Essays on Capital Flows and External Imbalances in the Euro Area

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To my loving parents . . .

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Abstract

The central research question of this thesis is the macroeconomic adjustment to external imbalances within the euro area. In particular, the thesis examines (i) the potential of internal devaluation to combat external imbalances within the euro area, and (ii) the specific role of the Eurosystem's interbank payment system TARGET2 in the adjustment to a reversal of capital inflows and the associated current account imbalances. Finally, the thesis (iii) provides a model implementation of euro area-wide safe assets to reduce banks' exposure to domestic sovereigns and, for instance, to limit the occurence of sudden stops.

After a brief introduction in Chapter 1, Chapter 2 investigates the welfare effects of fiscal devaluation, a budgetary-neutral tax shift from employers' social security contributions towards consumption tax. Fiscal devaluation has gained increasing attention due to the experience of large external imbalances and misaligned real exchange rates within the euro area and mimics the effects of external devaluation in the absence of flexible nominal exchange rates and an independent monetary policy. Using a small open economy model with nominal wage and price rigidities, this chapter finds that fiscal devaluation can support external rebalancing by accelerating real exchange rate adjustments and regaining price competitiveness. However, internal devaluation tends to induce welfare losses for the average households due to a worsening of the terms of trade. The overall welfare effects are pro-cyclical in the sense that the stronger the tax shift, the higher the welfare losses for the average household. The losses increase with the openness of the economy and the relative size of the tradable sector. In the presence of supply

shocks, however, fiscal devaluation can imply small welfare gains. A scenario with flexible nominal exchange rates and autonomous monetary policy performs better in terms of household welfare, but implies stronger external fluctuations in the short run.

Chapter 3 examines sharp reversals of private capital flows as experienced by several euro area Member States during the Great Financial Crisis. Examining macroeconomic adjustments to sudden stops in a small open economy DSGE model, the focus lies on the specific policy rules of the euro area's payments system TARGET2. We compare sudden stops in euro area Member States that have access to TARGET2 and, as a benchmark, countries pegged to the euro. Thereby, we emphasize the crucial role of the exchange rate regime in the adjustment to sudden stops with two main findings: Public capital flows in form of TARGET2 - in the short run - help euro area deficit countries to stabilize output, consumption, and investment after a sudden stop of private capital inflows. In the long run, however, euro area countries suffer under a prolonged economic recovery and larger public debt as well as higher welfare losses relative to euro peggers.

Chapter 4 builds upon the TARGET2 mechanism in Chapter 3, but extends the framework to an estimated two-region DSGE model, in order to examine the influence on credit and capital channels of core and peripheral euro area countries and to capture potential interregional feedback effects. In search for investments with low risk of default and litigation in the course of the financial and the sovereign debt crisis, private capital flows into periphery reversed, forcing the respective countries into phases of private and public deleveraging. We examine how the liquidity provision to peripheral banks by the Eurosystem affects cross-border capital flows, giving rise to divergent developments across the two regions: In the periphery, TARGET2 liabilities mitigate the effects of a sudden stop and private deleveraging for consumers. Beneficial terms of trade shift household consumption to the core region, while domestic output and labor decline. Core countries, on the other hand, increase their exports and thus output and labor while import demand decreases due to higher savings. Additionally, the distributional effects of the TARGET2 payment system lead to persistent external imbalances, and real exchange rate misalignments between the regions.

Chapter 5 presents a first DSGE model approach to integrate euro area-wide safe assets in a two-region framework. The integration of common safe assets improves the financial stability across the euro area and the diversification of banks' balance sheets by decreasing the home bias in banks' sovereign debt holdings. We use the European Commission's QUEST model with a banking sector and financial frictions and create a safe asset class for the two regions core and periphery by pooling safe domestic bonds across the regions, alongside domestic riskier bonds. We assess the macroeconomic effects of bank balance sheet restructuring from riskier domestic assets towards safe euro area-wide assets, in order to reduce domestic sovereign exposure of banks and mitigating the adverse feedback loop between banks and their sovereigns. The bank balance sheet restructuring has direct consequences for the shock stabilization, in this case the stabilization of a sovereign risk shock. First results show that a shift in bank balance sheet from risky to safe assets across euro area banks leads to a GDP stabilization and decrease in government debt relative to GDP in both regions, however at lower bond prices for risky assets.

Finally, Chapter 6 outlines the most important results and concludes with a summary.

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Chapter 1

Introduction

1.1 Motivation

The onset of the financial crisis and the subsequent European debt crisis revealed the problems of diverging external imbalances within the Economic and Monetary Union (EMU).

The main drivers behind the current account divergence among Member States in the pre-crisis period 2002–2008 can be attributed to capital flows from core euro area countries like Germany, the Netherlands and Luxembourg into periphery countries like Greece, Italy, Ireland, Portugal, and Spain (e.g. Jaumotte and Sodsriwiboon, 2010; Lane and Pels, 2012). Agents invested in periphery due to low borrowing costs. In the process of financial integration a decrease in country risk premia led to shrinking interest rate spreads, encouraging domestic lending and asset price inflation (Hale and Obstfeld, 2016). This process was accelerated by the European-wide TARGET payment system that was implemented to ensure an efficient financial infrastructure and settlement mechanism of cross-border transactions.

Additionally, while exporters in core countries like Germany profited from an increase in foreign demand and gross foreign asset positions in periphery, peripheral countries suffered from a real exchange rate appreciation. The increase in the real exchange rate and the concomitant loss of price competitiveness for peripheral exporters resulted in growing current account deficits and external liabilities (Chen et al., 2013) and increased the risk of sudden stops in capital flows. In such a situation fiscal policy tools can help facilitating external adjustment and reduce real exchange rate misalingments (Lane, 2010).

In the course of the financial crisis and the subsequent sovereign debt crisis contagion effects in sovereign bond markets and an increase in risk aversion led to significant reversals of private capital inflows to the periphery. Such sudden stops of capital inflows would embark in a process of private debt deleveraging, accompanied by a current account rebalancing in the crisis-hit countries.

However, those sudden stops are barely visible in the current account of periphery countries, as private capital outflows were compensated by public capital inflows in the current account.

Public capital inflows into the euro area periphery have taken three forms: the assistance programmes by the European Union and the IMF, the purchase programmes by the ECB, and liquidity provision by the Eurosystem (TARGET2 balances).

The role of TARGET2 imbalances within the euro area has been widely discussed in literature: While some authors interpret those TARGET2 balances as the pure mirror image of capital flow reversals within the financial account (e.g. Bindseil and König, 2012; Fahrholz and Freytag, 2012), and thus reflect a funding crisis in the euro area without any link to current account imbalances, a second strand of literature links growing TARGET2 balances directly to current account financing (e.g. Auer, 2014; Sinn and Wollmershäuser, 2012). Regardless of the question whether TARGET2 only mirrors a sudden stop of private sector capital imports in periphery or is interpreted as direct current account financing, in terms of Financial and Balance of Payment Statistics both views would imply a perpetuating of current account imbalances.

A precautionary motive against sudden stops would be the creation of euro area-wide safe assets that replace risky sovereign bonds in bank balance sheets, in particular exposures to the domestic sovereign.

1.2 Synopsis

The central research question of this thesis is the macroeconomic adjustment in the euro area to current account imbalances and sudden stops, which are often associated with external imbalances. In particular, the thesis examines 1) the potential of internal devaluation to combat real exchange rate misalignments and loss of competitiveness - the underlying cause of external imbalances in the euro area, 2) the macroeconomic adjustments to sudden stops with specific focus on the Eurosystem's interbank payment system TARGET2, and 3) the implementation of an euro area-wide safe asset to reduce banks' exposure to domestic sovereigns and, for instance, limit the occurrence of sudden stops.

Chapter 2 analyzes fiscal devaluation as a policy instrument to accelerate real exchange rate adjustment and support current account stabilization. Fiscal devaluation, a budgetary-neutral tax shift from employers' social security contributions towards consumption tax, mimics the effects of external devaluation in the absence of flexible nominal exchange rates and independent monetary policy. Using a small open economy with nominal wage and price rigidities, this chapter integrates an instrument rule that adjusts taxes in response to trade balance fluctuations caused by supply and demand shocks. The chapter finds a trade-off between current account stabilization and households welfare: Fiscal devaluation can support external rebalancing by accelerating real exchange rate adjustments and regaining price competitiveness. From a household welfare perspective, internal devaluation with its concomitant worsening of the terms of trade tends to induce welfare losses. The overall welfare effects are pro-cyclical in the sense that the stronger the tax shift, the higher the welfare losses for the average household. The losses increase with the openness of the economy and the relative size of the tradable sector. A scenario with flexible nominal exchange rates and autonomous monetary policy performs better in terms of household welfare, but implies stronger external fluctuations in the short run.

Chapter 3 examines how the specific policy rules of the euro area's payments system TARGET2 affects the macroeconomic adjustments to sudden stops, a sharp reversals of private capital flows of several euro area Member States during the Great Financial Crisis. The role of the exchange rate regime is a crucial factor in the adjustmet to sudden stops of private capital and account for the institutional differences between euro peggers and euro area Member States. We use the baseline model of a small open economy in the Monetary Union from Chapter 3 and compare sudden stops, modelled as a binding constraint on net foreign asset positions, in euro area Member States that have access to TARGET2 and countries pegged to the euro. Additionally, we evaluate the role of TARGET2 in an extended welfare analysis for the two exchange rate regimes. Shocks that are associated with a current account deficit and deteroriation in the net foreign asset position cause a binding of the credit constraint (contagion effects) and thus private capital outflows. The analysis shows that the automatic access to public external finance in form of TARGET2 - in the short run - help euro area deficit countries to stabilize output, consumption, and investment after a sudden stop of private capital inflows as compared to euro peggers. In the long run, however, euro area countries suffer under a prolonged economic recovery and large public debt as well as higher welfare losses relative to euro peggers.

Chapter 4 builds upon the TARGET2 mechanism in Chapter 3, but broadens the analysis to an estimated two-region DSGE model. We focus on the credit and capital channels of core and peripheral euro area countries, including feedback effects of TARGET2 imbalances between the two regions. While in the run-up to the financial crisis agents in core euro area countries like France and Germany invested in high-return assets in peripherial euro area countries, in the course of the financial and the subsequent sovereign debt crisis the core region acted as a safe asset provider, specifically to the euro periphery. In the search for investments with low risk of default and litigation, private capital flows reversed, forcing peripheral countries into phases of private and public deleveraging. However, in the euro area private capital outflows were offset by public capital inflows in form of TARGET2 balances. Chapter 4 includes risk shocks to the periphery that lead to sudden outflows of private capital from periphery. A binding constraint on credit growth forces the periphery into phases of private deleveraging. We examine how the liquidity provision to peripheral banks by the Eurosystem affects cross-border capital flows and the deleveraging process. Public capital flows prevent a reversal in financial accounts, giving rise to divergent results across the two regions: In the periphery, TARGET2 liabilites mitigate the negative effects of a sudden stop and private deleveraging for consumers. Beneficial terms of trade shift household consumption to the core region, while domestic output and labor decline. Core countries, on the other hand, increase their exports and thus output and labor while import demand decreases due to higher savings. Additionally, the TARGET2 payment system leads to persistent external imbalances, and real exchange rate misalignments between the regions.

Chapter 5 presents a first DSGE model approach to integrate euro area-wide safe assets in a two-region framework. We use the European Commission's QUEST model with a banking sector and financial frictions and create a common safe asset for the two regions, core and periphery. The financial and sovereign debt crisis revealed a mutually weakening between sovereigns and the domestic bank sector in the euro area. The weakening in sovereign debt markets spread to balance sheets of domestic banks, particularly peripheral banks that tend to have large sovereign debt holdings. The integration of safe assets improves the financial stability across the euro area and the diversification of banks' balance sheets by decreasing the home bias in sovereign debt holdings. First, we tranche national government debt into safe sovereign bonds that are pooled across regions and issued as safe assets (E-bonds) and riskier government debt that is issued domestically. The creation of euro area-wide safe assets would enable banks in the euro area to shift from riskier national to safe euro area assets. Therefore, we assess the macroeconomic effects of bank balance sheet restructuring from riskier (domestic) assets towards safe euro area-wide assets, in order to reduce banks' exposure to domestic sovereigns. The bank balance sheet restructuring has direct consequences for the shock stabilization, in our simulation the stabilization of a government risk shock. The results show that an euro area-wide shift in bank balance sheet from risky to safe assets leads to a stabilization of GDP, however at lower bond prices for risky assets and an increase in the term premium.

Finally, Chapter 6 concludes with a brief summary.

Chapter 2

Is Fiscal Devaluation Welfare Enhancing?

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2.1 Introduction

The experience of large external imbalances has made clear that prices and real exchange rates can diverge significantly between member countries of the euro area (EA), in particular without the possibility of nominal exchange rate adjustments. Although we have seen external adjustments in recent years, much of the trade balance improvements in some EA periphery countries have been driven by domestic demand contraction and cyclical factors rather than regaining price competitiveness (Tressel and Wang, 2014). To make the external adjustment more sustainable, it is important to support the export performance by improving price competitiveness.

Against this background, it is of particular interest to analyze policy tools that support real exchange rate adjustment in the presence of price and wage rigidities in order to regain price competitiveness. As an alternative to nominal exchange rate (external) devaluation, the concept of fiscal (internal) devaluation has gained increasing attention, which mimics the effects of an external devaluation in the absence of flexible nominal exchange rates and an independent monetary policy. The idea of fiscal devaluation is that a budgetary-neutral tax shift from labor to consumption, or more precisely, from employers' social security contributions (SSC) towards consumption tax (VAT) supports real exchange rate adjustment, improves price competitiveness, and reduces trade imbalances.

The effect of an internal devaluation on the economy is twofold: One the one hand, a reduction in employers' SSC lowers firms' labor costs, reduces producer prices and increases foreign demand for exports. On the other hand, higher consumption taxes increase the prices on imported goods while partly offsetting the fall in domestic producer prices. Both effects support real exchange rate adjustment and lead to an improvement of the trade balance. In the long run, however, labor unions could push through higher wages in order to compensate for higher consumption expenditures (de Mooij and Keen, 2012). Koske (2013) provides a comprehensive survey on the economic effects of fiscal devaluation and the transmission mechanisms behind it.

This chapter analyzes a revenue-neutral tax shift from employers' SSC towards consumption tax in order to accelerate real exchange rate adjustment, regain price competitiveness and support external rebalancing. The main focus is hereby on examining the welfare implications of such internal devaluation in the context of the utility-based assessment of household welfare.

The literature on fiscal devaluation mainly focuses on implementing a budgetary-neutral tax shift as an exogenous shock, but also supports the positive effect on regaining competitiveness. In this line, ECB (2012), Engler et al. (2014) and Stähler and Thomas (2012) use a two-region monetary union framework to implement an internal devaluation as a quasi-permanent shock. Engler et al. (2014) find that a fiscal devaluation in southern European countries increase GDP by around 1% and improves the trade balance by 0.2% of GDP. Stähler and Thomas (2012) calibrate their model-setting to Spain and simulate a number of policy measures including fiscal devaluation. They find that a permanent increase in VAT can improve Spain's competitiveness significantly. Another study by Gomes et al. (2016) uses a global model to assess the effects of a temporary fiscal devaluation for Spain and Portugal using a temporary tax shift over a four-year horizon equal to 1% of ex ante nominal GDP. They find a trade balance improvement by 0.5% of GDP for both countries. In contrast to these studies, we do not evaluate fiscal devaluation as an exogenous tax shift, but implement it as an endogenous fiscal intervention in response to trade balance fluctuations caused by exogenous disturbances.

Farhi et al. (2013) analyze under which conditions a fiscal devaluation, understood as a revenue-neutral VAT increase and a reduction in payroll taxes, can exactly replicate nominal exchange rate devaluation. Langot et al. (2012) provide an optimal tax scheme by contrasting two welfare dimensions, namely a welfare-improving reduction of labor market distortions and a welfare-reducing decline of agents' purchasing power. This thesis does not aim at deriving optimal tax schemes in order to improve household welfare, it rather implements instrument rules that adjust taxes in response to trade balance deficits to support real exchange rate adjustment in case of losses of competitiveness.

Burgert and Roeger (2014) use the European Commission's QUEST3 model to provide a detailed analysis of the distributional effects of a fiscal devaluation on income from financial and non-financial wealth, labor, and social transfers. We also examine distributive effects by implementing two types of households: the 'richer' Ricardian (NLC) households who have access to financial markets to smooth their consumption and the 'poorer' liquidity-constrained (LC) households who have no access to financial markets. The introduction of such financial frictions allows for comparing the associated welfare effects across different household types, whereby we do not explicitly address re-distributional effects between household types or potential compensations. The type of subsequent welfare implications are related to Hohberger et al. (2014) who provide utility-based welfare effects for sectoral reallocation of government expenditures between tradable and non-tradable goods.

Regarding the existing literature, this approach contributes in two main dimensions by (i) modelling fiscal devaluation as an instrument rule that adjusts taxes in response to trade balance fluctuations caused by a negative economy-wide productivity shock (loss of competitiveness) and (ii) focussing on the associated welfare effects in the context of a utility-based assessment of household welfare. To our knowledge, this approach is the first to assess the potential welfare implications of an internal devaluation based on a simple fiscal instrument rule. The welfare study also provides several sensitivity checks for changes in the model structure. Additionally, we contribute by using a scenario of monetary policy independence with flexible nominal exchange rates as benchmark in order to gain some intuition whether external devaluation might dampen external fluctuations.

The analytical framework is a small open economy DSGE model according to Galí and Monacelli (2008). The focus on a small member country of a monetary union excludes feedback effects from domestic events to monetary policy and the rest of the monetary union. This is particularly relevant for analyzing policy tools in open economies, which tend to be more exposed to asymmetric shocks. Due to our small open economy assumption, potential spillover effects are excluded as in ECB (2012) and Lipinska and von Thadden (2012).

This simulation study finds that fiscal devaluation, understood as a budget-neutral tax shift from employers' SSC to consumption tax, can help stabilizing fluctuations in the trade balance by supporting real exchange rate adjustment and regaining price competitiveness. From a welfare perspective, the internal devaluation tends to induce welfare losses for the average household due to a worsening of the terms of trade. The welfare losses are higher, (i) the higher the tax shift, (ii) the more open the economy and (iii) the larger the tradable sector. LC households, who have no access to financial markets, suffer more from fiscal devaluation than NLC households. However, under specific shocks and country-specific structures fiscal devaluation can be welfare enhancing for NLC households. A scenario with flexible nominal exchange rates and autonomous monetary policy performs better in terms of household welfare, but implies larger external fluctuations in the short run.

The chapter is organized as follows. Section 2.2 describes the analytical framework, and Section 2.3 explains the parameterization of a small open economy model within a monetary union. Section 2.4 presents simulations of a budgetary-neutral tax shift in response to an economy-wide loss of competitiveness. Section 2.5 provides associated welfare effects of fiscal devaluation as well as several sensitivity analyses in the context of a utility-based assessment of household welfare. Section 2.6 concludes.

2.2 The Model

The small open economy model is based on Hohberger et al. (2014) and consists of two sectors (tradable and non-tradable), two input factors, and includes additional frictions (wage stickiness, financial frictions, and capital adjustment costs). Figure 2.1 summarizes the model structure.

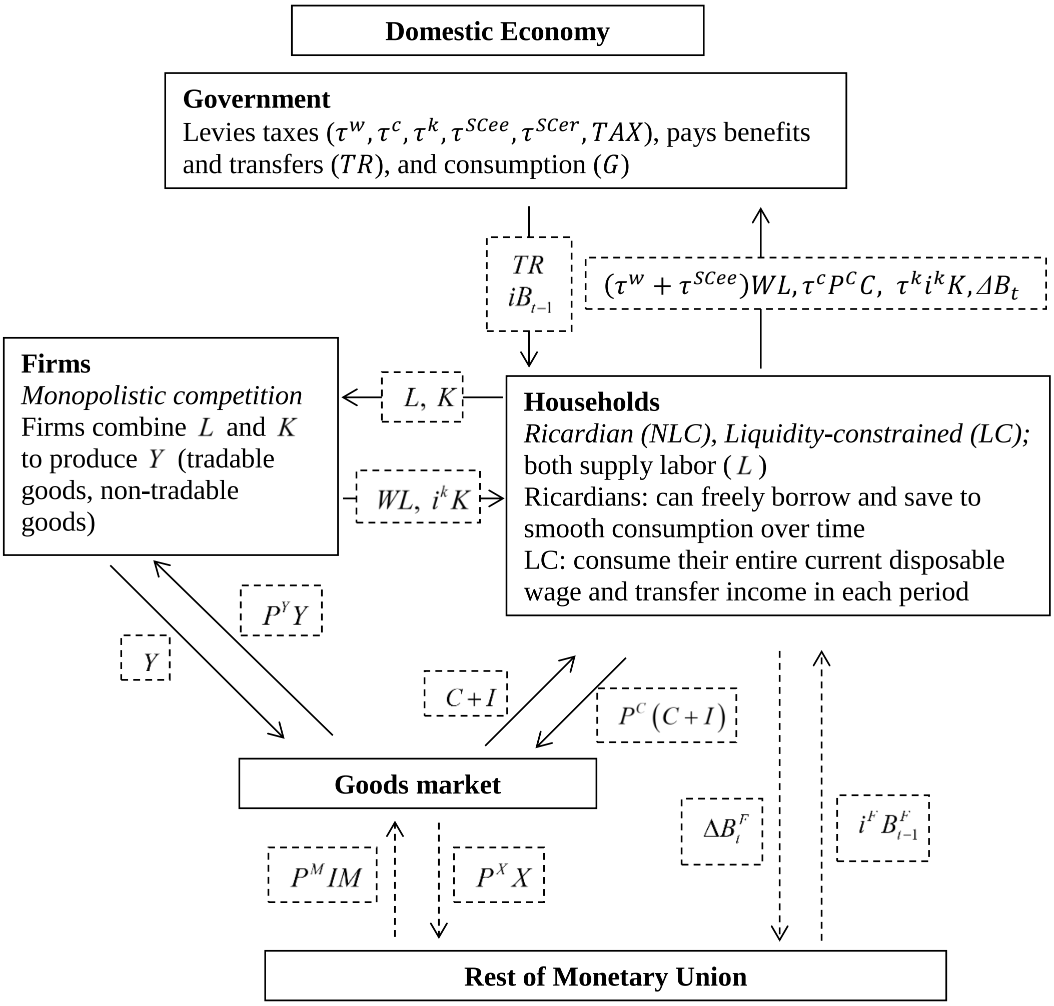

Figure 2.1 Model structure

We augment this model by adding social contribution costs for employers (τ_t^{SCer}) and employees (τ_t^{SCee}), and instrument rules to analyze the impact of fiscal devaluation on domestic activity and household welfare. The model features monopolistic competition in goods and labor markets, nominal price and wage stickiness, liquidity constraints, as well as capital and labor as production factors. Households are either intertemporal optimizing consumers (NLC) that can freely borrow and save to smooth consumption over time or liquidity-constrained (LC) households without access to financial markets, consuming their entire current disposable wage in each period.

Following Schmitt-Grohé and Uribe (2003), this model uses a debt-dependent country risk premium on foreign asset holdings as external closure. It allows for introducing risk-premium shocks that directly affect nominal interest rate differentials and serves as a way to mimic demand booms by lowering borrowing costs. Goods markets are imperfectly integrated across borders in the sense that there is home bias in the demand for goods. Labor is immobile between countries. The foreign economy (rest of Monetary Union) variables and monetary policy are exogenously given from the perspective of the small economy. In our benchmark scenario, we depart from this assumption and consider the case of a small open economy outside a monetary union, i.e. with monetary policy independence (Taylor-type monetary policy rule) and nominal exchange rate flexibility. For the sake of brevity, this section only displays the main equations of the model setting. The detailed description of the model structure can be found in Hohberger et al. (2014).

Households

Welfare of household i is given by the discounted sum of the period utilities with the discount factor β:

$$W = E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{1}{1-\sigma} (C_t^i)^{1-\sigma} - \frac{\kappa}{1+\varphi} (L_t^i)^{1+\varphi} \right) \tag{2.1}$$

Household utility is additive in consumption C_t^i and work L_t^i. As utility has a constant risk aversion σ, the elasticity of intertemporal substitution is given by $1/\sigma$, κ

specifies the weight on the disutility of work, and $1/\varphi$ stands for the elasticity of labor supply.

For NLC households, who are a fraction $(1 - slc)$ of the population, the intertemporal budget constraint is:

$$
\begin{aligned}
&(1-\tau_t^w-\tau_t^{SCee})W_t^iL_t^i+(1+i_{t-1})B_{t-1}+\left(1+i_{t-1}^*-\omega\frac{B_{H,t-1}^*}{4P_{t-1}^YY_{t-1}}+\varepsilon_t^r\right)B_{t-1}^*+TR_t\\
&+(1-\tau_t^k)i_t^kK_{t-1}^i+\tau_t^k\delta P_t^CK_{t-1}^i+PR_t=\\
&(1+\tau_t^c)P_t^CC_t^{NLC}+P_t^CI_t^i+B_t+B_{H,t}^*+\gamma_w/2(\pi_t^{w,i})^2P_t^CL_t+TAX_t
\end{aligned}
\tag{2.2}
$$

The revenue side includes the labor tax and social contribution costs adjusted net nominal wage income $(1 - \tau_t^w - \tau_t^{SCee})W_t^i L_t^i$, the payment on maturing one-period domestic government bonds B_{t-1} including interest i_{t-1}, the repayment of one-period net foreign assets $B_{H,t-1}^*$ including interest, which is the sum of the foreign rate i_{t-1}^*, the endogenous part of the risk premium $-\omega B_{H,t-1}^*/(4P_{t-1}^Y Y_{t-1})$ and the exogenous component ε_t^r, lump-sum transfers from the government TR_t, the return to capital $(1-\tau_t^k)i_t^k K_{t-1}^i + \tau_t^k \delta P_t^C K_{t-1}^i$ net of capital taxes τ_t^k and depreciation allowances $\tau_t^k\delta$, where $K_t^i \equiv K_{T,t}^i + K_{NT,t}^i$, and profit income PR_t from firm ownership. The expenditure side combines nominal consumption $P_t^C C_t^{NLC}$ taxed at rate τ_t^c, where P_t^C is the consumer price index (CPI), nominal investment in the tradable and non-tradable sector $P_t^C I_t^i$, where $I_t^i \equiv I_{T,t}^i + I_{NT,t}^i$, financial investment in domestic bonds and (net) foreign assets, quadratic costs γ_w of wage adjustment $(\pi_t^{w,i} \equiv W_t^i/W_{t-1}^i - 1)$ and lump-sum tax TAX_t as a non-distortionary tax.

The Euler equation for the optimal path of NLC consumption is given by:

$$
\beta E_t\left(\frac{1+\tau_t^c}{1+\tau_{t+1}^c}\frac{P_t^C}{P_{t+1}^C}\left(\frac{C_t^{NLC}}{C_{t+1}^{NLC}}\right)^{\sigma}\right)=\frac{1}{1+i_t} \tag{2.3}
$$

The combination of the FOC for domestic bonds and foreign assets gives an interest parity condition including the risk premium:

$$i_t = i_t^* - \omega \frac{B^*_{H,t-1}}{4P^Y_{t-1}Y_{t-1}} + \varepsilon_t^r \tag{2.4}$$

with ω >0 and the exogenous AR(1) risk-premium shock.[1]

The period budget constraint of LC households, constituting the share *slc* of the population, is:

$$(1 - \tau_t^w - \tau_t^{SCee})W_t^i L_t^i + TR_t^{LC} = (1 + \tau_t^c)P_t^C C_t^{LC} + \gamma_w/2(\pi_t^{w,i})^2 P_t^C L_t^{LC} \tag{2.5}$$

The per-capita level of aggregate consumption is the weighted average of NLC and LC consumption:

$$C_t \equiv (1 - slc)C_t^{NLC} + slc C_t^{LC} \tag{2.6}$$

Private demand combines domestically produced tradable ($C^i_{TH,t}$, $I^i_{TH,t}$), non-tradable ($C^i_{NT,t}$, $I^i_{NT,t}$) and imported ($C^i_{TF,t}$, $I^i_{TF,t}$) goods. Assuming the same trade price elasticity for consumption and investment demand, we can aggregate $Z_t \in (C_t^{NLC}, C_t^{LC}, I_t)$ and define Z_t as a CES aggregate of tradable ($Z^i_{T,t}$) and non-tradable goods ($Z^i_{NT,t}$):

$$Z_t = \left[(\phi)^{\frac{1}{\psi}} (Z_{T,t})^{\frac{\psi-1}{\psi}} + (1-\phi)^{\frac{1}{\psi}} (Z_{NT,t})^{\frac{\psi-1}{\psi}} \right]^{\frac{\psi}{\psi-1}} \tag{2.7}$$

where ϕ and ψ is the share of tradable goods and the elasticity of substitution between tradable and non-tradable goods, respectively. $Z_{T,t}$ is a composite index of domestically produced tradable goods ($Z_{TH,t}$) and imported goods ($Z_{TF,t}$) defined by:

$$Z_{T,t} = \left[(h)^{\frac{1}{\eta}} (Z_{TH,t})^{\frac{\eta-1}{\eta}} + (1-h)^{\frac{1}{\eta}} (Z_{TF,t})^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}} \tag{2.8}$$

[1]Note that Equation (2.4) does include an exchange rate term $\Delta E^i_{t+1}/E^i_t$ when we consider the non-monetary union case with monetary policy independence.

where h represents the steady state home bias and η indicates the elasticity of substitution between domestically produced goods and imports.

The domestic consumer price index (P_t^C) is given by:

$$P_t^C = \left[(\phi)(P_{T,t})^{1-\psi} + (1-\phi)(P_{NT,t})^{1-\psi}\right]^{\frac{1}{1-\psi}} \tag{2.9}$$

where the domestic country price index for tradable goods ($P_{T,t}$) has the following form:

$$P_{T,t} = \left[(h)(P_{TH,t})^{1-\eta} + (1-h)(P_{TF,t})^{1-\eta}\right]^{\frac{1}{1-\eta}} \tag{2.10}$$

Households supply labor services to both tradable and non-tradable goods sectors. The labor services are distributed equally across NLC and LC households, and specialized labor unions represent the different types of labor services i in the wage setting. The wage setting is subject to quadratic adjustment costs, which provide an incentive to smooth the wage adjustment and lead to nominal wage stickiness. Since we assume identical wages W_t^i for both sectors, the optimization problem of the labor union representing the labor service i is:

$$E_0 \sum_{t=0}^{\infty} \beta^t \left(-\frac{\kappa}{1+\varphi}(L_t^i)^{1+\varphi} + \lambda_t^i (1 - \tau_t^w - \tau_t^{SCee}) \frac{W_t^i}{P_t^C} L_t^i - \lambda_t^i \frac{\gamma_w}{2} (\pi_t^{w,i})^2 \frac{P_{TH,t}}{P_t^C} L_t \right) \tag{2.11}$$

The optimization problem is symmetric across unions i, which implies identical wages ($W_t^i = W_t$) and labor demand ($L_t^i = L_t$) across households. Hence, the aggregate wage setting equation is:

$$\begin{aligned} &(1 - \tau_t^w - \tau_t^{SCee}) \tfrac{W_t}{P_t^C} = \\ &\tfrac{\theta}{\theta-1} \tfrac{\kappa L_t^\varphi}{\lambda_t^{tot}} - \tfrac{\gamma_w}{\theta-1} \tfrac{W_t}{W_{t-1}} \tfrac{P_{TH,t}}{P_t^C} \pi_t^w + \tfrac{\gamma_w}{\theta-1} \beta E_t \left(\tfrac{\lambda_{t+1}^{tot}}{\lambda_t^{tot}} \tfrac{W_{t+1}}{W_t} \tfrac{P_{TH,t+1}}{P_{t+1}^C} \tfrac{L_{t+1}}{L_t} \pi_{t+1}^w \right) \end{aligned} \tag{2.12}$$

where the gross wage claims increase with increasing labor taxation (τ_t^w) and employees' social contribution costs (τ_t^{SCee}) for given levels of employment.

Firms

The economy consists of a continuum of monopolistically competitive firms in the tradable and non-tradable sector, which are owned by NLC households and produce a differentiated good $Y^j_{s,t}$ with capital $K^j_{s,t-1}$, labor $L^j_{s,t}$ and Cobb-Douglas production technology in each sector s:

$$Y^j_{s,t} = A_{s,t}(K^j_{s,t-1})^{\alpha}(L^j_{s,t})^{1-\alpha} \tag{2.13}$$

The sector-specific total factor productivity $A_{s,t}$ is identical across firms and follows an AR(1) process. The cost-minimal combination of capital and labor is given by:

$$\frac{L^j_{s,t}}{K^j_{s,t-1}} = \frac{1-\alpha}{\alpha}\frac{i^k_t}{(1+\tau^{SCer}_t)W_t} \tag{2.14}$$

which implies for the nominal marginal costs $MC^j_{s,t}$ of the optimizing firm:

$$MC^j_{s,t} = \frac{(i^k_t)^{\alpha}[(1+\tau^{SCer}_t)W_t]^{1-\alpha}}{A_{s,t}\alpha^{\alpha}(1-\alpha)^{1-\alpha}} \tag{2.15}$$

The employers' SSC is given by τ^{SCer}_t. The higher the employers' SSC as percentage of gross wage earnings, the lower the use of labor in the production of good $Y^j_{s,t}$.

The firms in each sector s face quadratic price adjustment costs γ_p and set prices $P^j_{s,t}$ to maximize the discounted expected profit. For each sector, firms profit maximization has the following form:

$$E_0\sum_{t=0}^{\infty}\beta^t\frac{\lambda^{NLC}_t}{\lambda^{NLC}_0}\left(\frac{P^j_{s,t}}{P_{s,t}}Y^j_{s,t} - \frac{(1+\tau^{SCer}_t)W^j_{s,t}}{P_{s,t}}L^j_{s,t} - \frac{\gamma_p}{2}(\pi^{p,j}_{s.t})^2Y_{s,t}\right) \tag{2.16}$$

The nominal GDP is the sum of domestically produced tradable and non-tradable output:

$$P^Y_tY_t = P_{TH,t}Y_{T,t} + P_{NT,t}Y_{NT,t} \tag{2.17}$$

Government

The government collects labor, capital, consumption, and lump-sum taxes that are levied on NLC households as well as SSC for employers and employees and issues one-period bonds to finance government purchases, transfers and the servicing of outstanding debt:

$$(\tau_t^w + \tau_t^{SCee} + \tau_t^{SCer})W_t L_t + \tau_t^k (i_t^k - \delta) K_{t-1} + \tau_t^c P_t^C C_t + (1 - slc) TAX_t + B_t = P_t^G G_t + TR_t + (1 + i_{t-1}) B_{t-1} \tag{2.18}$$

Expenditure on total government purchases is the sum of expenditure on tradable and non-tradable goods analogously to private demand:

$$P_t^G G_t = P_t^T G_{T,t} + P_t^{NT} G_{NT,t} \tag{2.19}$$

Steady state government consumption is given by:

$$\frac{G_t}{Y_t} = \rho_G \frac{G_{t-1}}{Y_{t-1}} \frac{Y_{t-1}}{Y_t} + (1 - \rho_G) \left(\frac{\bar{G}}{Y} \right) \tag{2.20}$$

Government adjusts lump-sum taxes to stabilize government debt and the budget deficit at their target levels according to:

$$\frac{TAX_t}{P_t^Y Y_t} = \frac{TAX_{t-1}}{P_{t-1}^Y Y_{t-1}} + \xi_b \left(\frac{B_{t-1}}{4 P_{t-1}^Y Y_{t-1}} - btar \right) + \xi_d \Delta \frac{B_{t-1}}{4 P_{t-1}^Y Y_{t-1}} \tag{2.21}$$

where *btar* is the target debt-to-GDP ratio. Therefore, the government increases lump-sum taxes to collect additional revenues if debt and/or deficit levels exceed the target values. The lump-sum tax helps to reduce the complexity of the model dynamics, as it does not affect labor supply decisions of workers and the disposable period income and consumption demand of LC households.

In the non-EMU scenario with monetary independence, the central bank sets interest rates according to the following Taylor-type monetary policy rule:

$$i_t = \rho_i i_{t-1} + (1-\rho_i)(1-\beta)/\beta + (1-\rho_i)\xi_\pi \left(\frac{P_t^C}{P_{t-1}^C}\right) \tag{2.22}$$

External Account

The total demand for domestic output is the sum of final domestic demand, net exports, and the wage/price adjustment costs ADC_t:

$$P_t^Y Y_t = P_t^C(C_t + I_t) + P_t^G G_t + P_t^{TH} X_t - P_{TF,t} M_t + ADC_t \tag{2.23}$$

where imports of tradable goods of the rest of the Monetary Union (TF) are given by M_t. Exports X_t of domestic tradable good (TH) correspond to the import demand of the rest of the Monetary Union:

$$X_t = (1-h)(P_{TH,t}/P^*_{TH,t})^{-\eta} Y_t^* \tag{2.24}$$

where h is the degree of home bias. We exclude price discrimination between countries, i.e. the law of one price holds.

The aggregate resource constraint of the domestic economy, which is also the law of motion for the net foreign asset (NFA) position, is given by:

$$B^*_{H,t} = (1+i_{t-1})B^*_{H,t-1} + P_t^Y Y_t - P_t^C(C_t + I_t) - P_t^G G_t - P_t^Y ADC_t \tag{2.25}$$

The current account equals the change in net foreign assets:

$$CA_t = B^*_{H,t} - B^*_{H,t-1} \tag{2.26}$$

We treat the rest of the monetary union (foreign economy) as a single, large country, which engages in trade with the small country. However, the trade volume with the small country is low such that the foreign economy can be seen as a closed one.

2.3 Parameterization

Following standard practice, we calibrate the real ratios of the model, such as consumption and investment shares, trade openness, and government size on the basis of national accounts data. As the model is supposed to reflect an average small open economy in a monetary union, the respective group of countries comprises Austria, Belgium, Finland, Greece, Ireland, the Netherlands, Portugal and Spain. The national data are obtained from the Eurostat database of the European Commission and the OECD database. The numerical values of the model parameters are obtained from empirical studies in the DSGE literature. The parameter values, steady state ratios and exogenous variables are summarized in Table 2.1[2].

The steady state ratios are calibrated to replicate the average share of private consumption (60%), investment (20%) and government purchases (20%) in euro area GDP during $1999Q1 - 2012Q4$. The parameter $h = 0.51$ matches the average import-to-GDP ratio of the eight small euro area countries. We set the share of tradable goods in total consumption to ϕ= 0.6 in order to get a steady state ratio of tradable goods to GDP of 60% (Lombardo and Ravenna, 2012). In the observed time period, the average government debt-to-GPD ratio is 74%. The budget closure implies that a 1 percentage point increase in government debt-to-GDP (deficit-to-GDP) ratio increases taxes or decreases transfers by 0.001 (1.0) percentage points.

[2]For the sake of brevity, this section focuses predominantly on describing general steady state shares and relevant parameter values to focus on the main objective of fiscal devaluation. Parameter values in Table 2.1 that are not explicitly mentioned in this section are obtained from Hohberger et al. (2014).

Table 2.1 Calibrated parameters and steady state ratios

Parameter	symbol	value
Discount factor	β	0.995
*Consumption relative to GDP	C/Y	0.6
*Government spending relative to GDP	G/Y	0.2
*Investment relative to GDP	I/Y	0.2
Tradable goods share of GDP	T/Y	0.6
*General transfers relative to GDP	TR/Y	0.12
Share of LC households	slc	0.4
Weight of labor disutility	κ	1.0
Elasticity of labor supply	$1/\varphi$	0.25
Share of tradable goods in consumption	ϕ	0.6
Elasticity of substitution T/NT goods	ψ	0.5
Intertemporal elasticity of substitution	$1/\sigma$	0.5
Elasticity of substitution between home and foreign goods	η	1.5
Elasticity of substitution between goods varieties j	ε	6
Elasticity of substitution for labor services i	θ	6
Cobb-Douglas parameter (capital share)	α	0.4
Country risk premium	ω	0.0025
*Degree of home bias	h	0.51
Wage adjustment costs	γ_w	80
Price adjustment costs	γ_p	48
Capital adjustment costs	γ_c	30
*Debt-to-GDP ratio	$btar$	0.74
Fiscal reaction to debt	ξ_b	0.001
Fiscal reaction to deficit	ξ_d	1.0
Persistence of fiscal instrument	ρ_G	0.5
Persistence of monetary instrument	ρ_i	0.5
Monetary coefficient on inflation	ξ_i	1.5
*Consumption tax rate	τ^c	0.197
*Labor income tax rate	τ^w	0.16
*Social security contribution of employers	τ^{SCer}	0.25
*Social security contribution of employees	τ^{SCee}	0.13
*Capital tax rate	τ^k	0.30
*Persistence of TFP shock	ρ_a	0.92
*Standard deviation TFP	σ_a	0.025
*Persistence of risk premium shock	ρ_r	0.85
*Standard deviation risk premium	σ_r	0.015

Note: The asterisked parameters and steady state ratios are based on national accounts data.

The tax rate on consumption of 19.7% is given by the average VAT rate within the euro area for the period 1999-2012 (European Union, 2013). The average tax rate on capital income is 30% (OECD Tax Database). Given the total gross earnings, households pay labor income tax and SSC as a percentage share of their gross wage earnings. The average labor income tax burden for the given period is 16% of total earnings plus 13% SSC for the households. Thus, the net income of households amounts to 71% of total gross wage earnings. Firms contribute on average 25% SSC as a percentage of total gross wage earnings to the general government. Consequently, the total labor costs of firms amount to 125% of gross wage earnings.

Following Rabanal (2009) and Gomes et al. (2016), the elasticity of substitution between tradable and non-tradable goods is set to $\psi = 0.5$. The trade elasticity between domestic and foreign tradable goods is $\eta = 1.5$ and corresponds to the euro area estimates by Imbs and Mejean (2010). According to Druant et al. (2012), we choose the wage and price adjustment cost parameters to match the average duration of wage and price adjustments of five and four quarters, respectively. The estimates for the share of liquidity-constrained (LC) households in the euro area clusters around 40% in the literature and is set to $slc = 0.4$ (e.g. Ratto et al., 2009).

Table 2.2 Comparing model and data moments

Variable	Baseline calibration		Actual data					
	Correlation with output	Standard deviation	Correlation with output			Standard deviation		
			Mean	*Max*	*Min*	*Mean*	*Max*	*Min*
Output	1.00	0.03	1.00	1.00	1.00	0.02	0.04	0.01
Consumption	0.82	0.85	0.85	0.92	0.80	0.88	1.21	0.47
Government	0.93	0.85	0.15	0.61	-0.46	1.28	2.43	0.38
Investment	0.87	1.82	0.82	0.93	0.64	3.64	5.83	1.67
Employment	0.22	1.34	0.64	0.93	0.38	0.76	1.06	0.57
Trade balance	-0.33	0.31	-0.27	0.15	-0.75	1.56	2.25	0.81
Inflation	0.13	0.42	0.46	0.82	-0.28	0.64	0.92	0.43

Note: All moments are based on quarterly data. The variables are in logarithms and hp-filtered with λ=1600 for quarterly data (except trade balance, which is relative to GDP, and inflation, which is the year-on-year percentage change of the Consumer Price Index). The actual data mean is calculated for the group of eight smaller EA-countries for 1999q1-2012q4, namely **AUT, BEL, ESP, FIN, GRC, IRL, NLD and PRT**. Maximum and minimum values are given by the lowest and highest ranked country for the particular measure. The standard deviation is the standard deviation relative to the standard deviation of output, which is the absolute standard deviation.

Table 2.2 compares moments of the benchmark model under the combination of a negative supply (TFP) and demand shock (risk premium) and the absence of fiscal devaluation to actual data for the group of eight smaller European member countries for the period from 1999Q1 to 2012Q4. It shows that the model matches important characteristics fairly well. More specifically, the model replicates the correlation of consumption, employment and the trade balance with output very well. The high correlation of government purchases with output is caused by the calibration of government purchases as a fixed share of GDP in the baseline calibration. Of particular note is the high volatility of investment, which is in line with the data patterns. The model generated volatility of employment is slightly higher compared to actual data. The trade balance is negatively correlated with output and matches the data pattern, whereas the volatility of the trade balance is relatively low. The low volatility of inflation compared to data moments is related to the assumption of constant import prices.

2.4 Simulation

Fiscal devaluation is simulated as a revenue-neutral tax shift from employers' SSC towards consumption tax in response to fluctuations in the trade balance (TB/Y):

$$\tau_t^c = \rho_G \tau_{t-1}^c + (1-\rho_G)\bar{\tau}^c + (1-\rho_G)\xi_{FD}\left(\frac{TB_t}{Y_t}\right) \tag{2.27}$$

$$\tau_t^{SCer} = \rho_G \tau_{t-1}^{SCer} + (1-\rho_G)\bar{\tau}^{SCer} - (\tau_t^c - \bar{\tau}_t^c)\left(\frac{P_t^C C_t}{W_t L_t}\right) \tag{2.28}$$

The mechanism behind these fiscal instrument rules are the following: In case of a trade balance deficit, a negative parameter value ($\xi_{FD} < 0$) implies an increase in consumption tax. The additional consumption tax revenues are then accompanied by lowering the employers' SSC in order to keep the overall level of government revenues constant.[3] This tax shift ensures budget-neutrality and mimics simultaneously the real effects of nominal exchange rate depreciation.

[3] Hohberger et al. (2014) simulates internal devaluation as a tax shift from labor income to consumption tax. In contrast to their approach, we follow the majority of the existing literature to affect directly the firms pricing process and avoid potential second round effects that might counteract the positive effect of supporting the supply side.

The parameter value $\xi_{FD} = -5$ is calibrated such that a 0.5 percentage point decline in the trade balance leads to a 1 percentage point increase in the consumption tax with a corresponding SSC reduction to ensure ex ante budget-neutrality.[4]

In order to analyze the impact of a fiscal devaluation on the domestic economy we present simulations for a negative economy-wide productivity (TFP) shock under different model and policy settings: First, we show impulse responses for the domestic economy that occur due to the competitiveness loss in the absence of supportive policies (no-policy case, NP). Second, we examine the potential of fiscal devaluation (FD) as a tax shift from employers' SSC towards consumption to accelerate real exchange rate adjustment and support trade balance stabilization. Third, we display IRFs for the case that the domestic economy is not a member of the euro area as a benchmark. We use this third scenario to address the question whether the domestic economy performs better in terms of household welfare in the presence of flexible nominal exchange rates, i.e. non-EMU membership, compared to the monetary union scenario.[5]

Negative economy-wide productivity shock ("loss of competitiveness")

Figure 2.2 shows impulse response functions (IRFs) for a negative economy-wide TFP shock, simulated as a temporary 2.5 percentage point decline of the total factor productivity relative to the rest of monetary union. In the no-policy scenario (NP), output and private consumption decline due to an increase in domestic goods prices, resulting in an appreciation (increase) of the real exchange rate and a corresponding trade balance deficit. Price and wage stickiness delays the increase in domestic prices and lowers the real interest rate, so that consumption and output decline more moderately

[4] Given the size of the underlying TFP shock and the associated trade balance deficit, the implied tax shift of this parameter value is quantitatively comparable to those used by Engler et al. (2014) and Gomes et al. (2016).

[5] The simulations and welfare computations are performed using the DYNARE toolbox for MATLAB (Adjemian et al., 2011).

on impact. The increase in employment by 2.5% is associated with a lower productivity level when prices and wages are sticky.

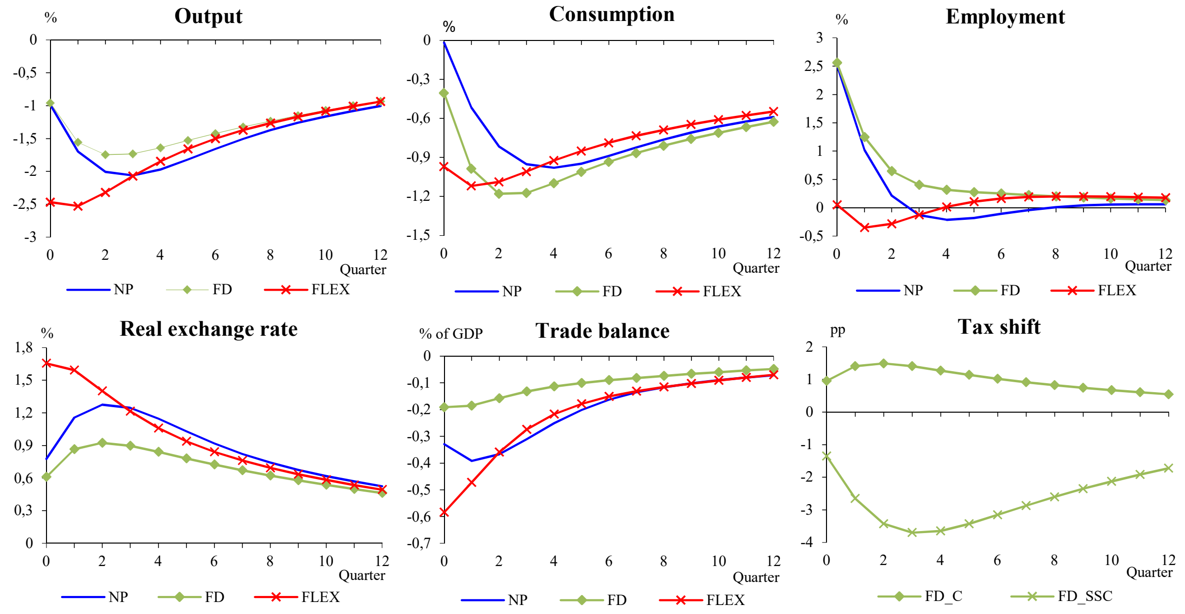

Figure 2.2 Fiscal devaluation in response to a negative TFP shock

Note: Impulse responses are specified in percent, except those for the trade balance and the tax rates, which are given in percent relative to GDP and percentage points, respectively.

Fiscal devaluation (FD) implies a tax shift from employers' SSC rate towards consumption tax (see Equations 2.27 and 2.28). More precisely, a fiscal parameter value of $\xi_{FD} = -5$ in Figure 2.2 implies an increase in consumption tax of around 1.5 percentage points and a corresponding reduction of employers' SSC rate of around 3.5 percentage points to keep the government tax revenues ex ante constant. As a consequence, fiscal devaluation dampens the real exchange rate appreciation and reduces the trade balance deficit substantially.

By shifting the tax burden from labor to consumption, producer (export) prices decline and import prices increase, as the increase in consumption tax only affects imported goods while exempting exported goods from domestic firms. The increase in consumption tax and corresponding reduction of labor costs in the production process dampens the real exchange rate appreciation and the decline in net exports. As a result, the trade balance improves substantially compared to the NP scenario. Our tax shift underlines the finding by Langot et al. (2012) that the increase in consumption taxes has to be accompanied by larger decreases in employers' SSC in order to ensure budget-neutrality. The effects of fiscal devaluation on domestic variables, e.g. output, consumption and employment are ambiguous: While consumption decreases due to higher consumption taxes, fiscal devaluation reduces the output decline and increases employment.

In the presence of autonomous monetary policy (Equation 2.22) and flexible exchange rates, i.e. the non-EMU case (FLEX), the simulation results show that in case of a negative economy-wide TFP shock, fluctuations of macroeconomic variables are even more pronounced compared to the monetary union scenario. This is due to the fact that the upward pressure on domestic prices leads to monetary policy tightening, i.e. an interest rate increase, with two accompanying effects on the economy: First, the increase in the nominal interest rate and the associated expectation of lower consumer prices lead to a higher real interest rate and a higher negative impact on consumption and investment. Second, the nominal exchange rate appreciates on impact with the increase in the interest rate. The subsequent increase in the real exchange rate worsens the trade balance. However, the expected nominal exchange rate depreciation in the future accelerates the adjustment process in the medium run.

Hence, the simulations for a loss in competitiveness suggest that (i) internal devaluation (FD) supports the supply side by reducing producer prices, accelerates real exchange rate adjustment and improves the trade balance; (ii) monetary devaluation (FLEX) leads to stronger real effects with higher output, consumption, and trade balance volatility on impact due to monetary policy tightening. In order to make conclusive statements about the effects of fiscal devaluation on household welfare, we provide a welfare analysis in the following section.

2.5 Welfare

As welfare implications have been mainly neglected so far in the literature on fiscal devaluation, we examine the welfare effects in the context of a utility-based assessment of household welfare. Following Lucas (2003) and Canzoneri et al. (2007), we use a second-order Taylor expansion of the household utility function (Equation 2.1) around a deterministic steady state. We measure the cost of policy intervention with a second-order approximation of a value function for aggregate welfare $W(\xi_{FD})$ for NLC and LC households, where we define $CC(\xi_{FD} = 0)$ as a cardinal number defining the cost of nominal rigidities without fiscal intervention ($\xi_{FD} = 0$) in percentages of consumption:

$$CC(\xi_{FD} = 0) = W(\xi_{FD} \neq 0) - W(\xi_{FD} = 0) \tag{2.29}$$

The second-order Taylor approximation of the discounted period utilities in terms of log-deviation yields:

$$W(\xi_{FD}) \approx \sum_{t=0}^{\infty} \beta^t \left[\begin{array}{l} \frac{(\bar{c}^i)^{1-\sigma}}{1-\sigma} - \frac{\kappa \bar{l}^{1+\varphi}}{1+\varphi} + (\bar{c}^i)^{-\sigma} E\hat{c}_t^i - \kappa \bar{l}^{\varphi} E\hat{l}_t \\ -\frac{\sigma(\bar{c}^i)^{-1-\sigma}}{2} Var(\hat{c}_t^i) - \frac{\kappa\varphi \bar{l}^{-1+\varphi}}{2} Var(\hat{l}_t) \end{array} \right] \tag{2.30}$$

where $\bar{c}$ and $\bar{l}$ denote the steady state level and $\hat{c}$ and $\hat{l}$ the period log-deviation from the steady state.[6] Following Canzoneri et al. (2007), the cost of fiscal devaluation CC $(\xi_{FD} \neq 0)$ measured in percent of steady state consumption and expressed in negative values is given by $100 * [1 - (1-\beta) * CC(\xi_{FD} = 0)]$ and leads to:

$$CC(\xi_{FD} \neq 0) = 100 * \{1 - (1-\beta) \; [W(\xi_{FD} \neq 0) - W(\xi_{FD} = 0)]\} \tag{2.31}$$

[6] The quantitative results refer to the overall welfare effects, i.e. the combination of mean and variance effects.

2.5.1 Loss of Competitiveness

Following Hohberger et al. (2014) and Vogel et al. (2013), we show welfare gains (positive values) and welfare losses (negative values) for a range of policy parameter values ξ_{FD} to provide information on the robustness of welfare effects. Therefore,we run simulations over the interval $[-10; 2]$ for the fiscal policy parameter ξ_{FD} in steps of 0.2. Welfare gains and losses are measured relative to non-stabilization ($\xi_{FD} = 0$) and are expressed in percent of steady state consumption for NLC households, LC households and the weighted average of both household types (TOTAL). The welfare effects are simulated for a negative productivity shock as in Section 2.4 and are shown in Figure 2.3.

Given a fiscal parameter value of $\xi_{FD} = -5$ (as used in Section 2.4) and lump-sum taxes as fiscal budget closure, fiscal devaluation implies moderate welfare losses of around 0.03% of steady state consumption for average households. Given the identical utility functions for both types of households, the welfare losses for LC households are considerably higher compared to NLC households, as they are not able to smooth their consumption over time. Therefore, LC households suffer (benefit) more than NLC households from policy interventions that imply higher (lower) temporary income fluctuations, which is line with findings by Vogel et al. (2013) and Burgert and Roeger (2014). Hence, shifting the tax burden towards consumption generates welfare losses for LC households of 0.09% of steady state consumption ($\xi_{FD} = -5$) due to the reduction of LC households' purchasing power of their disposable income. In contrast, NLC households experience small welfare gains, particularly for the policy parameters range $[-7; 0]$. For the fiscal policy parameter value of ($\xi_{FD} = -5$) welfare gains are relative stable with 0.01%. Increasing prices (due to the TFP shock) and higher consumption taxes encourage NLC households to decrease private consumption by increasing savings in order to maximize their welfare. This leads to higher net foreign assets compared to the no-policy scenario (NP) and, thus, to a decline in the trade balance deficit.

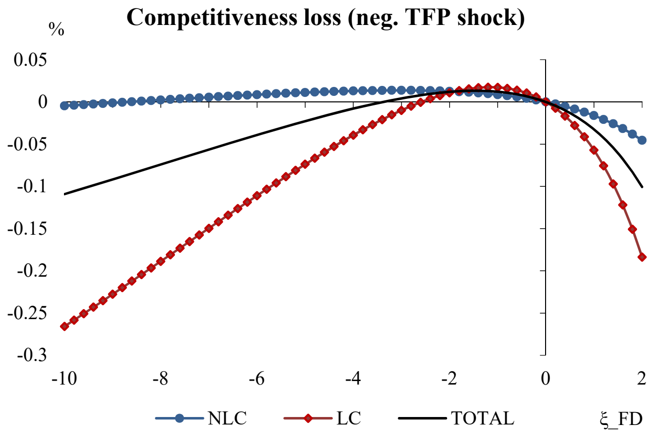

Figure 2.3 Welfare effects of fiscal devaluation

Note: Welfare is measured relative to non-stabilization and expressed in % of steady state consumption.

The implication of the welfare analysis suggests that the stronger the tax shift from labor to consumption the higher the welfare losses for NLC and LC households. To a given extent, however, fiscal devaluation might be a policy tool to regain price competitiveness even with subsequent welfare enhancing effects.

2.5.2 Changes in the Model Structure

In order to gain better insights in the robustness of the welfare implications we provide several analyses for changes in the model structure, i.e. in a macro- and microeconomic perspective. We examine (i) the welfare effects for economies with alternative relative sector sizes (T/NT) and different degrees of openness, (ii) the welfare implications for changes in different elasticity parameters that directly influence the utility function of households, and (iii) the welfare effects in case of a demand shock.

Relative T/NT-size and openness

The relative size of the two sectors (T/NT) should affect the stabilizing potential of fiscal devaluation on the trade balance as well as household welfare. Panels a) and b) in Figure 2.4 depict the welfare effects for tradable goods shares of $\phi = 0.1$ and $\phi = 0.9$

(instead of $\phi = 0.6$ in the baseline calibration). From a stabilization perspective, a tax shift away from labor decreases domestic produced goods prices, which reduces the prices for tradable goods as a composite of domestic and foreign produced tradables (see Equation 2.9). As a consequence, the relatively low price for domestic tradables compared to foreign goods increases net exports by increasing foreign demand and, hence, improves the trade balance. From a welfare perspective, however, households should benefit more from a fiscal devaluation in case of a relatively large non-tradable sector due to lower domestic average prices.

These hypotheses are supported by Panels a) and b) in Figure 2.4. Additionally, it implies a trade-off: The higher the relative size of the tradable goods sector, the higher the potential of trade balance stabilization on the one hand, but the higher the welfare losses for average household on the other hand.

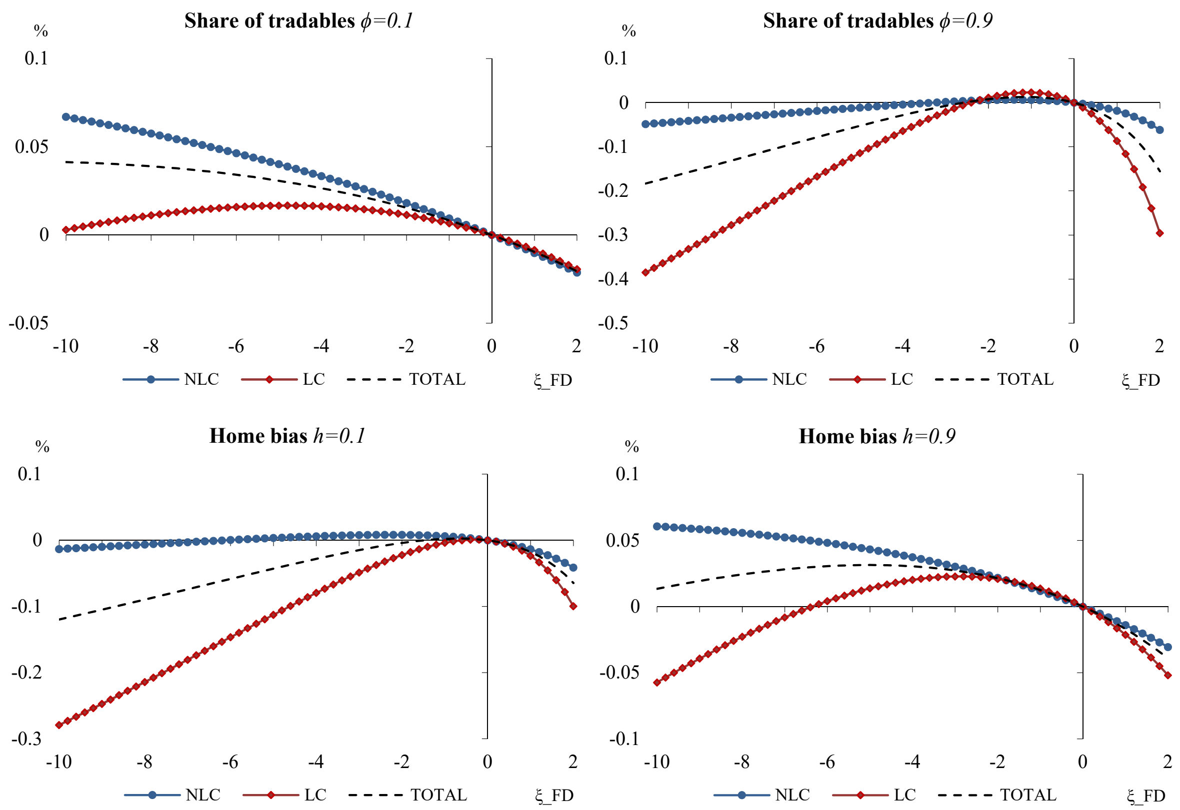

Figure 2.4 Welfare effects for alternative T/NT-size and openness

Note: Welfare is measured relative to non-stabilization and expressed in % of steady state consumption.

Similar considerations arise from changes in the home bias ($h = 0.1$ and $h = 0.9$ instead of $h = 0.51$ in the baseline calibration), which are depicted in Panels c) and d) in Figure 2.4. The lower the home bias (i.e. the more open the economy), the higher the potential of rebalancing, but the higher the welfare losses for the average household. Therefore, in scenarios of a low tradable goods share (a) or a high degree of home bias (d) average households can achieve moderate welfare gains.

Alternative microeconomic elasticities

Studies by Imbs and Mejean (2010) and Simonovska and Waugh (2014) highlight that trade elasticities play an important role in understanding the transmission mechanism between international prices and real variables. We use alternative values for the elasticity of substitution between domestic and foreign goods ($\eta = 1.5$ in our benchmark calibration) to show how it influences the welfare implications of an internal devaluation. Panels a) and b) in Figure 2.5 suggest that a low trade elasticity decreases the welfare losses for both types of households. Even more, it seems that NLC households experience small welfare gains in case of low trade elasticities, as households are willing to consume more at home with lower relative prices.

Potential welfare gains for NLC households also arise by higher intertemporal elasticity of substitution, i.e. a lower value of σ in Panel c). Due to a higher sensitivity to changes in the real interest rate, NLC households smooth their consumption more rapidly in response to higher consumption taxes.

Similar welfare implications arise by higher labor supply elasticity (lower value of φ). Panels e) and f) in Figure 2.5 suggest that the higher the elasticity of labor supply, the higher the potential welfare gains of a fiscal devaluation. In case of higher labor elasticity, households respond more strongly to higher real wages by increasing labor supply, which increases income and compensates for higher consumption taxes.

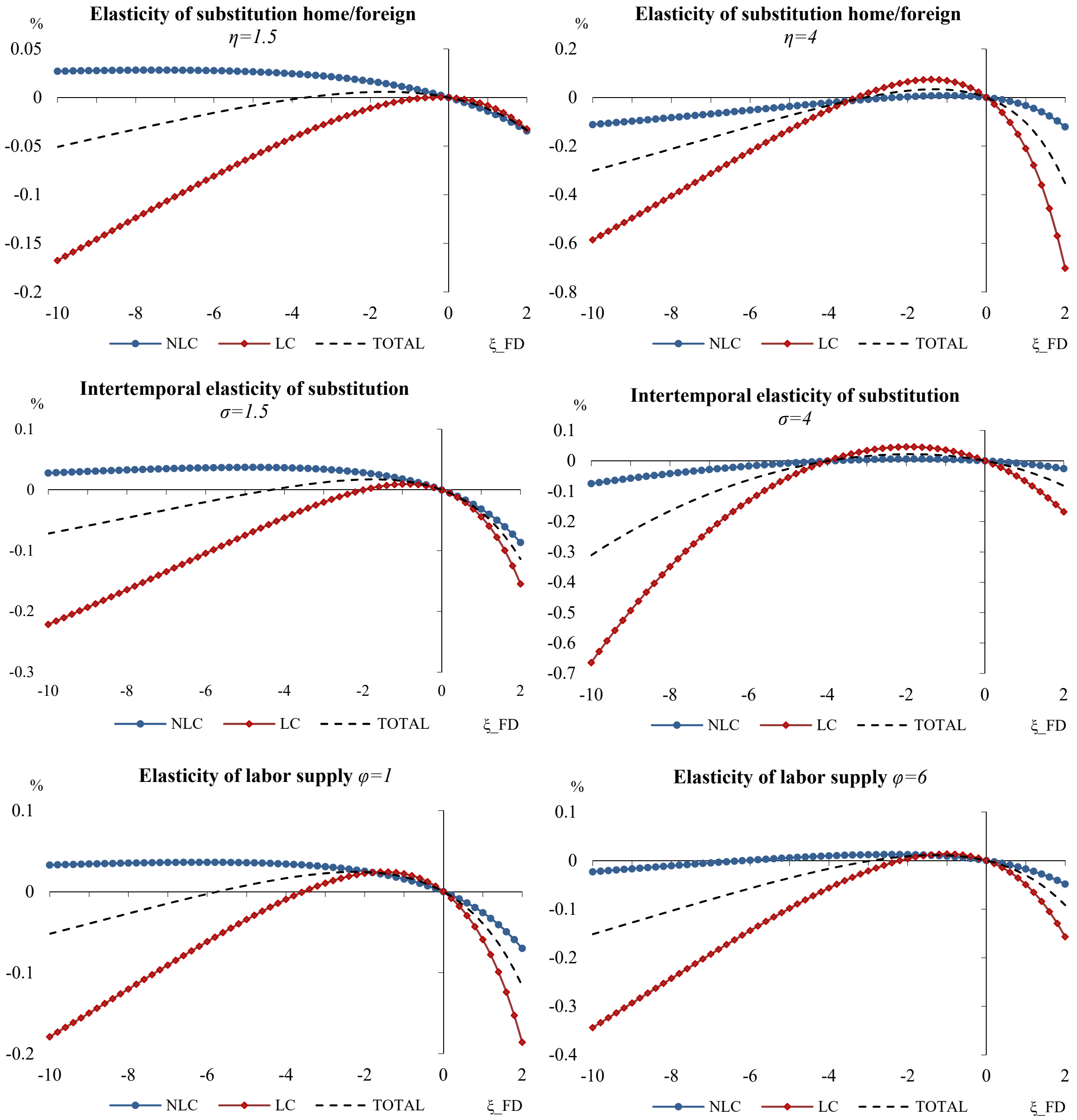

Figure 2.5 Welfare effects for alternative sensitivity analyses

Note: Welfare is measured relative to non-stabilization and expressed in % of steady state consumption.

2.5.3 Demand Boom (risk premium shock)

Based on the debate that fiscal devaluation could be used as policy tool to mitigate excessive consumption demand that leads to external imbalances, we address the question whether welfare effects change in case of demand shocks. We simulate a negative risk premium shock of 1.5 percentage points relative to the rest of monetary union. The negative risk premium shock induces a decline in domestic interest rates. Individuals face lower borrowing rates, which strengthen domestic consumption and investment demand and the demand for imports. The increase in domestic demand puts upward pressure on prices and wages and the real exchange rate appreciates. The higher domestic price level relative to the rest of monetary union leads to a loss of price competitiveness and deteriorating external positions.

Similar to the case of a productivity shock, fiscal devaluation implies an increase in consumption tax and a corresponding reduction of employers' SSC rate. The tax shift mitigates the demand boom, accelerates real exchange rate adjustment and improves the trade balance.

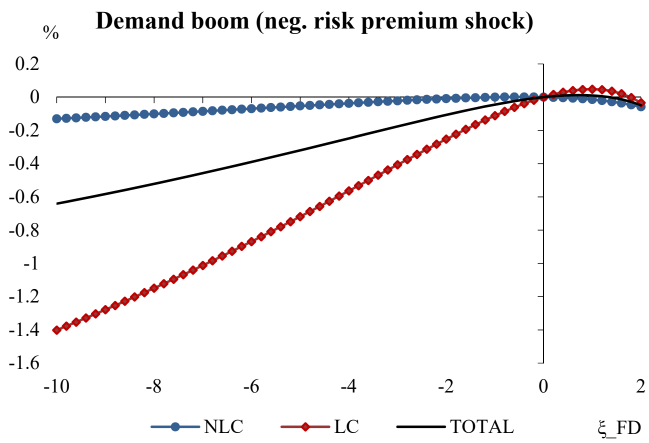

Figure 2.6 Welfare effects of fiscal devaluation

Note: Welfare is measured relative to non-stabilization and expressed in % of steady state consumption.

From a welfare perspective, Figure 2.6 displays that fiscal devaluation implies substantially higher welfare losses for both types of household in case of a demand shock compared to a supply shock. For a given fiscal parameter value of $\xi_{FD} = -5$, a tax shift from labor towards consumption generates welfare losses of 0.07% (0.7%) of steady state consumption for NLC households (LC households), respectively. In contrast to the TFP shock, even small magnitudes of fiscal devaluation denote welfare losses.

2.5.4 Comparison across Policies and Model Settings

In order to summarize and evaluate our results, welfare effects as well as standard deviations of output and the trade balance over a 10-year horizon (40 quarters) are shown in Table 2.3. It provides an overview over the performance relative to alternative model settings across different economic disturbances, i.e. supply and demand shocks.

Table 2.3 Summary of welfare effects

		Sensitivity analysis		
Model and policy setting		NLC welfare	LC welfare	Total welfare
Benchmark model	ξ_{FD}=-5; *TFP shock*	0.01 %	-0.09 %	-0.03 %
Sector size	ϕ=0.1	0.04 %	0.02 %	0.03 %
Sector size	ϕ=0.9	-0.01 %	-0.14 %	-0.06 %
Home bias	h=0.1	0.00 %	-0.12 %	-0.05 %
Home bias	h=0.9	0.05 %	0.00 %	0.03 %
Int. El. Subst.	σ=1.5	0.04 %	-0.07 %	-0.01 %
Int. El. Subst.	σ=4	-0.01 %	-0.06 %	-0.03 %
Labor supply	φ=1	0.04 %	-0.04 %	0.01 %
Labor supply	φ=6	0.00 %	-0.09 %	-0.04 %
Flexible prices	γ_p=0	-0.02 %	0.08 %	0.02 %
Flexible wages	γ_w=0	0.28 %	0.11 %	0.21 %
Demand boom (neg. risk premium)		-0.07 %	-0.69 %	-0.32 %
Flexible exchange rate adjustment		0.21 %	0.04 %	0.14 %
		Standard deviations		
Macroeconomic variable		No policy (NP)	Fiscal devaluation (FD)	Flexible EXR adjustment (FLEX)
TFP shock	Output	0.55	0.47	0.66
	Trade balance	0.11	0.05	0.14
Demand shock	Output	0.17	0.20	0.07
	Trade balance	0.22	0.14	0.23

Note: Shaded numbers with positive values imply welfare gains.

Summarizing the previous discussion, the standard deviations in Table 2.3 highlight that fiscal devaluation is a potential policy tool to accelerate real exchange rate adjustment and support external rebalancing, albeit with different effects on stabilizing economic activity, depending on the nature of the shocks.

From a utility-based assessment of household welfare, fiscal devaluation tends to induce welfare losses, whereby LC households, who cannot smooth their consumption over time, are substantially more affected.[7]

Changes in the model structure suggest that the higher the relative size of the tradable sector and the more open the economy, the higher the average welfare losses through fiscal devaluation. This is because higher consumption taxes offset the fall in domestic prices, but increase the prices on import goods. Hence, households suffer more from higher import prices, the higher the openness and the larger the tradable goods sector. Sensitivity checks in case of flexible wages and prices deliver the expected improvements in terms of welfare. In case of flexible wages, substantial welfare gains arise due to an immediate increase in wage claims in response to higher consumption taxes. However, this comes at the expense of destabilizing effects on economic activity, as firms will only face lower labor costs and decrease domestic prices as long as firms are not immediately faced with increasing wage costs.[8] In case of flexible prices, fiscal devaluation increases particularly the welfare of LC households, as the immediate reduction of lower domestic prices increase real wages and, hence, their disposable income for consumption.

Furthermore, the scenario outside a monetary union (FLEX) with nominal exchange rate flexibility and inflation-targeting monetary policy does not automatically dampen external fluctuations[9]; but lower consumption and employment volatilities induce welfare gains for both types of households compared to the monetary union scenario.

[7]The welfare implications are also robust and do not change qualitatively with respect to variations in the compositions of the two household types. However, the welfare results shift more in the direction of the respective household type, which supports the importance of access to financial markets in order to smooth consumption - and enhance welfare - in case of cyclical or fiscal disturbances.

[8]This trade-off highlights that fiscal devaluation is explicitly based on the assumption of rigid wages (de Mooij and Keen, 2012).

[9]For the sake of brevity, we exclude simulation results for the alternative FLEX case outside a monetary union, but present welfare gains for comparison reasions; the focus lies on the effects of fiscal devaluation in the case of a small open economy inside monetary union.

2.6 Conclusion

This chapter uses a two-sector DSGE model of a small open economy within a monetary union with nominal and real rigidities to analyze the potential of fiscal devaluation, specified as budgetary-neutral tax shift from employers' SSC towards consumption tax (VAT), to support real exchange rate adjustment, regain price competitiveness and help stabilizing external fluctuations.

We contribute to the existing literature by (i) modelling fiscal devaluation as an instrument rule that adjusts taxes in response to trade balance fluctuations and (ii) examining the welfare implications of fiscal devaluation in the context of a standard assessment of household welfare. We compare the welfare effects with an economy outside the monetary union with nominal exchange rate flexibility and monetary independence.

The simulations suggest that fiscal devaluation is a potential policy tool to facilitate real exchange rate adjustment by supporting the economies supply side. The subsequent improvement in price competitiveness (terms of trade deterioration) supports external rebalancing in the presence of economy-wide supply and demand shocks. From a utility-based welfare perspective, the associated tax shift from labor towards consumption induces welfare losses for the average household. The overall welfare effects are pro-cyclical in the sense that the stronger the tax shift, the higher the welfare losses for both types of household. Thereby, LC households, who have no access to financial markets and cannot smooth their consumption over time, suffer more from fiscal devaluation with higher welfare losses compared to NLC households.

Our welfare results are robust to changes in the model structure. Depending on the nature of the shock and/or country-specific structures, however, fiscal devaluation can also imply welfare enhancing effects, particularly for NLC households in the event of productivity shocks. In general, welfare losses are higher, the higher the relative size of the tradable goods sector and the more open the economy. This is because higher consumption taxes offset the fall in domestic producer prices, but prices on imported goods increase.

The alternative scenario with nominal exchange rate flexibility and monetary independence shows that monetary devaluation does not automatically dampen external fluctuations. However, lower consumption and employment volatilities induce welfare gains for both types of household compared to the monetary union scenario.

Chapter 3

Sudden Stops in a Currency Union – Some Lessons from the Euro Area

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3.1 Introduction

During the run-up to the European Monetary Union, an open and intense debate on the pros and cons of a common European currency covered numerous issues like sustainability of fiscal policy, no-bail out clause, and (a)symmetry of shocks - however, sudden stops were not among them. Yet, with the advent of the Great Financial Crisis countries with external deficits faced sharp reversals in private capital flows with negative effects on output and employment (e.g. Lane and Milesi-Ferretti, 2011; Merler and Pisani-Ferry, 2012a). The choice of an exchange rate regime with irrevocably fixed exchange rates turned out to be a crucial factor in the adjustment to sudden stops.

With strong preferences for and long tradition of stabilizing exchange rates, two types of fixed exchange rates have been most prevalent in Europe. A number of small open economies, namely the Baltic countries and Bulgaria, have implemented a strict euro peg while other members of the European Union chose to stabilize the exchange rate by joining the euro area.

The task of stabilizing the nominal exchange rate between two currencies can be allocated in different ways between participating countries, giving rise to a great variety of fixed exchange rate regimes. Depending on the specific rules of the game (McKinnon, 1993), such fixed exchange rate regimes imply very different transmission channels with important consequences for the effectiveness of monetary policy and the financing of external deficits (Herz and Roeger, 1992).

The euro peg is an asymmetric fixed exchange rate regime. The central bank operates under a foreign reserve constraint and the adjustment burden in case of external imbalances - positive as well as negative - lies solely with the pegging country. The central bank cannot pursue an autonomous policy as monetary policy is ineffective under open capital markets due to the well-known impossible trinity; an aggregate deficit in the current account and the private financial account has to be balanced by public capital exports, typically in the form of foreign exchange interventions.

In contrast, a currency union can be taken as a symmetric fixed exchange rate regime in which the effectiveness of monetary policy and the financing of external deficits is determined by the specific intervention rules. It is a symmetric regime in the sense that a change in the money supply in one participating country/region is neutralized by an opposite change in other countries/regions leaving the monetary stance in the currency union as a whole unchanged. The specific features of the euro area payment system **T**rans-European **A**utomated **R**eal-time **G**ross Settlement **E**xpress **T**ransfer (TARGET2) are of crucial importance for the rules of the game.

In their seminal analysis of the massive build-up of TARGET2 imbalances during the Great Financial Crisis, Sinn and Wollmershäuser (2012) document how in times of crisis private banks in deficit countries have turned to their central banks for refinancing. Using the printing press to pay for imports of goods and financial assets, the base money supplied in deficit countries was moved to surplus countries via TARGET2 leaving the aggregate money supply in the euro area as a whole unchanged. Deficit countries were de facto debited with TARGET2 liabilities, surplus countries credited with corresponding TARGET2 claims against the Eurosystem. In this process, surplus countries were forced by the workings of TARGET2 to grant an unlimited swap line to deficit countries and to provide quasi-automatic finance of these external deficits.

Following Calvo et al. (2004), who define sudden stops as an abrupt and sizable reversal of capital flows, Lane and Milesi-Ferretti (2011) confirm sudden stops for euro area Member States during the Great Financial Crisis. This view is supported by Merler and Pisani-Ferry (2012a), who find evidence of private capital flows being replaced by public capital in form of TARGET2 imbalances.

An intensive debate developed on the causes and adequate assessments of the dramatic increase in TARGET2 imbalances (e.g. Buiter et al., 2011; Sinn, 2012). This debate was mainly framed within the systems of national accounts, balance of payments as well as monetary financial institution (MFI) balance sheets and clarified the interactions within the euro area between external imbalances, money supply and implied bailout guarantees.[1] In a policy analysis, Gros and Alcidi (2014) find important differences in the economic adjustment to sudden stops inside and outside the euro area, which they relate to differences in the currency regimes. Particularly, they point to the easy access to external finance that euro area members implicitly have via the TARGET2 payments system.

However, a model-based analysis of the macroeconomic effects of TARGET2 is still missing to a large degree. Is euro area membership advantageous as it de facto removes the external constraint to monetary policy and allows a more flexible adjustment to sudden stops? Does the easy access to external finance turn into a disadvantage in the long run as countries might be tempted to delay necessary adjustments, e.g. wage and price adjustments as well as government budget consolidation? And how does the adjustment to sudden stops differ between euro area members and euro peggers, the closest alternative to joining the euro?

Our goal is to analyze how the automatic access to public external finance via the TARGET2 payment mechanism has affected the macroeconomic adjustment of euro area Member States to sudden stops during the Great Financial Crisis. The analytical framework is a small open economy DSGE model (Corsetti et al., 2013, 2017). We account for the policy restrictions implied by fixing the exchange rate and relate sudden stops to a credit constraint analogous to financial frictions in the form of collateral constraints tied to the housing sector (e.g. Iacoviello, 2005; Iacoviello and Neri, 2010; Roeger and in't Veld, 2009).

[1] See Dinger et al. (2014) and Westermann (2014) for an analysis of related common pool problems of the ECB monetary policy.

Analyzing the macroeconomic consequences of sudden stops with an occasionally binding collateral constraint, Mendoza (2010) finds a negative impact on output and consumption amplified by a decline in domestic asset prices. He triggers sudden stops endogenously by productivity and interest rate shocks that cause a binding constraint on foreign debt. We modify this approach and directly relate credit constraints to net borrowings from the foreign economy, in order to focus on the effects of sudden stops on current account dynamics. Based on Mendoza (2010), Fagan and McNelis (2014) analyze TARGET2 financing in a calibrated equilibrium business cycle model. They relate TARGET2 balances to interest rate spreads against Germany as a safe country and find higher incidence of future sudden stops due to TARGET2.

We build on Kraus et al. (2018), who analyze and estimate a small open economy model of Greece, Ireland, and Portugal (GIP) as a group of peripheral euro members for the period 2003-2013, in order to analyze the adjustment process to sudden stops inside the euro area. For a better appraisal of the underlying adjustment processes, we take a group of generic euro peggers (Bulgaria and the Baltic States = BELL) as a quasi counterfactual. Based on the Bayesian impulse response functions, we evaluate the adjustment to sudden stops and the role of TARGET2 in an extended welfare analysis.

We contribute to the existing literature in three dimensions: (i) We explicitly account for the institutional differences between conventional euro peggers and euro area Member States with access to the TARGET2 system. (ii) We use an estimated model for groups of representative countries and analyze how differences in access to external finance affected the macroeconomic adjustment to sudden stops during the Great Financial Crisis. (iii) We supplement our simulation results with a welfare analysis of euro peggers and euro area Member States that have access to TARGET2. We focus on the role of TARGET2 for capital flight during the debt and banking crisis, leaving aside other important aspects to subsequent research, e.g. the possible risk of debtor countries leaving the Monetary Union. As we focus on the adjustment processes within small deficit countries, the repercussions for surplus countries are also deferred to future work.

We find that - in the short run - TARGET2 helped euro area deficit countries to stabilize output, consumption, and investment. This could lead to higher per period utility for households that benefit from access to the TARGET2 system relative to euro peggers without access to TARGET2 financing. In the long run, however, euro area countries experienced a prolonged economic recovery and accumulated large public debt resulting in higher welfare losses relative to euro peggers.

The remainder of this chapter proceeds as follows. Section 3.2 describes the theoretical model and Section 3.3 explains the estimated and calibrated parameters. To illustrate the effects of a binding collateral constraint, Section 3.4 presents simulation results for a number of shocks with negative effects on net foreign asset (NFA). Section 3.5 supports the findings with a welfare decomposition, and Section 3.6 addresses some policy implications of our analysis.

3.2 The Model

The small open economy model within EMU is based on Hohberger et al. (2014). It consists of two sectors (tradable and non-tradable), two input factors, and includes nominal as well as real frictions. Households are differentiated into liquidity constrained (LC) households which do not have access to financial markets but consume their entire current disposable wage in each period and Ricardian (NLC) households that have full access to financial markets and are able to smooth consumption over time. NLC households are credit constrained if subject to a sudden stop.

We analyze how the effects of a sudden stop differ between countries with and without public capital financing in form of TARGET2. Reversals in capital flows are induced by a credit constraint on the NFA positions of NLC households analogous to Roeger and in't Veld (2009) that restricts private foreign indebtedness when the premium on households' borrowings from abroad increases. We compare the effects of the binding credit constraint (BELL) with the case of euro insiders (GIP) where public capital flows substitute private capital flows via the TARGET system.

Following Schmitt-Grohé and Uribe (2003), we use a debt dependent country risk premium on foreign asset holdings as external closure. It allows for introducing risk premium shocks that directly affect nominal interest rate differentials and serves as a way to mimic demand booms by lowering borrowing costs. Goods markets are imperfectly integrated across borders with a home bias in the demand for goods. Labor is immobile between countries. Monetary policy is exogenously given from the perspective of the small economy. For the sake of brevity, this section only displays the main equations of the model setting. The detailed description of the baseline model can be found in Hohberger et al. (2014). Figure 3.1 summarizes the model structure[2].

Financial frictions

NLC households maximize their utility given the budget constraint and the credit constraint. The credit constraint $(1-\chi)$ relates domestic NFA positions to households investment decisions:

$$\psi_c \left[B_H^* + \mathit{TARGET2} - (1 - \chi + \epsilon_t^\chi) P_t^C I_t \right] = 0 \tag{3.1}$$

Equation (3.1) restricts the domestic economy when refinancing on international capital markets via the Lagrange multiplier ψ_c. The basic mechanism is the following: A shock that creates a negative NFA position tightens the credit constraint and the Lagrange multiplier ψ_c acts like a premium on the interest rate that forces down foreign indebtedness and thus domestic investment and consumption (see Roeger and in't Veld

[2]Figure 3.1 highlights the extensions of the baseline model and changes in model structure compared to Chapter 2, i.e. credit constrained households and central bank policy.

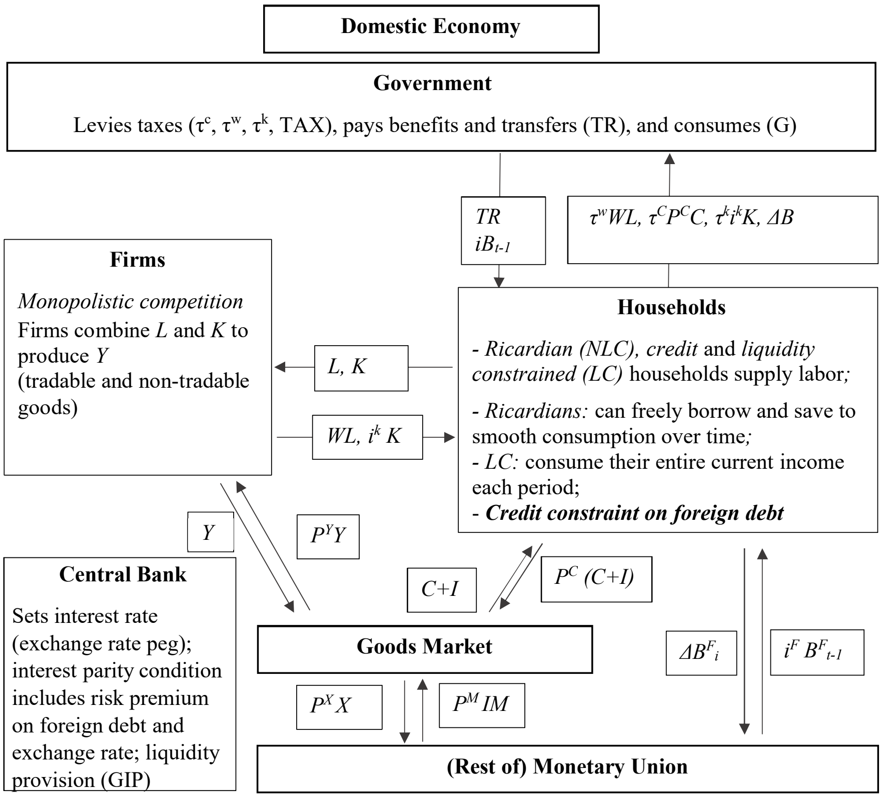

Figure 3.1 Model structure

(2009) for an application in the real estate sector). Thus, when the shadow price, the Lagrange multiplier ψ_c, equals zero, the credit constraint is not binding.

In the special case of euro insiders, a reversal of private capital inflows is (partly) compensated by an increase in TARGET2 when the credit constraint binds. These TARGET2 liabilities allow for larger negative NFA positions and are captured in the estimation by the (negative) TARGET2 data of the respective countries.

From the benchmark case without binding credit constraint ($\psi_c = 0$), we determine the NFA position without financial friction ($NFA_{Benchmark}$) and compare it to the NFA position under a binding credit constraint (NFA_{BELL}) to determine the shortfall of external finance created by the sudden stop. In the limiting case of a smoothly working TARGET2 system ($\zeta_{T2} = -1$), this lack of private capital inflows would be completely substituted by public external finance:

$$TARGET2 = \zeta_{T2}\left(B^*_{H,Benchmark} - B^*_{H,BELL}\right) \tag{3.2}$$

The estimation results from Kraus et al. (2018) indicate that in practice the TARGET2 system indeed comes very closely to this limiting case. *TARGET2* liabilities add to foreign debts and drive the country-specific risk premium ω on interest rates as in Equation (3.6).

Households

The household sector consists of a continuum of households i. The welfare of household i is the discounted sum of the period utilities:

$$U = E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{\epsilon^c_t}{1-\sigma}(C^i_t)^{1-\sigma} - \frac{\kappa}{1+\varphi}(L^i_t)^{1+\varphi} \right) \tag{3.3}$$

For NLC households, who are a fraction $(1 - slc)$ of the population, the intertemporal budget constraint is given by:

$$\begin{aligned} &(1-\tau^w_t)W^i_t L^i_t + (1+i_{t-1})B_{t-1} + (1+i^*_{t-1} - \omega\frac{B^*_{H,t-1}}{4P^Y_{t-1}Y_{t-1}} + \epsilon^r_t)B^*_{t-1} + \\ &TR_t + (1-\tau^k_t)i^k_t K^i_{t-1} + \tau^k_t \gamma P^C_t K^i_{t-1} + PR_t \\ =\, &(1+\tau^C_t)P^C_t C^{NLC}_t + P^C_t I^i_t + B_t + B^*_{H,t} + \gamma_w/2(\pi^{w,i}_t)^2 P^C_t L_t + TAX_t. \end{aligned} \tag{3.4}$$

The revenue side includes net nominal wage income $(1-\tau^w_t)W^i_t$ adjusted by labor tax and social contribution costs, the payment on maturing one-period domestic government bonds B_{t-1} including interest i_{t-1}, the repayment of one-period net foreign assets $B^*_{H,t-1}$ including interest i^*_{t-1} and the endogenous part of the country risk premium $-\omega\frac{B^*_{H,t-1}}{4P^Y_{t-1}Y_{t-1}}$ and the exogenous component ϵ^r_t, lump-sum transfers from the government

TR_t, the return to capital $(1-\tau_t^k)i_t^k K_{t-1}^i$ net of capital taxes, depreciation allowances, and profit income from firm ownership PR_t. The expenditure side combines nominal consumption including taxes $P_t^C C_t^{NLC}$, nominal investment in the tradable and non-tradable sector $P_t^C I_t^i$, financial investment in domestic bonds and net foreign assets, quadratic adjustment costs γ_w for wages ($\pi_t^{w,i} = W_t^i/W_{t-1}^i - 1$), and the non-distortionary lump-sum tax TAX_t.

Both the budget constraint and the credit constraint are present in the consumption decision of NLC households.

The optimal consumption path for NLC households is given by:

$$\beta E_t\left(\frac{1+\tau_t^C}{1+\tau_{t+1}^C}\frac{P_t^C}{P_{t+1}^C}\left(\frac{C_t^{NLC}}{C_{t+1}^{NLC}}\right)^{\sigma}\epsilon^c\right) = \frac{1-\psi_c}{1+i_t} \tag{3.5}$$

where ψ_c is the Lagrange multiplier on the credit constraint for NFA positions (Equation 3.1) and correlates positively with a tightening constraint.

The interest parity condition

$$i_t = i_t^* - \omega\frac{B_{H,t-1}^*}{4P_{t-1}^Y Y_{t-1}} + \epsilon_t^r \tag{3.6}$$

includes the country risk premium with $\omega > 0$ and ϵ_t^r as an exogenous AR(1) risk premium shock.

Household utility is additive in consumption C_t^i and work L_t^i. As utility has a constant risk aversion σ, the elasticity of intertemporal substitution is given by $1/\sigma$, κ specifies the weight on the disutility of work, and $1/\varphi$ stands for the elasticity of labor supply.

LC households account for the share *slc* of population. Their period budget constraint is:

$$(1-\tau_t^w)W_t^i L_t^i + TR_t^{LC} = (1+\tau_{t+1}^C)P_t^C C_t^{LC} + \gamma_w/2(\pi_t^{w,i})^2 P_t^C L_t^{LC} \tag{3.7}$$

The weighted average of NLC and LC households' consumption gives the per-capita level of aggregate consumption:

$$C \equiv (1 - slc)C_t^{NLC} + slcC_t^{LC} \tag{3.8}$$

Private demand for goods Z_t is a aggregate of tradable ($Z^i_{T,t}$) and non-tradable ($Z^i_{NT,t}$) goods. Assuming the same price elasticity for consumption and investment demand, we can combine domestically produced tradables ($C^i_{TH,t}, I^i_{TH,t}$), non-tradables ($C^i_{NT,t}, I^i_{NT,t}$) and imported goods ($C^i_{TF,t}, I^i_{TF,t}$) to $Z_t \in (C_t^{NLC}, C_t^{LC}, I_t)$.

$$Z_t = [(\phi)^{\frac{1}{\nu}}(Z_{T,t})^{\frac{\nu-1}{\nu}} + (1-\phi)^{\frac{1}{\nu}}(Z_{NT,t})^{\frac{\nu-1}{\nu}}]^{\frac{\nu}{\nu-1}} \tag{3.9}$$

with ϕ and ν as the share of tradable goods and the elasticity of substitution between tradable and non-tradable goods. $Z_{T,t}$ is a composite index of domestically produced $Z_{TH,t}$ and imported goods $Z_{TF,t}$:

$$Z_{T,t} = [(h)^{\frac{1}{\eta}}(Z_{TH,t})^{\frac{\eta-1}{\eta}} + (1-h)^{\frac{1}{\eta}}(Z_{TF,t})^{\frac{\eta-1}{\eta}}]^{\frac{\eta-1}{\eta}} \tag{3.10}$$

where h represents the steady state home bias and η indicates the elasticity of substitution between domestically produced goods and imports.

The domestic producer price index (P_t^C) is given by:

$$P_t^C = [(\phi)(P_{T,t})^{1-\nu} + (1-\phi)(P_{NT,t})^{1-\nu}]^{\frac{1}{1-\nu}} \tag{3.11}$$

where the domestic country price index for tradable goods is:

$$P_{T,t} = [(h)(P_{TH,t})^{1-\eta} + (1-h)(P_{TF,t})^{1-\eta}]^{\frac{1}{1-\eta}} \tag{3.12}$$

Households supply labor services to both tradable and non-tradable goods sectors. The labor services are distributed equally across NLC and LC households, and specialized labor unions represent the different types of labor services i in the wage setting. The wage setting is subject to quadratic adjustment costs, which provide an incentive to smooth the wage adjustment. Since we assume identical wages W_t^i for both sectors, the optimization problem of the labor union representing the labor service i is:

$$E_0 \sum_{t=0}^{\infty} \beta_t \big(-\frac{\kappa}{1+\varphi}(L_t^i)^{1+\varphi} + \lambda_t^i (1-\tau_t^w)\frac{W_t^i}{P_t^C} L_t^i - \lambda_t^i \frac{\gamma_w}{2}(\pi_t^{w,i})^2 \frac{P_{TH,t}}{P_t^C} L_t\big) \tag{3.13}$$

Firms

The economy consists of a continuum of monopolistically competitive firms in the tradable and non-tradable sector. Firms are owned by NLC households which receive the profits. Each firm j produces a differentiated good $Y_{s,t}^j$ with capital $K_{s,t-1}^j$, labor $L_{s,t}^j$ and a Cobb-Douglas production technology in each sector s:

$$Y_{s,t}^j = A_{s,t}(K_{s,t-1}^j)^{\alpha}(L_{s,t}^j)^{1-\alpha} + \epsilon_t^a \tag{3.14}$$

The sector-specific total factor productivity $A_{s,t}$ is identical across firms and follows an AR(1) process. The cost-minimal combination of capital and labour implies for the nominal marginal costs $MC_{s,t}^j$ of the optimizing firm:

$$MC_{s,t}^j = \frac{(i_t^k)^{\alpha} W_t^{1-\alpha}}{A_{s,t}\alpha^{\alpha}(1-\alpha)^{1-\alpha}} \tag{3.15}$$

The firms in each sector s face quadratic price adjustment costs γ_p and prices $P_{s,t}^j$ to maximize the discounted expected profit. For each sector, firms profit maximization has the following form:

$$E_0 \sum_{t=0}^{\infty} \beta_t \frac{\lambda_t^{NLC}}{\lambda_0^{NLC}} \big(\frac{P_{s,t}^j}{P_{s,t}} Y_{s,t}^j - \frac{W_{s,t}^j}{P_{s,t}} L_{s,t}^j - \frac{\gamma_p}{2}(\pi_{s,t}^{p,j})^2 Y_{s,t}\big) \tag{3.16}$$

The nominal GDP is the sum of domestically produced tradable and non-tradable output:

$$P_t^Y Y_t = P_{TH,t} Y_{T,t} + P_{NT,t} Y_{NT,t} \tag{3.17}$$

Government

The government collects labor, capital, consumption and lump-sum taxes, levied only on NLC households, as well as social security contribution (SSC) for employers and employees and issues one-period bonds to finance government purchases, transfers and the servicing of outstanding debt:

$$\begin{aligned} &(\tau_t^w) W_t L_t + \tau_t^k (i_t^k - \gamma) K_{t-1} + \tau_t^c P_t^C C_t + (1 - slc) TAX_t + B_t \\ &= P_t^G G_t + TR_t + (1 + i_{t-1}) B_{t-1} \end{aligned} \tag{3.18}$$

Expenditure on total government purchases is the sum of expenditure on tradable and non-tradable goods analogously to private demand:

$$P_t^G G_t = P_t^T G_{T,t} + P_t^{NT} G_{Nt,t} \tag{3.19}$$

Steady state government consumption is given by:

$$\frac{G_t}{Y_t} = \rho_G \frac{G_{t-1}}{Y_{t-1}} \frac{Y_{t-1}}{Y_t} + (1 - \rho_G)(\frac{\bar{G}}{Y}) + \epsilon^g \tag{3.20}$$

The central bank sets interest rates according to the simple rule:

$$i_t = \rho_i i_{t-1} + (1 - \rho_i)(1 - \beta)/\beta + (1 - \rho_i)\xi_\pi(\frac{P_t^C}{P_{t-1}^C}) \tag{3.21}$$

External account

The total demand for domestic output is the sum of final domestic demand, net exports and the wage/price adjustment costs ADC_t:

$$P_t^Y Y_t = P_t^C(C_t + I_t) + P_t^G G_t + P_t^{TH} X_t - P_{TF,t} M_t + ADC_t \tag{3.22}$$

Exports X_t correspond to the import demand of the rest of the Monetary Union:

$$X_t = (1-h)(P_{TH,t}/P^*_{TH,t})^{-\eta} Y_t^* \tag{3.23}$$

where h is the degree of home bias. We exclude price discrimination between countries, i.e. the law of one price holds. The aggregate resource constraint of the domestic economy, which is also the law of motion for NFA positions, is given by:

$$B^*_{H,t} = (1 + i_{t-1})B^*_{H,t-1} + P_t^Y Y_t - P_t^C(C_t + I_t) - P_t^G G_t - P_t^Y ADC_t \tag{3.24}$$

The current account equals the change in NFA positions:

$$CA_t = B^*_{H,t} - B^*_{H,t-1} \tag{3.25}$$

3.3 Calibration and Parameter Estimates

For our choice of parameter values, we build on Kraus et al. (2018). Following Schorfheide (2000) and Schorfheide and Lubik (2003) they apply a two-step estimation procedure involving calibration and Bayesian techniques in order to estimate a small open economy with financial frictions with quarterly data for GIP including real GDP and consumption, hours worked, investment, CPI inflation, long-term interest rates, real exchange rates, government expenditure and current account. Public capital flows in form of TARGET2 data replace private capital flows when the credit constraint binds.

Several shocks are added to the model, namely domestic and foreign TFP, domestic and foreign risk premium, credit constraint, consumption, government spending, price and wage markup shocks[3] in order to evaluate how access to TARGET2 financing contributed to movements in key variables like output, consumption and current account[4].

Calibrated parameter values for the discount factor, steady state ratios of the model, such as consumption, investment and government spending shares are on the basis of national accounts data for the euro area members, the share of LC households, the capital share, and tax rates. The target government debt-to-GPD ratio is set to 74%. The budget closure implies that a 1 percentage point increase in government debt-to-GDP ratio increases taxes or decreases transfers by 0.001 percentage points. The average tax rate on consumption (VAT rate) and capital income is 19.7% and 30% (OECD Tax Database), respectively. The average labor income tax burden for the given period is 29% of total earnings. The estimates for the share of LC households in the euro area clusters around 40% in the literature (e.g. Ratto et al., 2009) and is set to $slc = 0.4$, accordingly.

Table 3.1 lists the main estimated and calibrated parameters for GIP. The detailed description of the estimation results for two groups of countries, namely BELL and GIP, can be found in Kraus et al. (2018).

[3]Shocks follow an AR(1) process and are listed in Appendix 3.7.3.

[4]The period 2003Q1 to 2013Q4 was chosen as it covers the sudden stop and the adjustment processes after the financial and sovereign debt crisis while avoiding possible disturbing effects in later periods when the Baltic countries joined the euro area and Quantitative Easing set in.

Table 3.1 Calibrated parameters and steady state ratios

Parameter	symbol	value
β	discount factor	0.995
$*C/Y$	Consumption relative to GDP	0.6
$*G/Y$	Government spending relative to GDP	0.2
$*I/Y$	Investment relative to GDP	0.2
$*T/Y$	Tradable goods share relative to GDP	0.6
$*TR/Y$	General transfers relative to GDP	0.12
$*slc$	Share of LC households	0.4
ω	Country risk premium	0.0048
σ	Inverse of intertemp. elast. of subst.	1.4828
η	Trade elast. between home/foreign	2.2837
ν	Elasticity of substitution T/NT	0.3924
ϵ	Elasticity of goods varieties j	4.9166
h	Degree of home bias	0.1795
$1-\chi$	Credit constraint	0.1087
ζ_{T2}	TARGET2 parameter	0.9345
κ	Weight of labor dis-utility	0.9268
φ	Inverse of elasticity of labor supply	6.9197
ϕ	Share of tradable goods in consumption	0.6688
$*\alpha$	Cobb-Douglas parameter (capital share)	0.4
γ_w	Wage adjustment costs	73.87
γ_p	Price adjustment costs	39.38
$*\gamma_c$	Capital adjustment costs	30
$*btar$	Debt-to-GDP ratio	0.74
$*\xi_b$	Fiscal reaction to debt	0.001
$*\rho_G$	Persistence of fiscal instrument	0.5
$*\rho_i$	Persistence of monetary instrument	0.5
$*\xi_i$	Monetary coefficient on inflation	1.5
$*\tau^c$	Consumption tax rate	0.197
$*\tau^w$	labor income tax rate (incl. social security contribution)	0.29
$*\tau^k$	Capital tax rate	0.30
ρ_a	Persistence of TFP shock	0.8652
ρ_c	Persistence of consumption shock	0.7488
ρ_{rp}	Persistence of risk premium	0.9633
ρ_χ	Persistence credit constraint	0.9036
ρ_g	Persistence of government spending	0.7181
ρ_{afor}	Persistence of TFP shock foreign	0.8652
ρ_{rpfor}	Persistence of risk premium foreign	0.6973
ρ_{γ_w}	Persistence wage markup	0.7138
ρ_{γ_p}	Persistence price markup	0.7740
σ_a	Std dev TFP	0.0070
σ_{rp}	Std dev risk premium	0.0185
σ_χ	Std dev credit constraint	0.1637
σ_g	Std dev gov spending	0.0095
σ_{rpfor}	Std dev risk premium foreign	0.0234
σ_{afor}	Std dev TFP foreign	0.0170
σ_c	Std dev consumption	0.0278
σ_w	Std dev wage markup	0.0688
σ_p	Std dev price markup	0.0241

Note: The asterisked parameters and steady state ratios are calibrated based on national accounts data or literature; the remaining parameters are estimated with quarterly data for GIP; see Kraus et al. (2018), Eurostat database of the European Commission and Appendices 3.7.2 - 3.7.4.

3.4 Policy Experiment

Figures 3.2 - 3.3 depict the dynamic responses of alternative shocks that emerge as the most important drivers of key variables in the shock decomposition and illustrate the basic mechanisms with a focus on sudden stops of private capital inflows.

The IRFs for the estimated model include a negative total factor productivity (TFP) shock, a negative risk premium shock, and a positive (binding) credit constraint shock. Further shocks are discussed in Appendix 3.7.1, including a negative (relaxing) credit constraint shock (Figure 3.8), positive consumption preference (Figure 3.9) and government spending shocks (Figure 3.10) as well as price (Figure 3.11) and wage (Figure 3.12) markup shocks. For each shock, we differentiate three cases,

I. a small open economy without financial frictions as a benchmark

II. two small open economies under financial frictions (Equation 3.1), namely

   (a) a country (e.g. BELL) with no access to public external finance,

   (b) an euro area Member State (GIP) with access to public external finance via *TARGET2*.

Shocks like the negative TFP shock that are associated with a current account deficit obviously imply a concomitant deterioration in the NFA position. In the benchmark case of no financial frictions (I) the constraint on foreign borrowings is not binding and the respective Lagrange multiplier ψ_c is zero (Figure 3.2). Two modification have been made to account for financial frictions and the specific institutional framework of euro and non-euro countries. Under financial frictions and no access to public external finance, i.e. the case of the BELL group (II.a), the negative NFA position causes a binding of the collateral constraint and private capital outflows as NLC consumers invest in foreign instead of domestic bonds. As TARGET2 financing is not available to these euro outsiders, the reaction of the variable *TARGET2* to a binding credit constraint is set to zero. ψ_c becomes positive and acts like a premium on interest rates. In the case of the euro members GIP, (II.b) countries under financial stress due to capital outflows have access to public external finance, and thus we allow for a reaction in TARGET2. However, these additional TARGET2 liabilities in turn cause the risk premium on foreign debt to increase.

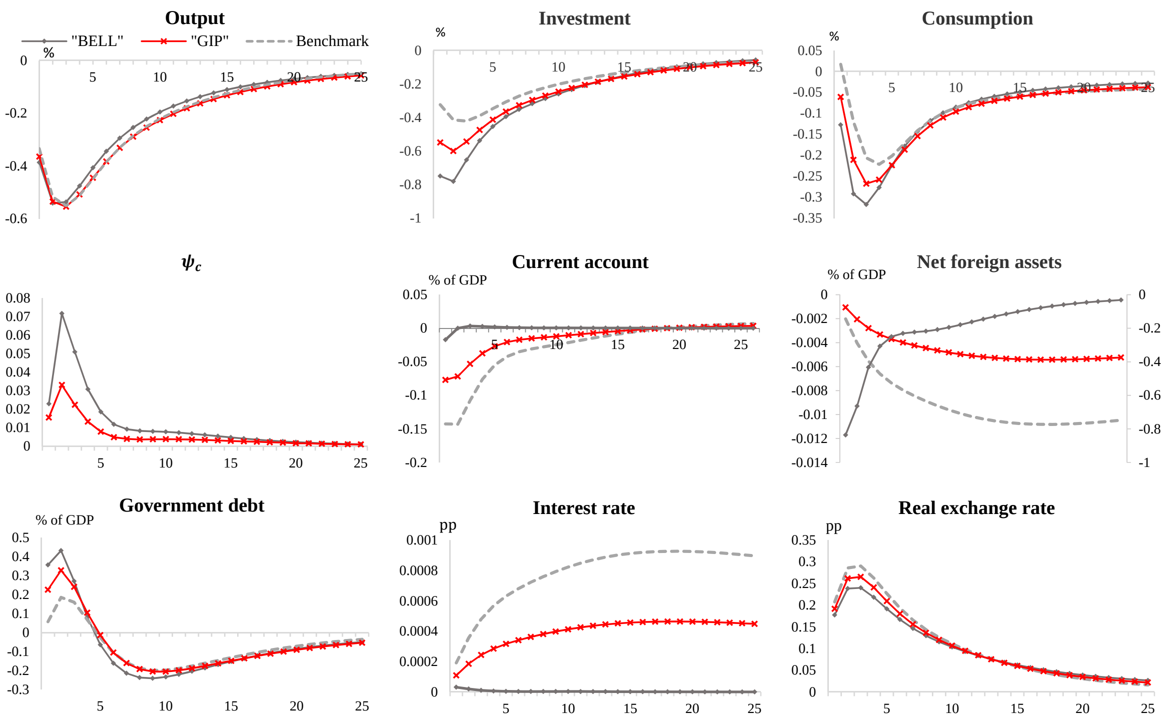

Figure 3.2 Sudden stop in response to a negative TFP shock

Note: Net foreign asset for 'BELL' on the LHS, for 'GIP' and 'Benchmark' case on the RHS.

Negative total factor productivity shock

Figure 3.2 illustrates the effects of a temporary 0.7 percentage point **decline in TFP** relative to the rest of EMU.

In the benchmark case, price stickiness draws out the increase in domestic prices and the decrease in real interest rates with a (negatively) hump-shaped reaction of output, consumption and investment. The real appreciation leads to a negative current account over the medium term and a concomitant deterioration of the NFA position. The drop of investment under financial frictions causes the collateral constraint to bind as indicated by the increasing Lagrange multiplier (premium) ψ_c (see Equation 3.1), which restricts the NFA position.

In the case of non-euro members, the financing of domestic demand through private capital inflows dries up, further aggravating the fall in consumption and investment relative to the benchmark case. The drop in consumption and investment with its contemporaneous drop in tax revenues causes an increase of government debt that quickly levels off due to lower interest rate risk premia on the lower level of foreign debt.

In contrast, euro area Member States have access to TARGET2 and the inflow of public capital substitutes for the net outflow of private capital - the negative effects of the sudden stop are mitigated by public intervention. The associated increase in government debt is initially smaller due to the smaller loss in tax revenues but also more extended over time, as the weaker foreign debt position implies higher interest rate payments on sovereign bonds. Similar adjustments hold for consumption: households experience a sharper drop in consumption in the BELL case, but the recovery process evolves more quickly due to the lower interest burden.

These differences in the adjustment process of GIP relative to the BELL case become more apparent, the longer the shock process lasts and the higher the risk premium on foreign debt ω is.

Negative risk premium shock

Figure 3.3 depicts the macroeconomic adjustments to a demand boom caused by a 2.3 percentage point **decrease in country risk premium**.

In the benchmark case, the negative shock reduces borrowing rates. Real interest rates are even lower as inflation is drawn out due to nominal rigidities. The current account and the NFA position deteriorate with a concomitant real appreciation. Lower

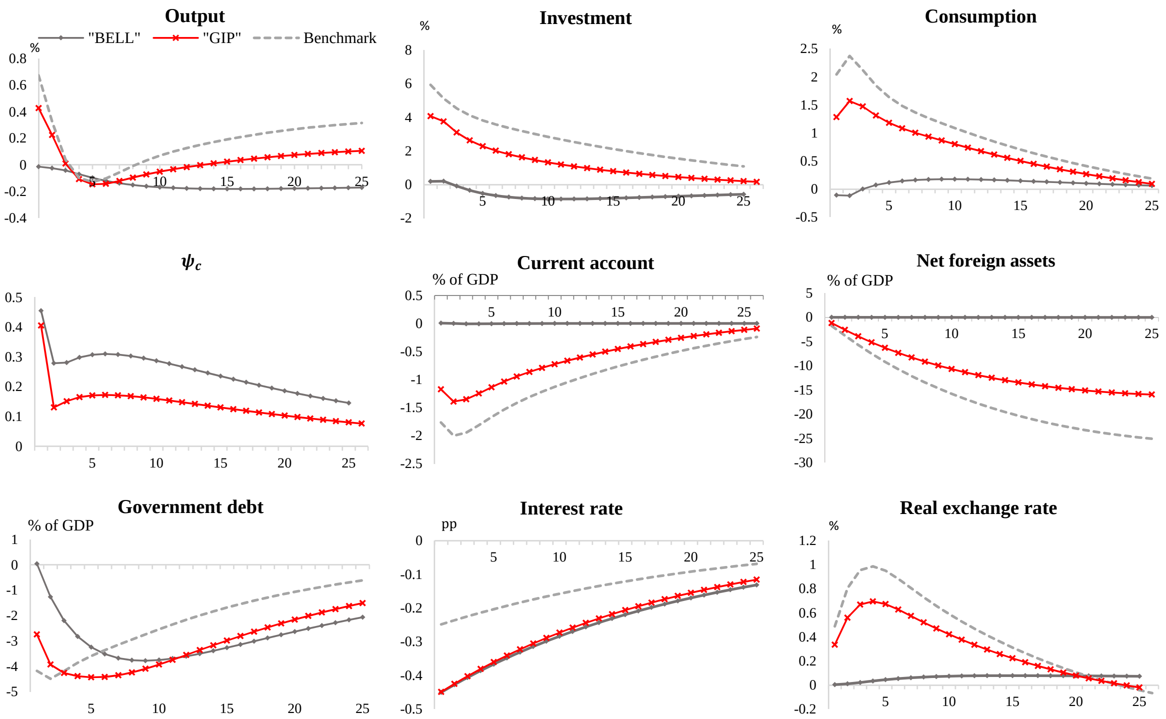

Figure 3.3 Sudden stop in response to a negative risk premium shock

government borrowing costs and higher tax revenues reduce the government debt burden.

Under financial frictions, the credit constraint limits the deterioration of the NFA positions, and thus mitigates the subsequent need for macroeconomic adjustments. The effects on current account and the NFA are neutralized in the BELL case, while additional public capital flows cause a deterioration of the NFA position (GIP case) and allow for higher output and consumption levels as described in the benchmark case.

Positive credit constraint shock

A **positive credit constraint shock** of 1.5 percentage points (Figure 3.4) tightens the credit constraint on foreign borrowings (starting from a balanced current account). Output, consumption and investment decrease, while government debt increases. Initially, the real exchange rate depreciates and the current account increases due to higher

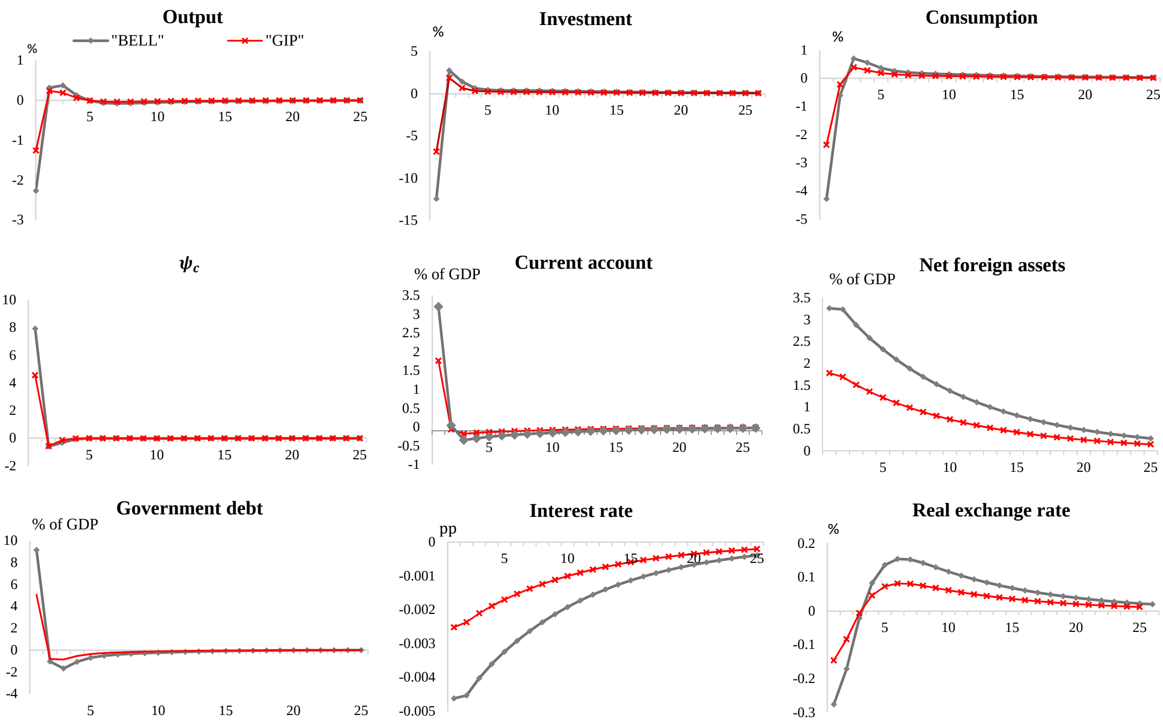

Figure 3.4 Sudden stop in response to a credit constraint shock

net foreign asset positions (BELL case). Additional public capital flows in GIP allow NFA positions to deteriorate and lead to a decrease in current account.

3.5 Utility and Welfare

In our welfare analysis, we apply a second-order Taylor expansion of the household utility function around a deterministic steady state (see e.g. Hohberger and Kraus, 2016). This second-order Taylor approximation of the discounted period utilities in terms of log-deviation yields:

$$W(\zeta_{T2}) \approx \sum_{t=0}^{\infty} \beta^t \left[\frac{(\bar{c}^i)^{1-\sigma}}{1-\sigma} - \frac{\kappa(\bar{l})^{1+\varphi}}{1+\varphi} + (\bar{c}^i)^{-\sigma} E(\hat{c}_t^i) - \kappa(\bar{l})^{\varphi} E(\hat{l}_t) \right.$$
$$\left. - \frac{\sigma(\bar{c}^i)^{-1-\sigma}}{2} Var(\hat{c}_t^i) - \frac{\kappa\varphi\bar{l}^{-1+\varphi}}{2} Var(\hat{l}_t) \right] \tag{3.26}$$

In a second step, we distinguish between the composits Φ_{mean} for unconditional mean effects and Φ_{var} for unconditional volatility effects of the two factors consumption and leisure in the welfare function (Bergin et al., 2007):

$$\Phi_{mean} = (\bar{c}^i)^{-\sigma} E(\hat{c}_t^i) - \kappa(\bar{l})^{\varphi} E(\hat{l}_t)$$
$$\Phi_{var} = -\frac{\sigma(\bar{c}^i)^{-1-\sigma}}{2} Var(\hat{c}_t^i) - \frac{\kappa\varphi\bar{l}^{-1+\varphi}}{2} Var(\hat{l}_t)$$

where $\bar{c}$ and $\bar{l}$ denote the steady state level and $\hat{c}$ and $\hat{l}$ the log-deviation from steady state.

We measure the cost of policy intervention via TARGET2 with a second-order approximation of a value function for aggregate welfare $W(\zeta_{T2})$ and define $CC(\zeta_{T2} < 0)$ as a cardinal number of the cost of a sudden stop with additional public capital flows. The cost of public external finance via the TARGET2 system relative to non-stabilization CC($\zeta_{T2} < 0$) is measured analogous to Canzoneri et al. (2007) in percent of steady state consumption, and is given - expressed in negative values - by:

$$CC(\zeta_{T2} < 0) = 100 * \{1 - (1 - \beta)\left[W(\zeta_{T2} < 0) - W(\zeta_{T2} = 0)\right]\} \tag{3.27}$$

Following Bergin et al. (2007), Equation (3.27) refers to conditional welfare as it captures the discounted sum of expected future utilities and takes into account expectation dynamics after the sudden stop and the implementation of TARGET2 financing.

Conditional welfare gains and losses are measured relative to non-stabilization ($\zeta_{T2} = 0$) and are expressed in percent of steady state consumption of NLC and LC households. We run simulations for policy parameter values ζ_{T2} over the interval $[-1; 0]$ while the remaining parameters are given in Section 3.3 in order to provide information on the robustness of welfare effects.

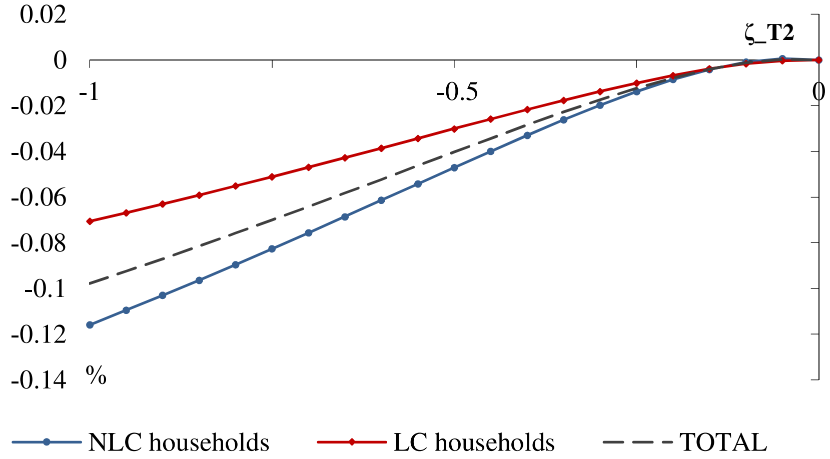

Figure 3.5 Welfare effects for combined supply and demand shocks

Note: Welfare is measured relative to non-stabilization and expressed in % of steady state consumption.

Figure 3.5 simulates the effects for combined negative productivity and demand shocks as discussed in Section 3.4. Given the parameter value of $\zeta_{T2} = -0.9$ (as used in Section 3.3), public capital flows in form of TARGET2 transfers imply welfare losses of around 0.9% of steady state consumption for average households. Welfare analysis suggests that the higher the TARGET2 transfers, the higher the welfare losses for NLC and LC households. Additionally, NLC households, who are able to smooth consumption over time, bear considerably higher welfare losses than LC households, as the policy of TARGET2 financing dampens their incentive to accumulate wealth. The results are in line with findings for fiscal policy interventions by e.g. Vogel et al. (2013): LC households benefit more than NLC households from the stabilizing effects of TARGET2 on temporary income fluctuations.

Table 3.2 provides deeper insights into determinants of welfare losses in a TARGET2 setting relative to a non-TARGET2 regime by decomposing changes in the mean levels of uncertain consumption and leisure versus the uncertain variance of changes of these variables.

For combined supply and demand shocks, the mean consumption effects are the main driver behind welfare losses, making up around 90% of the overall welfare losses, while positive mean leisure effects have only marginal influence on total welfare. Variance effects in form of income fluctuations after a sudden stop, which are more present without TARGET2 financing ($\zeta_{T2} = 0$), have less influence on total welfare than the negative mean effects via TARGET2 financing ($\zeta_{T2} < 0$) due to 'overconsumption'. TARGET2 flows that allow for negative NFA positions and overconsumption when the credit constraint binds lead to lower steady state as well as mean consumption levels and higher foreign indebtedness in the long run. Consequently, higher foreign indebtedness in the long run increases the probability of future sudden stops.

In contrast, a direct restrictive shock to the credit constraint improves welfare in the case of TARGET2 financing relative to non-stabilization. With a tightening shock to the credit constraint, consumption decreases leading to a build-up of net foreign asset position, thereby distortioning savings-consumption decisions by the households. In the case of a direct shock to the credit constraint, TARGET2 financing accelerates the stabilization in consumption while reducing precautionary savings in net foreign assets.

The findings point to a long run versus short run trade-off, as supply and demand shocks imply welfare losses of TARGET2 financing that mainly result from overconsumption and foreign indebtedness, and thus a socially suboptimal solution. In contrast, shocks that are directly linked to a tightening of the credit constraint reduce interest rate distortions and stabilize consumption and NFA positions.

Table 3.2 Welfare decomposition

		Supply and Demand			Credit Constraint		
Effect		NLC	LC	**Avg**	NLC	LC	**Avg**
Φ_{mean}	overall	-0.32	-0.25	**-0.29**	0.14	0.04	**0.2**
	C	-0.39	-0.32		0.38	0.10	
	L	0.07	0.07		-0.07	-0.07	
Φ_{var}	overall	-0.01	-0.02	**-0.02**	0.16	0.19	**0.17**
	C	-0.003	-0.01		0.005	0.04	
	L	-0.007	-0.007		0.15	0.15	

Note: Decomposition refers to mean level and volatility of consumption and leisure for the policy parameter $\zeta_{T2} = -0.9$ relative to non-stabilization.

Sensitivity of welfare results

In order to analyze the robustness of our welfare implications, we provide sensitivity tests on a number of model parameters with respect to estimation results for BELL countries in Kraus et al. (2018), which indicate different parameter values e.g. for the intertemporal elasticity of substitution, the country risk premium, as well as the share of tradable and the elasticity between tradable and non-tradable goods.

We examine conditional welfare effects for (a) a decrease in the intertemporal elasticity of substitution (higher σ value) from $\sigma = 1.5$ to $\sigma = 2$, (b) a decrease in the country risk premium from $\omega = 0.005$ to $\omega = 0.004$, (c) a decrease in the trade elasticity between home and foreign from $\eta = 2.3$ to $\eta = 1.6$, and (d) an increase in the relative size of the tradables to non-tradables sectors from $\phi = 0.67$ in the baseline scenario to $\phi = 0.8$. Additionally, we present a negative shock to the credit constraint.

Panel a) in Figure 3.6 depicts a switch in welfare losses for NLC and LC households with higher values of σ. Thus, welfare losses for NLC households decrease with lower intertemporal elasticity of substitution, the incentive to smooth consumption in response to changes in the interest rate.

Lower values of the country risk premium in Panel b) suggest about the same welfare results for the reference parameter $\zeta_{T2} = -0.9$ as in the baseline scenario in Figure 3.5. However, the lower the TARGET2 stabilization (ζ_{T2} close to zero), the higher the welfare gains of NLC households relative to LC households, as low values of country risk premium outweighs the level of foreign indebtedness via TARGET2 financing.

As Gros and Alcidi (2014) and Kraus et al. (2018) point out, BELL countries are characterized by a large share of tradable goods in consumption together with a low trade elasticity between home and foreign. Furthermore, Imbs and Mejean (2010) highlight the influence of trade elasticities on the transmission mechanism from international prices to real variables. TARGET2 financing reduces the price of tradable versus

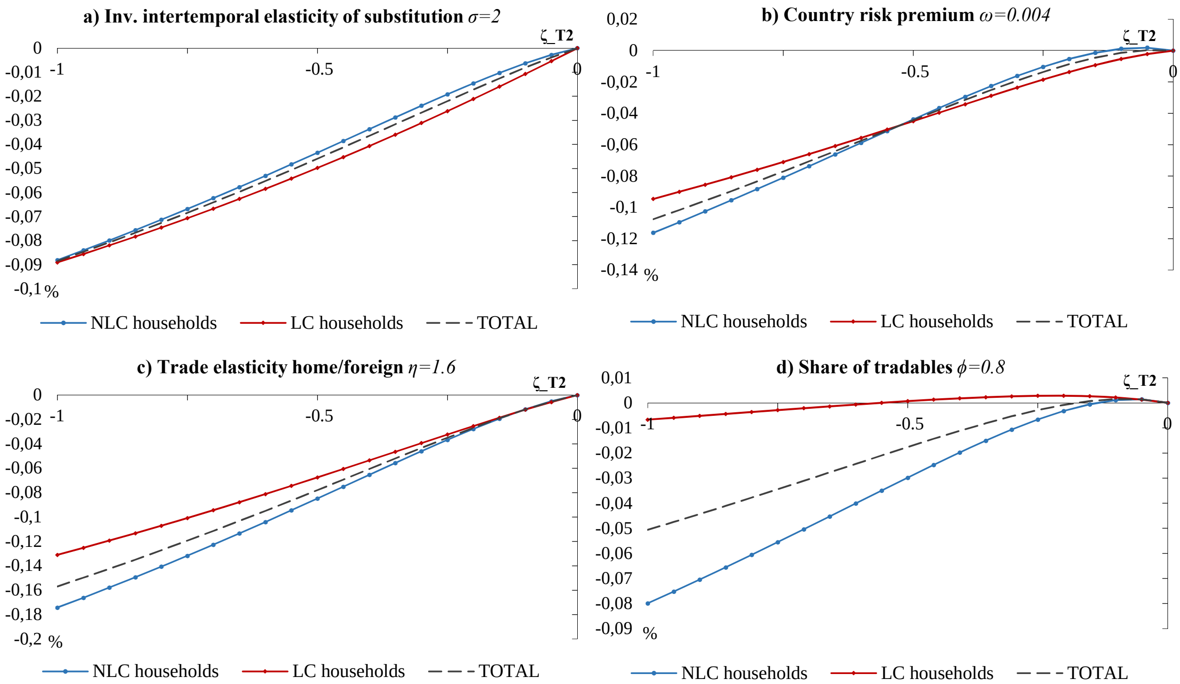

Figure 3.6 Sensitivity of welfare effects for combined supply and demand shocks
Note: Welfare is measured relative to non-stabilization and expressed in % of steady state consumption.

non-tradable goods compared to non-stabilization and leads to a further deterioration of current account. Therefore, higher shares of tradable goods in consumption and a higher trade elasticity between home and foreign lead to an increase in mainly LC households welfare, who are not able to smooth consumption over time and profit from lower tradable goods prices.

The results in panel c) and d) in Figure 3.6 confirm that the lower the trade elasticity between home and foreign, the higher the welfare losses for both household types. Additionally, LC households gain from higher shares of tradable goods in consumption. In the latter case, LC households even show positive welfare results relative to non-stabilization with TARGET2 up to a value of $\zeta_{T2} = -0.5$.

Figure 3.7 presents welfare gains of 0.34% for average households in the case of a tightening shock to the credit constraint that increases NFA positions. As discussed above, TARGET2 flows relax the immediately binding constraint, dampen the real

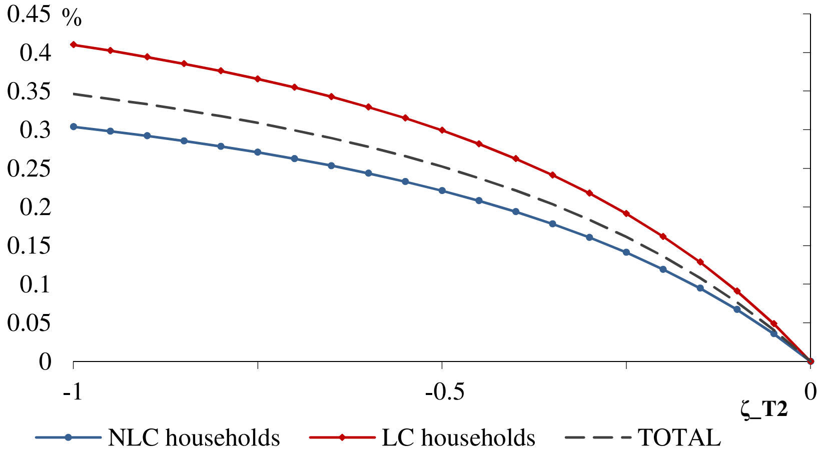

Figure 3.7 Welfare effects for a credit constraint shock

Note: Welfare is measured relative to non-stabilization and expressed in % of steady state consumption.

exchange rate appreciation and the increase in NFA positions, and lead to unconditional mean and variance welfare gains for average households.

In summary, public external finance via TARGET2 can be used to stabilize output, investment and consumption after a sudden stop of private capital. However, from a utility-based assessment of household welfare, TARGET2 financing tends to induce welfare losses, whereby NLC households, who smooth their consumption over time, are more affected by the stabilizing policy due to overconsumption. One main factor behind those findings are distortions in the interest rate.

A sensitivity analysis suggest that the higher the relative size of the tradable sector and the higher the trade elasticity between home and foreign, the lower the average welfare losses through TARGET2, as households profit more from a fall in relative prices of tradable goods. A tightening credit constraint shock induces welfare gains of TARGET2 for average households, as the tendency to suboptimal consumption levels in crisis times vanishes.

3.6 Conclusion

Using a two-sector model for a small open economy, we analyze the macroeconomic adjustments to sudden stops of private capital inflows. In particular, the focus lies on the role of the much discussed TARGET2 system in this adjustment process. We contribute to the literature by (i) modeling sudden stops of private capital inflows for two types of fixed exchange rate regimes, namely an economy that is pegged to the euro and an economy that is member of the currency union with automatic access to public external finance, and (ii) evaluating the welfare effects in an estimated model for a representative group of countries, namely Greece, Ireland, and Portugal as euro insiders relative to a group of euro peggers.

Our analysis points to a severe long run vs. short run trade-off that characterizes the adjustment to sudden stops for these two types of monetary regimes. TARGET2 access is advantageous in the short run as it helps to mitigate the negative output effects of the reversals in capital flows, however, in the long run it leaves countries worse off, not the least due to an increased debt and risk burden and welfare losses relative to euro peggers. As the experience in the euro area after 2011 indicates, these negative long run effects can have very severe repercussions ranging from the possibility of countries leaving the euro area to the risk of an outright euro area break up.

Thus, our analysis of countries with TARGET2 liabilities against the Eurosystem after a sudden stop complements the controversial debate on the nature of TARGET2 balances and the implied wealth risks with focus on surplus countries (e.g. Buiter et al., 2011; Sinn, 2012), intensified by recent discussions with respect to a potential exit of a debtor country. In this case, the exiting country would have to introduce a new currency which would likely depreciate vis-a-vis the euro. As TARGET2 liabilities are denominated in euro, the real debt burden of the exeteer would increase, making debt restructuring even more likely. Accordingly, surplus countries holding TARGET2 receivables could face substantial wealth losses.

Such an exit scenario obviously raises a number of serious, far-reaching issues: How could TARGET2 be reformed as it seems to be more part of the problem and not so much part of the solution in times of crises? How should a debt write-off in case of an euro exit be conducted? Should exiting countries be given the perspective to re-enter the euro area after a grace period? Is the reduced euro area more stable or more prone to sudden stops once a deficit has exited? What is the role of TARGET2 in the specific context of Quantitative Easing?

These questions call for further research and for reforms to improve the workings of TARGET2. Politics could become an important constraint on the workings of the euro area.[5] As recent experiences indicate, political support in the surplus countries for the euro project is likely to disappear with an excessive use of TARGET2 credit. In this situation it might be helpful and even imperative to disincentivize the use of TARGET2 financing, e.g. by risk adjusting interest rates, and establish/strentghen alternative adjustment mechanisms, e.g. a fiscal policy rule that reacts to foreign debt burdens or excessive current account imbalances.

[5] see Steiner et al. (2017) for possible limits on TARGET2 balances.

3.7 Appendix

3.7.1 Impulse Responses

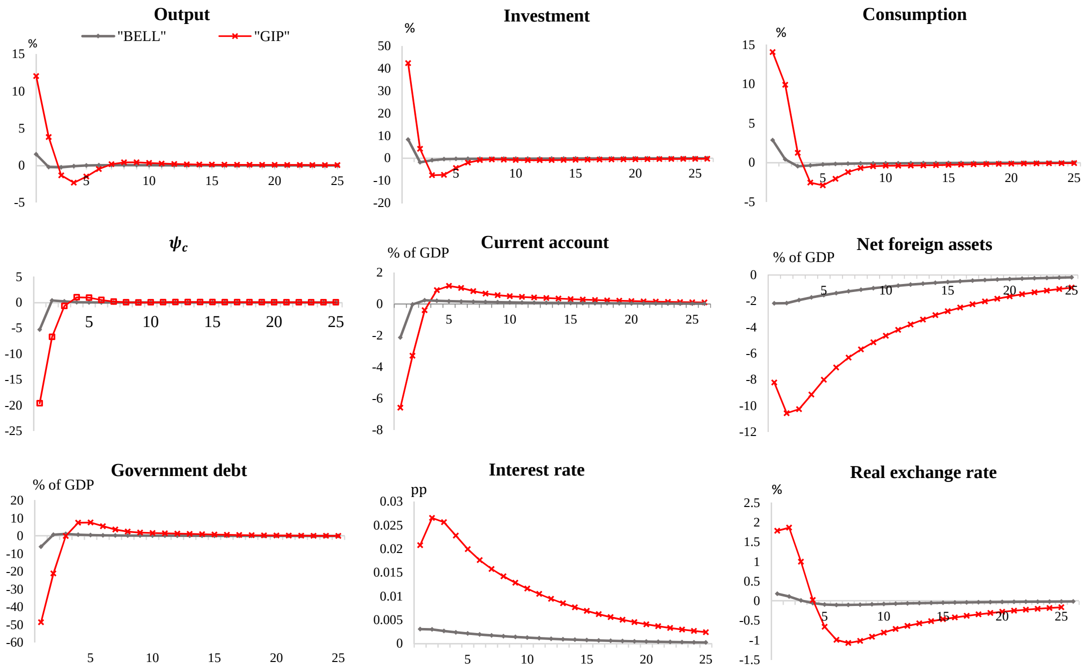

Figure 3.8 Sudden stop in response to a negative credit constraint shock

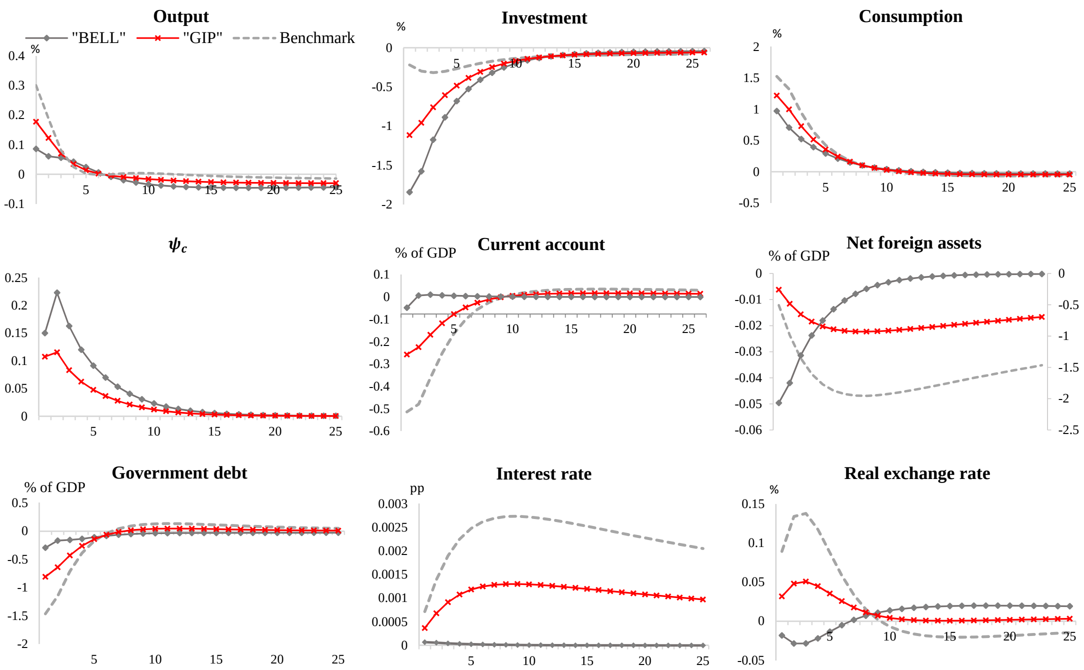

Figure 3.9 Sudden stop in response to a positive consumption preference shock

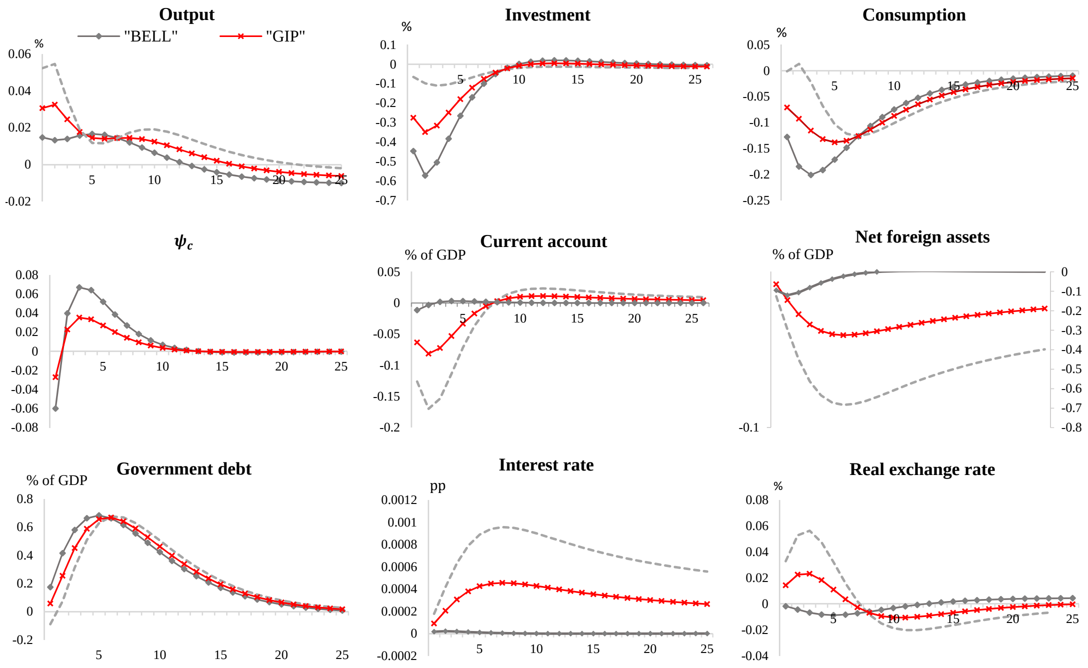

Figure 3.10 Sudden stop in response to a positive government shock

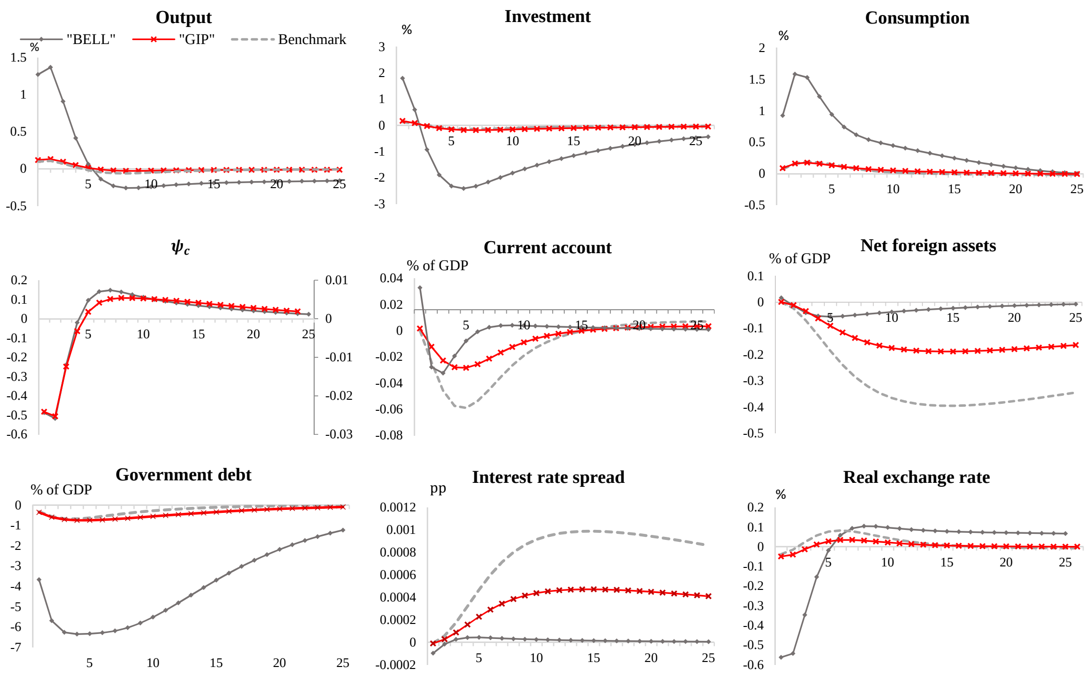

Figure 3.11 Sudden stop in response to a negative price markup shock

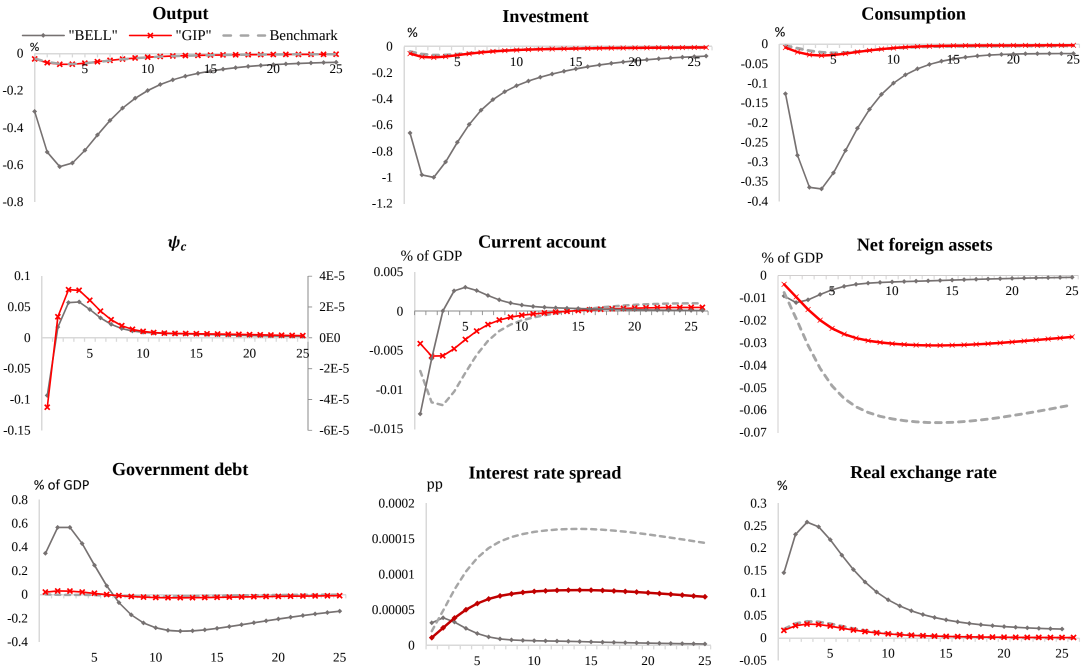

Figure 3.12 Sudden stop in response to a positive wage markup shock

3.7.2 Data and Sources

Since we distinguish between countries pegged to the Euro and countries inside the Euro are, data for the peggers is obtained by aggregating data for Bulgaria, Estonia, Latvia and Lithuania and for the euro area periphery by combining data of Greece, Ireland and Portugal. We depart from including Spain as it does not really fit the features of a small euro area country and has a rather dominant construction sector. All data is seasonally and calendar adjusted and demeaned.

Real GDP: Nominal GDP at current market prices. Source: Eurostat (*namq_10_gdp*).

Real Consumption: Final consumption expenditure of households. Source: Eurostat (*namq_10_gdp*).

Hours Worked: Thousand hours worked in all economic sectors (NACE Rev.2). Source: Eurostat (*namq_10_gdp*).

Investment: Gross capital formation by households. Source: Eurostat (*namq_10_gdp*).

CPI Inflation: Implicit price deflator 2010=100. Source: Eurostat (*namq_10_gdp*).

Interest Rate: Government bonds (including risk premium). Source: International Financial Statistics.

Real Exchange Rate: GDP Deflator of BELL (GIP) relative to the (rest of) Euro area GDP Deflator. Source: Eurostat.

Government Expenditure: Total general government spending in Millions Euro at current market prices. Source: National Statistics.

Current Account: Current account balance total economy, except from the period 2003-2006 for Bulgaria where current account data was taken from balance of payments and interpolated to quaterly data. Source: Eurostat (*bop_c6_q*).

TARGET2: Monthly data on TARGET2 balances converted into quarterly data. Source: ECB's Statistical Data Warehouse.

3.7.3 Shock Processes

The shocks evolve according to the following AR(1) processes:

$$\epsilon_t^a = \rho_a \epsilon_{t-1}^a + \sigma_a$$

$$\epsilon_t^c = \rho_c \epsilon_{t-1}^c + \sigma_c$$

$$\epsilon_t^{rp} = \rho_{rp} \epsilon_{t-1}^{rp} + \sigma_{rp}$$

$$\epsilon_t^{\chi} = \rho_{\chi} \epsilon_{t-1}^{\chi} + \sigma_{\chi}$$

$$\epsilon_t^g = \rho_g \epsilon_{t-1}^g + \sigma_g$$

$$\epsilon_t^{afor} = \rho_{afor} \epsilon_{t-1}^{afor} + \sigma_{afor}$$

$$\epsilon_t^{rpfor} = \rho_{rpfor} \epsilon_{t-1}^{rpfor} + \sigma_{rpfor}$$

$$\epsilon_t^{\gamma_w} = \rho_{\gamma_w} \epsilon_{t-1}^{\gamma_w} + \sigma_{\gamma_w}$$

$$\epsilon_t^{\gamma_p} = \rho_{\gamma_p} \epsilon_{t-1}^{\gamma_p} + \sigma_{\gamma_p}$$

3.7.4 Estimation Results

Posterior estimates - GIP

The estimation of GIP data by Kraus et al. (2018) for the period 2003Q1 to 2013Q4 generated the following results:

Table 3.3 Estimation results: GIP

		Prior			Posterior max.		Metropolis-Hastings		
Param	description	Type	Mean	sd.	mode	sd.	Mean	90% HPD interval	
ω	Country risk premium	Norm	0.0025	0.001	0.0035	0.0008	0.0048	0.0012	0.0084
σ	Inverse of intertemp. elast. of subst.	Norm	1.5	0.2	1.4520	0.1727	1.4828	1.2090	1.7759
η	Trade elast. between home/foreign	Norm	1.5	0.2	2.3159	0.1545	2.2837	2.0293	2.5488
ν	Elasticity of substitution T/NT	Gamma	0.5	0.1	0.3588	0.0719	0.3924	0.2608	0.5251
ϵ	Elasticity of goods varieties j	Gamma	6.0	0.75	5.7544	0.7199	4.9166	2.9202	7.5769
h	Degree of home bias	Beta	0.5	0.1	0.1695	0.0387	0.1795	0.1144	0.2428
$1-\chi$	Credit constraint	Gamma	0.1	0.02	0.1053	0.0214	0.1087	0.0727	0.1424
ζ_{T2}	TARGET2 parameter	Beta	0.8	0.1	0.9580	0.0290	0.9345	0.8895	0.9885
ϕ	Share of tradable goods consumption	Beta	0.6	0.2	0.6644	0.0230	0.6688	0.6185	0.7100
κ	disutility of work	Beta	1	0.1	0.9108	0.0964	0.9268	0.7693	1.0807
φ	Inverse of elast. of labor	Beta	4	1	5.8544	0.9845	6.9197	4.9746	8.7428
γ_w	Wage adjustment costs	Beta	80	20	79.91	19.93	73.87	35.54	109.48
γ_p	Price adjustment costs	Beta	48	10	47.19	10.45	39.38	25.44	52.86
ρ_a	Persistence of TFP shock	Beta	0.7	0.1	0.8761	0.0347	0.8652	0.8045	0.9304
ρ_c	Persistence of consumption shock	Beta	0.7	0.1	0.7719	0.0695	0.7488	0.6398	0.8617
ρ_{rp}	Persistence of risk premium	Beta	0.7	0.1	0.9661	0.0121	0.9633	0.9461	0.9790
ρ_χ	Persistence credit constraint	Beta	0.7	0.1	0.9185	0.0285	0.9036	0.8531	0.9541
ρ_g	Persistence of government spending	Beta	0.7	0.1	0.7326	0.0761	0.7181	0.5948	0.8379
ρ_{afor}	Persistence of TFP shock foreign	Beta	0.7	0.1	0.7248	0.1050	0.8652	0.5358	0.8629
ρ_{rpfor}	Persistence of risk premium foreign	Beta	0.7	0.1	0.7265	0.1046	0.6973	0.5264	0.8621
ρ_{γ_w}	Persistence wage markup	Beta	0.7	0.1	0.7271	0.1045	0.7138	0.5778	0.8513
ρ_{γ_p}	Persistence price markup	Beta	0.7	0.1	0.8522	0.0600	0.7740	0.6262	0.9287
σ_a	Std dev TFP	InvG	0.01	0.01	0.0068	0.0010	0.0070	0.0053	0.0087
σ_{rp}	Std dev risk premium	InvG	0.01	0.01	0.0162	0.0032	0.0185	0.0126	0.0240
σ_χ	Std dev credit constraint	InvG	0.01	0.01	0.1609	0.0175	0.1637	0.1346	0.1921
σ_g	Std dev gov spending	InvG	0.01	0.01	0.0089	0.0016	0.0095	0.0066	0.0122
σ_{rpfor}	Std dev risk premium foreign	InvG	0.01	0.01	0.0217	0.0029	0.0234	0.0181	0.0240
σ_{afor}	Std dev TFP foreign	InvG	0.01	0.01	0.0170	0.0032	0.0170	0.0053	0.0238
σ_c	Std dev consumption	InvG	0.01	0.01	0.0250	0.0046	0.0278	0.0194	0.060
σ_w	Std dev wage markup	InvG	0.01	0.01	0.0058	0.0022	0.0688	0.0029	0.1393
σ_p	Std dev price markup	InvG	0.01	0.01	0.0381	0.0079	0.0241	0.0033	0.0458
Marginal likelihood (Laplace approximation)		1161.66							
Marginal likelihood (Harmonic mean)		1164.31							
Average acceptance rate for each chain		0.32	0.31						

Note: Following Almeida (2009), we test for loose prior standard deviations (10 and 25 percent plus on initial standard deviation) and initial prior means. While in the former case some posterior means show higher sensitivity than in the latter case, the estimation results are robust. Additionally, the results are robust to changes in the prior specification and changes in the estimation period to 2005Q1 to 2013Q4 and to 2003Q1 to 2015Q1. Moreover, all parameters are identified under application of Ratto and Iskrev (2010a,b).

Posterior estimates - BELL

The estimation of BELL data by Kraus et al. (2018) for the period 2003Q1 to 2013Q4, preventing possible disturbances due to euro area membership of the corresponding countries, generated the following results:

Table 3.4 Estimation results: BELL

		Prior			Posterior max.		Metropolis-Hastings		
Parameter	description	Type	Mean	sd.	mode	sd.	Mean	90% HPD interval	
ω	Country risk premium	Norm	0.0025	0.001	0.0020	0.0010	0.0040	0.0020	0.0000
σ	Inverse of intertemp. elast. of subst.	Norm	1.5	0.2	1.9418	0.1593	1.9673	1.7189	2.2106
η	Trade elast. between home/foreign	Norm	1.5	0.2	1.5491	0.1993	1.6205	1.3417	1.9220
ν	Elasticity of substitution T/NT	Gamma	0.5	0.1	0.4727	0.0969	0.4867	0.3386	0.6492
ϵ	Elasticity of goods varieties j	Gamma	6.0	0.75	5.4100	0.6910	5.9147	4.7330	7.0416
h	Degree of home bias	Beta	0.5	0.1	0.2276	0.0506	0.1957	0.1202	0.2698
$1-\chi$	Credit constraint	Gamma	0.1	0.02	0.1087	0.0219	0.1137	0.0777	0.1492
ϕ	Share of tradable goods consumption	Beta	0.6	0.1	0.7876	0.0553	0.8364	0.7593	0.9066
κ	disutility of work	Gamma	1	0.4	0.8379	0.3656	0.9940	0.3842	1.5962
φ	Inverse of elast. of labor	Gamma	4	1	3.3139	0.8602	3.9036	2.4321	5.2777
γ_w	Wage adjustment costs	Gamma	80	20	80.094	16.824	84.677	53.671	113.847
γ_p	Price adjustment costs	Gamma	48	10	48.049	9.488	52.785	36.567	68.732
ρ_a	Persistence of TFP shock	Beta	0.7	0.1	0.8690	0.0394	0.8427	0.7740	0.9123
ρ_c	Persistence of consumption shock	Beta	0.7	0.1	0.7024	0.0839	0.6822	0.5434	0.8402
ρ_{rp}	Persistence of risk premium	Beta	0.7	0.1	0.9536	0.0140	0.9542	0.9339	0.9745
ρ_χ	Persistence credit constraint	Beta	0.7	0.1	0.9206	0.0241	0.9084	0.8640	0.9544
ρ_g	Persistence of government spending	Beta	0.7	0.1	0.7148	0.0989	0.7063	0.5567	0.8508
ρ_{afor}	Persistence of TFP shock foreign	Beta	0.7	0.1	0.7222	0.1056	0.6989	0.5429	0.8634
ρ_{rpfor}	Persistence of risk premium foreign	Beta	0.7	0.1	0.7222	0.1056	0.7039	0.5475	0.8646
ρ_{γ_w}	Persistence wage markup	Beta	0.7	0.1	0.7249	0.1059	0.7304	0.6113	0.8489
ρ_{γ_p}	Persistence price markup	Beta	0.7	0.1	0.8243	0.0817	0.7090	0.5633	0.8720
σ_a	Std dev TFP	InvG	0.01	0.01	0.0111	0.0013	0.0112	0.0091	0.0133
σ_{rp}	Std dev risk premium	InvG	0.01	0.01	0.0015	0.0032	0.0063	0.0032	0.0091
σ_χ	Std dev credit constraint	InvG	0.01	0.01	0.1299	0.0159	0.1348	0.1049	0.1656
σ_g	Std dev gov spending	InvG	0.01	0.01	0.0059	0.0023	0.0110	0.0038	0.0177
σ_{rpfor}	Std dev risk premium foreign	InvG	0.01	0.01	0.0025	0.0029	0.0166	0.0125	0.0208
σ_{afor}	Std dev TFP foreign	InvG	0.01	0.01	0.0046	0.0012	0.0057	0.0032	0.0081
σ_c	Std dev consumption	InvG	0.01	0.01	0.0287	0.0052	0.0227	0.0108	0.0338
σ_w	Std dev wage markup	InvG	0.01	0.01	0.0058	0.0022	0.1005	0.0660	0.1362
σ_p	Std dev price markup	InvG	0.01	0.01	0.0245	0.0068	0.0084	0.0032	0.0142
Marginal likelihood (Laplace approximation)		934.25							
Marginal likelihood (Harmonic mean)		936.78							
Average acceptance rate for each chain		0.30	0.29						

Chapter 4

Capital Flows, Deleveraging & Central Bank Liquidity Provision

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4.1 Introduction

Before the financial crisis, investors from 'core' euro area countries like France and Germany invested in 'peripheral' countries like Greece, Italy, Ireland, Portugal, and Spain (GIIPS).[1] Thereby, core countries built up significant net foreign asset (NFA) positions against the periphery (Hale and Obstfeld, 2016). When peripheral countries experienced a sudden increase in risk after the financial crisis and during the European sovereign debt crisis, core countries became attractive for investors in their search for safe assets (Gourinchas and Rey, 2016). Private capital inflows into peripheral countries not only stopped but reversed (Schmidt and Zwick, 2015). Merler and Pisani-Ferry (2012a) determine three periods of sudden stops between January 2007 and December 2011 in the euro area, i.e. the GIIPS.

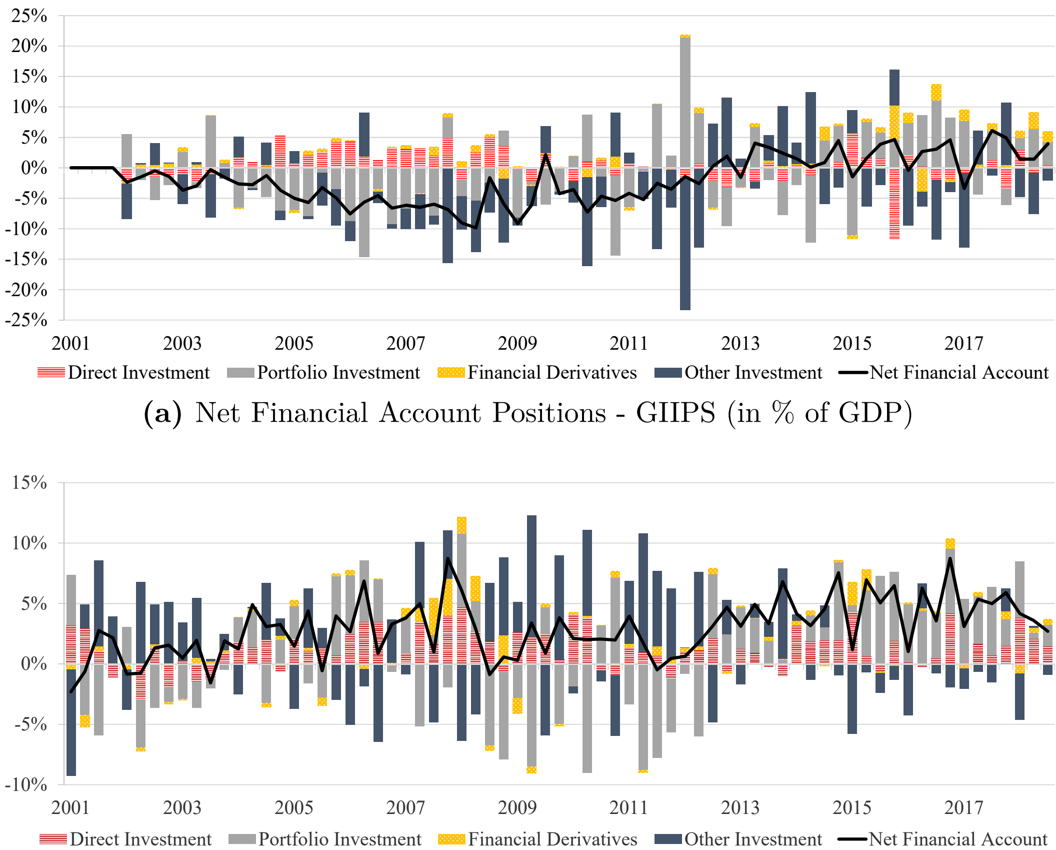
Figures 4.1a - 4.1b show net capital flows from the financial account in GIIPS and core euro area countries, respectively. GIIPS experienced a net capital inflow before the crisis in 2008, mostly portfolio investments. In the years 2011-2012, the capital inflows from portfolio investments reversed and even became net outflows, a sudden stop.

Typically, sudden stops of private capital exert deleveraging pressure. The drop in portfolio investments requires compensating asset sales by banks as well as cuts in private spending and higher savings by households[2]. The process of global deleveraging after the financial crisis is discussed extensively in McKinsey Global Institute (2012).

However, in the euro area additional public components ('other investments') in form of TARGET2 liabilities against the Eurosystem substitute private capital outflows in the periphery. Liquidity provision via the Eurosystem's TARGET2 (= **T**rans-European **A**utomated **R**eal-time **G**ross Settlement **E**xpress **T**ransfer) mechanism is essential for

[1] In this chapter, we use data for Germany and France as core countries and data for GIIPS as peripheral countries; see Basse (2014) for a detailed discussion on the identification of core member countries in the European Monetary Union considering risk premia for sovereign credit risk.

[2] In GIIPS, high government debt-to-GDP ratios play an important role for the deleveraging process; however, this chapter foregoes the government sector and focuses on private deleveraging, leaving aside public deleveraging.



(a) Net Financial Account Positions - GIIPS (in % of GDP)

(b) Net Financial Account Positions - Core (in % of GDP)

Figure 4.1 Net financial accounts

monetary policy within the European Monetary Union (EMU) and played a crucial role in mitigating sudden stops of private capital.

Shambaugh (2012) and Lane and Pels (2012) provide in-depth analyses of the euro area, where public capital flows countered sudden stops in peripheral countries during times of financial distress (see also ECB, 2013; Merler and Pisani-Ferry, 2012a). The public capital flows relaxed banks' liquidity constraints and mitigated the effects of deleveraging on the real economy (Buttiglione et al., 2014; Cour-Thimann, 2013). Buttiglione et al. (2014) illustrate that the reversal in private capital flows was much larger than the increase in overall NFA, since private outflows were partly substituted by public inflows.

Within the euro area, deficit countries are debited with TARGET2 liabilities and surplus countries credited with corresponding TARGET2 claims against the Eurosystem

(Deutsche Bundesbank, 2011). By the workings of TARGET2, the Eurosystem provides direct liquidity via the euro payment system.

The fact that TARGET2 acts as a liquidity provider after a sudden stop and thus relieves pressure on crisis-hit countries to deleverage is widely accepted in literature (e.g Bindseil and König, 2012; Fahrholz and Freytag, 2012; Hristov et al., 2019). However, the implications of TARGET2 imbalances are interpreted differently: While some authors see TARGET2 as a vehicle of direct current account financing (Auer, 2014; Sinn, 2014; Sinn and Wollmershäuser, 2012), the second strand of literature interprets TARGET2 balances only as a mirror image of a balance of payment crisis. They argue that TARGET2 balances reflect a reversal of capital flows and cannot be linked to current account imbalances within the euro area (Bindseil and König, 2012; Buiter et al., 2011).

Given the controversial discussion regarding possible distributional consequences of TARGET2 across the EMU, we investigate cross-country capital flows after a sudden stop. Additional public capital flows between TARGET2 participants affect the deleveraging of distressed countries as well as consumption and savings of creditor countries in the EMU via feedback effects.

Leaving aside intra-euro area cross-border capital flows and the feedback effects on creditor countries, both Fagan and McNelis (2014) and Kraus et al. (2019) find that access to TARGET2 can help crisis-hit countries to mitigate the effects of a sudden stop on output and consumption, however with divergent results for households' welfare. Relating TARGET2 to a direct binding credit constraint shock in a small open economy business cycle model, Fagan and McNelis (2014) suggest modest welfare gains. Kraus et al. (2019) find a long run versus short run trade-off. Supply and demand shocks lead to current account deficits and thus an indirect binding credit constraint that imply welfare losses of TARGET2 flows due to higher risk premia on precautionary savings and indebtedness.

This chapter provides a model-based analysis of the macroeconomic effects of TARGET2 across euro area Member States, thereby attenuating private deleveraging after a sudden stop. Our analytical framework is an estimated version of the two-region model of the euro area by Quint and Rabanal (2013). We account for the policy restrictions implied by the currency union and relate sudden stops to a risk shock in perphery that increases the default rate of borrowers. The shock leads to a sudden outflow of private capital from periphery to core, improving periphery's NFA position and current account. The deleveraging process is simulated by a binding borrowing constraint that restricts credit growth between borrowers and savers, i.e. active deleveraging (Cuerpo et al., 2015). In a second step, we allow for public capital in form of TARGET2 to mitigate the effects of deleveraging via international credit markets (NFA). Through the implementation of TARGET2, public and private capital constitute before only private NFA positions.

Building on simple balance of payment mechanisms, we quantify the effects of replacing private capital by TARGET2 liabilities on the economic adjustment within EMU and contribute to the existing literature in three main dimensions: We investigate how the automatic access to public external finance via the TARGET2 payment mechanism (i) affects cross-border capital flows between regions in the euro area, and (ii) counters private deleveraging in crisis-hit countries, thereby altering macroeconomic adjustment across euro area Member States. In addition, we examine (iii) the behavior of key variables in a Zero Lower Bound (ZLB) environment.

We find that risk shocks to the durable sector that are comparable to an increase in non-performing loans are among the main drivers of sudden stops in peripheral euro area countries. Our simulations indicate that the impact on cross-border capital flows via TARGET2 enables countries in periphery to stabilize and even increase their consumption after a sudden stop and subsequent deleveraging processes, however at the cost of a severe and durable drop in output. Core countries on the other hand profit from an increase in output mainly through exports while consumption stays low (due to higher savings). In sum, the TARGET2 payment system leads to persistent external imbalances (destabilizing effects) due to interregional feedback effects, and real exchange rate misalignments between the regions. Additionally, when both regions are restricted by a ZLB, the nominal interest rate does not fall sufficiently to offset the effects of deleveraging such as the decrease in prices. This leads to prolonged deflationary processes that negatively affect output and consumption, particularly in the core region.

The chapter is organized as follows: Section 4.2 describes the analytical framework of the two-region model of a monetary union and introduces deleveraging and the TARGET2 mechanism. We evaluate the estimation results that are used to simulate the union-wide effects of TARGET2 in Section 4.4. Section 4.5 provides several sensitivity analyses, including the stabilization potential of TARGET2 and the effects of a ZLB. Section 4.6 concludes.

4.2 The Model

The model is based on Quint and Rabanal (2013) with a durable goods market. We account for a core and a peripheral economy, where the relative size of the core area is denoted as n and the size of periphery as $(1-n)$ with $n \in [0,1]$. Both economies consume two types of goods, durables and non-durables (e.g. housing), which are produced under monopolistic competition and nominal rigidities. While non-durable goods can be traded across the two regions, durable goods are non-tradable. In each area, there are two types of agents, savers S, and borrowers B.

The model (Quint and Rabanal, 2013) takes into account the financial accelerator mechanism of Bernanke et al. (1999) introducing credit frictions. Domestic intermediaries take deposits and provide loans. International intermediaries trade bonds between regions.

We include a risk shock that mimics an increase in non-performing loans. The shock leads to a sudden stop of private capital inflows in the periphery, and consequently to a decrease of private credits to borrowers. Private deleveraging in the form of a constraint to the credit supply limits interbank market efficiency and further decreases credits to borrowers. We address TARGET2 flows that disturb processes of private deleveraging, as the sharp decrease in cross-border capital flows after the sudden stop is substituted by TARGET2 liabilities against the respective region.

Households

The expected utility function of borrowers $j \in [0, \lambda]$ and savers $j \in [\lambda, 1]$ is presented in Equation (4.1). Expected utility today depends on current and future consumption of non-durables C_t^j and durables D_t^j, and the disutility of labor L_t^j.

The model includes external habit persistence by Smets and Wouters (2003) and uses ε^j to measure the influence of aggregated previous consumption. High values of habit persistence reduce the influence of the real interest rate on consumption.

Additionally, non-durable consumption is split up into goods from core $C_{H,t}^t$ and periphery $C_{F,t}^t$. The parameter γ represents the share of non-durable goods in the utility function and $\beta^{j,t}$ denotes the discount factor. φ is defined as the inverse elasticity of labor supply. The parameters ξ_t^C and ξ_t^D are preference shocks of consumers towards non-durable goods and durable goods, respectively.

$$E_0 \left\{ \sum_{t=0}^{\infty} \beta^{j,t} \left[\gamma \xi_t^C log(C_t^j - \varepsilon^j C_{t-1}^j) + (1-\gamma)\xi_t^D log(D_t^j) - \frac{(L_t^j)^{1+\varphi}}{1+\varphi} \right] \right\} \tag{4.1}$$

The superscript $i = \{B, S\}$ denotes borrower and saver specific parameters and variables. Borrowers are more impatient than savers, and their habit formation parameter differs $(\varepsilon^B \neq \varepsilon^S)$. They are willing to take loans and offer their housing stock D_t^B as a collateral.

Savers maximize their utility function subject to the nominal budget constraint:

$$P_t^C C_t^S + P_t^D I_t^S + S_t^S \leq R_{t-1} S_{t-1}^S + W_t^C L_t^{C,S} + W_t^D L_t^{D,S} + \Pi_t^S \tag{4.2}$$

Savers either consume $P_t^C C_t^S$, invest $P_t^D I_t^S$ or save S_t^S their income. The variables P_t^C and P_t^D are defined as the price indices of non-durable and durable goods. Labor supply is imperfectly substitutable among sectors (Iacoviello and Neri, 2010), and wages are flexible and set sector-specific in the durable W_t^D and non-durable W_t^C sector. Additionally, savers are paid interest R_t and receive profits Π_t^S. Profits are accumulated from intermediate good producers in both sectors in each area, from domestic and international financial intermediaries and from debt collecting agencies. When agents buy durable goods or do residential investment, these purchases are used to increase the stock, but come with a lag:

$$D_t^j = (1-\delta) D_{t-1}^j + F\left(I_{t-1}^j, I_{t-2}^j\right) \tag{4.3}$$

With insights from Christiano et al. (2005), Quint and Rabanal (2013) model investment adjustment costs $F(\cdot)$ given by a convex function that meets the steady state criteria: $\bar{F} = 0$, $\bar{F}' = 0$ and $\bar{F}'' > 0$.

Since borrowers are loan takers, they do not earn any profits from intermediate goods companies, debt collecting firms, or financial intermediaries. Each borrower extends their liquidity by borrowing loans S_t^B from domestic financial intermediaries at the lending rate R_t^L and is subject to a distinctive quality shock ω_t^j, which influences the value of the investment (housing) stock D_t^B owned by borrowers:

$$\begin{aligned} &P_t^C C_t^B + P_t^D I_t^B + P_t^D \int_0^{\bar{\omega}_{t-1}} \omega dF(\omega, \sigma_{\omega,t-1}) D_t^B + [1 - F(\bar{\omega}_{t-1}, \sigma_{\omega,t-1})] R_{t-1}^L S_{t-1}^B \\ &\leq S_t^B + W_t^C L_t^{C,B} + W_t^D L_t^{D,B} \end{aligned} \tag{4.4}$$

Each quality shock ω_t^j follows a log normal distribution with the cumulative distribution function $F(\omega)$. The standard deviation $\sigma_{\omega,t}$ associated with the quality shock follows an AR(1) process. The quality shock can lead borrowers to default on their loans. At the end of the period borrowers know whether they will default on their loans. This happens if borrowers draw a lower value of ω_{t-1} than the ex-post threshold $\bar{\omega}_{t-1}$, presented in Equation (4.5) (Quint and Rabanal, 2013).

$$\bar{\omega}_{t-1}^{(post)} = \frac{R_{t-1}^L S_{t-1}^B}{P_t^D D_t^B} \tag{4.5}$$

On the contrary, a high value of ω_{t-1} allows borrowers to fully repay their loans, i.e. $R_{t-1}^L S_{t-1}^B$. Banks expect an ex-ante threshold of borrowers default $E_t(\bar{\omega}_t)$ that is given by the loan and the lending rate borrowers need to pay divided by the expected future investment prices and investment stock:

$$\bar{\omega}_t^{(ante)} = \frac{R_t^L S_t^B}{E_t[P_{t+1}^D D_{t+1}^B]}$$

The ex-ante and ex-post thresholds may be different. At the time of the loan contract, $\bar{\omega}_t^{(ante)} = E_t(\bar{\omega}_t^{(post)})$ holds.

The term $\frac{S_t^B}{P_{t+1}^D D_{t+1}^B}$ represents the loan to value (LTV) ratio. If the ratio is greater than one, loans exceed the underlying value of the collateral. Hence, a higher LTV ratio implies a higher ex ante threshold and, therefore, financial intermediaries expect more borrowers to default on their loans. If an agent defaults on his loan, a debt collecting agency collects the remaining nominal value of the investment stock after the shock occurred. The debt collecting agency that is owned by savers charges domestic financial intermediaries a fraction h of the remaining value. Financial intermediaries are risk neutral, so that the expected return of granting a loan must equal the rate at which the bank funds itself, i.e. the deposit rate (Quint and Rabanal, 2013):

$$R_t = E_t \left\{ \underbrace{(1-h)\int_0^{\bar{\omega}_t} \omega dF(\omega, \sigma_{\omega,t}) \frac{P^D_{t+1} D^B_{t+1}}{S^B_t}}_{\text{if loan defaults}} + \underbrace{[1 - F(\bar{\omega}_t, \sigma_{\omega,t})] R^L_t}_{\text{if loan is repaid}} \right\} \tag{4.6}$$

Deleveraging

The shadow price $\xi_t^{S^B,*}$ affects the credit channel between financial intermediaries and borrowers, such that financial intermediaries only lend a fraction of their loanable funds. The costs of the decrease in lending is transferred to households. The aggregate balance sheet of financial intermediaries in periphery ($*$) includes savers deposits ($S^{S,*}$) and borrowers demand for loans ($S^{B,*}$) as well as an excess B_t^* of domestic funds that is transferred to core:

$$(1-n)\lambda \frac{1}{\xi_t^{S^B,*}} (S_t^{S,*} + B_t^*) = (1-n)(1-\lambda) S_t^{B,*} \tag{4.7}$$

The shadow price $\xi_t^{S^B,*}$ is assumed to be constant and equal to one in the baseline scenario. When we analyze TARGET2 and its effects on private deleveraging, we allow $\xi_t^{S^B,*}$ to increase. Households' private deleveraging relates to credit growth in periphery:

$$\left[\frac{S_t^{B,*}}{S_{t-1}^{B,*}} \right]^{\gamma_\xi} \leq \xi_t^{S^B,*} \tag{4.8}$$

A positive risk shock to the durable sector per se decreases the credit-to-GDP ratio, however solely due to an increase in the lending-deposit spread. Additionally, Equation (4.8) states that credit growth of peripheral agents is restricted with the shadow price $\xi_t^{S^B,*}$ as the cost of borrowing and the parameter γ_ξ, in order to model the active reduction in credit supply/demand (Cuerpo et al., 2013, 2015). The drop in credit availability decrases households' debt-to-GDP and the LTV ratio.

Firms

Periphery and core produce homogeneous durable and non-durable goods according to their size $1-n$ and n, respectively. The model uses staggered price setting of Calvo (1983) and monopolistic competition for intermediate firms (Quint and Rabanal, 2013). Final goods proucers sell non-durables across borders. However, durable goods are not tradable between periphery and core.

The production function for final goods is:

$$Y_t^k \equiv \left[\left(\frac{1}{n}\right)^{\frac{1}{\sigma_k}} \int_0^n Y_t^{k\,\frac{\sigma_k-1}{\sigma_k}} \right]^{\frac{\sigma_k}{\sigma_k-1}} \tag{4.9}$$

for the two types of final goods product $k=\{C,D\}$, where σ_k describes the price elasticity of intermediate goods. This leads to the following demand for intermediate goods:

$$Y_t^C = \left(\frac{P_t^H}{P_t^H}\right)^{-\sigma_C} Y_t^C \quad \text{and} \quad Y_t^D = \left(\frac{P_t^D}{P_t^D}\right)^{-\sigma_D} Y_t^D \tag{4.10}$$

and the price levels for domestically non-durable (P_t^H) and durable final goods (P_t^D):

$$P_t^H \equiv \left\{ \frac{1}{n} \int_0^n [P_t^H]^{1-\sigma_C} dh \right\}^{\frac{1}{1-\sigma_C}} \quad \text{and} \quad P_t^D \equiv \left\{ \frac{1}{n} \int_0^n [P_t^D]^{1-\sigma_D} dh \right\}^{\frac{1}{1-\sigma_D}} \tag{4.11}$$

The price level for non-durable goods produced in the core area consists of the price of non-durables produced in core (P_t^H) and the price of imported non-durables (P_t^F).

$$P_t^C = \left[\tau(P_t^H)^{1-\iota_C} + (1-\tau)(P_t^F)^{1-\iota_C}\right]^{\frac{1}{1-\iota_C}} \tag{4.12}$$

At the end of each period the fraction $(1-\theta_C)$ of non-durable and $(1-\theta_D)$ of durable intermediate goods producers are able to re-optimize their prices. The prices of the remaining firms (θ_C and θ_D) are linked to sector-specific inflation with the parameters ϕ_C and ϕ_D. Intermediate goods are produced with labor ($L_t^C(h)$ and $L_t^D(h)$) as the only input factor:

$$Y_t^C(h) = A_t Z_t^C L_t^C(h), \quad Y_t^D(h) = A_t Z_t^D L_t^D(h) \quad \forall \quad h \in [0, n] \tag{4.13}$$

with A_t as a union wide technology shock as well as Z_t^C and Z_t^D as sector specific shocks in each country.

International Credit Markets

Demand and supply of loans (S^B and S^S) do not necessarily add up. International financial intermediaries can trade the excess funds of core B_t to periphery and vice versa (see Equation 4.7). International intermediaries can lend to peripheral financial intermediaries which can use the funds to satisfy the excess demand for loans in periphery. The international deposit rate spread is given as in Schmitt-Grohé and Uribe (2003):

$$R_t^* = R_t + \left\{ \vartheta_t \kappa_B \left(\frac{B_t}{P_t^C Y^C} \right) \right\} \tag{4.14}$$

The fraction $\frac{B_t}{P_t^C Y^C}$ denotes the private NFAs in terms of private capital flows divided by non-durable GDP in core. The parameter κ_B is the elasticity of core interest rate to the level of peripheral assets (international risk premium). The parameter ϑ_t denotes the international premium shock. Savers own the international intermediaries in core and periphery and profits are split equally to profit gaining intermediaries. Since supply does not necessarily equal demand of loans in a respective credit market area, the following condition must hold for the international bond markets. Hence, international intermediaries must completely hedge their exposure:

$$n\lambda B_t + (1-n)\lambda^* B_t^* = 0 \tag{4.15}$$

The private NFA equation is given by Equation (4.16a):

$$\begin{aligned} n\lambda B_t = n\lambda R_{t-1}B_{t-1} + \big\{&(1-n)P_{H,t}\left[\lambda^* C_{H,t}^* + (1-\lambda^*)C_{H,t}^{B^*}\right] \\ &-nP_{F,t}\left[C_{F,t} + (1-\lambda)C_{F,t}^{B}\right]\big\} \end{aligned} \tag{4.16a}$$

$$\begin{aligned} n\lambda B_t = n\lambda R_{t-1}B_{t-1} + \big\{&(1-n)P_{H,t}\left[\lambda^* C_{H,t}^* + (1-\lambda^*)C_{H,t}^{B^*}\right] \\ &-nP_{F,t}\left[C_{F,t} + (1-\lambda)C_{F,t}^{B}\right]\big\} + TARGET2 \end{aligned} \tag{4.16b}$$

Equation (4.16a) makes use of the balance of payment mechanisms and describes the development of private bonds over time (law of motion). Therefore, a change in NFA positions has feedback effects on output and consumption, and thus current account.

We introduce TARGET2 to Equation (4.16a) that reacts to sudden stops in periphery and the related increase in the NFA position relative to its steady state level (Equation 4.17). The reversal of private capital inflows is (partly) compensated by TARGET2 (4.16b).

$$TARGET2 = \zeta_{T2}\left(NFA_{H,Steady} - NFA_{H,t}\right) \tag{4.17}$$

Thereby, the central bank provides additional liquidity to the periphery. Following the model dynamics in Equation (4.16b), TARGET2 liabilities in periphery as well as related TARGET2 credits in core affect NFA positions in bank balance sheets, and thus consumption and output in both regions[3].

In the baseline scenario, NFA positions comprise only private capital flows. Via the TARGET2 mechanism, private capital outflows are subsituted by public capital inflows, leading to negative current account positions in the region originally hit by a sudden stop.

Current account in period t is related to the change in NFA position:

$$\begin{aligned} CA_t = n\lambda R_{t-1}B_{t-1} + (1-n)P_{H,t}\left\{Y_t - \left[\lambda C_{H,t} + (1-\lambda)C^B_{H,t}\right] - Y^D_t\frac{P^D_t}{P^C_t}\right\} \\ - nP_{F,t}\left\{\lambda C_{F,t} + (1-\lambda)C^B_{F,t}\right\} - n\lambda B_t \end{aligned} \tag{4.18}$$

Relations (4.16) - (4.18) do not imply financing current account deficits by TARGET2 (e.g. Auer, 2014), but generate an indirect transmission channel from TARGET2 liabilities and NFA positions to current account imbalances. TARGET2 liabilites lead to an increase in periphery's NFA positions as well as a decrease in current account, and consequently an adjustment in the terms of trade and the consumption behavior.

The interest rate is determined by the following rule:

$$R_t = \gamma_R R_{t-1} + (1-\gamma_R)\gamma_\pi(\pi_t)^n(\pi^*_t)^{(1-n)} + (1-\gamma_R)\gamma_y\hat{y}^{EMU}_t + \varepsilon^m_t \tag{4.19}$$

The monetary policy shock is defined as ε^m_t and is *i.i.d.*. The parameters γ_π, γ_y and γ_R are the reaction parameters to inflation, real growth and the interest rate smoothing.

[3]As the model structure implies NFA positions that are demand driven (households domestic ($C^*_{H,t}$) and foreign ($C^*_{F,t}$) consumption), the effects of the TARGET2 mechanism in Section 4.4 are driven by changes in consumption and the terms of trade.

4.3 Calibration and Parameter Estimates

Following Schorfheide (2000) and Schorfheide and Lubik (2003), we apply a two-step estimation procedure involving calibration and Bayesian techniques to represent a two-region model with financial frictions, i.e. peripheral and core euro area countries (Quint and Rabanal, 2013). The estimation results and the historical shock decomposition determine the drivers behind sudden stops in GIIPS.

The core region is obtained by aggregating data for France and Germany, whereas the GIIPS countries represent the periphery region. For both regions, we use quarterly data on nominal and real GDP, nominal private consumption, nominal gross fixed capital formation, credit to households and non-profit institutions serving households, current account, the harmonized index of consumer prices, real house price index, and the three month Euro Interbank Offered Rate from 2000Q1 to 2017Q1. The data is aggregated to core and periphery using weighted averages of GDP.[4]

We add several shocks to the model for both core and periphery, namely technology shocks to the durable and non-durable sector, preference shocks to the durable and non-durable sector, risk shocks to the durable sector, international risk premium shocks, and monetary policy shocks[5]. The shock processes are specified in Appendix 4.7.2.

Calibrated Parameters

We calibrate parameters following Quint and Rabanal (2013), except the elasticity of substitution between intermediate goods σ as well as the weight of non-durables in the utility function in core (γ) and periphery (γ^*) that are estimated.

We assume that the discount factors are the same in both countries ($\beta = \beta^*$ and $\beta^B = \beta^{B*}$). The cut-off point for loan defaults is set to $\bar{\omega} = 0.7$ for both regions (Gerali

[4]See Appendix 4.7.1 for a detailed description of the data.

[5]Other shocks like shocks to consumption, prices, investment, and output are summarized, as they have negligible influence on the main variables like output, investment, and current account.

Table 4.1 Calibrated parameters

	Parameter	Value
n	Size of the core country	0.6000
β	Discount factor savers	0.9900
β^B	Discount factor borrowers	0.9850
δ	Depreciation rate	0.0125
h	Monitoring costs	0.2000
$\bar{\omega}$	Loan to value ratio	0.7000
ι_L	Labour disutility cost parameter	0.7174
φ	Labour disutility	0.3702
ε	Habit formation parameter: Savers	0.7187
ε^B	Habit formation parameter: Borrowers	0.4550
α	Size of non-durable sector in GDP Core	0.9400
α^*	Size of non-durable sector in GDP Periphery	0.9400
$\bar{\sigma}_\omega$	Steady state risk	0.1742
$\bar{F}$	Default on loans	0.0250
τ	Share of home produced non-durable consumption in Core	0.9400
τ^*	Share of periphery-produced non-durable goods available in periphery	$1 - \frac{n(1-\tau)}{1-n}$

et al., 2010). Pre-crisis data from the IMF for the EMU reveal an average default value ($\bar{\text{F}}$) of about 2.5% (Time period: 2000-2007) as in Quint and Rabanal (2013). Using GDP data, the average size of the core region is set to 60%. Using the weighted average of total imports to private consumption, we set the share parameter for home produced non-durable consumption in core to 0.94. Furthermore, following the findings by Iacoviello and Neri (2010), we set labour disutility $\varphi = 0.37$. Table 4.1 summarizes the calibrated values.

Prior and Posterior Distributions

Table 4.2 depicts the prior and posterior distribution for the estimates in the benchmark model. Further, estimation results for the shock processes are in Tables 4.4 - 4.5 in Appendix 4.7.2.

The choice of the prior distribution is in line with Ratto and Iskrev (2010b) and Ratto et al. (2001), in order to increase the model fit[6]. We run 200,000 draws with four distinct chains, using the Metropolis-Hastings algorithm. We drop the first 50 % to account for any dependence of the chains from its starting values (Röhe, 2012).

Results from posterior and Metropolis-Hastings estimation are shown in the last three columns of Table 4.2, including the Highest Posterior Density Interval (HPDI)[7].

The prior estimates for the mean of the shock processes are set to 0.75 with a standard deviation of 0.1 and thus lie within the range of 0.5 and 0.8, as suggested by Marcellino and Rychalovska (2012) and Justiniano and Preston (2010). In order to estimate the standard deviation of shocks and the measurement errors, inverse gamma distributions are specified. The posterior mean for shock persistences (Table 4.4) are consistently higher for GIIPS, except for preference shocks in the non-durable sector.

A comparison of the posterior estimates indicates a somewhat higher markup for each firm of 3.4455 than the prior mean of 2.500 with a large standard deviation of 0.5, in order to fit the data. However, the posterior estimates are lower than those calibrated by Quint and Rabanal (2013). The parameter κ_B describes the international risk premium elasticity, which is the elasticity of domestic interest rates to the level of foreign assets. Posterior estimates show that a one percent increase in the external debt-to-GDP ratio leads to a 4.55 basis points move of the risk premium elasticity between countries. Additionally, we find a large elasticity of substitution between home and foreign goods ι_C with a value of 2.66.

The estimates for the Taylor rule indicate a strong response to inflation in the euro area (2.37) and a high degree of interest smoothing (0.90), while the reaction to real GDP

[6]The identification analysis deals with the challenge to identify best estimates of parameters within a statistical computation.

[7]In contrast to confidence intervals, the HPDI has two important properties: (1) the density for each point lying within the interval is greater than for those points lying outside. (2) The interval is of the shortest length for a default probability content (e.g. Chen and Shao, 1999).

Table 4.2 Prior and posterior distribution of estimated parameters

		Prior			Metropolis Hastings		
	Parameter	Type	Mean	sd.	Mean	90% HPD Interval	
σ	EOS bw. intermediate goods	Gamma	2.5000	0.5000	3.4455	2.7665	4.1432
κ_B	International risk premium	Gamma	0.0300	0.0100	0.0455	0.0275	0.0653
ι_C	EOS bw. goods	Gamma	2.5000	0.5000	2.6619	1.7800	3.5189
ψ	Investment adjustment costs	Gamma	2.5000	0.5000	3.0040	2.3240	3.6354
λ	share of savers	Beta	0.5000	0.1000	0.4087	0.3770	0.4431
γ_π	Taylor rule reaction to inflation	Gauss.	2.0000	0.2000	2.3739	1.9785	2.5526
γ_r	Interest rate smoothing	Beta	0.7000	0.1000	0.8296	0.7891	0.8700
γ_y	Taylor rule reaction to real growth	Gamma	0.4000	0.1000	0.4778	0.2932	0.6693
γ	Weight of non-durables in the utility function	Beta	0.6000	0.1000	0.4473	0.3881	0.5051
γ^*	Weight of non-durables in the utility function	Beta	0.6000	0.1000	0.7707	0.7120	0.8291
θ_C	Calvo lottery, non-durables	Beta	0.7000	0.1500	0.7970	0.7210	0.8711
θ_D	Calvo lottery, durables	Beta	0.7000	0.1500	0.9508	0.9246	0.9756
θ_C^*	Calvo lottery, non-durables	Beta	0.7000	0.1500	0.6289	0.5304	0.7418
θ_D^*	Calvo lottery, durables	Beta	0.7000	0.1500	0.8967	0.8720	0.9221
ϕ_C	Indexation, non-durables	Beta	0.3300	0.1500	0.2174	0.0405	0.3787
ϕ_D	Indexation, durables	Beta	0.3300	0.1500	0.3082	0.0689	0.5452
ϕ_C^*	Indexation, non-durables	Beta	0.3300	0.1500	0.1730	0.0280	0.3153
ϕ_D^*	Indexation, durables	Beta	0.3300	0.1500	0.4001	0.1638	0.6149

Note: Table 4.2 depicts the prior and posterior distribution of the estimated EMU parameters. Asterisks(*) indicate parameters of GIIPS; The term 'Elasticity of Substitution' is abbreviated by EOS.

growth (0.48) is moderate compared to the prior mean, however, higher than suggested by Quint and Rabanal (2013) (0.20).

Our posteriors for the duration of price contracts suggest an average contract length of approximately 10 (periphery) to 20 (core) quarters for the price stickiness of durable goods. Posteriors of non-durable goods indicate that prices are reset approximately every 3 (periphery) to 5 (core) quarters.

Historical Shock Decomposition

We estimate the individual contribution of each shock to the movements of specific endogenous variables.

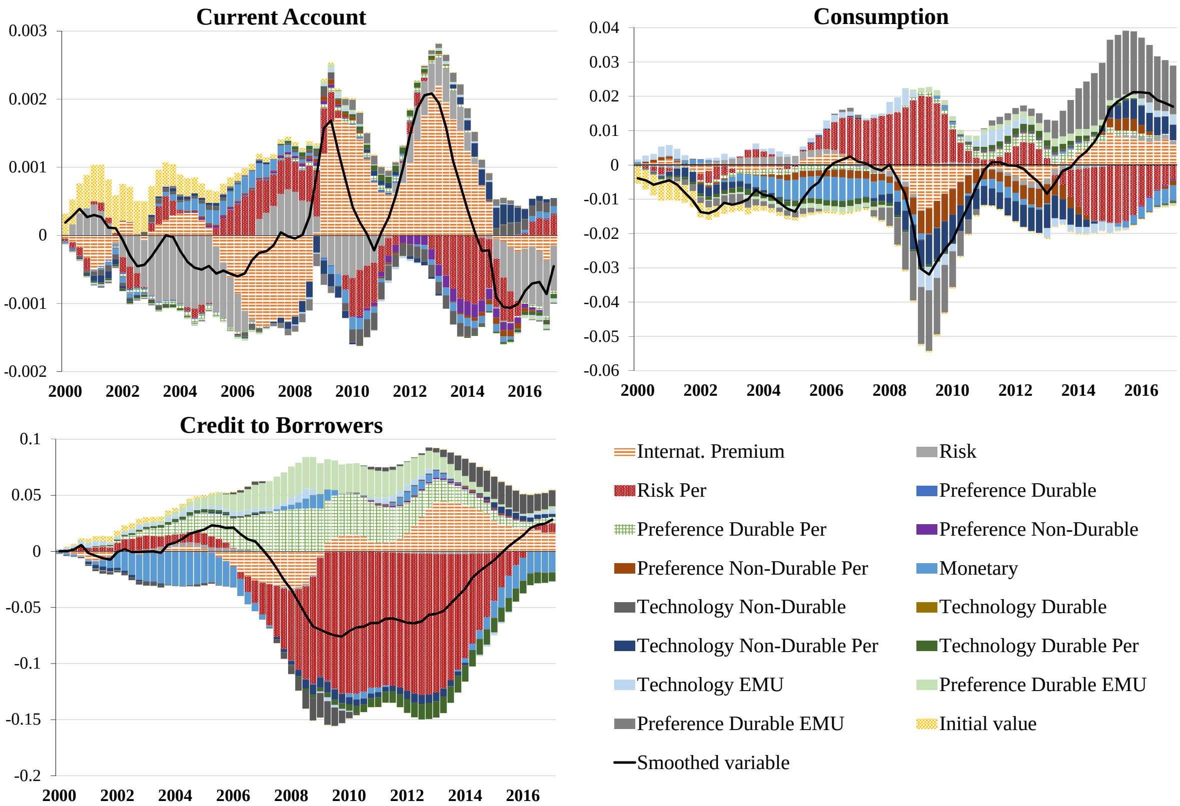


Figure 4.2 Historical shock decomposition for GIIPS

Figure 4.2 plots the historical shock decomposition for credit to borrowers, consumption, and current account relative to GDP in periphery. The solid line depicts the smoothed value of the deviation of a variable's historical value from its steady state, whereas the vertical bars show the contribution of the different smoothed shocks and initial values to the development of the variable.

The shock decomposition indicates that the regions are strongly driven by the risk shock to the durable sector, which is associated with a sudden stop of private capital, next to the international premium shock and the preference shock in the durable sector for the estimated period 2000Q1-2017Q1.

We find that the risk shock to the durable sector drives down credits during the crisis and afterward, until the end of the estimation period (Figure 4.2). This can be attributed to the massive increase in non-performing loans in the periphery during the financial crisis and the subsequent debt crisis.

Using the findings from the shock decomposition, the subsequent analysis focuses on the simulation of risk shocks to the durable sector in periphery.

4.4 Simulation

Figures 4.3 - 4.4 present the development of key variables. In the baseline scenario (solid line), we illustrate the effects of a risk shock in periphery, the main driver of sudden stops of private capital inflows. Then, we implement a restriction of loans to borrowers in periphery, in order to replicate active deleveraging of most peripheral countries in the course of the financial as well as the subsequent sovereign debt crisis (dotted line). Finally, we introduce TARGET2 as a payment by the central bank that is based on the private NFA position (dashed line), i.e. we replenish to a certain extent capital in periphery that moved to core and evaluate the influence on the deleveraging process in periphery as well as feedback effects on the core (creditor) region.

4.4.1 Baseline scenario

The risk shock to the durable sector of about 11.7% (see Table 4.5) increases the amount of non-performing loans of borrowers in periphery, which forces them to reduce their consumption. As a result, total consumption in periphery drops and prices fall, leading to deflationary processes with a decline in wages and labor supply, and thus output. This recession is caused by a loss in value of borrower's collateral, which impedes their credit-financed consumption, while consumption in core slightly increases. To sum up, the risk shock induces private capital outflows, i.e. a sudden stop in periphery. In the baseline scenario, this capital outflows increase periphery's current account.

4.4.2 Deleveraging

The binding constraint in Equation (4.8) directly relates deleveraging in periphery with respect to credit growth with the shadow price ξ_t^{SB} as the cost of borrowing. Higher shadow prices ξ_t^{SB} decrease credits (dotted line) due to higher exposure on peripheral balance sheets. The binding constraint shuts down the credit channel between financial intermediaries and borrowers and thus intensifies the deleveraging process.

Active deleveraging magnifies the initial effects of the baseline scenario: The substantial drop in credits to borrowers leads to significantly higher capital flows from periphery to core and private NFA positions increase. The parameter γ_ξ is chosen such that private deleveraging in periphery corresponds to a total decline in private capital inflows (NFA) of about 25% of steady state GDP, which is in the range for the GIIPS countries (e.g. Higgins and Klitgaard, 2014; Merler and Pisani-Ferry, 2012a). The effects on other parts of the economy are rather small. This is in line with Justiniano et al. (2015), who show that, given two household types, borrowers' deleveraging and lower consumption are counteracted by savers' increasing activity. However, in total, deleveraging slightly accelerates the recovery of consumption and output in GIIPS after an initial higher drop in the respective variables.

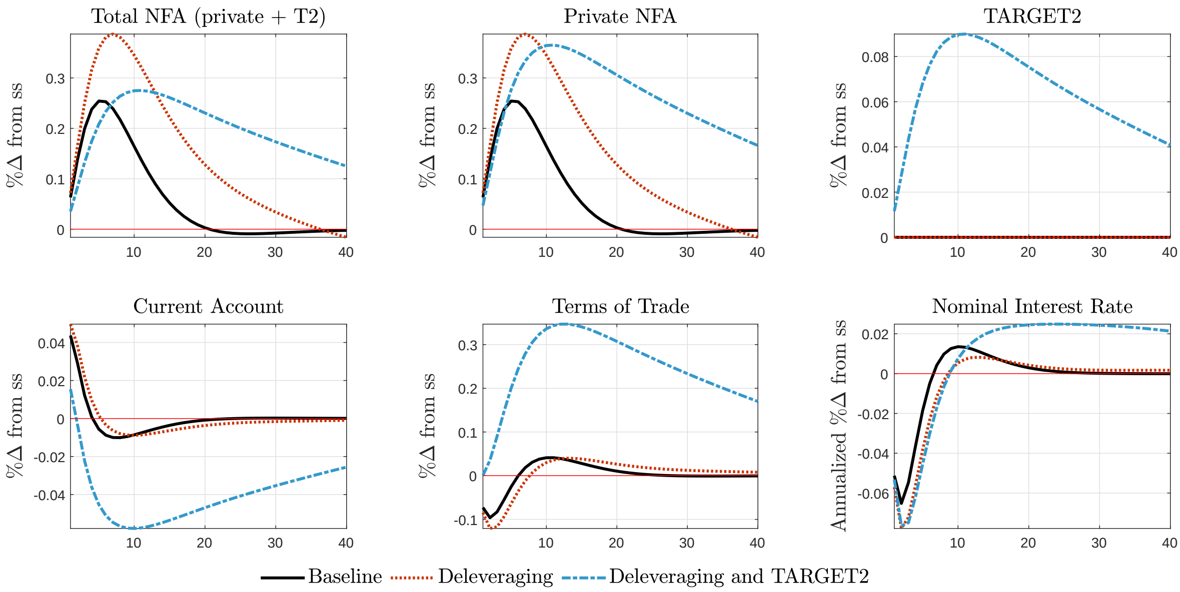


Figure 4.3 Cross-border capital flows after a risk shock in periphery

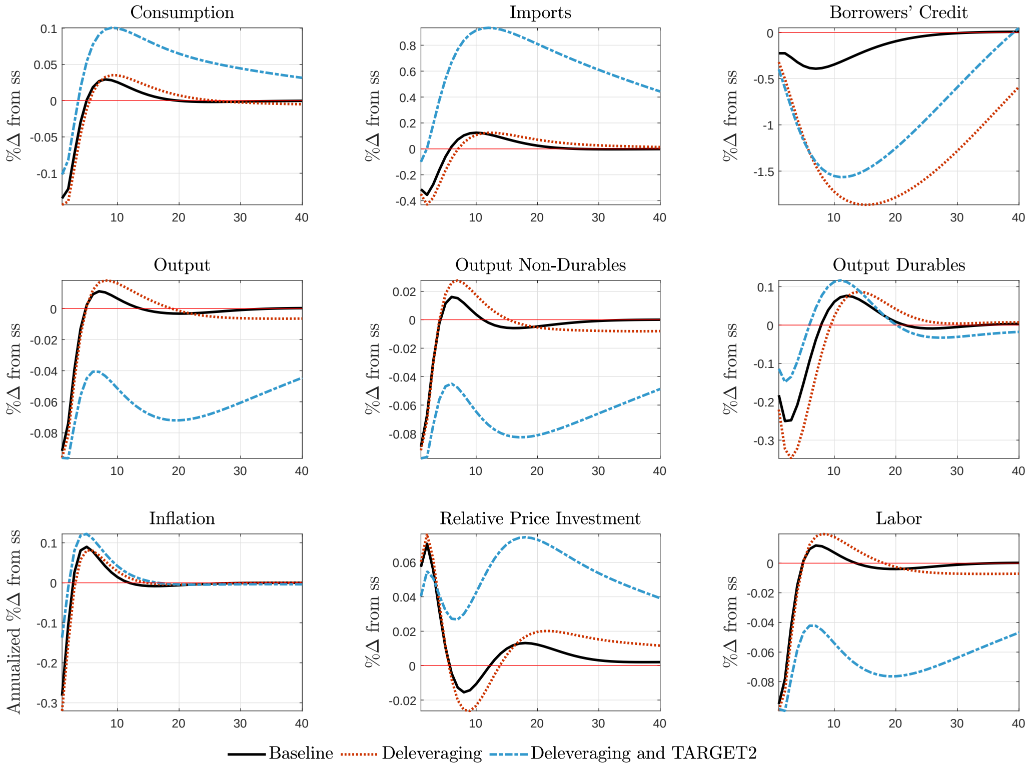
Note: Total NFA, private NFA, TARGET2 liabilities, and current account are represented from periphery's perspective, while the terms of trade are defined as the price level of core's imported non-durables from periphery relative to non-durables produced in core. The nominal interest rate is the interest rate set by the ECB.

4.4.3 TARGET2

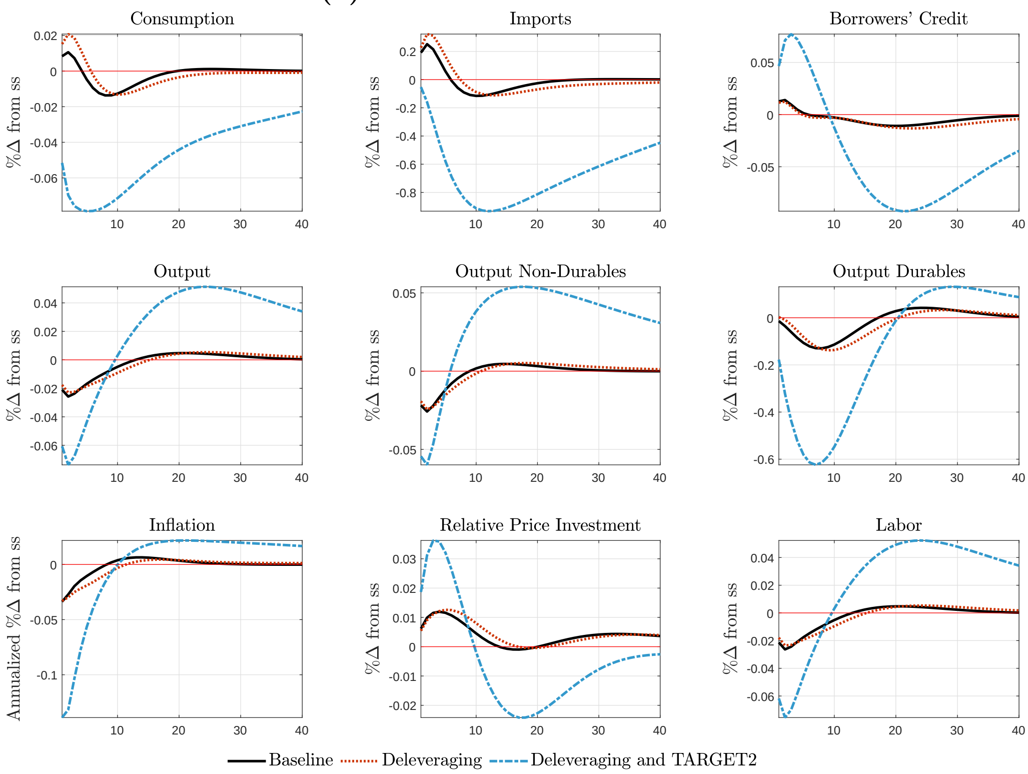
Allowing additional TARGET2 flows (partly) compensates for a reversal of private capital inflows by an increase in public capital inflows. TARGET2 is introduced by increasing the parameter ζ_{T2} from zero to 0.9. The increase in TARGET2 liabilities allows for a decrease in peripheral NFA positions that now consist of private flows plus (negative) TARGET2 (dashed line). The parameter choice follows the estimation by Kraus et al. (2018, 2019) and implies that the initial drop in NFA through deleveraging is nearly substituted by TARGET2 financing as in Figure 4.3.[8] We compare the results to the private NFA position under pure deleveraging (dotted line) in order to determine the shortfall of external finance.

Private capital outflows trigger the automated central bank response via the TARGET2 system, thereby mitigating the sudden stop, i.e. capital outflows are substituted by

[8] Higgins and Klitgaard (2014) calculate a nearly 1:1 substitution of private capital through TARGET2 financing for peripheral euro area countries; see Section 4.5 for a sensitivity analysis with lower intervention parameter $\zeta_{T2} = 0.1$.



(a) Economic effects in GIIPS



(b) Economic effects in Core

Figure 4.4 Cross-regional economic effects after a risk shock in periphery central bank liquidities, which closely represents the influence of TARGET2 during the crisis. The unevenly distribution of central bank liquidity leads to the well known TARGET2 imbalances. Total NFA positions of private and public capital increase considerably, leading to distortionary effects of TARGET2 via the credit channel:

In periphery, public capital inflows induce higher inflation rates, and beneficial terms of trade allow for higher consumption. However, due to their ability to consume goods from abroad at lower prices, households can increase consumption through imports from core while labor declines. Thus, while consumption levels highly benefit from TARGET2 'subsidies', production of non-durable goods stays far beneath its steady state level in periphery. Additionally, higher consumption prices in periphery extrude households' consumption from core (exports) and lead to a further decrease in labor and drop in output.

In core, labor increases and output by far exceeds its steady state level, while higher import prices channel households' activity from consumption of imports to savings. The recovery process is significantly prolonged, reflected in periphery's current account against the core, which is still negative after 40 periods, as well as private and public capital that point to an extended phase of cross-border flows relative to the baseline scenario.

Thus, additional public capital flows create inflation differentials between the two regions and consequently real exchange rate misalignments within the euro area: TARGET2 enables countries in periphery to stabilize and even increase their (import) consumption. However, this comes at the cost of a severe and persistent drop in output and current account. Core countries, on the other hand, heavily increase their exports, which leads to an increase in output, while consumption of non-durable goods stays low.

4.5 Sensitivity Analysis

The sensitivity analyses for a peripheral risk shock for the three cases of (1) the baseline scenario, (2) deleveraging, and (3) deleveraging & TARGET2 assess differences in macroeconomic adjustments in core versus periphery and illustrate the stabilization effects of TARGET2. The section closes with the introduction of a ZLB, that amplifies the negative effects on output and consumption and leads to stronger deflationary processes.

Table 4.3 supports the simulation results, that additional TARGET2 flows stabilize credit to borrowers in periphery relative to pure deleveraging, but increase the volatility of credits to borrowers in core. Volatility in consumption increases in both regions, albeit for different reasons: Households in periphery consume more imported goods with public capital inflows, yet extrude core households' consumption due to beneficial terms of trade. Low inflation volatility in periphery due to a moderated fall in prices contrasts with destabilizing effects of TARGET2 in core, leading to higher deflation. This contrast is also reflected in the interest rate volatility. While additional TARGET2 flows stabilize interest rates in periphery, deflation rates cause higher volatility in core.

In summary, the substitution of private through public capital reveals a rather destabilizing effect, particularly in the core region. This relates to the disturbing effects of beneficial terms of trade in the NFA position, caused by additional public financing in a system of international capital flows.

Sensitivity analyses for alternative values of the parameter ζ_{T2} in parentheses show that lowering the parameter ζ_{T2} to 0.1 brings volatility values close to a case of pure deleveraging. However, NFA positions indicate an increase in volatility for parameter values $\zeta_{T2} = [0; 0.7]$, as (low) TARGET2 flows are out-weighed by the prolonged stabilization of NFA positions due to a disturbance of cross-border flows.

Table 4.3 Theoretical moments - Comparison of standard deviations (in %)

		Baseline	**Deleveraging**	**Deleveraging & TARGET2**
Variable		Risk	Risk	Risk
NFA		0.68	1.29	1.34 (1.41)
Current Account		0.04	0.05	0.42 (0.07)
Credit Borrowers				
	Core	0.05	0.06	0.45 (0.1)
	Periphery	1.26	9.45	7.43 (8.98)
Consumption				
	Core	0.04	0.05	0.36 (0.07)
	Periphery	0.21	0.25	0.46 (0.25)
Inflation				
	Core	0.01	0.02	0.07 (0.02)
	Periphery	0.09	0.10	0.07 (0.09)
Interest Rate				
	Core	0.03	0.04	0.05 (0.04)
	Periphery	0.05	0.08	0.06 (0.08)

Note: Table 4.3 reports the comparison of standard deviations (in %) between the three cases 1. baseline scenario 2. deleveraging in periphery and 3. Deleveraging in periphery plus TARGET2 assistance for the risk premium shock in periphery (sudden stop); numbers in parentheses indicate sensitivity results for lower $\zeta_{T2} = 0.1$.

Zero Lower Bound (ZLB)

The simulation of TARGET2 at the ZLB ties in with the wide-ranging debate on the economic consequences when the short-term nominal interest rates are at or near zero, limiting central banks to fight deflation.

Figure 4.5 resembles the results from Figure 4.4 for key variables in a ZLB environment. To implement a ZLB, we make use of the perturbation approach as in (Iacoviello and Neri, 2010). Note that in our model, interest rates are jointly determined by a mutual central bank and deviate slightly due to region-specific premia. Hence, TARGET2 increases risk premia on interest rates in GIIPS due to higher foreign indebtedness (see Section 4.4) and mitigate the economic effects of a ZLB in periphery.

The lower bound on nominal interest rates leads to intensified and prolonged deflationary processes that amplify the recession (e.g. Arce et al., 2016; Justiniano et al., 2015):

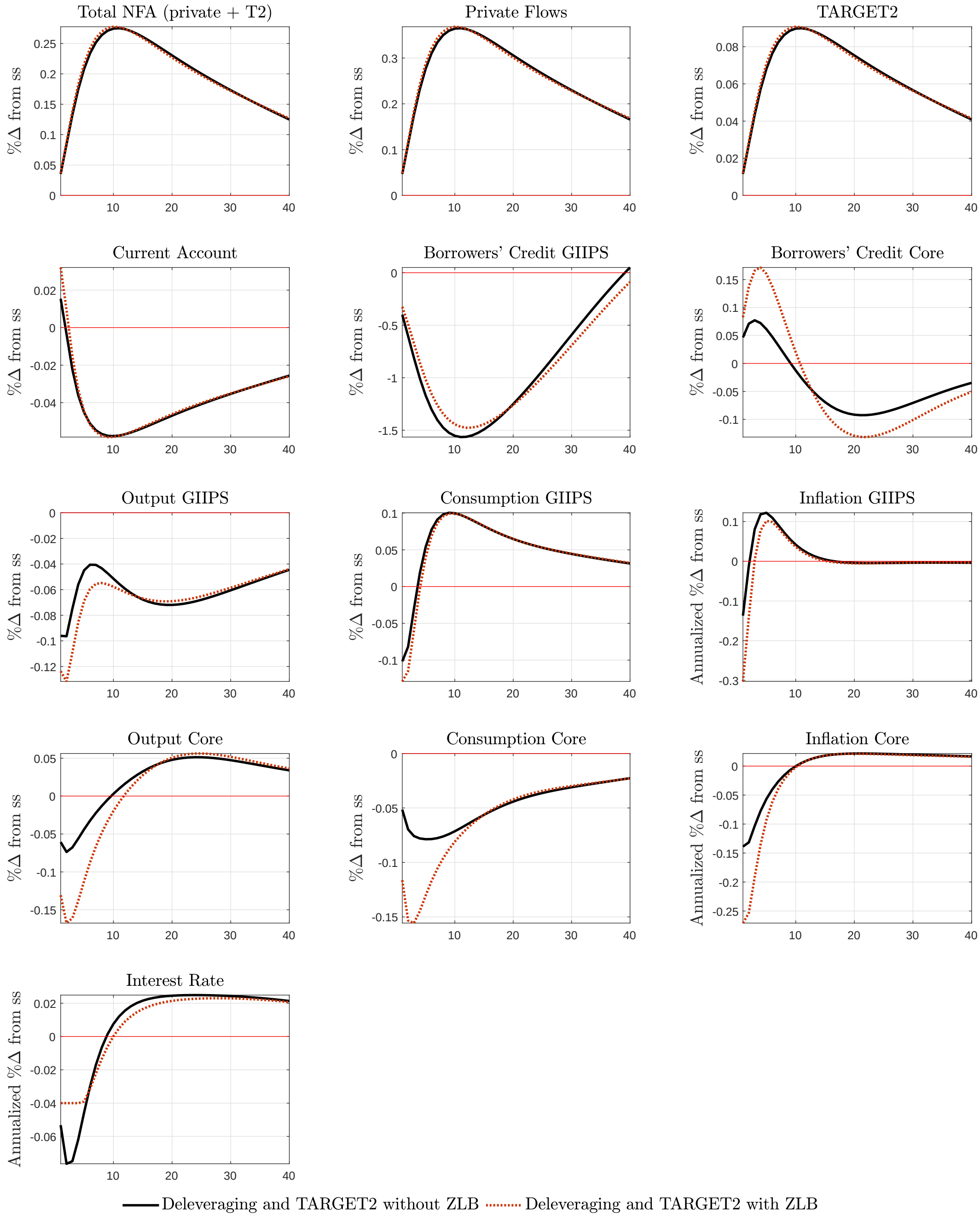


Figure 4.5 Risk shock in periphery: Private capital flows and economic effects at the ZLB

in both regions relatively higher interest rates make savings more attractive relative to consumption. Financial intermediaries lend money at increased interest rates to borrowers. The tightening balance sheet of borrowers delays the deleveraging process (Benigno et al., 2016). An overall drop in consumption affects the profits of firms and forces down wages and, consequently, labor. Output decreases while prices deteriorate and lead into a deflationary spiral with limited option for central banks to intervene. However, interest rate and inflation differentials between regions due to TARGET2 lead to stronger effects of a ZLB on core variables.

4.6 Conclusion

This chapter uses a two-sector two-region model with financial frictions to analyze the role of the euro area's payment system TARGET2 in the adjustment to a sudden stop of private capital and subsequent deleveraging processes. We contribute to the existing literature on TARGET2 by examining (i) cross-border capital flows and the macroeconomic adjustment of euro area Member States, (ii) the mitigation of private deleveraging and (iii) the behavior of key macroeconomic variables when a Zero Lower Bound intensifies the deleveraging process.

In this chapter, we make several findings. First, the historical shock decomposition confirms the existence of post-crisis sudden stops for the GIIPS. Second, TARGET2 impedes recovery processes and leads to higher economic divergence within monetary union due to adverse terms of trade developments: The substitution of private by public capital leads to inflation differentials between core and peripheral euro area countries. Beneficial terms of trade for consumers in periphery maintain negative current account levels. On the contrary, core's consumption drops with additional TARGET2 flows, as households tend to increase their savings and reduce their import demand from periphery. As a consequence, output in periphery drops considerably, while output in core increases. A sensitivity analysis confirms that access to TARGET2 has a slightly destabilizing effect within the euro area. Output, consumption and current account volatilities increase relative to a case of pure deleveraging.

The results are robust to changes in the liquidity provision by the central bank. The lower TARGET2 liabilities in GIIPS, the closer we get to the case of pure deleveraging concerning volatility of key macroeconomic variables such as consumption and output.

The alternative scenario with constrained monetary policy at the ZLB shows that the euro area is driven into prolonged deflationary processes, aggravating the effects of deleveraging on consumption and output in both regions. However, inflation differentials between core and periphery caused by TARGET2 lead to more pronounced effects of a lower bound on interest rates in the core region.

Our analysis contributes to the controversial debate on the macroeconomic effects of TARGET2 balances with distributional aspects of disturbed cross-border capital flows within the euro area. The TARGET2 payment system is of crucial importance for smooth cross-border transfers within the Monetary Union. Nonetheless, the need for reforms to improve the workings of the euro area's payment system calls for further research. Considering our results, one key aspect would be targeting real exchange rate misalignments between core and peripheral euro area countries.

4.7 Appendix

4.7.1 Data and Sources

The estimation of the two-region DSGE model includes 14 observables for the EMU. Thereby, six observables are designated to the core economy (y_t^{data}, $c_t^{tot,data}$, $inv_t^{tot,data}$, $s_t^{B,data}$, ca_t^{data}, dpd_t^{data}), another six observables are linked to GIIPS ($y_t^{*,data}$, $c_t^{*,tot,data}$, $inv_t^{*,tot,data}$, $s_t^{B*,data}$, $ca_t^{*,data}$, $dpd_t^{*,data}$) and two observables are used for the entire euro area ($dpemu_t^{data}$, r_t^{data}). The data except the EURIBOR is seasonally adjusted. The X-12-ARIMA adjustment process, in most of the cases a one-sided HP filter, was applied to detrend the data.

GDP: Seasonally adjusted data for the *gross domestic product at market value* denoted by y_t^{data} for the core and $y_t^{*,data}$ for the periphery. Source: Eurostat (*namq*_10_*gdp*).

Consumption: *household and NPISH final consumption expenditure.* Modified data is provided by $c_t^{tot,data}$ for core and $c_t^{*,tot,data}$ for periphery. Source: Eurostat (*namq*_10_*gdp*).

Investment: *gross fixed capital formation* denoted by $inv_t^{tot,data}$ for the core and $inv_t^{*,tot,data}$ for the periphery. Source: Eurostat (*namq*_10_*gdp*).

Credit to Borrowers: Data for Ireland is available from 2002Q1 onwards, only. Data used is *credit to households and NPISH* denoted by $s_t^{B,data}$ for the core and $s_t^{B*,data}$ for the periphery. Source: BIS.

Current Account: Data for Greece and Ireland is available from 2002Q1 onwards, only. The data used is the *current account.* Modified data is provided by ca_t^{data} for core and by $ca_t^{*,data}$ for periphery. Current account is the only variable divided by GDP instead of taking the logarithm. Source: Eurostat (*bop_c6_q*).

Consumption Prices: The CPI is given by the Harmonized Index of Consumer Prices *HICP* to describe union wide inflation in non-durable prices with quarter on quarter logarithmic differences, denoted by $dpemu_t^{data}$. Source: ECB ECB Statistical Data Warehouse.

Investment Prices: This input variable represents the change in the prices of durable goods. The data used is the seasonally adjusted *real house prices* index with quarterly logarithmic differences to describe the differences in durable prices per period. Modified data for the core area is given in dpd_t^{data} for the core and in $dpd_t^{*,data}$ for the periphery. Source: OECD.

Nominal Interest Rate: The *three month EURIBOR* data enters the model using r_t^{data}. Interest rates are not seasonally adjusted. Source: ECB Statistical Data Warehouse.

4.7.2 Shock Processes

The shocks evolve according to the following AR(1) processes:

$$
\begin{aligned}
\vartheta_t &= \rho_{\vartheta}\vartheta_{t-1} + \epsilon_{\vartheta} \\
log(\sigma_{\omega,t}) &= (1-\rho_{\sigma_\omega})log(\bar{\sigma}_{\omega}) + \rho_{\sigma_\omega}log(\sigma_{\omega,t-1}) + u_{\omega,t} \\
log(\sigma^*_{\omega,t}) &= (1-\rho_{\sigma_\omega})log(\bar{\sigma}^*_{\omega}) + \rho_{\sigma_\omega}log(\sigma^*_{\omega,t-1}) + u^*_{\omega,t} \\
\xi^D_t &= \rho_{\xi^D}\xi^D_{t-1} + \epsilon_{\xi^D} + \epsilon_{\xi^D,COM} \\
\xi^{D*}_t &= \rho_{\xi^{D*}}\xi^{D*}_{t-1} + \epsilon_{\xi^{D*}} + \epsilon_{\xi^{D*},COM} \\
\xi^C_t &= \rho_{\xi^C}\xi^C_{t-1} + \epsilon_{\xi^C} \\
\xi^{C*}_t &= \rho_{\xi^{C*}}\xi^{C*}_{t-1} + \epsilon_{\xi^{C*}} \\
Z^C_t &= \rho_{Z^C}Z^C_{t-1} + \epsilon_{Z^C,t} + \epsilon_{Z^C,COM} \\
Z^{C,*}_t &= \rho_{Z^{C,*}}Z^{C,*}_{t-1} + \epsilon_{Z^{C,*},t}\epsilon_{Z^{C,*},COM} \\
Z^D_t &= \rho_{Z^D}Z^D_{t-1} + \epsilon_{Z^D,t} \\
Z^{D,*}_t &= \rho_{Z^{D,*}}Z^{D,*}_{t-1} + \epsilon_{Z^{D,*},t}
\end{aligned}
$$

However, the non-stationary innovation to the union-wide technology shock ε^A_t and the monetary policy shock ε^m_t are *i.i.d.*

4.7.3 Estimation Results

Posterior estimates

Table 4.4 Prior and posterior distribution of shock persistence parameters

		Prior			Metropolis Hastings		
	Parameter	Type	Mean	SD	Mean	90% HPD Interval	
ρ_{ϑ}	Risk premium, int.	Beta	0.7500	0.1000	0.8163	0.7454	0.8827
ρ_{ω}	Risk shock, durables	Beta	0.7500	0.1000	0.7974	0.7610	0.8348
ρ_{ω}^{*}	Risk shock, durables*	Beta	0.7500	0.1000	0.9163	0.8744	0.9566
$\rho_{\xi,D}$	Preference shock, durables	Beta	0.7500	0.1000	0.8813	0.7832	0.9654
$\rho_{\xi,D}^{*}$	Preference shock, durables*	Beta	0.7500	0.1000	0.9539	0.9391	0.9918
$\rho_{\xi,C}$	Preference, non-durables	Beta	0.7500	0.1000	0.9220	0.8753	0.9680
$\rho_{\xi,C}^{*}$	Preference, non-durables*	Beta	0.7500	0.1000	0.8005	0.6374	0.9640
$\rho_{Z,C}$	Technology., non-durables	Beta	0.7500	0.1000	0.8598	0.7898	0.9250
$\rho_{Z,C}^{*}$	Technology, non-durables*	Beta	0.7500	0.1000	0.8823	0.8232	0.9484
$\rho_{Z,D}$	Technology, durables	Beta	0.7500	0.1000	0.7615	0.6174	0.9154
$\rho_{Z,D}^{*}$	Technology, durables*	Beta	0.7500	0.1000	0.9494	0.9138	0.9881

Note: Asterisks(*) indicate persistence parameters for peripheral shocks.

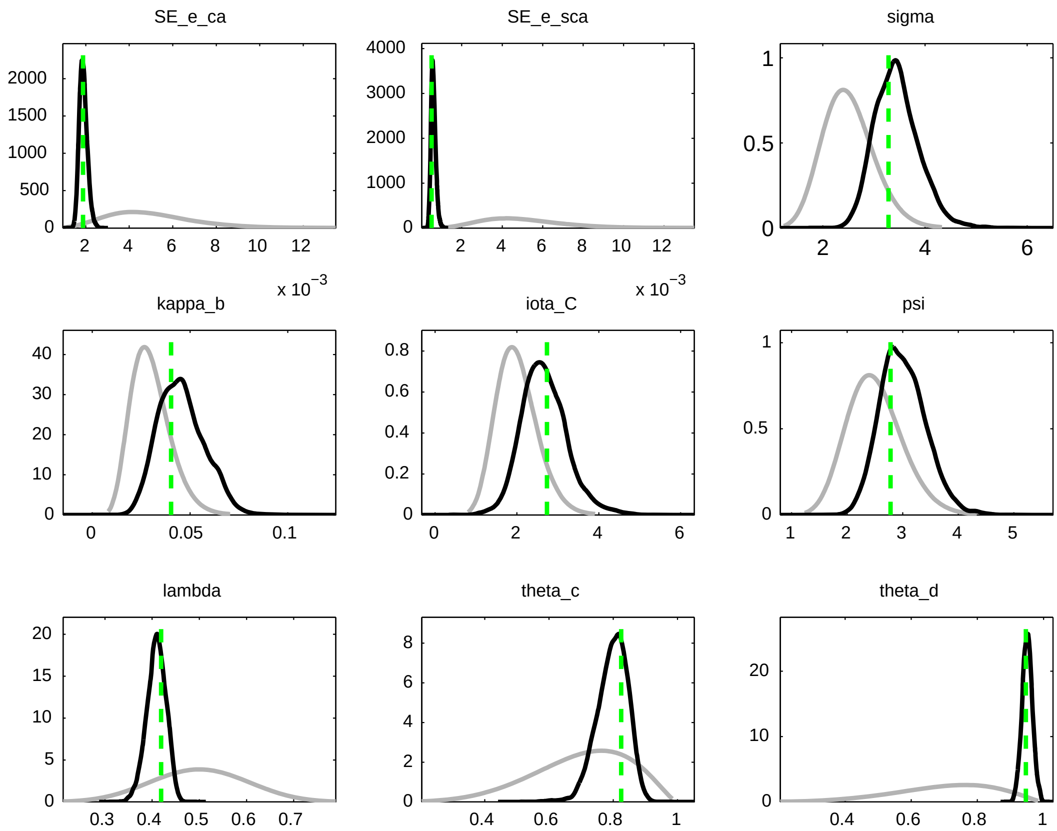
Table 4.5 Prior and posterior distribution of shock standard deviations

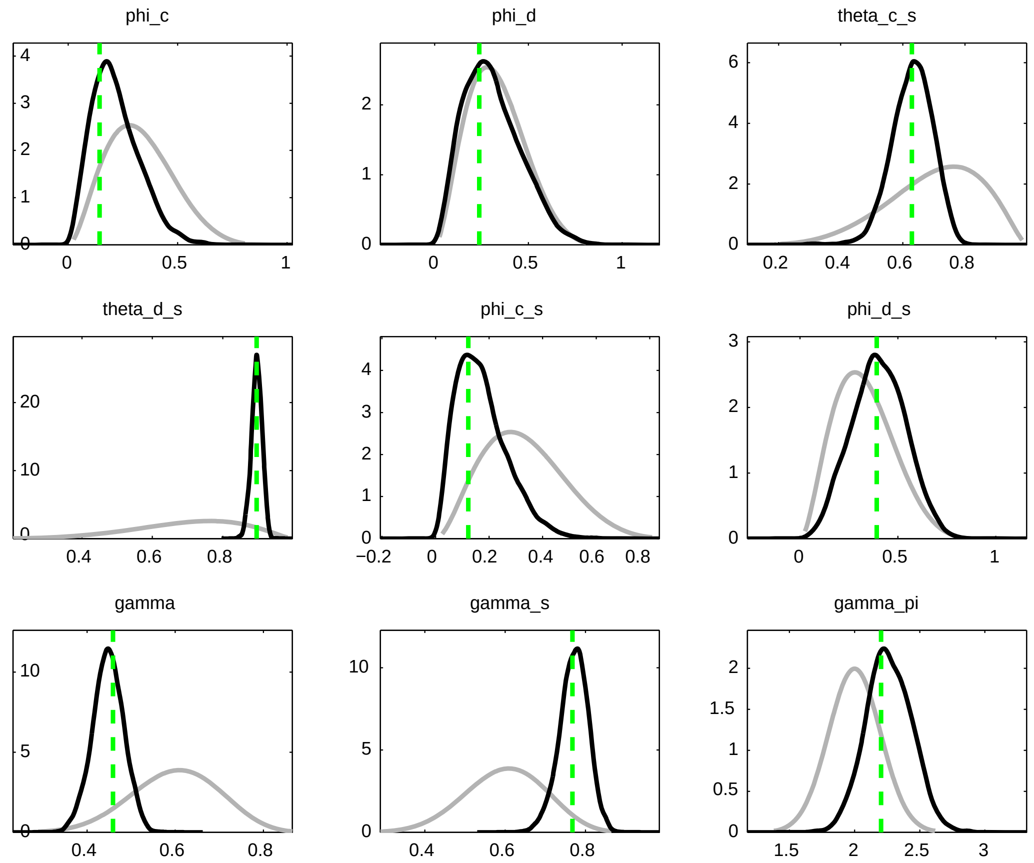
	Parameter	Prior			Metropolis Hastings		
		Type	Mean	SD	Mean	90% HPD Interval	
σ_m	Monetary	Gamma	0.0050	0.0020	0.0014	0.0010	0.0017
$\sigma_{u_\omega,t}$	Risk shock, durables	Gamma	0.2500	0.1250	0.1620	0.1264	0.1998
$\sigma^*_{u_\omega,t}$	Risk shock, durables*	Gamma	0.2500	0.1250	0.1166	0.0751	0.1555
σ_ϑ	Risk premium	Gamma	0.0050	0.0020	0.0027	0.0018	0.0035
σ_ξ^D	Pref., durables	Gamma	0.0100	0.0050	0.0150	0.0031	0.0256
σ_ξ^{D*}	Pref., durables*	Gamma	0.0100	0.0050	0.0140	0.0045	0.0224
$\sigma_\xi^{D,COM}$	Pref., durables, EMU	Gamma	0.0100	0.0050	0.0138	0.0054	0.0222
σ_ξ^C	Pref., non-durables	Gamma	0.0100	0.0050	0.0076	0.0053	0.0098
σ_ξ^{C*}	Pref., non -durables*	Gamma	0.0100	0.0050	0.0046	0.0020	0.0072
σ_Z^D	Tech., durables	Gamma	0.0070	0.0020	0.0072	0.0038	0.0103
σ_Z^{D*}	Tech., durables*	Gamma	0.0070	0.0020	0.0113	0.0077	0.0151
σ_Z^C	Tech., non -durables	Gamma	0.0070	0.0020	0.0072	0.0045	0.0098
σ_Z^{C*}	Tech., non -durables*	Gamma	0.0070	0.0020	0.0046	0.0028	0.0063
$\sigma_Z^{C,COM}$	Tech., non -durables, EMU	Gamma	0.0070	0.0020	0.0058	0.0041	0.0074
σ_{EMU}	Technology, EMU	Gamma	0.0070	0.0020	0.0030	0.0019	0.0041

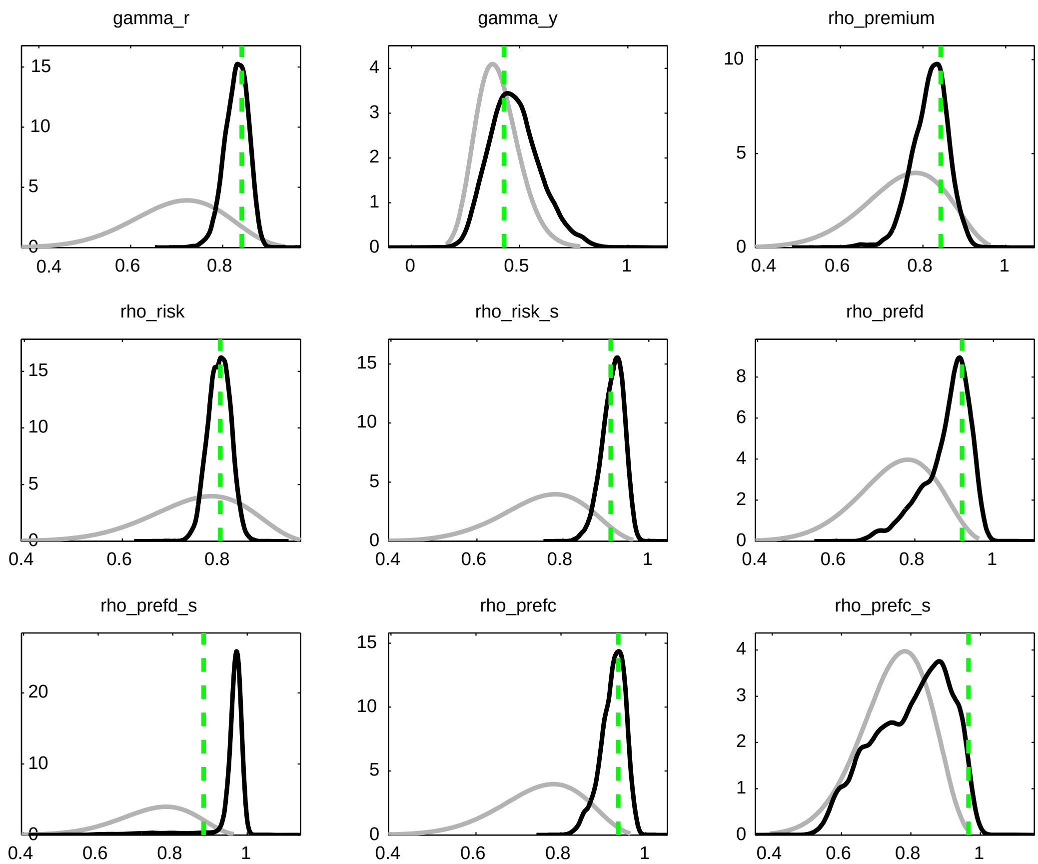
Note: Tech.=Technology; Pref.=Preferences; EMU indicates shocks affecting both areas simultaneously;
Asterisks(*) indicate shocks on the peripheral area.

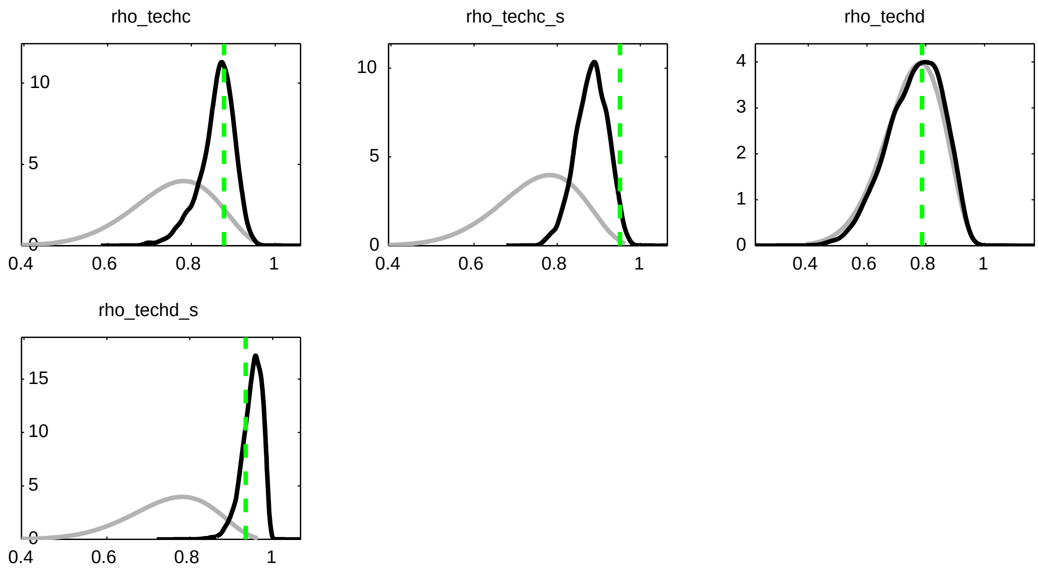
Prior and Posterior Distribution

The estimation generated the following prior-posterior mode plots:




phi_c
phi_d
theta_c_s
theta_d_s
phi_c_s
phi_d_s
gamma
gamma_s
gamma_pi


gamma_r
gamma_y
rho_premium
rho_risk
rho_risk_s
rho_prefd
rho_prefd_s
rho_prefc
rho_prefc_s


rho_techc
rho_techc_s
rho_techd
rho_techd_s

Chapter 5

European Safe Assets

Chapter 5 stems from a research project at the European Commission's Directorate-General for Economic and Financial Affairs (DG ECFIN) in coordination with Lukas Vogel. I would like to thank in particular Werner Roeger and Lukas Vogel for their very helpful comments and suggestions.

5.1 Introduction

The 2010–2012 euro area sovereign debt crisis revealed a mutually weakening between sovereigns and the domestic bank sector in the euro area. Large exposures of banks to the domestic government in form of sovereign bond holdings gave rise to negative feedback loops between banks and governments, so called 'doom loops'. This sovereign bank nexus occurred predominantly in peripheral euro area countries like Greece and Italy, where troubles in balance sheets and sovereign fragility reinforced each other and led policy makers, economists and academics to conclude this phenomenon to be a key feature of the euro area crisis. Evaluating the relationship between sovereigns and banks, the empirical literature shows that sovereign bailouts lowered banks' default risk and that the default risks of sovereigns and banks are positively correlated (Acharya et al., 2014). These findings accord with theoretical feedback loop models by Brunnermeier et al. (2016) and Cooper and Nikolov (2018) that indicate the potential for inefficient equilibria, the doom loops, of high domestic sovereign exposures of banks.

On the policy side, progress has already been achieved in increasing bank capital requirements to fulfil the BASEL III Liquidity Coverage Ratio (Brunnermeier et al., 2016; Sode and Faubert, 2013) and to establish the new bank resolution framework. However this regulatory framework supports (domestic) sovereign holdings, including the liquidity standards or the zero risk weights on domestic government bonds irrespective of sovereign risk. Therefore, banks' exposures to domestic sovereigns are still very high (Brunnermeier, 2017). The Organisation for Economic Co-operation and Development (OECD) (OECD, 2018) calculates an average share of 70% of domestic sovereign bonds in banks' portfolio of sovereign bonds in the euro area (Figure 5.1). Thus, a policy option for improving financial stability across the euro area could be to increase the diversification of banks' sovereign debt holdings by pooling sovereign debt of Member States in the euro area and issuing common safe assets.

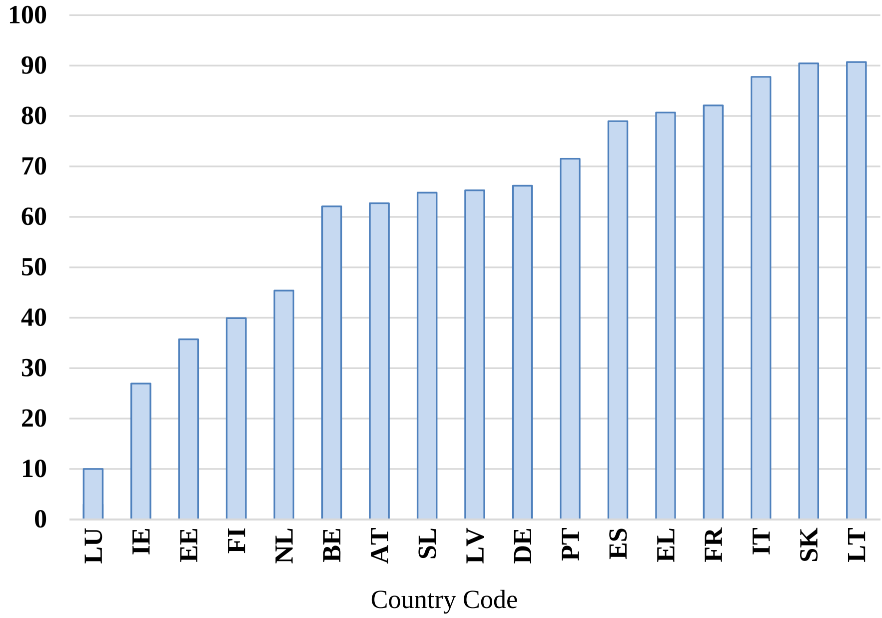


Figure 5.1 Share of domestic sovereign bonds in banks' portfolios of sovereign bonds in %

This would require cross-border integration of banking and financial markets, so as to make economies less dependent on the health of the domestic banking sector and to decrease the home bias in banks' sovereign debt holdings. Broner et al. (2014) determine a higher home bias in sovereign debt holdings to be welfare-reducing. Crowding out effects lower private credit and investment, and thus economic growth. Banks that acquire euro-wide safe assets instead of (riskier) country-specific sovereign bonds can avoid the sovereign bank nexus that was even more severe for peripheral euro area countries in the sovereign debt crisis. Furthermore, a pooled area-wide safe asset might prevent capital flights from peripheral to core euro area countries, thus avoid harmful sudden stops in the respective countries (see Kraus et al., 2019). Lastly, a euro-denominated safe asset could homogenize the bond market at the euro area level and increase the supply of European and global safe assets (Leandro and Zettelmeyer, 2018).

In order to break up the diabolic sovereign bank nexus, Brunnermeier et al. (2016) propose a shift in banks' sovereign debt holdings to a diversified euro area sovereign bonds portfolio, more specifically to the safe senior tranche of the euro area-wide bond with little exposure backed by junior tranches, in order to replace national sovereign debt in banks' balance sheets by more diversified and senior assets.

The motivation of safe assets for the euro area changed over time. Initially, the idea of a 'Eurobond' envisaged the guarantee by the Member States (De Grauwe and Moesen, 2009). As public guarantees has been rejected by relatively 'safe' euro area sovereigns, such as Germany and the Netherlands, alternative proposals with reduced or even eliminated guarantees have been made: First proposals concentrated on supporting financial integration and the single market in the euro area and set out the pooling of sovereign debt with joint liabilities (Juncker and Tremonti, 2010; Monti, 2010). Recently, literature concentrates on supply side effects of safe assets and the restriction in banks' domestic sovereign exposures. They offer different path to the creation on a common euro area-wide safe asset, whereby non of these proposals stipulate explicit guarantees by the Member States. Leandro and Zettelmeyer (2018) provide a comprehensive overview, reaching from (1) pure national tranching, (2) a euro area-wide senior security backed (ESBies) that is subtranched by junior backed securities (EJBies), (3) a diversified pool of national debt (E-bonds) with debt mutualization and accompanying national junior bonds, to (4) one single euro area budget. However, while ESBies (Brunnermeier et al., 2016) and national tranching do not entail cross-country redistribution in case of national defaults, other proposals like E-bonds (e.g. Hild et al., 2014) and the euro area budget (Ubide, 2015) involve at least some form of joint liability, depending on their design.

The proposals differ with regard to diversification and tranching. While the first proposal of national tranching is the tranching of purely national sovereign debt, the second proposal is a combination of tranching and pooling, where intermediaries - public or private - issue debt securities in two tranches (ESBies and EJBies) backed by a diversified portfolio of euro area sovereign bonds. Critics argue that there could be little demand for risky junior tranches (EJBies) of first diversified and then tranched euro area debt, as they have to be sufficiently large to make ESBies as safe as German sovereign bonds. The third proposal of E-bonds, which is closest to our modelling apporach, reverses the order of tranching and diversification. A public intermediary first tranches debt in each Member State in senior and junior tranches, where the senior tranches could subsequently be bundled and issued as E-bonds. However, earlier proposals of E-bonds refer to the untranched bonds issued by a senior intermediary as E-bonds.

All proposals have in common that they aim at increasing the supply of safe assets and, except in the case of national tranching, at replacing national (more risky) sovereign bonds on bank balance sheets by a single pooled bond for the euro area (Brunnermeier et al., 2017). Safe assets should enable regions that have a shortage of safe national sovereign bonds to restructure their bank balance sheets and increase the proportion of safe assets in their government bond holdings by pooling, thereby reducing the home bias in sovereign debt.

While the literature so far provides numerous claims on the positive overall effects, based on the design of such safe assets, a consistent macroeconomic analysis is still missing. We depart from a comprehensive model that addresses the volume requirements and sufficient subordination levels for the euro area-wide asset to be considered as safe, and focus on the effects of bank balance sheet resturcturing towards such a safe asset that is pooled across regions. To our knowledge, we provide a first DSGE model approach to address tranching and pooling of cross-border portfolios of sovereign bonds and to assess the macroeconomic effects of bank balance sheet restructuring from riskier (domestic) towards safe euro area-wide assets. The international diversification of (safe) government bond holdings by banks mitigates the adverse feedback loop between banks and the domestic government.

The model uses a two-region (core-periphery) extension of the European Commission's QUEST model with a banking sector and financial frictions. The paper focuses on the implementation of a euro area-wide safe asset of pooled sovereign debt and highlights the elements of bank balance sheet restructuring under senior (safe) assets, alongside national junor (riskier) assets. This creation of a common safe asset enables banks to diversify their sovereign bond holdings with pooled euro area-wide assets and to reduce the home bias in bank balance sheets. A shift in bank balance sheets from riskier national bonds to safe euro area bonds, and consequently a shift in households balance sheets has direct consequences for shock stabilization, in this case the stabilization of a government risk shock. In doing so, we refrain from the analysis of multiple self-fulfilling equilibria, which can generate risk premia on sovereign bonds that are not justified by fundamentals. The emergence of multiple self-fulfilling equilibria might be an important aspect of the diabolic loop between sovereigns and banks. We refrain from quantifying these mechanisms and focus on a scenario in which self-fulfilling equilibria are ruled out. Instead the stabilization gains by bank balance sheet restructuring in crisis times in this paper are entirely due to improved international fundamental risk sharing within the euro area.

First, we describe the model and the implementation of a common safe asset class by pooling safe national sovereign debt, alongside riskier national debt, where banks hold predominantly risky domestic sovereign bonds. Then, we consider a scenario of bank balance sheet restructuring towards safe asset holdings. In order to assess the differences in the two states of government bond holdings by banks (before and after the restructuring measures), we simulate a shift of 10% from risky to safe assets in bank balance sheets. Hereby, we depart from volumes and subordination requirements of safe assets and assume that safe assets can be produced in sufficient volume. Finally, we provide first insights into the stabilizing effects of bank balance sheet restructuring under a sovereign risk shock in the periphery.

Results show that a bank balance sheet restructuring in both regions leads to an increase in risky asset holdings by households in both regions, however at lower long-term bond prices and increased term premia. Additionally, after a sovereign risk shock in periphery the increase of safe E-bonds in bank balance sheets stabilizes GDP in both regions and decreases government debt relative to GDP.

The remainder of this chapter proceeds as follows. Section 5.2 describes the model extension as well as the basic mechanisms of the theoretical model, and Section 5.3 summarizes crucial calibrated parameters. To illustrate the macroeconomic effects of euro area-wide bank balance sheet restructuring, Section 5.4 presents simulation results for a) a pure 10% shift from risky towards safe asset holdings as well as alternatively b) bank balance sheet restructuring under a sovereign risk shock in the periphery. Section 5.5 concludes and addresses some policy implications of our analysis and recommendations for future research.

5.2 Model Structure

This paper extends the QUEST model to study the domestic and euro area-wide effecs of financial shocks. The QUEST model features a sovereign risk channel, by allowing banks and households to hold domestic government bonds (Breuss et al., 2015; Corsetti et al., 2013). The model distinguishes between countries called ’periphery’ that suffer from financial and sovereign risk shocks like Greece, Ireland, Italy, Portugal and Spain as well as a remaining group of countries called ’core’ that are not directly affected. In order to focus on the introduction of common euro area safe assets, we model two symmetric regions with equal size. For the sake of brevity, we forego and concentrate on the main contributions of our paper, i.e. the integration of a common (safe) asset for the euro area alongside riskier domestic assets and the effects on balance sheets of banks and households. The model closest to ours is Roeger et al. (2019), which examines risk sharing and the implementation of a common deposit insurance scheme as well as wider portfolio diversification across regions. The model description is mostly taken from Roeger et al. (2019) and Breuss et al. (2015).

The international capital mobility is limited to some extent: We assume that in the fragmentation benchmark, international sovereign asset holdings are restricted to euro area-wide safe assets. In particular, banks and households trade deposits internationally in a money market. However, long-term (riskier) government bonds are not traded across euro area countries. This a very restrictive assumption that serves to establish an international fragmented financial market. Firms in both regions produce internationally traded goods.

The model builds on model features in Iacoviello (2005) that differentiate households into borrowers and savers, and further saver households into more risk averse savers, that hold the deposits and bonds issued from the government sector, and less risk averse equity owners. Savers and borrowers in the household sector differ with respect to their rate of time preference β. We differentiate between saver households with a low rate of time preference, who put their deposits into banks, and borrower households with a high rate of time preference, who receive loans from banks. Banks lend money to borrowers in form of loans for investment and consumption. The loan supply to the corporate non-financial sector is neglected in this model. The banking sector holds a fixed share of the shares by the corporate sector[1]. Monetary policy is carried out by an euro area-wide central bank (Breuss et al., 2015).

Safe and risky assets

We refer to safe assets as *E-bonds*, the closest form to safe assets in our model framework. E-bonds are modelled as a diversified pool of national (safe) debt and accompanying national junior (risky) debt. Therefore, we first tranche government debt into risky

[1]Shares of non-financial corporations and banks are held by equity owners, thus equity owners own all corporations.

and safe government debt, and second pool safe government bonds across core and periphery. The diversified pool of national government debt is issued as E-bonds to first banks and second saver households, while risky government debt is issued to national banks and households only. E-bonds are supposed to change the structure of banks' balance sheets. Figure 5.2 summarizes the structure of sovereign bonds.

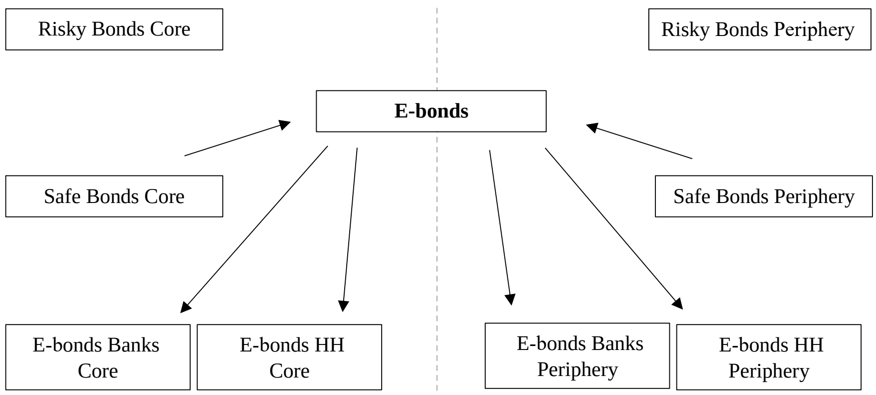


Figure 5.2 Sovereign bonds structure

We follow Priftis and Vogel (2016) and assume different asset classes. Assets with different maturities are imperfects substitutes in portfolio of savers. Therefore, saver households face adjustment costs γ_b for deviating from their preferred portfolio of mainly liquid safe (short-term) assets, such that a forced shift in bank balance sheets from risky to safe and a related portfolio reallocation of households to riskier assets affects the term premium and asset prices. We introduce long-term (risky) government bonds (superscript L) as a share of total national government debt that is not traded across borders. On the contrary, short-term (safe) government debt (superscript S) is pooled from the two regions, periphery and core ($*$) euro area, according to their size s (which is set equal in our simulation). The E-bonds are then issued to banks and households in both regions:

$$B_t^{Safe} = sB_t^S + s^* B_t^{S*} \tag{5.1}$$

Following Woodford (2001), Chen et al. (2012), and Priftis and Vogel (2016), finite long-term government bonds are modelled as risky bonds (liquidity motive), for which the face value depreciates with δ_b. Long-term government bonds pay a coupon τ in each period, which is a small share of the face value. The period t price of a long-term bond issued in t (p_t^G) equals the discounted value of future payments:

$$p_t^G = \sum_{n=0}^{T} \frac{\delta_b^n}{(1+i)^{1+n}} \tau \tag{5.2}$$

where T is the maturity period of the bond. Analogously, the price in period t of a long-term bond issued in *t-1* ($p_t^{\tilde{G}}$) equals the discounted sum of outstanding payments:

$$p_t^{\tilde{G}} = \sum_{n=0}^{T-1} \frac{\delta_b^{1+n}}{(1+i)^{1+n}} \tau \tag{5.3}$$

If $\frac{\delta_b}{(1+i)} < 1$ and T is large, the price in t of long-term bonds issued in *t-1* approximates to the price of newly issued government bonds times the depreciation rate:

$$p_t^{\tilde{G}} \approx \delta_b p_t^G \tag{5.4}$$

Equation (5.4) determines the price of the long-term bond that declines over time with δ_b, where we assume that the long-term bonds in the model have 10-year maturity, such that one 40^{th} of the long-term bonds matures each quarter.

Total government debt consists of long-term bonds B_t^L and short-term bonds B_t^S:

$$B_t = B_t^L + B_t^S \tag{5.5}$$

where B_t^S is pooled across regions to B_t^{Safe} and issued to banks and households.

From the outstanding long-term bonds, $B_t^{L,H}$ are held by the private sector and $B_t^{L,B}$ by banks[2]:

$$B_t^L = B_t^{L,H} + B_t^{L,B} \tag{5.6}$$

We assume that long-term bonds held by banks account for a steady state share s^L of the stock of long-term government debt, and safe short-term assets are predominantely held by households in steady state:

$$B_t^{L,B} = s^L B_t^L \tag{5.7}$$

The model relates to the formulation of portfolio preferences/adjustment costs by, e.g., Andrés et al. (2004), Falagiarda (2013), and Priftis and Vogel (2016) and introduces imperfect substitutability between safe and risky bonds, which takes the form of quadratic portfolio adjustment costs. In particular, households prefer holding safe short-term bonds, and the holding of risky assets generates quadratic adjustment costs, which are scaled by the parameter γ_b.

Corporate sector

The *non-financial corporate sector* produces output under a Cobb-Douglas production function with capital and labor (Breuss et al., 2015):

$$Y_t = K_t^{1-\alpha} N_t^{\alpha} (Z_t^Y)^{\alpha} \tag{5.8}$$

with

$$N_t = \left[\int_0^1 {N_t^i}^{\frac{\theta-1}{\theta}} di \right]^{\frac{\theta}{\theta-1}}$$

[2]Note, that in the steady state households have a preference for holding safe short-term bonds.

The constant elasticity of substitution (CES) function N_t of labor supply by household types i captures the substitution elasticity θ between labor household types. The non-financial corporations issue outstanding shares S_t^{NF} at price q_t^{NF} (Breuss et al., 2015). The cash flow is given as dividends div_t^{NF}:

$$div_t^{NF} = (Y_t - w_t N_t) - p_t^I J_t + q_t^{NF} \Delta S_t^{NF} \tag{5.9}$$

The maximization problem for the non-financial corporate sector includes the present discounted value of dividends to the equity owners.

$$\begin{aligned} V_0^{NF} &= E_0 \sum_{t=0}^{\infty} \prod_{j=0}^{t} \left(1 + r_{t+j}^E\right)^{-1} \left[div_{t+j}^{NF}\right] \\ &\quad - E_0 \sum \lambda_t \beta^t \left[K_t - J_t Z_t^J - (1-\delta) K_{t-1}\right] \end{aligned} \tag{5.10}$$

Z_t^Y is an economy-wide technology shock and Z_t^J is a technology shock that is specific to investments J.[3]

The *banking sector* invests in long- and short-term government bonds. Long-term government bonds $B_t^{B,L}$ held by the bank are perpetuities which pay, as for households, a coupon τ each period and have a price p_t^G.

It is assumed that banks are holding a fixed value of long-term government bonds for liquidity reasons, alongside safe euro area-wide $B_t^{B,Safe}$. Short-term government bonds in both regions are pooled to E-bonds according to their size and emitted to first banks $B_t^{B,Safe}$ (and second households $B_t^{H,Safe}$) in the two regions. Bank holdings of pooled E-bonds in core and periphery is fixed by the steady state share of safe national government debt in both regions, such that valuation losses on sovereign debt (e.g. by a government risk shock) require recapitalization with risky bonds by domestic equity owners and thus lower dividend payments.

[3] Prices are given relative to the GDP deflator.

Additionally, banks hold deposits D_t of savers and money market loans F_t^B and give loans L_t to borrowers $\left(L_t + p_t^G B_t^{B,L} + B_t^{B,Safe} - D_t - F_t^B\right)$. The bond market between domestic and foreign banks is characterized by F_t^B. The money market is a deposit market, where interbank loans and deposits are perfect substitutes up to a risk premium γ_f that rises with interbank indebtedness (negative F_t^B). The bank faces an additional quadratic constraint for holding excessive deposits as a fraction Γ^L of total loans. Less capital than required in relation to the loan supply in the balance sheet generates costs for the banks. Thus, $\left(D_t + F_t^B - \Gamma^L \left(L_t + p_t^G B_t^{B,L} + B_t^{B,Safe}\right)\right)$ are the leverage costs borne by the banks (Breuss et al., 2015).

The cash flow of banks might also be negatively affected by unexpected loan losses Λ_t^{CC} (loan shock), thus $\Lambda_t^{CC} = L_{t-1} loss_t - L_{t-1} E_{t-1} loss_t$. However, we concentrate on feedback loops that start on the government side (sovereign risk shocks) in the simulation. Domestic equity owners hold the bank shares and get the dividends div_t^B. Dividends of banks are revenues from loans, government bonds, money market bonds and changes in the stock of deposits minus interest payments for deposits of savers, government and money market bonds, and changes in the loan supply to borrowers. Dividends are the cash flow of the banks. The parameter Γ characterizes the monitoring costs $\Gamma\left(D_t + L_t\right)$ for deposits and loans in bank balance sheets (Breuss et al., 2015).

$$
\begin{aligned}
div_t^B = {} & \left(1 + r_{t-1}^L\right) L_{t-1} + \left(\tau_t B_{t-1}^{B,L} + \delta p_t^G B_{t-1}^{B,L}\right) - p_t^G B_t^{B,L} \\
& + \left(1 + r_{t-1}^{Safe}\right) B_{t-1}^{B,Safe} - B_t^{B,Safe} - \left(1 + r_{t-1}^D\right) D_{t-1} - \left(1 + r_{t-1}^F\right) F_{t-1}^B \\
& - L_t + D_t + F_t^B - \varphi/2 \left(D_t + F_t^B - \Gamma^L \left(L_t + p_t^G B_t^{B,L} + B_t^{B,Safe}\right)\right)^2 \\
& + r_t^{LL} L_t^L - \Lambda_t^{CC} - \Gamma\left(D_t + L_t\right)
\end{aligned}
\tag{5.11}
$$

In addition, the government can issue a certain amount as safe debt and has to cover additional financing needs (valuation losses) by issuing risky debt:

$$B_t^{Safe} = \Gamma^G \tag{5.12}$$

Households

Households in Breuss et al. (2015) are a continuum of different types ($h \in [0,1]$). The intertemporal utility function is similar for all household types h and specified as a nested CES function between consumption (C_t^h) and housing (H_t^h). However, the function is additive in deposits (D_t^h) and leisure/labor ($s^h - N_t^h$) with the utility weights $\vartheta^{D,h}$ and $\vartheta^{N,h}$, respectively[4]. Savers are a share (s^s) of all households indexed by s, while borrowers make up s^c of the households. Equity owners comprise a share (s^e) of the households. Following Breuss et al. (2015), deposits are captured in the utility function of savers to account for their liquidity motive. Additionally, the model includes habit persistence in consumption. Household h has the following utility:

$$\begin{aligned} U^h\left(C_t^h, H_t^h, D_t^h, 1-N_t^h\right) &= \frac{\left\{CES^h\left(C_t^h, H_t^h\right)\right\}^{1-\sigma^h}}{1-\sigma^h} \\ &\quad + \vartheta^{D,h} D_t^{h,1-\nu} + \vartheta^{N,h}\left(s^h - N_t^h\right)^{1-\kappa} \end{aligned} \tag{5.13}$$

$$CES^h\left(C_t^h, H_t^h\right) = \left[s_{h,C}^{\frac{1}{\sigma^H}}\left(C_t^h - h^h C_{t-1}^h\right)^{\frac{\sigma^H-1}{\sigma^H}} + s_{h,H}^{\frac{1}{\sigma^H}} H_t^{h\,\frac{\sigma^H-1}{\sigma^H}}\right]^{\frac{\sigma^H}{\sigma^H-1}} \tag{5.14}$$

Labor unions of savers and borrowers maximize a joint utility function. Breuss et al. (2015) assume equally distributed labor services over saver and borrower households

[4]Note that the utility is household specific with respect to preferences.

types. Furthermore, they determine nominal wage rigidity as adjustment costs borne by household for changing wages.

Savers

Savers supply deposits D_t to the banks and hold short- (safe) as well as long-term (risky) government bonds $B_t^{H,Safe}$ and $B_t^{H,L}$. Additionally, they hold foreign money market bonds F_t^H that they trade with foreign households. They spend on consumption and residential investment and receive income from wages w_t, unemployment benefits ben_t, and government transfers TR_t. Households have a preference for safe government bonds, which they hold predominantely in the steady state while banks hold predominantly risky assets. Holding risky assets generates costs for households, determined by the adjustment cost parameter γ_b. Due to the bank balance sheet restructuring and the accompanying shift in their asset holdings from risky to safe, risky assets are forced into households' balance sheets, through reduced price p_t^G and higher real interest rate $r_t^{G,L}$ for long-term bonds.[5]

[5] The model includes an additional asset class B, B^* (national government debt level) with the only objective to determine the interest rate parity with the exchange rate e_t that relates interest rates i_t in both regions via a country risk premium. However, B^* is integrated for modelling purposes only and its influence on the results of our simulations is negligible; country risk premium is exogenously given and set constant.

The Lagrangian of this maximization problem is

$$
\begin{aligned}
&\max L_0^s = E_0 \sum_{t=0}^{\infty} \beta^{st} U^s \left(C_t^s, s^s - N_t^s, H_t^s, D_t^s\right) \\
&-E_0 \sum_{t=0}^{\infty} \lambda_t^s \beta^{st} \left(
\begin{array}{c}
(1+t_t^c)\, p_t^C C_t^s + p_t^H J_t^{H,s} + p_t^G B_t^{L,H} + B_t^{Safe,H} \\
+e_t F_t^H + D_t^s - \delta p_t^G B_{t-1}^{L,H} - \tau_{t-1} B_{t-1}^{L,H} \\
-\left(1 + r_{t-1}^{Safe}\right) B_{t-1}^{Safe,H} - \left(1 + r_{t-1}^{D}\right) D_{t-1}^s \\
-\left(1 + r_{t-1}^{F,H}\right) e_t F_{t-1}^H - (1-t_t^w) w_t N_t^s - ben_t \left(1 - N_t^s\right) - TR_t^s \\
B_t - (1 + r_{t-1}) B_{t-1} + e_t B_{t-1}^* - \left(1 + r_{t-1}^*\right) e_t B_{t-1}^* \\
+\frac{\gamma_f}{2} \left(e_t \left(B_t^* - B^*\right)\right)^2 + \frac{\gamma_b}{2} \left(p_t^G B_t^{L,H} - \overline{B^{L,H}}\right)^2
\end{array}
\right) \\
&-E_0 \sum_{t=0}^{\infty} \lambda_t^s \zeta_t^s \beta^{st} \left(H_t^s - J_t^{H,s} - \left(1 - \delta^H\right) H_{t-1}^{H,s}\right) \qquad (5.15)
\end{aligned}
$$

The maximization problem provides us with the following first-order conditions (FOC):

$$\frac{\partial L^s}{\partial B_t^{H,Safe}} \Rightarrow \beta E_t \left(\frac{\lambda_{t+1}}{\lambda_t}\right) = E_t \left(\frac{1}{1 + r_t^{Safe}}\right) \qquad (5.16)$$

$$\frac{\partial L^s}{\partial B_t^{H,L}} \Rightarrow \beta E_t \left(\frac{\lambda_{t+1}}{\lambda_t}\right) = E_t \left(p_t^G + \gamma_b p_t^G \left(p_t^G B_t^{H,L} - \overline{B^{H,L}}\right)\right) / \left(\frac{1}{\delta_b p_{t+1}^G + \tau}\right) \qquad (5.17)$$

$$\frac{\partial L^s}{\partial B_t^*} \Rightarrow \beta E_t \left(\frac{\lambda_{t+1}}{\lambda_t}\right) = E_t \left(\frac{e_t}{e_{t+1}}\right) \left(\frac{p_{t+1}}{p_t}\right) \left(\frac{1}{1 + i_t^*} + \gamma_f \left(B_t^* - \overline{B}^*\right)\right) \qquad (5.18)$$

$$\frac{\partial L^s}{\partial B_t} \Rightarrow \beta E_t \left(\frac{\lambda_{t+1}}{\lambda_t}\right) = E_t \left(\frac{1}{1 + r_t}\right) \qquad (5.19)$$

$$\frac{\partial L^s}{\partial C_t^s} \Rightarrow U_t^C = (1 + t_t^c)\, p_t^C \lambda_t \qquad (5.20)$$

Combining Equations (5.17), (5.18), (5.19), and (5.20) illustrates the transmission channels to the real economy:

$$1 + i_t = E_t \left(\frac{e_{t+1}}{e_t} \right) \left(1 + i_t^* + \gamma_f \left(B_t^* - \overline{B}^* \right) \right) \tag{5.21}$$

$$(1 + r_t) \left(p_t^G + \gamma_b p_t^G \left(p_t^G B_t^{L,H} - \overline{B^{L,H}} \right) \right) = E_t \left(\delta_b p_{t+1}^G + \tau \right) (1 - \varepsilon_{rprem}) \tag{5.22}$$

$$\frac{1}{1 + r_t} = \beta \frac{(1 + t_t^c)\, p_t^c U_{t+1}^C}{\left(1 + t_{t+1}^c\right) p_{t+1}^c U_t^C} \tag{5.23}$$

where ε_{rprem} is a premium shock to sovereign (risky) debt. In Section 5.4, we analyze the effects of a sovereign risk shock under bank balance sheet restructuring.

Borrowers

Borrowers have a higher rate of time preference ($\beta^c < \beta^s$) that leaves them indebted in the equilibrium. Borrower households (i=1,...,I) are ex ante identical but are subject to idiosyncratic housing capital shocks ω_t^i. These shocks occur after all decisions with regard to housing and loans have been made, but are set to zero in the model simulation, as we focus on sovereign risk shocks only.

The loan to value ratio $\chi^c = \omega$ is imposed by banks and the interest rate on loans is consistent with expected loan losses across all borrower households. According to

Breuss et al. (2015), the Lagrangian of this maximization problem is:

$$\begin{aligned}
\max V_0^c &= E_0 \sum_{t=0}^{\infty} \beta^{c^t} U^c \left(C_t^c, 1 - N_t^c, H_t^c\right) \qquad (5.24) \\
&\quad - E_0 \sum_{t=0}^{\infty} \Big(\lambda_t^c \beta^{c^t} \Big(p_t^C C_t^c + p_t^H J_t^{H,c} - L_t + \left(1 + r_{t-1}^L\right) L_{t-1}\Big) \\
&\qquad - \Lambda_t^{CC} - (1 - t_t^w) w_t N_t^c - ben_t \left(1 - N_t^c\right) + T_t^c - TR_t^c\Big) \\
&\quad - E_0 \sum_{t=0}^{\infty} \lambda_t^c \zeta_t^c \beta^{c^t} \Big(H_t^c - J_t^{H,c} - \left(1 - \delta^H\right) H_{t-1}^c + \Lambda_t^{CC}\Big) \\
&\quad - E_0 \sum \lambda_t^c \psi_t \beta^{c,t} \left(\left(1 + r_t^L\right) L_t - \chi^c \left(1 - \delta\right) p_t^H H_t^c\right)
\end{aligned}$$

Equity owners

Equity owners maximize an intertemporal utility function that includes consumption[6]. They get dividends from the financial and non-financial corporations:

$$\begin{aligned}
\max V_0^E &= E_0 \sum_{t=0}^{\infty} \beta^{e,t} U^e \left(C_t^e\right) \qquad (5.25) \\
&\quad - E_0 \sum_{t=0}^{\infty} \lambda_t \beta^{e,t} \Big[q_t^B S_t^{BP} - \left(div_{t-1}^B + q_t^B\right) S_{t-1}^{BP} + q_t^{NF} \\
&\qquad - \left(div_{t-1}^{NF} + q_t^{NF}\right) S_{t-1}^{NF} - p_t^C C_t^e + T_t^e\Big]
\end{aligned}$$

where S_{t-1}^{BP} is the number of outstanding private equity shares. Equity owners do not directly borrow or lend to other domestic households or to foreign households or banks. They interact with other household sectors via their bank holdings[7].

[6] Breuss et al. (2015) assume that equity owners do not invest in housing, have demand for deposits or supply labor.

[7] Please note that the QUEST model represents the household sector of equity owners in core in a rudimentary form with regard to their consumption behavior; thus, the transmission of shocks (e.g. government risk shocks) is more pronounced (at least on impact) than in periphery, even when regions are calibrated to equal sizes.

Retail Sector

Breuss et al. (2015) integrate a retail sector into the model that buys and diversifies goods. Retailers face a monopolistic competition in the goods market. Furthermore, retailers bear nonminal rigidities in the form of quadratic price adjustment costs γ_p. The inflation (π_t^F) dynamics that are related to r_t^F are given by a New Keynesian Phillips curve in the model equilibrium:

$$\pi_t^F = \beta E_t \pi_{t+1}^F + 1/\gamma_p MC_t \tag{5.26}$$

with MC_t as the marginal cost in the sector.

Monetary Policy

It is assumed that a Taylor rule reacts to average aggregate inflation τ_π^{EA} and average output growth $\tilde{y}_t^{EA}$ in the euro area over one year (Breuss et al., 2015):

$$\begin{aligned} i_t \;=\; & \tau_{lag}^M i_{t-1} + \left(1 - \tau_{lag}^M\right)\left[r^{Equ} + \overline{\pi_t}\right. \\ & +\tau_\pi^M \left(\pi_t^{EA} + \pi_{t-1}^{EA} + \pi_{t-2}^{EA} + \pi_{t-3}^{EA} - 4\overline{\pi_t}\right)/4 \\ & \left. + \tau_y^M \left(\tilde{y}_t^{EA} + \tilde{y}_{t-1}^{EA} + \tilde{y}_{t-2}^{EA} + \tilde{y}_{t-3}^{EA} - 4\overline{\tilde{y}}\right)/4\right] + z_t^M \end{aligned} \tag{5.27}$$

where z_t^M is a shock that captures deviations from the policy rule. Additionally, we implement a lower bound that prevents the interest rate from falling below zero.

Government Sector

The government sector buys goods and services G_t and makes the transfers to saver and borrowers TR_t, whereas the total tax revenues T_t comprise the overall tax revenues from savers, borrowers and equity owners (Breuss et al., 2015). The government sector fulfills the debt-to-GDP target. Total government bonds B_t are 'tranched' into risky B_t^L and safe B_t^S debt and issued to banks and saver households, whereby safe assets take the form of E-bonds by pooling across regions.

Except for explicit discretionary interventions, government consumption (G_t) and investment (I_t^G) are held constant in real terms:

$$G_t = \overline{g} p_t^C \tag{5.28}$$

$$I_t^G = \overline{i^G} p_t^C \tag{5.29}$$

Also the real consumption value of transfers (TR_t) is kept constant:

$$TR_t = \overline{tr} p_t^C \tag{5.30}$$

The nominal benefits that are paid to the non-employed households correspond to the exogenous rate ($\overline{ben}$) times the nominal wage:

$$BEN_t = \overline{ben} w_t \left(1 - N_t\right) \tag{5.31}$$

The government receives consumption tax, labour tax, and corporate tax:

$$T_t = t_t^C p_t^C C_t + t_t^w w_t N_t - t_t^K PR_t \tag{5.32}$$

Nominal government debt (B_t) as a composite of short-term and long-term bonds evolves according to:

$$\begin{aligned} B_t^S + p_t^G B_t^L &= (1 - r_{t-1}) B_{t-1}^S + \left(\delta_b p_t^G + \tau\right) B_{t-1}^L \\ &\quad + G_t + I_t^G + TR_t + BEN_t - T_t \end{aligned} \tag{5.33}$$

Labor taxes are used to stabilize the debt-to-GDP ratio:

$$\Delta t_t^W = \tau^B \left(\frac{B}{P_t Y_t} - b \right) + \tau^{def} \Delta B_t \tag{5.34}$$

with b being the target government debt-to-GDP-ratio. The consumption tax, corporate and income tax rates as well as the social security contribution rate are given exogenously.

Foreign region and the current account

The economies are modelled such that both regions buy domestic goods d and foreign goods f (Breuss et al., 2015):

$$A^i = \left[\left(1 - s^R - z_t^R\right)^{\frac{1}{\sigma^R}} A^{d,i\,\frac{\sigma^R - 1}{\sigma^R}} + \left(s^R + z_t^R\right)^{\frac{1}{\sigma^R}} A^{f,i\,\frac{\sigma^R - 1}{\sigma^R}} \right]^{\frac{\sigma^R}{(\sigma^R - 1)}} \tag{5.35}$$

with $i = periphery, core$. Agents in both regions have preferences for consumption and (housing) investment goods $A^i \in \{C^i, J^i, G^i\}$. The parameter s^R is subject to shocks z_t^R. The variables $A^{d,i}$ and $A^{f,i}$ represent the demand for differentiated goods from the two regions. Domestic households and banks trade money market bonds $e_t F_t^H$ and $e_t F_t^B$. The net foreign asset position is given by:

$$e_t\left(F_t^H+F_t^B\right) = \left(1+r_{t-1}^{F,H}\right)e_tF_{t-1}^H+\left(1+r_{t-1}^{F,B}\right)e_tF_{t-1}^B \\ +\Lambda_t^{CC}+X_t-e_tM_t \quad (5.36)$$

with imports $M_t = C_t^{P,f} + J_t^{P,f}$ and exports $X_t = C_t^{C,f} + J_t^{C,f}$.

Equilibrium

The equilibrium in Breuss et al. (2015) is determined by the utility maximization in the household sector and the market clearing condition for periphery and core. The market clearing condition also holds for investment markets, labor markets, loans and deposits markets as well as bond markets:

$$Y_{t_t}^i = C_t^{i,d} + J_t^{i,d} + X_t^i \quad (5.37)$$

The demand for safe short-term assets in both regions is adjusted according to the safe nominal interest rate i_t^{Safe}:

$$\beta E_t\left(\frac{\lambda_{t+1}}{\lambda_t}\right) = \left(\frac{1}{1+r_t^{Safe}}\right) \quad (5.38)$$

$$\beta E_t\left(\frac{\lambda_{t+1}^*}{\lambda_t^*}\right) = \left(\frac{1}{1+r_t^{*Safe}}\right) \quad (5.39)$$

The real interest rate for safe assets r_t^{Safe} in periphery and r_t^{*Safe} in core are calculated by the same nominal safe interest rate i_t^{Safe} minus the respective inflation rate in the respective region. Equations (5.38) and (5.39) guarantees that the return on safe E-bonds is the same across regions, while risky assets contain the risk of valuation losses and associated real interest rates r_t and r_t^* include the country risk premium with respect to the national government debt levels (Equation 5.22).

After the implementation of euro area-wide safe assets that stem from first tranching national government debt into risky and safe assets and second pooling safe national assets across regions, we go ahead with a simulation exercise of bank balance sheet restructuring under euro area-wide safe assets.

5.3 Calibration

The calibration is taken from Breuss et al. (2015) and Kollmann et al. (2013). In order to focus on the pure restructuring effects of the introduction of a common euro area safe asset, we model two regions with equal size s. Accordingly, we depart from differences in the sovereign debt levels across regions and riskiness in terms of expected losses, but assume that safe assets can be produced in sufficient volume. Merler and Pisani-Ferry (2012b) find that euro area banks in tend to hold relatively large shares of domestic sovereign debt. They calculate a share between 16% and 21% of GDP for Greece, Italy, Portugal and Spain. Additionally, this sovereign bond holdings are rather risky assets in the bank balance sheets. For the simulations, we assume that domestic banks holdings of sovereign debt are 15% of GDP. Furthermore, banks hold 15% of total safe E-bonds in steady state, which is increased by 10% due to restructuring measures in the simulation. The steady state share of long-term bonds held by banks is set to $s^L = 0.5$, implying that the steady state maturity matches the value of around 6.6 (years).

As we assume long-term bonds in the model to have 10-year maturity, the depreciation rate on the coupon is set in line with this to $\delta_b = 0.975$. Thus, long-term (risky) government bonds are less liquid than short-term government bonds with a one-year-maturity. Additionally, households' cost of risk exposure in their balance sheets γ_b is a crucial parameter in the model, but also hard to calibrate. The parameter choice for households' adjustment costs of $\gamma_b = 0.01$ implies a decompression of the interest rate spread between long- and short-term bonds, which is chosen such that it matches the findings by Hammermann et al. (2019). The authors analyze a reversed portfolio restructuring under Quantitative Easing, where long-term bonds get withdrawn from households balance sheets and substituted by short-term safe bonds, leading to a yield curve compressions.

The subjective discount factor of the saver household is 0.996. Following Iacoviello and Neri (2010), we set the discount factor of the borrower household at a lower value of 0.990 in order to ensure that the collateral constraint always binds. The subjective discount factor of the equity owner is 0.974, which allows to capture the private non-residential capital to GDP ratio of 1.05. According Sierminska et al. (2006), we assume that the top 10% of the population in the EU own roughly 50% of total net wort and set the net worth holdings of equity owners to 0.5.

According to Kollmann et al. (2013) and Breuss et al. (2015), the output elasticity of labor equals 0.65, which corresponds to the (adjusted) wage share in the euro area. Corporate capital depreciates with 0.1 (p.a.) and residential capital with 0.04 (p.a.). The steady state ratio of mortgage loans to GDP is set to 45% and the steady state bank capital ratio is set to 8%.

The parameter Γ^L for the cost of banks of deviating from target bank capital implies that a one percentage point increase in the bank capital ratio lowers the spread between the loan rate and the deposit rate by 40 basis points. This parameter depends crucially on the degree of risk aversion of saver households. This parameter as well as all other behavioral and technological parameters that are the same across regions are taken from the estimated model for the euro area in Kollmann et al. (2013). Parameters that

Table 5.1 Calibrated parameters and steady state ratios

Parameter	value
Discount factor (S)	0.996
Discount factor (C)	0.960
Discount factor (E)	0.974
Output elasticity for labor	0.65
Price changes (mean duration)	7Q
Wage changes (mean duration)	4Q
Real wage rigidity	0.9
Frisch labor supply elasticity	0.25
Income share of borrowers	25%
Net worth equity owners	50%
Mortgage loans (% of GDP)	45%
Bank capital ratio	8%
Bank capital constraint	0.65
HH cost of risk exposure	0.4
Sovereign debt (% of bank assets)	15%
Corporate capital depreciation	0.1 p.a
Residental capital depreciation	0.04 p.a
Long-term bond depreciation	0.975

Note: The calibration takes into account equal sizes for the two regions as well as parameters for the estimated QUEST model for the euro area in Kollmann et al. (2013).

depend on the region size, like trade openness, are adjusted to match equal sizes of both regions.

5.4 Simulation Results

In the following, we discuss the effects of a) a bank balance sheet restructuring in the form of a 10% shift from risky to safe euro area assets and b) a sovereign risk shock in the periphery under bank balance sheet restruturing. Though the sovereign risk channel works, there are monetary and fiscal backstops (e.g. tax revenues, recapitalization) in place such that government solvency is not at risk. The idea of E-bonds is that governments can issue a certain amount as safe debt, but will have to cover additional financing needs by issuing risky debt. It is assumed that there exists no deposit insurance, sovereign bond holdings of banks are diversified, however in the steady state banks hold predominantely risky assets[8]; the tax rule (Equation 5.34) is off for the first 10 years.

Bank balance sheet restructuring

In Section 5.2, we introduced E-bonds by pooling national sovereign debt, in order to diversify bank balance sheets. Now, we assume that banks further reduce their domestic exposure and shift their bond holdings to the safe E-bond, implied by an increase of safe asset holdings $B^{B,Safe}$ of 10% with an concomittant decrease of risky bond holding $B^{L,B}$. Now that banks hold a higher share of total safe assets, households are forced to shift their holdings to risky domestic assets, similar to a junior tranche of national sovereign debt. However, the risk averse households only accept the holding of risky assets at lower bond prices. Table 5.2 depicts the effects of a restructuring of bank balance sheets in both regions in form of a 10% shift from risky to safe euro assets. This bank balance sheet restructuring follows the idea of safe euro area-wide assets insofar as it addresses the critial aspect in literature, i.e. the reduction in banks' home bias in sovereign debt.

In the case of E-bonds, both banks and households hold a diversified pool of safe sovereign bonds of the euro area at real interest rate r^{Safe}. Banks' holdings of E-bonds increases by a shift of 10% from risky to safe (pooled) asset holdings. The shift implies that banks want to reduce their domestic exposure to predominantly risky assets, and they do so by shifting their bond holdings towards the safe E-bonds. Therefore, households adjust their safe and consequently risky holdings, i.e. they move to the junior tranche $B^{L,H}$ of domestic sovereign debt according to Equations (5.32) and (5.38) across regions.

[8]Banks hold 15% of total safe assets in steady state, which is increased by 10% due to restructuring measures.

Table 5.2 Bank balance sheet restructuring

	Safe Assets							
Variable	Pure bank balance sheet restructuring in both regions							
	2020	**2021**	**2022**	**2023**	**2024**	**2025**	...	**2040**
GDP	-0.05	0.00	0.00	-0.00	0.00	-0.00	...	-0.00
Price Bonds	-3.46	-3.51	-3.56	-3.60	-3.64	-3.67	...	-3.74
Consumption S	-0.02	-0.05	-0.06	-0.07	-0.07	-0.07	...	0.02
Consumption C	-0.06	0.02	0.03	0.02	0.01	0.01	...	-0.07
Consumption E	-0.09	0.04	0.05	0.05	0.05	0.05	...	0.05
Investment House	-0.02	-0.00	-0.03	-0.04	-0.03	-0.03	...	0.03
Investment House S	-0.05	-0.10	-0.11	-0.11	-0.11	-0.10	...	0.02
Investment House C	0.04	0.23	0.19	0.16	0.16	0.16	...	0.01
Investment Corp.	-0.07	-0.02	-0.00	-0.00	0.00	0.00	...	-0.01
Spread	0.36	0.37	0.37	0.38	0.38	0.39	...	0.44
Governm. debt to GDP	-0.35	-0.34	-0.31	-0.27	-0.23	-0.19	...	0.11

Note: Table 5.2 reports the effects of a forced 10% shift in bank balance sheets from risky to safe assets (restructuring) (in %, percentage points for the spread, and in % relative to GDP for government debt) in the short and long run.

As the baseline scenario depicts two nearly identical regions, both regions behave in similar ways. The restructuring in bank balance sheets generates a drop in long-term bonds prices, as risk averse households are forced to switch to riskier (domestic) assets. Households have costs for holding risky assets, thus long-term bond prices p_t^G decrease. A reduction in bond prices imply an increase in real interest rates. The term premium, which is the spread between long- and short-term bonds, steadily increases due to higher real interest rates of risky assets and falling bond prices. Saver households S decrease their consumption and housing investment, yet stabilize both demand components in the long run at higher levels. Credit constraint households C and equity owners E, on the other hand, increase both demand components after a initial drop in the first period, as they are less prone to the decrease in long-term bond prices than saver households who hold long-term government bonds.

Additionally, the bank balance sheet restructuring reduces overall government debt relative to GDP, which is mainly due to the issuance of long-term government debt at lower bond price. However, in the long run debt-to-GDP levels slightly increase.

GDP falls to a small degree due to the decrease in consumption and investment, but stabilizes in the long run.

Sovereign risk shocks under euro area-wide bank balance sheet restructuring

The above mentioned feedback loop between sovereigns and domestic banks starts either on the government or the bank side. In our case scenario in Table 5.3, a sovereign risk shock on the government side generates a recession in the periphery (drop of GDP of nearly 0.4%) with features typical for a crisis as in 2010–2017 in the periphery. We generate a sovereign-induced loop ("government risk shock" ε_{rprem}) as a temporary increase in the sovereign risk premium by 10 percentage points (annualized) – a shock size with the magnitude of the risk premia in the periphery during the crisis within the euro area. As the sovereign risk shock is strong but relatively short-lived compared to doom loops that start in the banking sector (financial shocks), negative demand and GDP effects are high on impact, but less persistent. However, spillover effects of sovereign risk shocks to the private sector in the domestic region amplifies the contraction of domestic demand and activity.

The shock leads to a higher government risk premium that causes valuation losses on sovereign debt and thus a decrease in government debt[9]. The increase in long-term interest rates and the fall in bond prices leads to an increase in the term premium, which is higher in periphery. Sovereign-induced bank losses require recapitalization with risky bonds by domestic equity owners and thus lower dividend payments. Therefore, they reduce private consumption. Additionally, saver households decrease consumption. Both banks and saver households in periphery decrease their risky and increase their safe asset holdings due to valuation losses of risky bonds. In core, saver households who

[9]However, in the long run the sovereign risk shock in periphery leads to an increase in government debt relative to GDP in periphery due to valuation losses and recapitalization with risky debt, while government debt relative to GDP stabilizes in core.

Table 5.3 Sovereign risk shock in periphery under bank balance sheet restructuring

	Short run effects					
	Sovereign risk shock		restructuring		restructuring in core	
Variable	2020	2021	2020	2021	2020	2021
GDP	-0.38	0.24	-0.24	0.14	-0.62	0.16
GDP*	-0.42	0.21	-0.28	0.12	-0.32	0.32
Bond Prices	-21.83	-16.04	-24.24	-18.75	-22.72	-17.05
Bond Prices*	-11.61	-8.43	-14.43	-11.43	-13.23	-10.18
Consumption S	-0.03	-0.11	-0.02	-0.08	-0.33	-0.70
Consumption S*	-0.01	-0.07	-0.00	-0.04	0.15	0.19
Consumption C	-0.33	0.71	-0.20	0.41	-1.41	0.49
Consumption C*	-0.64	0.29	-0.43	0.17	-0.09	0.75
Investment	0.08	0.12	0.06	0.10	-0.17	-0.28
Investment*	-0.12	0.34	-0.09	0.22	0.16	0.51
Investment House S	-0.08	-0.18	-0.07	-0.14	-0.48	-0.88
Investment House S*	-0.07	-0.16	-0.04	-0.10	0.03	-0.03
Invest. House C	0.50	0.90	0.39	0.72	0.63	1.25
Investment House C*	-0.27	1.63	-0.20	1.04	0.49	1.90
Investment Corp.	-0.49	0.26	-0.33	0.13	-0.81	-0.07
Investment Corp.*	-0.49	0.29	-0.34	0.14	-0.49	0.33
Spread	9.89	10.03	10.13	10.33	10.19	10.24
Spread*	4.91	4.96	5.18	5.27	5.20	5.21
Government Debt	-2.10	-1.62	-2.50	-1.83	-1.91	-1.38
Government Debt*	-0.89	-0.84	-1.50	-1.35	-1.22	-1.36

Note: Table 5.3 reports the effects (in %, percentage points for the spread, and in % relative to GDP for government debt) of 1) a pure sovereign risk shock in periphery, 2) the same shock under a region-wide bank balance sheet restructuring, and 3) a sovereign risk shock under one-sided bank balance sheet restructuring in core; due to low persistency of the shock and for the sake of clarity, we show simulation results for the first two periods, starting in 2020; core values are characterized by the symbol ($*$).

are mainly affected by the shock through the trade channel and the interest rate parity in Equation (5.18), reduce risky and safe bond holdings.

A shift in bank balance sheets of 10% from risky to safe assets leads to an increase in risky asset holdings by households in both regions and a further decrease in long-term bond prices, as households only accept risky assets in their balance sheets at lower prices. The increase of safe E-bonds in bank balance sheets stabilizes GDP in both regions. Government debt relative to GDP decreases, as risky bonds are forced into households' balance sheets.

Sovereign risk shocks under bank balance sheet restructuring in core

We now assume that banks in the periphery do not reduce exposure in their balance sheets and only banks in core restructure bank balance sheets. One reason for that could be, requirements to reduce exposure of banks to the domestic government are simply not politically feasible in periphery.

As banks in periphery do not reduce their risky asset holdings, they are more prone to the peripheral sovereign risk shock than under bank balance sheet restructuring. Due to one-sided restructuring measures, prices for long-term bonds in periphery fall more than in the case of pure sovereign risk shock, but less than under a euro area-wide restructuring policy, as households are not forced to increase their risky asset holdings after the restructuring in bank balance sheets.

The decline in long-term bond prices in core is due to the bank balance sheet restrucutring and the concomittant increase in risky asset holdings by households. However, core savers give up less safe assets compared to bilateral restructuring measures and even increase consumption and investment. On the other hand, savers in the periphery experience a massive decline in consumption and investment.

In sum, banks in the euro area hold less safe short-term assets relative to GDP in their balance sheets in total than under a bilateral restructuring policy and are more prone to the peripheral sovereign risk shock. Both regions experience a larger decline in GDP than in the case of an area-wide restructuring policy. The negative effects for the periphery are larger than for the core, where banks restructure their balance sheets.

5.5 Conclusion

In this paper, we focus on the implementation of risk diversification into a DSGE model by pooling sovereign debt of Member States in the euro area and issuing a common safe asset. Furthermore, we analyze the elements of bank balance sheet restructuring under euro area-wide safe assets with consequences for shock stabilization, in this case the stabilization of a government risk shock.

First, we describe the model where we introduce a common safe asset for the two regions core and periphery. Then, we consider a bank balance sheet restructuring towards safe asset holdings, in order to mitigate the adverse feedback loop between banks and domestic government. Finally, we look at the stabilizing effects of bank balance sheet restructuring towards the safe asset class under a sovereign risk shock in the periphery for the two cases (1) euro area-wide restructuring, and (2) one-sided restructuring in the core region.

The results show that a shift in bank balance sheets in both regions of 10% from riskier to safe assets leads to an increase in risky asset holdings by households in both regions, however at lower long-term bond prices. Additionally, after a sovereign risk shock in periphery the increase of safe E-bonds in bank balance sheets stabilizes GDP in both regions and decreases government debt relative to GDP. However, this is mainly due to a decrease in long-term bond prices. Therefore, a model setting with region-specific government debt-to-GDP ratios could give further insights.

In contrast, one-sided restructuring measures in core lead to a stronger decrease in GDP, and government debt to GDP decreases less in both regions. Banks in the euro area hold less safe short-term assets relative to GDP in their balance sheets than under a restructuring policy across regions and are more prone to the peripheral sovereign risk shocks. Therefore, in order to break up the sovereign bank nexus, safe assets in combination with feasible restructuring measures across all Member States are required.

This approach is a first attempt to model a common safe asset for the euro area. In the simulation, we set both regions to equal sizes and depart from differentiating regions according to their risk level in government bond holdings. In order to give a comprehensive evaluation of the macroeconomic effects of safe assets, specific model features need to be incorporated into the model. Therefore, the proposals of ESBies, E-bonds, or a euro area budget provide the basis for further research on this topic, including the adjustment of government debt levels as well as the comparison of different volume and subordination level requirements.

Chapter 6

Conclusions

The aim of this thesis was to analyze the implications of external imbalances within the euro area. The thesis has addressed several policy questions: (i) A potential fiscal policy rule to reduce external imbalances and (ii) the adjustment to sudden stops of private capital inflows, with specific focus on the liquidity provision via the Eurosystem's TARGET2. Finally, the thesis (iii) provides a model approach of an euro area-wide safe asset to reduce banks' exposure to domestic sovereigns.

Chapter 2 examines the potential of fiscal policy to stabilize current account and regain price competitiveness. The contribution of this approach is to evaluate the effects of fiscal devaluation, a tax shift from labor towards consumption. The tax shift is implemented by an instrument rule that reacts on current account deficits, where current account deficits result from negative economy-wide productivity shocks (loss of competitiveness) or risk premium shocks (demand boom). The simulation shows that fiscal devaluation helps to facilitate exchange rate ajustments and improve price competitiveness. From a utility-based welfare perspective, however, the tax shift induces welfare losses for the average household, with higher losses for liquidity constrained households that cannot smooth consumption. When comparing fiscal devaluation within a monetary union and a similar small open economy with flexible exchange rates, this alternative scenario shows that a nominal exchange rate devaluation does not automatically dampen current account deficits. A nominal devaluation implies stronger external fluctuations in the short run, but generates welfare gains for households.

Chapter 3 is based on the model framework in Chapter 2, but includes a credit constraint on foreign indebtedness, in order to analyze sudden stops of private capital inflows for two types of fixed exchange rate regimes: 1) An economy that is pegged to the euro, the closest alternative to a monetary union, and 2) an economy that is member of the currency union with automatic access to the TARGET2 payment system. For this purpose, a DSGE model of a small open economy within the Monetary Union has been set up to analyze macroeconomic adjustments to sudden stops. The main finding of the chapter is that the role of the exchange rate regime is a crucial factor in the adjustment to sudden stops of private capital. More specifically, public capital flows in form of TARGET2 substitute private capital outflows and help euro area deficit countries to stabilize output, consumption and investment in the short run. In the long run, however, they suffer under a prolonged recovery and large public debt - reflected in higher welfare losses relative to euro peggers.

Chapter 4 broadens the setting to an estimated two-region model of core and peripheral euro area Member States, with particular focus on the influence of the TARGET2 mechanism on cross-border capital flows and private deleveraging in crisis-hit countries. In this respect, the analysis of core versus periphery represents the perspective of surplus and deficit countries The framework accounts for policy restrictions implied by the currency union and relates sudden stops to a risk shock in periphery, leading to a sudden outflow of private capital from periphery to core. TARGET2 acts as a liquidity provider and mitigates the deleveraging pressure on peripheral countries. The analysis contributes to the existing literature by focussing on the divergent adjustment process in core (surplus) and peripheral (deficit) euro area countries after a sudden stop in the distressed countries: The respective countries stabilize and even increase consumption at the cost of a severe and durable drop in output, as beneficial terms of trade channel consumption towards imports from core. Core countries on the other hand profit from an increase in (export) output, while consumption stays low due to crowding-out-effects. Furthermore, the analysis points to growing inflation differentials and real exchange rate misalignments between the regions.

Chapter 5 presents a first DSGE model approach to integrate euro area-wide safe assets in a two-region framework. The integration of area-wide safe assets improves the financial stability across the euro area and the diversification of banks' balance sheets by decreasing the home bias in banks' sovereign debt holdings. We use the European Commission's QUEST model with a banking sector and financial frictions and create a common safe asset for the two regions core and periphery by pooling safe domestic bonds across regions, alongside domestic riskier bonds. We assess the macroeconomic effects of bank balance sheet restructuring from riskier domestic assets of 10 percent towards safe euro area-wide assets, in order to reduce domestic sovereign exposure of banks. The bank balance sheet restructuring has direct consequences for the shock stabilization, in this case the stabilization of a sovereign risk shock. The results show that a shift in bank balance sheet from risky to safe assets across euro area banks leads to a GDP stabilization and decrease in government debt relative to GDP in both regions, however at lower bond prices for risky assets.

In summary, large-scale external liabilites increase the susceptibility to sudden stops of capital flows that force abrupt cuts in (private or public) spending. This thesis shows that sudden stops of private capital inflows within the euro area are substituted by public capital inflows in form of TARGET2. TARGET2 flows help to mitigate the effects of sudden stops and private deleveraging on consumption and current account in the short run, however at the cost of prolonged recovery processes and welfare losses for households in the long run. Additionally, TARGET2 has distributional consequences across the EMU, between surplus core and deficit peripheral euro area countries. Fiscal policy rules that mitigate external imbalances in the first place, e.g. fiscal devaluation, help crisis-hit countries to combat real exchange rate misalignments and regain price competitiveness. However, from a welfare perspective, fiscal devaluation within a monetary union loses out to nominal devaluation under flexible exchange rates.

External imbalances have many causes and dimensions, and this thesis cannot give a comprehensive overview on fiscal policy interventions to combat those imbalances within a currency union. Additionally, TARGET2 is a crucial factor for the smooth functioning of cross-border interbank transfers within the Monetary Union. Nevertheless, the results of this thesis point out the risks of growing external imbalances as well as the automatic access to central bank liquidity. This thesis addresses the need for reform options and proposes fiscal devaluation as one policy approach to minimize those risks. Additionally, the reduction of banks' exposure to domestic sovereigns by shifting bank holdings to pooled euro area-wide safe assets potentially lead to a macroeconomic stabilization after a sovereign risk shock in periphery.

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