the following loan interest rate rule

(7) $$r_t^L = (1 - \Gamma^L) r_{t+1}^E + \Gamma^L r_t^D + (1 + \Gamma^L)\Gamma$$

The loan interest rate is set equal to marginal cost, which is a weighted average of the deposit rate and the return on bank equity. The weights are determined by the constraints on the bank balance sheet imposed by capital requirement and the marginal operating cost of the bank. Notice also, actual and expected losses as well as government relief measures do not appear in the loan interest rate rule since it is assumed that these losses relate to past loan supply decisions

of banks. Since the real expected loan rate is below the rate of time preference of borrowing households, the bank needs to impose a collateral constraint (see eq. 16) in order to prevent over-borrowing. The stock market equalises rates of return on bank and physical capital by applying the same stochastic discount factor to financial and non-financial sector capital.

Households

The household sector consists of a continuum of households $h \in [0,1]$. A fraction s^s of all households are savers and indexed by *s*. s^c households are credit constrained (debtors) and indexed by *c* and there is a fraction s^e of equity owners. The period utility functions have identical functional forms for all household types[21] and are specified as a nested constant elasticity of substitution (CES) aggregate of consumption (C_t^h) and housing services (H_t^h) and separable in deposits D_t^h and leisure ($s^h - N_t^h$). We follow Van den Heuvel (2008) in adding deposits to the utility function, this simplifies modelling of portfolio decisions of households. We also allow for habit persistence in consumption. For each household type $h \in \{s, c, e\}$ the temporal utility is given by

$$U^h(C_t^h, H_t^h, D_t^h, 1-N_t^h) = \frac{\left\{CES^h(C_t^h, H_t^h)\right\}^{1-\sigma^h}}{1-\sigma^h} + \vartheta^{D,h} D_t^{h,1-\nu} + \vartheta^{N,h}\left(s^h - N_t^h\right)^{1-\kappa} \tag{8a}$$

$$CES^h(C_t^h, H_t^h) = \left[s_{h,C}^{\frac{1}{\sigma^H}} \left(C_t^h - h^h C_{t-1}^h\right)^{\frac{\sigma^H-1}{\sigma^H}} + s_{h,H}^{\frac{1}{\sigma^H}} H_t^{h\,\frac{\sigma^H-1}{\sigma^H}} \right]^{\frac{\sigma^H}{\sigma^H-1}} \tag{8b}$$

Only savers and debtors supply differentiated labour services to unions which maximise a joint utility function for each type of labour *i*. It is assumed that types of labour are distributed equally over the two household types. Nominal rigidity in wage setting is introduced by assuming that the household faces adjustment costs for changing wages. These adjustment costs are borne by the household.

[21] Preference parameters can be different across household types.

Savers

Savers provide deposits D_t to the banking system and hold government bonds B_t^H and foreign assets F_t^H which they trade with foreign households. They also own the stock of land $Land_t$ and they use a CES technology

$$(9) \qquad J_t^H = \left(s_L^{\frac{1}{\sigma_L}} J_t^{Land\,\frac{(\sigma_L-1)}{\sigma_L}} + (1-s_L)^{\frac{1}{\sigma_L}} J_t^{Constr\,\frac{(\sigma_L-1)}{\sigma_L}} \right)^{\frac{\sigma_L}{\sigma_L-1}}$$

to combine land and final goods for the production of new houses J_t^H. Producers of new houses charge a price p_t^H which is equal to marginal cost which can be represented as a CES aggregate of land p_t^{Land} and construction prices p_t^{Constr}. In order to capture deviations of construction prices from the GDP deflator we assume that producers in the construction sector transform wholesale goods into residential investment using a linear technology subject to an auto-correlated technology shock. The Lagrangian of this maximisation problem is

(10)

$$\begin{aligned}
&Max \quad V_0^s = \mathrm{E}_0 \sum_{t=0}^{\infty} \beta^{s^t} U^s(C_t^s, s^s - N_t^s, H_t^s, D_t^s) \\
&- \mathrm{E}_0 \sum_{t=0}^{\infty} \lambda_t^s \beta^{s^t} \left(\begin{array}{l} p_t^C C_t^s + p_t^H J_t^{H,s} + J_t^{Constr} + p_t^G B_t^H + e_t F_t^H + D_t^s - p_t^G B_{t-1}^H - \tau_{t-1} B_{t-1}^H \\ -(1+r_{t-1}^D) D_{t-1}^s - (1+r_{t-1}^{F,H}) e_t F_{t-1}^H - w_t N_t^s - p_t^L J_t^{Land} - p_t^H J_t^{H,s} + T_t^s - TR_t^s \end{array} \right) \\
&- \mathrm{E}_0 \sum_{t=0}^{\infty} \lambda_t^s \zeta_t^s \beta^{s^t} \left(H_t^s - J_t^{H,s} - (1-\delta^H) H_{t-1}^{H,s} \right) \\
&- \mathrm{E}_0 \sum_{t=0}^{\infty} \lambda_t^s \xi_t^s \beta^{s^t} \left(Land_t + J_t^{Land} - (1+g_t^{Land}) Land_{t-1} \right)
\end{aligned}$$

where T_t^S and TR_t^S are lump sum taxes and transfers of saver households. The consumption and housing investment decision are determined by the following first-order conditions (FOCs) Consumption:

(11) $$U^{s}_{C,t} = E_t(1+r_t)\frac{p^{C}_{t}}{p^{C}_{t+1}}\beta^{s}U^{s}_{C,t+1}$$

Define the discount factor $d^{s}_{t} = \frac{1}{(1+r_t)} = E_t(\frac{U^{s}_{C,t+1}\beta^{s}}{U^{s}_{C,t}}\frac{p^{C}_{t}}{p^{C}_{t+1}})$

Deposits:

(12) $$\frac{U^{s}_{D,t}}{U^{s}_{C,t} / p^{c}_{t}} = d^{s}_{t}(1+r^{D}_{t})$$

Residential investment

(13) $$p^{H}_{t} = \frac{U^{s}_{H,t}}{U^{s}_{C,t} / p^{C}_{t}} + \mathrm{E}_t\left(d^{s}_{t} P^{H}_{t+1}(1-\delta^{H})\right)$$

Land price

(14) $$p^{Land}_{t} = \mathrm{E}_t\left(d^{s}_{t} p^{Land}_{t+1}(1+g^{Land})\right)$$

Government bond price

(15) $$p^{G}_{t} = \mathrm{E}_t\left(d^{s}_{t}(\tau_t + p^{G}_{t+1})\right) \quad \text{where } \tau_t = \tau(1-\mu_t)$$

The first order conditions determine a savings schedule where the ratio between current and future expected consumption is as negative function of the real interest rate. With deposits in the utility function we capture the fact that deposits, apart from providing interest income, also provide liquidity services to the household. For constant prices and interest rates residential capital and consumption grow at equal rates. The elasticity of substitution between *C* and *H* determines how strongly the demand for consumption and housing reacts to relative price changes. Finally residential investment is a negative function of opportunity costs which consist of the nominal interest rate minus capital gains from expected increases in house prices. Land

constitutes an asset for the household and arbitrage requires a return equal to the risk free rate. Only saver households engage actively in the market for government bonds, thus the price of government bonds is determined applying the save discount rate. We assume that governments issue perpetuities which pay a fixed coupon τ each period. However, we assume that saver households expect governments to reduce (future) coupon payments at rate μ_t which itself depends on government indebtedness.

Debtors

Debtor households differ from saver households in two respects. First they have a higher rate of time preference ($\beta^c < \beta^s$) and they face a collateral constraint on their borrowing L_t . Banks impose a loan to value ratio χ^c . The Lagrangian of this maximisation problem is given by

$$
\begin{aligned}
&Max \quad V_0^c = \mathrm{E}_0 \sum_{t=0}^{\infty} \beta^{c\,t} U^c(C_t^c, 1-N_t^c, H_t^c) \\
&-\mathrm{E}_0 \sum_{t=0}^{\infty} \lambda_t^c \beta^{c\,t} \left(p_t^C C_t^c + p_t^H J_t^{H,c} - L_t + (1+r_{t-1}^L) L_t \right) - \Lambda_t^{CC} - w_t N_t^c + T_t^c - TR_t^c \Big) \\
&-\mathrm{E}_0 \sum_{t=0}^{\infty} \lambda_t^c \zeta_t^c \beta^{c\,t} \left(H_t^c - J_t^{H,c} - (1-\delta^H) H_{t-1}^c \right) \\
&-E_0 \sum \lambda_t^c \psi_t \beta^{c,t} \left((1+r_t^L) L_t - \chi^c p_t^H H_t^c \right)
\end{aligned}
\tag{16}
$$

Consumption

$$
U_{C,t}^c = E_t \frac{(1+r_t^L)\beta^c}{(1-(1+r_t^L)\psi_t)} \frac{p_t^C}{p_{t+1}^C} U_{C,t+1}^c \tag{17}
$$

Define the discount factor $d_t^c = \dfrac{(1-(1+r_t^L)\psi_t)}{(1+r_t^L)} = E_t \dfrac{U_{C,t+1}^c \beta^c}{U_{C,t}^c} \dfrac{p_t^C}{p_{t+1}^C}$

Residential investment

$$(18) \qquad p_t^H = \frac{U_{H,t}^c}{U_{C,t}^c / p_t^C} \frac{1}{(1-\psi_t(1-\delta^H)\chi^c)} + E_t d_t^c \frac{(1-\delta^H)}{(1-\psi_t(1-\delta^H)\chi^c)} p_{t+1}^H$$

Both consumption and residential investment are affected by the collateral constraint. A tightening of the constraint induces debtors to shift consumption from current to future periods and to reduce residential investment by increasing shadow capital costs by $\psi_t(1-\chi_t^c)$. A high loan to value ratio reduces the impact of credit tightening on residential investment, since in this case an increase in the capital stock makes investment valuable for the household by increasing its borrowing capacity.

Equity owners

Equity owners receive income (distributed profits) from dividends paid by financial and non financial corporations. They maximise an intertemporal utility function[22] subject to a budget constraint

$$Max\, V_0^E = E_0 \sum_{t=0}^{\infty} \beta^{e,t} U^e(C_t^e) -$$

$$(19) \qquad E_0 \sum_{t=0}^{\infty} \lambda_t \beta^{e,t} \left[q_t^B S_t^{BP} - (div_{t-1}^B + q_t^B) S_{t-1}^{BP} + q_t^{NF} - (div_{t-1}^{NF} + q_t^{NF}) S_{t-1}^{NF} - p_t^c C_t^e + T_t^e \right]$$

Optimisation yields the following (inverse of the) stochastic discount factor for corporate investment

$$(20) \qquad E_t \frac{U_{C,t}^e p_t^c}{U_{C,t+1}^e p_{t+1}^c \beta^e} = (1 + r_t^E)$$

Notice that by using the same stochastic discount factor r^E managers are implicitly determining the dividend stream to maximise consumption of equity owners.

Wage setting

A trade union is maximising a joint utility function for each type of labour *i* where it is assumed that types of labour are distributed equally over constrained and unconstrained households with

[22] We assume that equity owners do not engage in housing investment, deposit demand and labour supply.

their respective population weights. The trade union sets wages by maximising a weighted average of the utility functions of these households. The wage rule is obtained by equating a weighted average of the marginal utility of leisure to a weighted average of the marginal utility of consumption times the real wage of these two household types, adjusted for a wage mark up

$$\frac{s^c U^c_{s^c - N^c,t} + s^s U^s_{s^s - N^s,t}}{s^c U^c_{c,t} + s^s U^s_{c,t}} = \frac{w_t}{p^C_t}\eta_t \quad (21)$$

where η_t is the wage mark up factor, with wage mark ups fluctuating around $1/\theta$ which is the inverse of the elasticity of substitution between different varieties of labour services. The trade union sets the consumption wage as a mark up over the reservation wage. The reservation wage is the ratio of the marginal utility of leisure to the marginal utility of consumption. This is a natural measure of the reservation wage. If this ratio is equal to the consumption wage, the household is indifferent between supplying an additional unit of labour and spending the additional income on consumption and not increasing labour supply.

3. The retail sector

There is a retail sector which buys wholesale goods and diversifies them. Retailers sell these differentiated goods in a monopolistically competitive market at price p^F_t. Retailers only face quadratic price adjustment costs. This introduces nominal rigidities in this economy and in a symmetric equilibrium, inflation dynamics is given by a standard New Keynesian Phillips curve

$$\pi^F_t = \beta E_t \pi^F_{t+1} + 1/\gamma_p MC^{WS}_t \quad (22)$$

where MC^{WS}_t is real marginal cost in the wholesale sector.

4. Monetary Policy

We assume that monetary policy in the monetary union follows a Taylor rule which is targeting EA aggregate inflation and output growth

(23) $$i_t = \tau_{lag}^M i_{t-1} + (1-\tau_{lag}^M)[r^{EQ} + \pi_t^T + \tau_\pi^M (\pi_t^{C,EA} + \pi_{t-1}^{C,EA} + \pi_{t-2}^{C,EA} + \pi_{t-3}^{C,EA} - 4\pi_t^T)/4 + \tau_y^M (gy_t^{EA} + gy_{t-1}^{EA} + gy_{t-2}^{EA} + gy_{t-3}^{EA} - 4\overline{gy})/4] + z_t^M$$

The term z_t^M indicates discretionary deviations from the Taylor rule.

5. Fiscal Policy

Government expenditure is government purchases of goods and services G_t and transfers to saver and debtor households TR_t^H. Total tax revenues T_t are the sum of tax revenues from the three households. The government uses taxes to balance the budget and meeting a long run debt target. In addition governments receive income from bank shares. Government bonds are held by saver households and banks $B_t = B_t^S + B_t^B$. The government budget constraint is given by

(24) $$p_t^G B_t = p_t^G B_{t-1} + \tau_{t-1} B_{t-1} + G_t + TR_t^H - T_t$$

6. The rest of the world, foreign trade and the current account

We assume that households, firms and the government have CES preferences over domestic and foreign goods

(25) $$A^i = \left[(1 - s^M - Z_t^M)^{\frac{1}{\sigma^M}} A^{di} \frac{\sigma^M - 1}{\sigma^M} + (s^M + Z_t^M)^{\frac{1}{\sigma^M}} A^{fi} \frac{\sigma^M - 1}{\sigma^M} \right]^{\frac{\sigma^M}{(\sigma^M - 1)}}$$

across goods used for consumption, and investment $A^i \in \{C^i, I^i, G^i\}$. The share parameter s^M can be subject to a shock Z_t^M and A^{di} and A^{fi} are indexes of demand across the continuum of differentiated goods produced respectively in the two economies. We assume producer pricing. Domestic households and banks hold internationally tradable bonds $e_t F_t^H$ and $e_t F_t^B$ which are denominated in foreign currency. The stock of net foreign assets thus evolves as

(26)

$$e_t(F_t^H + F_t^B - L_t^{ESM}) = (1+r_{t-1}^{F,H})e_t F_{t-1}^H - (1+r_{t-1}^{ESM})e_t L_{t-1}^{ESM} + (1+r_{t-1}^{F,B})e_t F_{t-1}^B + (1-s^{BU})\Lambda_t^{CC} + X_t - e_t M_t$$

Where imports and exports are defined as $M_t = C_t^{P,f} + J_t^{P,f}$, and $X_t = C_t^{C,f} + J_t^{C,f}$.

7. Equilibrium

Equilibrium in our model economy is an allocation, a price system and monetary policy in the Euro area periphery and core countries such that households maximise utility, and the following market clearing conditions hold for the two regions:

(27) $$Y_{t_t}^i = C_t^{i,d} + J_t^{i,d} + J_t^{Constr,i} + X_t^i, \qquad i=P,C$$

In addition markets for residential investment, labour, loans, deposits, equity and internationally traded bonds clear.

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