The evolution of debtor-creditor relationships within a monetary union: Trade imbalances, excess reserves and economic policy

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Abstract

This paper analyses the emergence of internal debtor-creditor relationships within a monetary union. Developing a stock-flow consistent model consisting of three regions – North, South, and the Rest of the World (RoW), where North and South form a monetary union – it shows how the simultaneous presence of investment booms, declining export performance and mercantilist policies within a monetary union can interact in order to create Minsky-type boom-bust cycles. Fiscal policy and an internal lender of last resort can help sustain economic life under existing structural imbalances, though without eliminating the root causes of boom-bust patterns.

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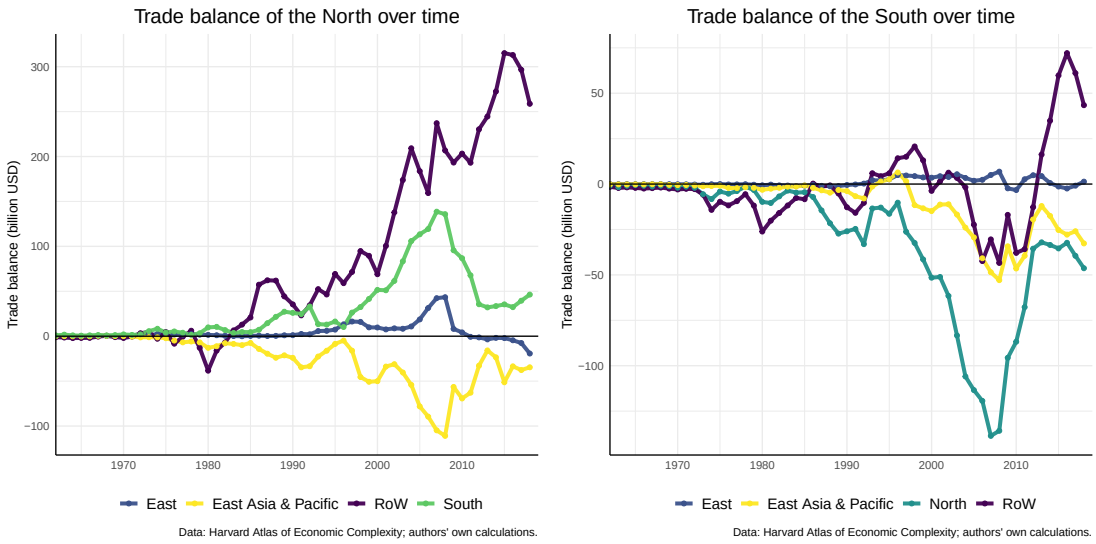
1 Introduction

Two complementary narratives of the Eurozone crisis have dominated the discourse. The first narrative argues that European imbalances were due to the initial optimism of financial investors related to European financial integration and the catching-up prospects of southern Eurozone countries. The introduction of the common currency eliminated currency risk, while regulatory harmonization policies also reduced transaction costs (e.g. Chen *et al.*, 2013; Kalemli-Ozcan *et al.*, 2010). According to neoclassical theory, financial funds should flow from richer countries to poorer countries in such a scenario, as the marginal product of capital is supposedly higher in the poorer countries (Schmitz & von Hagen, 2011). The second narrative relates to improved lending conditions in southern economies leading to unsustainable spending in the non-tradeable sector (e.g. Giavazzi & Spaventa, 2010). The latter was accompanied by a rise in wages that led to a deterioration of international competitiveness (Schmitt-Grohé & Uribe, 2013). Other authors have argued that income inequality alongside with financial sector developments had an impact on current account imbalances (Marzinotto, 2016). In this view, high income inequality in combination with easier access to credit that came with the accession of the Eurozone led to a rise in household sector borrowing, which in turn contributed to the negative current account in southern countries.

While these complementary narratives emphasize the intra-Eurozone origin of growing macroeconomic imbalances that ultimately led to the crisis, others have pointed to trade developments with the rest of the world (Chen *et al.*, 2013). In particular, this argument points to the decline in export competitiveness in southern Eurozone countries vis-a-vis emerging market economies in Asia and asymmetric trade developments with respect to the rest of the world (here in particular China, Central and Eastern Europe and oil exporting countries; e.g. Nauschnigg, 2013). In particular, the rise of China came with rising demand for (medium-high technology) machinery and equipment goods, which were to a large extent exported by Germany. On the other hand exports of southern periphery countries were partly displaced by Chinese exports (Storm & Naastepad, 2015; Gräbner *et al.*, 2020; Mikkelsen & Ruiz, 2012). The problems were in turn exacerbated by rising oil prices and by the nominal appreciation of the Euro. Within the Eurozone, Germany was less affected by the former terms of trade shock as high oil revenues also generated demand for machinery and equipment in oil exporting countries, which in turn benefited German exports. Furthermore, the latter also managed to retain or even improve cost competitiveness by integrating the new EU member countries from Central and Eastern Europe into their production chain, thereby reducing unit labor costs (Marin, 2010; Storm & Naastepad, 2015). From a southern policy perspective, a nominal depreciation of the currency would have been of help in dealing with some of these issues. However, such a depreciation either (with respect to the rest of the world) did not or (with respect to other Eurozone countries) could not happen. Figure 1 displays the growing trade imbalance between northern and southern Eurozone countries in the run-up to the 2008 financial crisis. It shows that though both country groups experienced growing deficits with respect to East Asia, the North could compensate these deficits through rising trade surpluses with other regions (including southern Eurozone countries), while the South could not.

While a considerable part of the southern countries' trade deficits have their origin outside of



(a) Trade balance of the Northern Eurozone. **(b)** Trade balance of the Southern Eurozone.

Figure 1: Decomposition of northern and southern Eurozone countries trade balances over time (country groupings can be found in appendix D)

the Eurozone, the related financial means for financing them have come mostly from within the Eurozone (mostly Germany and France; see also Hale & Obstfeld, 2016). The aim of this paper is to shed new light on how investment booms and shifts in competitiveness give rise to internal and external trade imbalances and how these imbalances foster the evolution of internal debtor-creditor relationships and, ultimately, financial crises. For this purpose we develop a stock-flow consistent model consisting of three regions – North, South, and the Rest of the World (RoW) – where North and South form a monetary union and have trade and financial relations with each other as well as with the Rest of the World. In order to model the developments that give rise to these booms and busts, we will particularly draw on the work of Minsky (1986).

The rest of the paper is structured as follows: Section 2 discusses the theoretical literature on financial crises and international imbalances. Afterwards, section 3 introduces our 3-region stock-flow consistent model. Section 4 presents a series of simulation exercises that illustrate the emergence of international debt and financial crises. Based on these results, section 5 shows how economic policy can contribute to sustaining structural imbalances or mitigating financial crises. Section 6 offers some concluding thoughts.

2 Existing literature

Since 2008 there have been many attempts to capture the essential dynamics leading to the the global crisis that ensured afterwards. Most of these contributions focus on a single economy and do not explicitly take international interrelations into account. Among them have been attempts to incorporate financial frictions into DSGE models influenced by Gertler & Kiyotaki (2011) (see e.g. Brunnermeier & Pedersen, 2009; Brunnermeier & Sannikov, 2014), neoclassical models focusing on the borrowing between multiple agents (see e.g. Lorenzoni, 2008; Eggertson & Krugman, 2012) as well as attempts to capture these dynamics within stock-flow consistent

models (see e.g. Dafermos, 2018; Nikolaidi, 2014; Passarella, 2012; Barwell & Burrows, 2011; Kapeller & Schütz, 2014; Kapeller *et al.*, 2018; Zezza, 2008) and agent-based stock-flow consistent models (see e.g. Riccetti *et al.*, 2013, 2015; Assenza *et al.*, 2015; Dosi *et al.*, 2015; Raberto *et al.*, 2012; Cinotti *et al.*, 2010; Caiani *et al.*, 2016; Cardaci & Saraceno, 2018).

In the wake of 2007/2008, many scholars drew comparisons between the unfolding of events and the pattern of developments described by Hyman Minsky's financial instability hypothesis: According to Minsky (1986), stable states of the economy will gradually evolve into more fragile ones, ultimately culminating in financial crises, as perceived stability promotes risk taking of investors and lenders alike, being supported by accommodating policies of innovation and deregulation within the financial sector. Since this theory indeed provides a solid foundation for the analysis of financial crises, our model draws on some of its concepts.

In contrast to the majority of the models that formalize Minskyan ideas, we explicitly consider the possibility of bankruptcy[1] and credit rationing.[2] Furthermore, unlike most of the existing theoretical Minsky literature, our model takes into account fiscal policy.[3] For a detailed survey of the theoretical Minsky literature see Nikolaidi & Stockhammer (2017). Kapeller *et al.* (2018) provide the only contribution to the formal Minsky literature that includes all three of the just mentioned features. Though focusing on household debt, in their model banks grant loans as long as borrowers' incomes are above a certain margin of safety. In a Minskyan fashion, this margin of safety declines during times of relative stability, but rapidly increases during times of economic distress. If debtors become credit constrained (as their income no longer fulfills said margin of safety) and cannot afford debt payments, they become bankrupt and banks have to cancel a fixed proportion of outstanding loans. The endogenous nature of the margin of safety as well as the resulting waves of debt accumulation and debt cancellation give rise to cycles.

Since the model provided by Kapeller *et al.* (2018) allows us to incorporate the possibility of bankruptcy, credit rationing and fiscal policy, aspects that are relevant when we want to deal with international financial crises, we use it as a point of departure for the coming analysis. However, in contrast to their model we focus on firm and interbank debt instead of household debt. Even more importantly, however, we add an international dimension which has not been done by any of the Minskyan models discussed above.

Among those authors that have made a significant contribution in addressing the international dimension of this crisis are Belabed *et al.* (2018), who develop a stock-flow consistent model that shows how relative consumption motives and access to credit can lead to current account imbalances in a 3-country-setup. They assume exogenous exchange rates and calibrate their model so that it matches the US, Germany and China. In a similar vein, Cardaci & Saraceno (2017) – building on Cardaci & Saraceno (2018) – offer an agent-based stock flow consistent model that looks at this issue in a Eurozone context. Their framework includes two countries that share a common central bank. Households have the possibility to apply for loans

[1] Minskyan models that account for the possibility of bankruptcy are Chiarella & Di Guilmi (2011), Delli Gatti *et al.* (2005, 2010), Kapeller & Schütz (2014) and Kapeller *et al.* (2018).

[2] Other Minskyan models featuring a credit rationing mechanism can be found in Delli Gatti *et al.* (2005, 2010), Kapeller & Schütz (2014), Kapeller *et al.* (2018), Nikolaidi (2014), Ryoo (2013b,a, 2010, 2016) and Ryoo & Kim (2014).

[3] Minskyan models that include fiscal policy can be found in Dafermos (2018), Kapeller *et al.* (2018), Keen (1995) and Nikolaidi (2014).

at their domestic bank (it is assumed that there is only one bank in each country) or at the other country's bank. Thereby, the authors create a situation in which one country becomes an international net creditor by assuming that only one bank can provide loans to households from the other country while the other bank is restricted to its domestic clients. Caiani *et al.* (2018) use a multi-country agent-based stock-flow consistent model to show how rigid public deficit rules can be self-defeating (by leading to higher debt to GDP ratios) within a monetary union. Caiani *et al.* (2019) build on the previous work and analyse the impact of different wage growth regimes. They find that higher wage growth in one country leads to trade deficits and a decline in GDP in the short run, although the economy eventually recovers due to the impact of higher wage pressure on firm innovation. On the other hand, if an increase in the growth rate of wages takes place in a coordinated manner, it leads to higher GDP and higher productivity growth. Dawid *et al.* (2018) use the Eurace model to analyse a scenario in which a poorer region tries to close the gap to the more advanced region by raising public spending. They find that the most effective policy to close the gap is to combine household and firm subsidies and when the resulting debt burden is shared by the more advanced region (by sharing debt repayments). Godley & Lavoie (2007a) have proposed a three country stock-flow consistent framework that already anticipated some of the Eurozone's problems that would emerge post 2007. They point out the need for coordinated fiscal policy within a monetary union and an active central bank. Duwicquet & Mazier (2010) present a two-country SFC model investigating whether cross-boarder financial relations can exercise a stabilising role within a currency union. They find that in case of exogenous shocks, holding foreign financial assets can have a minor stabilising impact, whereas inter-zone credit has no such impact. Similarly to our model, their model accounts for the possibility of credit restriction, which in their case takes place when the demand for credit exceeds the banks willingness to supply it. Mazier & Valdecantos (2014) develop a 4-country SFC model (Germany, Spain, USA, Rest of the World) that provides a very detailed representation of the Eurosystem. Furthermore, the Eurozone countries' exchange rate with respect to the other countries is endogenous, its level being determined by supply and demand conditions on the foreign exchange market. Their model is able to illustrate how a loss in Spanish competitiveness leads to a deterioration of the Spanish private and public sector financial account that is mirrored by gains in the corresponding German financial accounts. Mazier & Valdecantos (2015) use this model to look at the impact of alternative exchange rate arrangements (e.g. the introduction of a Northern and a Southern Euro), finding favorable economic effects. Mazier & Valdecantos (2019) add an additional piece to this analysis, simulating an alternative Eurozone setting that follows Keynes' original International Clearing Union proposition. They find that such an institutional setting would enhance economic stability. Finally, Greenwood-Nimmo (2014) explores the role of stabilisation policies in a two-country SFC framework based on Godley & Lavoie (2007b), pointing out the positive effects of internationally coordinated policies.

In this paper, we go beyond the existing literature on international financial crises. While Belabed *et al.* (2018) offer some guidance in how to design a 3-country stock flow consistent framework, their focus is not on the Eurozone (they calibrate it to match the US, Germany and China). Moreover, they concentrate on the impact of rising income inequality within such an

international setting. Cardaci & Saraceno (2017) propose a model that is stock flow consistent as well as agent based within a Eurozone context. However, they only consider a 2-country framework (core vs. periphery). In their model, international imbalances emerge because they assume that only the bank in one country is able to also lend to foreign households, while the bank of the other country is restricted to its domestic households. Within our model, debtor-creditor relationships emerge endogenously in the process of interbank lending (reflecting external imbalances), making the assumption that only one banking sector is able to lend to foreigners unnecessary. Furthermore, since trade imbalances with the rest of the world played a key role for the emergence of inter-Eurozone imbalances, we go beyond a 2-country structure. In contrast to Duwicquet & Mazier (2010) our analysis covers both intra- and extra-Eurozone imbalances and the role of bankruptcies in the private and the financial sector. Finally, in contrast to Caiani *et al.* (2018), Caiani *et al.* (2019), Dawid *et al.* (2018), Godley & Lavoie (2007a), Mazier & Valdecantos (2014, 2015, 2019) and Greenwood-Nimmo (2014) we focus on the emergence of financial crises and its implications within a monetary union.

Finally, our analysis also deals with the impact of fiscal policy within financial crises. Here, Keen (1995) introduces two kinds of counter-cyclical policies into a model that is Minskyan in nature: First, he allows government spending to react to changes in unemployment. Second, he considers the rate of taxation of firm profits to adjust to movements in the rate of profit. What he finds is that with these two policies in place, the likelihood of depression is greatly diminished.As has been already mentioned, Greenwood-Nimmo (2014) introduces an inflation-targeting fiscal policy rule into a 2-country SFC framework, where governments raise fiscal spending if inflation is below the target rate and lower it in the opposite case, finding that a coordination of fiscal and monetary policies enhances stability. Nikolaidi (2014) proposes a fiscal regime in which the government raises expenditure when Minsyan desired margins of safety increase, while reducing it in the opposite case, thereby finding a stabilising effect. In Dafermos (2018), private sector spending is driven by the deviation of its debt to income ratio from its target, where the target debt to income ratio depends positively on the deviation of economic growth from the perceived normal growth rate. He shows that the resulting cycles are amplified if the government adheres to a Maastricht-type fiscal rule, whereas counter-cyclical fiscal policy has a stabilizing impact. In contrast to the previous models, we assume in our analysis that the government reacts to financial crises by raising fiscal spending during periods in which the private sector is left credit-constrained, which follows the approach chosen by Kapeller *et al.* (2018). Our findings confirm the stabilizing impact of fiscal intervention reported in these previous studies.

Among the limitations of our analysis are that we do not consider the impact of income inequality[4] and changes in asset prices.[5] Moreover, we assume that the exchange rate between the currency union and the rest of the world is exogenous. While we acknowledge that introducing an endogenous exchange rate would be worthwhile, for the sake of the tractability of the model we keep the proper integration of a foreign exchange market for future research.[6] Finally,

[4]See on this Kapeller & Schütz (2014), Kapeller *et al.* (2018) and Ryoo & Kim (2014) who show how income inequality and consumption emulation can give rise to cyclical behavior.

[5]For Minskyan models that account for asset price dynamics see Chiarella & Di Guilmi (2011), Delli Gatti & Gallegati (1990); Delli Gatti *et al.* (1994), Franke & Semmler (1989), Ryoo (2010, 2013b, 2016) and Taylor & O'Connell (1985).

[6]See Mazier & Valdecantos (2014, 2015, 2019) for an example of how such a foreign exchange market can be

contrary to many Minsky-type models we assume exogenous interest rates. On the one hand this will keep the model simple, while on the other hand it also serves to illustrate that changes in the interest rate are not a necessary condition for creating cycles (see on this Nikolaidi & Stockhammer, 2017).

3 Model

Our model builds on Kapeller & Schütz (2014) and Kapeller *et al.* (2018) and uses the method of stock-flow consistent modelling (Lavoie & Godley, 2002; Godley & Lavoie, 2007b). In what follows we provide an overview of its most essential features. For a complete list of equations and variable definitions please see the Appendix.

We assume three regions, which we call North (N), South (S) and Rest of the World (RoW). Furthermore, we assume that North and South form a monetary union, whereas RoW has its own currency. The three regions are trading with each other. The corresponding transactions are settled through international banks, where the importer's bank has to submit the corresponding amount in reserves. The economies of the North and the South each consist of the following four sectors: households, firms, the government and banks. Moreover, the two countries also share a common central bank, which supplies the national banking sectors with reserves. For the RoW, in order to keep things simple, we only look at its trade balance and the corresponding reserve transactions.

Equations for North and South are identical, with the two regions only differing in terms of some of the parameter values. In any region i, real GDP (Y_i) is equal to the sum of private expenditure for consumption (C_i) and investment (I_i), expenditure by the government (G_i) and total exports (X_i) minus total expenditures for imports (M_i).

$$Y_i = C_i + I_i + G_i + X_i - M_i \tag{1}$$

We assume that consumption demand depends on an autonomous part ($c_{0,i}$) as well as previous period's household disposable income ($Y_{H,i}$) and net wealth ($V_{H,i}$) (see e.g. Godley & Lavoie, 2007a; Greenwood-Nimmo, 2014; Nikolaidi, 2014; Mazier & Valdecantos, 2014). The government's demand for goods is assumed to be equal to net government income from the previous period, consisting of income tax paid by households (T_i) plus its share ρ_i of central bank profits (Π_{CB}) minus interest expenses on government debt ($L_{G,i}$). Firms' investment demand depends on an autonomous part ($i_{0,i}$), last period's degree of utilization of the capital stock (z_i) and the rate of return (π_i) (see e.g. Caiani *et al.*, 2016; Kapeller & Schütz, 2014) as well as the debt ratio (DR_i) (see e.g. Duwicquet & Mazier, 2010) We assume for simplicity that firms distribute all their profits to households, which results in investment being financed through bank loans. Here we make the critical assumption that banks accommodate firms' credit demand as long as the firm sector's rate of profit ($\pi_{F,i}$) is above a certain margin of safety ($\theta_{F,i}$)(Minsky, 1986). However, whenever this condition is not fulfilled, banks become cautious and restrict lending to the firm sector. The latter means that only a certain proportion rcr ('rate of credit restriction') of investment demand gets financed, which we refer to as a situation

incorporated within an SFC model.

of financial distress.[7]

$$C_{D,i} = c_{0,i} + c_1 \cdot Y_{H,i}(t-1) + c_2 \cdot V_{H,i}(t-1) \tag{2}$$

$$G_{D,i} = T_i(t-1) + \rho \cdot \Pi_{CB}(t-1) - i_L \cdot L_{G,i}(t-1) \tag{3}$$

$$I_{D,i} = \begin{cases} \pi_{F,i}(t-1) - \theta_{F,i}(t-1) \geq 0 : i_{0,i} + i_{1,i} \cdot z_i(t-1) + i_{2,i} \cdot \pi_i(t-1) + i_{3,i} \cdot DR_i(t-1) \\ \text{otherwise} : rcr \cdot (i_{0,i} + i_{1,i} \cdot z_i(t-1) + i_{2,i} \cdot \pi_i(t-1) + i_{3,i} \cdot DR_i(t-1)) \end{cases} \tag{4}$$

Following the work of Minsky (1986), this margin of safety ($\theta_{F,i}$) is endogenous: it slowly declines in periods of perceived financial stability, only to shoot up in a situation of financial distress. We define the latter as periods in which bankruptcies occur (see Kapeller & Schütz, 2014; Kapeller *et al.*, 2018). Furthermore, the margin of safety also depends on changes in the indebtedness of firms measured by their debt ratio ($DR_{F,i}$) (see Duwicquet & Mazier, 2010; Nikolaidi, 2014) as well as changes in the borrowing banks' risk exposure measured by their leverage ratio ($LR_{B,i}$) (see Kapeller *et al.*, 2018).

$$\theta_{F,i} = \theta_{F,i}(t-1) + \mu_{F,i} \cdot |\theta_{F,i}(t-1)| + \zeta_1 \cdot \Delta DR_{F,i} + \zeta_2 \cdot \Delta LR_{B,i} \tag{5}$$

$$\mu_{F,i} = \begin{cases} CANC_{F,i} = 0 : -\gamma_F \\ \text{otherwise} : \tau_F \end{cases} \tag{6}$$

Bankruptcy occurs when firm revenues are insufficient to cover debt payments (i.e. firm profits $\Pi_{F,i}$ turn negative). Whenever this happens, banks have to cancel a fixed proportion χ of outstanding loans according to (see Kapeller & Schütz, 2014; Kapeller *et al.*, 2018):[8]

$$CANC_{F,i} = \begin{cases} L_{F,i}(t-1) > 0 \wedge \pi_{F,i}(t-1) - \theta_{F,i}(t-1) < 0 \wedge \Pi_{F,i}(t-1) < 0 : \chi \cdot L_{F,i}(t-1) \\ \text{otherwise} : 0 \end{cases} \tag{7}$$

Finally, region i imports goods from region j as well as from the rest of the world. The rest of the world also imports products from these two regions.

Banks receive interest i_L on outstanding loans and pay interest i_D on deposits. Each sector repays a certain proportion a of outstanding loans each period. Banks distribute all profits to the household sector. The household sector's income therefore consists of the wage income it receives from the firm sector, firm and bank profits as well as interest earned on deposits minus a proportional income tax. Any surpluses (savings) get transferred to households' bank deposits,

[7] For a similar mechanism see Kapeller & Schütz (2014) and Kapeller *et al.* (2018).

[8] Note that debt cancellation is perfectly in line with model consistency, since loans have the character of an asset (for the lender) and a liability (for the debtor) at the same time (see table 1). Therefore, debt cancellation increases the net-worth of the firm, while it decreases the net-worth of the bank. This can be seen in table 2 (rows 20-22), which shows that debt cancellation always enters the system twice, with the sum of those two entries summing up to zero.

while any deficits lead to new bank loans.[9] The government finances any deficits through bank loans, while any surplus is used to repay past debt.

Whenever banks grant a loan, they create the corresponding deposit(see Lavoie, 2014; Godley & Lavoie, 2007b). Households, firms and the government subsequently use these newly created bank deposits to pay for their outlays. Since we treat each national banking system as one giant bank, deposits are simply shifted within the banking system and transactions of reserves (high powered money) are not necessary for these (internal) transactions. This changes when it comes to international transactions: When sectors from region i pay for imports from region j, the corresponding deposit transaction has to be accommodated by a flow of reserves. The national banking sectors receive those reserves by borrowing them from the central bank of the monetary union. In return, the central bank receives interest rate $i_{L,B}$ (where $i_{L,B} < i_L$). The national banking sectors hold these reserves in deposits at the central bank, for which they receive interest i_D. Each national banking sector has to fulfil the minimum reserve requirement ratio rrr. We assume that the banking sector of country i first tries to satiate its reserve demand through loans on the international interbank market (loans from the banking sector located in country j). The banking sector in country j only accommodates that demand if it has excess reserves (i.e. reserves are exceeding minimum requirements). If that is not enough, the banking sector in country i borrows additional reserves from the central bank; at this stage we assume no restrictions constraining access to central bank lending. Furthermore, we assume that exports to and imports from the RoW are also settled in North's and South's common currency, leading to an inflow of reserves in case of exports and an outflow of reserves in case of imports. The RoW can obtain these reserves through foreign reserve transactions (FRT) at the exogenous exchange rate $e = 1$, leading to an increase in the central bank's holding of foreign reserves (R_F). The central bank distributes all its profits to the governments of North and South.

When a national banking sector decides about whether to lend to the other country's banking sector (international lending), it applies a margin of safety similar to the one applied to firms. This means that the banking sector in region i only receives interbank loans if its rate of return ($\pi_{B,i}$) exceed the following margin of safety $\theta_{B,i}$. The banking sector again gradually relaxes margins of safety in times of perceived stability and dramatically increases them in times of perceived distress (i.e. once foreign bank bankruptcies occur). Furthermore, these margins of safety also depend on changes in the risk exposure of the borrowing and the lending bank (measured by their respective leverage ratios $LR_{B,i}$ and $LR_{B,j}$):

$$\theta_{B,i} = \theta_{B,i}(t-1) + \mu_{B,i} \cdot |\theta_{B,i}| + \eta_1 \cdot \Delta LR_{B,i} + \eta_2 \cdot \Delta LR_{B,j} \tag{8}$$

$$\mu B_i = \begin{cases} CANC_{B,i} = 0 : -\gamma_B \\ \text{otherwise} : \tau_B \end{cases} \tag{9}$$

Whenever banking sector i is credit constrained and its income is insufficient to cover debt payments (i.e. bank profits ΠB_i are negative), it goes bankrupt and lenders have to cancel a

[9] In this model we assume that only firms can be credit constrained. For an analysis of household debt dynamics see Kapeller & Schütz (2014) and Kapeller *et al.* (2018).

certain proportion χ of outstanding loans:

$$CANC_{B,i} = \begin{cases} L_{IB,i}(t-1) > 0 \wedge \pi_{B,i}(t-1) - \theta_{B,i}(t-1) < 0 \wedge \Pi_{B,i}(t-1) < 0 : \\ \chi \cdot L_{IB,i}(t-1) \\ \text{otherwise} : 0 \end{cases} \tag{10}$$

In order to carry out the transactions related to imports, banking sector i needs an equivalent amount of reserves. If it is credit constrained, it has to rely on its existing reserves and incoming reserves related to export revenues. If reserves required for import transactions exceed the available amount, part of these transactions cannot be carried out, which amounts to a 'sudden stop'. Since many economic activities actually depend on imports, we assume that in this case consumption, investment and government demand are reduced proportionately such that the amount of reserves available when credit constrained (RCC_i) is enough to cover the demand for imports at the given import propensities. Since this channel can be shown to lead to strong contractions of the economy, we assume that once a certain rate elr ('emergency lending rate') of demand contraction has been reached, the central bank steps in as lender of last resort to avoid further declines of demand beyond this rate.

$$C_i = \begin{cases} \pi_{B,i}(t-1) - \theta_{B,i}(t-1) \geq 0 : C_{D,i} \\ \text{otherwise} : Max[Min[C_{D,i}, RCC_i \cdot \frac{C_{D,i}}{C_{D,i}+I_{D,i}+G_{D,i}}], elr \cdot C_{D,i}] \end{cases} \tag{11}$$

$$I_i = \begin{cases} \pi_{B,i}(t-1) - \theta_{B,i}(t-1) \geq 0 : I_{D,i} \\ \text{otherwise} : Max[Min[I_{D,i}, RCC_i \cdot \frac{I_{D,i}}{C_{D,i}+I_{D,i}+G_{D,i}}], elr \cdot I_{D,i}] \end{cases} \tag{12}$$

$$G_i = \begin{cases} \pi_{B,i}(t-1) - \theta_{B,i}(t-1) \geq 0 : G_{D,i} \\ \text{otherwise} : Max[Min[G_{D,i}, RCC_i \cdot \frac{G_{D,i}}{C_{D,i}+I_{D,i}+G_{D,i}}], elr \cdot GD_i] \end{cases} \tag{13}$$

$$\begin{aligned} RCC_i = \; & \big[X_i(t-1) + \rho \cdot \Pi_{CB}(t-1) + i_D \cdot R_i(t-1) + i_L \cdot \big(L_{IB,j}(t-1) \\ & - L_{IB,i}(t-1) - L_{CB,i}(t-1)\big) + a \cdot \big(L_{IB,j}(t-1) - L_{IB,i}(t-1) \\ & - L_{CB,i}(t-1)\big) + R_i(t-1) - rrr \cdot M_{H,i}(t-1)\big]/m_i \end{aligned} \tag{14}$$

For an overview of all stocks and flows see table 1 and 2.

Table 1: Stock matrix

	North				**South**				**CB**	**RoW**	$\sum$
	Households	**Firms**	**Government**	**Banks**	**Households**	**Firms**	**Government**	**Banks**			
Money deposits	$M_{H,n}$			$-M_{H,n}$	$M_{H,s}$			$-M_{H,s}$			0
Bank Loans	$-L_{H,n}$	$-L_{F,n}$	$-L_{G,n}$	L_n	$-L_{H,s}$	$-L_{F,s}$	$-L_{G,s}$	L_s			0
Capital		K_n				K_s					K
Reserve Deposits				R_n				R_s	$-R$	R_w	0
CB Loans				$-L_{CB,n}$				$-L_{CB,s}$	L_{CB}		0
Interbank Loans N				$-L_{IB,n}$				$L_{IB,n}$			0
Interbank Loans S				$L_{IB,s}$				$-L_{IB,s}$			0
Foreign Reserves									R_F	$-R_F$	0
Retained profits				$R\Pi_{B,n}$				$R\Pi_{B,s}$			$R\Pi_B$
Balance (net-worth)	$-V_{H,n}$	$-V_{F,n}$	$-V_{G,n}$	$-V_{B,n}$	$-V_{H,s}$	$-V_{F,s}$	$-V_{G,s}$	$-V_{B,s}$	$-V_{CB}$	$-V_{RoW}$	$-(K+R\Pi_B)$
$\sum$	0	0	0	0	0	0	0	0	0	0	0

Table 2: Flow matrix

	North								South								Central Bank		RoW		$\sum$
	Households		**Firms**		**Government**		**Banks**		**Households**		**Firms**		**Government**		**Banks**						
	Curr.	Cap.	Curr.	Cap.	Curr.	Cap.	Curr.	Cap.	Curr.	Cap.	Curr.	Cap.	Curr.	Cap.	Curr.	Cap.	Curr.	Cap.	Curr.	Cap.	
[1]	$-C_n$		$(1-m_n)\cdot C_n$								$m_{s,n}\cdot C_n$								$m_{w,n}\cdot C_n$		0
[2]			$m_{n,s}\cdot C_s$						$-C_s$		$(1-m_s)\cdot C_s$								$m_{w,s}\cdot C_s$		0
[3]			$(1-m_n)\cdot I_n$	$-I_n$							$m_{s,n}\cdot I_n$								$m_{w,n}\cdot I_n$		0
[4]			$m_{n,s}\cdot I_s$								$(1-m_s)\cdot I_s$	$-I_s$							$m_{w,s}\cdot I_s$		0
[5]			$(1-m_n)\cdot G_n$		$-G_n$						$m_{s,n}\cdot G_n$								$m_{w,n}\cdot G_n$		0
[6]			$m_{n,s}\cdot G_s$								$(1-m_s)\cdot G_s$		$-G_s$						$m_{w,s}\cdot G_s$		0
[7]			$m_{n,w}\cdot Y_w$								$m_{s,w}\cdot Y_w$								$-m_w\cdot Y_w$		0
[8]			$[Y_n]$								$[Y_s]$										
[9]	$w\cdot E_n$		$-w\cdot E_n$						$w\cdot E_s$		$-w\cdot E_s$										0
[10]	$-T_n$				T_n				$-T_s$				T_s								0
[11]	$i_D\cdot M_{H,n}$						$-i_D\cdot M_{H,n}$		$i_D\cdot M_{H,s}$						$-i_D\cdot M_{H,s}$						0
[12]	$-i_L\cdot L_{H,n}$		$-i_L\cdot L_{F,n}$		$-i_L\cdot L_{G,n}$		$i_L\cdot L_n$		$-i_L\cdot L_{H,s}$		$-i_L\cdot L_{F,s}$		$-i_L\cdot L_{G,s}$		$i_L\cdot L_s$						0
[13]							$-i_L\cdot L_{IB,n}$								$i_L\cdot L_n$						0
[14]							$i_L\cdot L_{IB,s}$								$-i_L\cdot L_s$						0
[16]							$-i_L\cdot L_{CB,n}$								$-i_L\cdot L_{CB,s}$		$i_L\cdot L_{CB}$				0
[18]							$i_D\cdot R_n$								$i_D\cdot R_s$		$-i_D\cdot R$				0
[19]	$-REP_{H,n}$	$REP_{H,n}$	$-REP_{F,n}$	$REP_{F,n}$	$-REP_{G,n}$	$REP_{G,n}$			$-REP_{H,s}$	$REP_{H,s}$	$-REP_{F,s}$	$REP_{F,s}$	$-REP_{G,s}$	$REP_{G,s}$							0
[20]				$CANC_{F,n}$				$-CANC_{F,n}$				$CANC_{F,s}$				$-CANC_{F,s}$					0
[21]								$CANC_{B,n}$								$-CANC_{B,n}$					0
[22]								$-CANC_{B,s}$								$CANC_{B,s}$					0
[23]	$\Pi_{F,n}$		$-\Pi_{F,n}$						$\Pi_{F,s}$		$-\Pi_{F,s}$										0
[24]	$\Pi^{dist}_{B,n}$						$-\Pi^{dist}_{B,n}$		$\Pi^{dist}_{B,s}$						$-\Pi^{dist}_{B,s}$						0
[25]					$\Pi_{CB,n}$								$\Pi_{CB,s}$				$-\Pi_{CB}$				0
[26]	$-S_{H,n}$	$S_{H,n}$			$-S_{G,n}$	$S_{G,n}$	$-S_{B,n}$	$S_{B,n}$	$-S_{H,s}$	$S_{H,s}$			$-S_{G,s}$	$S_{G,s}$	$-S_{B,s}$	$S_{B,s}$			$-B_w$	B_w	0
[27]		$-\Delta M_{H,n}$						$\Delta M_{H,n}$		$-\Delta M_{H,s}$						$\Delta M_{H,s}$					
[28]		$\Delta L_{H,n}$		$\Delta L_{F,n}$		$\Delta L_{G,n}$		$-\Delta L_n$		$\Delta L_{H,s}$		$\Delta L_{F,s}$		$\Delta L_{G,s}$		$-\Delta L_s$					0
[29]								$\Delta L_{CB,n}$								$\Delta L_{CB,s}$		$-\Delta L_{CB}$			0
[30]								$\Delta L_{IB,n}$								$-\Delta L_{IB,n}$					0
[31]								$-\Delta L_{IB,s}$								$\Delta L_{IB,s}$					0
[32]																		$-FRT$		FRT	0
[33]								$-\Delta R_n$								$-\Delta R_s$		ΔR		$-\Delta R_w$	0
[34]								$-\Delta R\Pi_{B,n}$								$-\Delta R\Pi_{B,s}$		ΔR		$-\Delta R_w$	0
$\sum$	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

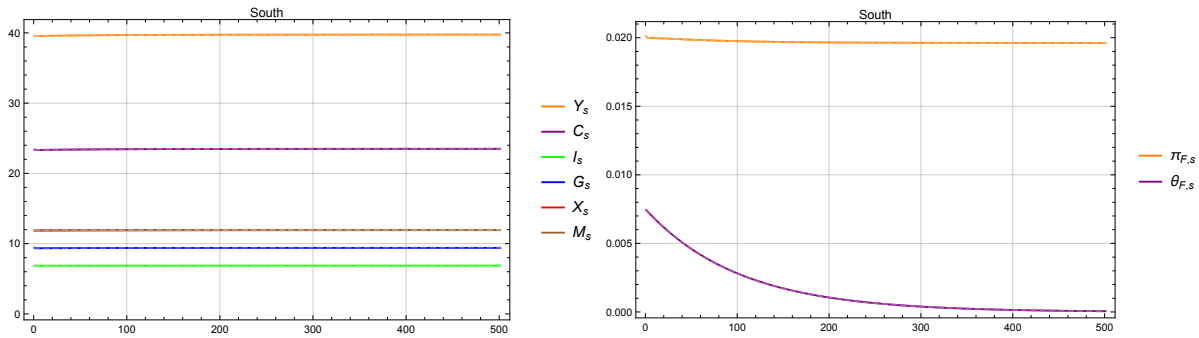
[1] Consumption North, [2] Consumption South, [3] Investment North, [4] Investment South, [5] Government Spending North, [6] Government Spending South, [7] Import Demand RoW, [8] [Total Production], [9] Wage Income, [10] Taxes [11] Interest on Deposits, [12] Interest on Loans [13] Interbank Interest Payment North [14] Interbank Interest Payment South, [15] Installments Interbank Loans, [16] Interest Payment to Central Bank, [17] Installments Central Bank Loans, [18] Interest on Reserve Deposits, [19] Installments Household Bank Loans, [20] Firm Debt Cancellation, [21]-[22] Inter Bank Debt Cancellation, [23] Distributed Firm Profits, [24] Distributed Bank Profits, [25] Profit Central Bank, [26] Surpluses, [27] Δ Deposits, [28] Δ Loans, [29] Δ Central Bank Loans, [30] Δ Interbank Loans given to North, [31] Δ Interbank Loans given to South, [32] Foreign Reserve Transaction, [33] Δ Reserves, [34] Δ Retained Bank Profits

4 Crisis scenarios

This very stylized model can provide us with some very interesting insights into the dynamics of financial crises in an international setting. In the baseline scenario, the regions N and S are structurally equal to each other and only differ in their relative size; we set the southern economy to be two thirds of the size of the North. After also setting all other parameter values, we let the model run through a burn-in period, at the end of which both regions arrive at a stable level of GDP. This stationarity is due to ignoring technological progress in our model (see also Kapeller & Schütz, 2014; Kapeller *et al.*, 2018); Introducing a trend growth rate would not contribute significantly to showing the qualitative features of crises dynamics we want to demonstrate in our three region model. We subsequently take these results as starting values for the simulation exercises reported in the following sections. A complete list of all parameters and starting values can be found in the appendix. Furthermore, the appendix also investigates the sensitivity of results with respect to variations in key parameter values. The initial stability of the system is demonstrated in figure 2, which shows southern GDP and its components, as well as the associated profit rate of firms. We only see banks' margins of safety decline since the economic situation is perceived as stable.

In the scenarios introduced below we attempt to capture in a staggered way stylized features of the evolving crisis and policy reactions which reflect the developments within the EU and in its relations to the outside world. We start with a private-sector (and debt-) driven expansion in the EU-South (scenario 1), then add to this the underlying competitiveness problems which the EU-South encountered with some of the global emerging economies particularly in South-East Asia (scenarios 2 and 3) and then introduce the feature that EU-Northern countries could partly de-couple themselves from developments within the EU by increasing their exports to the RoW (think of the high demand for German capital goods exports to a fast growing Chinese economy) in scenario 4. Hence the scenario simulations serve to allow a decomposition to follow the impact of the individual most important features that were present during the financial and Euro-crisis and which cumulatively shaped overall developments. These are followed by policy scenarios (5 and 6) that attempt to explore monetary and fiscal policy options and responses.

Figure 2: GDP and its components (left) and firms' rate of profit ($\pi_{F,s}$) and the margin of safety ($\theta_{F,s}$) (right): Baseline scenario (South; results for North differ only in magnitude)



4.1 Scenario 1: Investment boom in the South

In our first scenario, we simulate an investment boom in the South. We refer here to the analysis of many authors (for a synthetic assessment see Baldwin & Giavazzi, 2015) that in the build-up to the financial crisis, many EU-Southern countries (Spain, Portugal, Greece, but also Ireland) experienced a strong increase in private sector debt used in parts for investment (particularly in the construction industry) and also for household consumption. We replicate this stylized fact by assuming in this first scenario a permanent increase in exogenous investment ($i0_s$) taking place solely in the South. The result is depicted in figures 3 and 4 respectively, where we compare them to the results of our baseline scenario (see the dashed lines): higher investment in the South initially starts a self-propagating boom, as it leads to higher consumption and higher government expenditure, which in turn feeds back into higher investment through higher capacity utilization. Through higher import demand, the boom is transmitted to the economy of the North. Due to higher sales, firm profits also increase.

At some point, however, the rise in production capacities exceeds the rise in demand. The resulting decline in capacity utilization reduces investment demand, which leads into recession. During the recession, it seems as if output were to converge towards a new stable level that exceeds the level of GDP in the baseline scenario.

However, what cannot be seen by simply looking at GDP is that the profit rate of firms, after an initial increase, gets on a steady downward trajectory throughout the subsequent recession (figure 4), as lower revenues and increasing debt payments take its toll. At some point, the rate of profit declines below the banks' margin of safety, which means that firms are suddenly credit constrained. Losing partial access to credit leads to a drop in investment, which triggers a substantial drop in output. Falling demand leads to a sharp decline of profits, meaning that firms remain credit constrained for an extended period. With investment at a low level, demand starts to outgrow production capacities, and investment demand finally starts growing again. Low levels of investment also mean that firm indebtedness declines and the profit rate recovers. At some point the profit rate has recovered sufficiently such that firms are no longer credit constrained. Once this happens, we observe the beginning of another boom-bust cycle. The latter evolves in a similar nature, the only difference being that during the next financial crisis, firm profits drop into negative territory, meaning that banks have to cancel a large proportion of their debt. As a result the margin of safety increases substantially and only recovers gradually, leading to a long period of firms being credit constrained.

When we look at the evolution of exports and imports (figure 5), we see that in the South, those boom phases go along with trade deficits, while crisis episodes are accompanied by trade surpluses. The North in turn experiences initial trade surpluses, but finds itself with trade deficits once crises start appearing in the South.

Southern trade deficits lead to growing external indebtedness of the southern banking sector (figure 6): increasing payments for imports mean that southern banks have to transfer more and more deposits to northern banks. These transfers in turn have to be accommodated by a corresponding flow of reserves. In order to get these reserves, southern banks borrow from northern banks (as can be seen from the rise in interbank loans $L_{IB,s}$ incurred by the South). Since we assume that northern banks can only lend existing surpluses, the southern banks obtain

Figure 3: GDP and its components: Investment boom in the South (baseline scenario depicted with dashed lines)

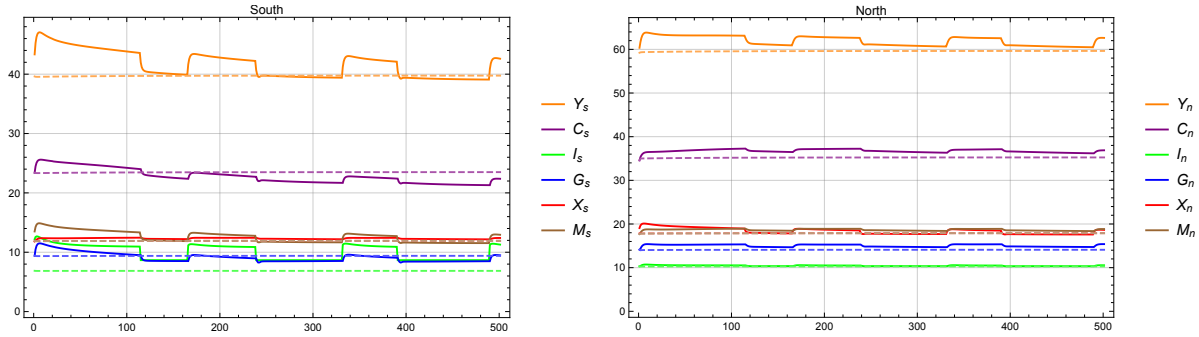
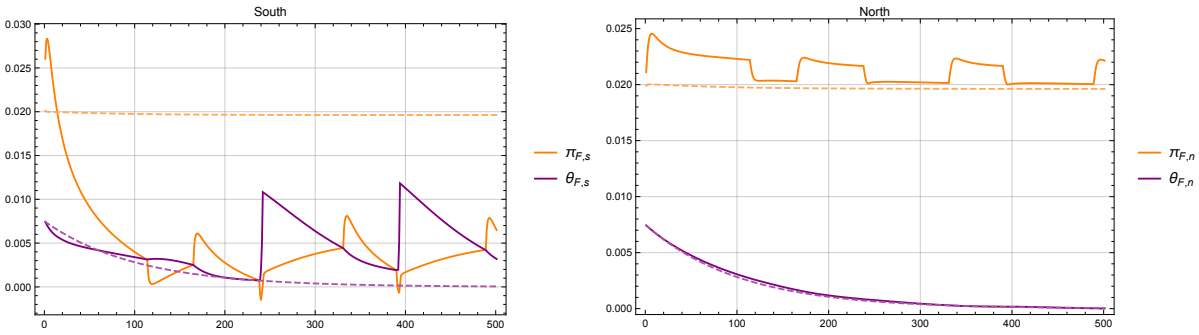


Figure 4: Firms' rate of profit ($\pi_{F,i}$) and the margin of safety ($\theta_{F,i}$): Investment boom in the South (baseline scenario depicted with dashed lines)



the rest through central bank loans, which also increase.

Northern banks in turn initially experience an net inflow of reserves. Part of these reserves is kept in order to fulfil growing minimum reserve requirements (trade surpluses favor the accumulation of deposits by northern households), while another part is needed for paying installments on existing central bank loans. What is left is lent to southern banks. Once financial crises in the South put and end to these trade surpluses, a further expansion of interbank credit is put to a halt.

Finally, we see that – although southern firms suffer from repeated periods of being credit constrained – southern banks do never lose access to interbank or central bank credit, as their profits stay above the necessary margin of safety (figure 7).

Figure 5: Exports and imports: Investment boom in the South (baseline scenario depicted with dashed lines)

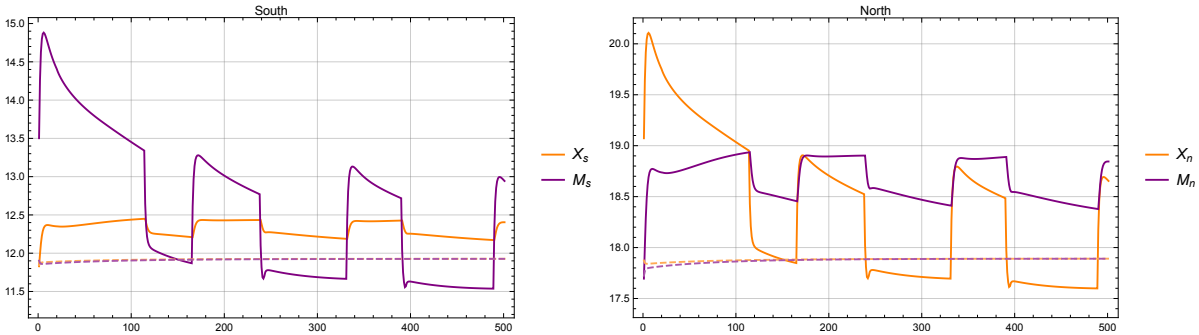


Figure 6: Interbank loans ($L_{IB,i}$), central bank loans ($L_{CB,i}$) and reserves (R_i) (baseline scenario depicted with dashed lines)

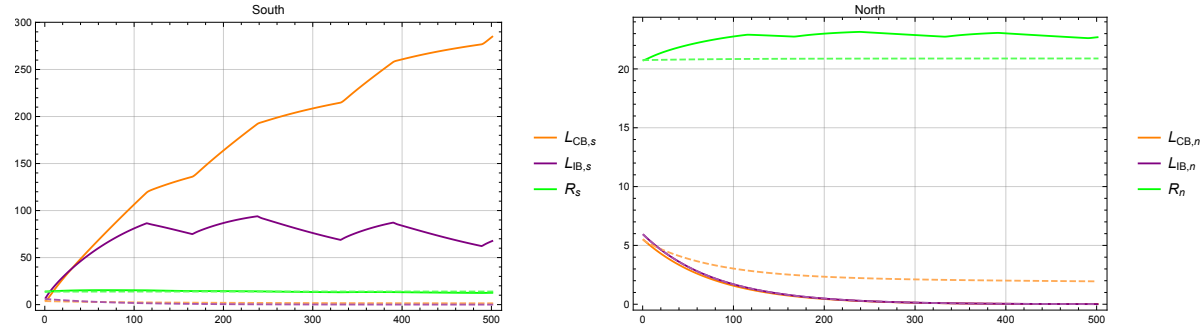
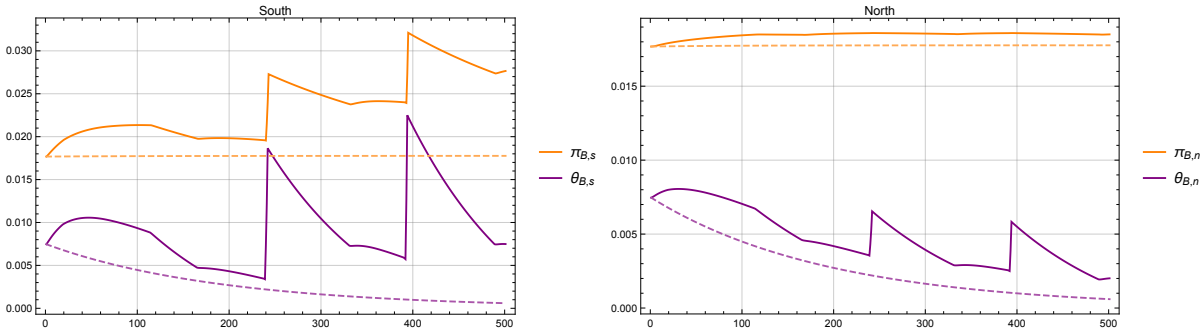


Figure 7: Banks' rate of profit ($\pi_{B,i}$) and the margin of safety ($\theta_{B,i}$): Investment boom in the South (baseline scenario depicted with dashed lines)



4.2 Scenario 2: South loses competitiveness relative to the RoW

In the next scenario, we assume that the RoW gains competitiveness in those products that are produced predominantly by the South. This scenario attempts to cover the additional feature that EU-Southern countries - given their industrial and export structures - came under increasing competitive pressure on the import and export side, especially from Southeast and East Asia, already significantly before the crisis (see Gräbner *et al.*, 2020). Particularly, we will assume that the northern import propensity for products from RoW increases by the same amount as its import propensity for products from the South declines. Ceteris paribus, this should leave the northern region's trade balance unchanged, while leading to a deterioration of the southern trade balance. However, since the drop in southern GDP spills back via import demand into the northern economy, northern GDP declines as well (figure 8). With both regions suffering a reduction in their exports, both experience trade deficits (figure 9).

Both banking sectors experience net outflows of reserves (with the RoW reporting the corresponding net inflows). Without any surplus reserves, both banking sectors rely on central bank loans to satiate their growing demands for reserves (figure 10). Therefore we get the result that a decline of competitiveness of the South does not lead to growing indebtedness with respect to the North. Instead, the South incurs an increasing amount of loans from the central bank, which in the end increases the amount of reserves that the RoW holds.

Figure 8: GDP and its components: South loses competitiveness relative to the RoW (baseline scenario depicted with dashed lines)

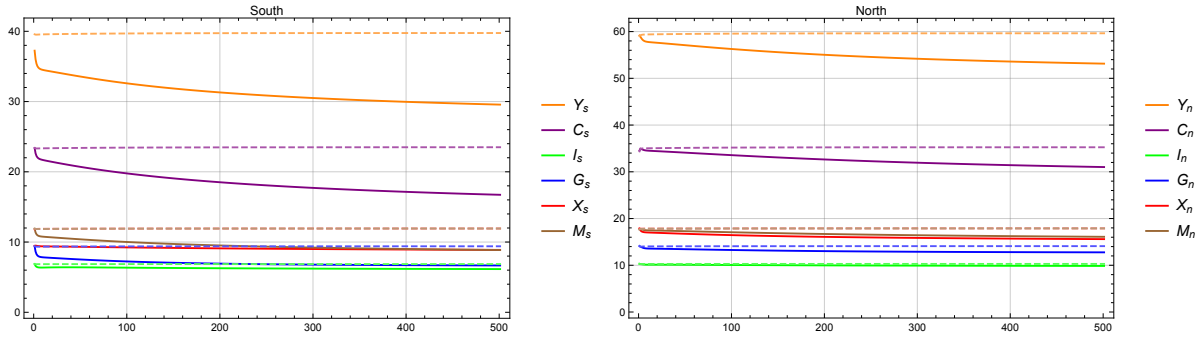


Figure 9: Exports and imports: South loses competitiveness relative to the RoW (baseline scenario depicted with dashed lines)

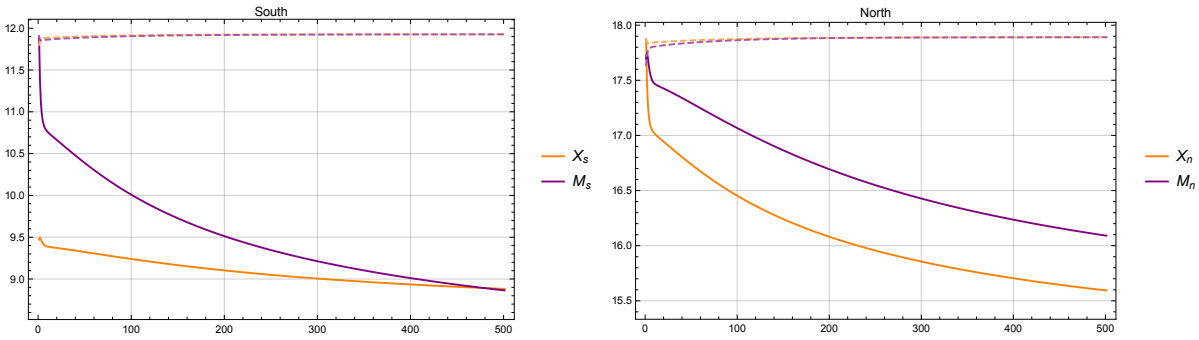
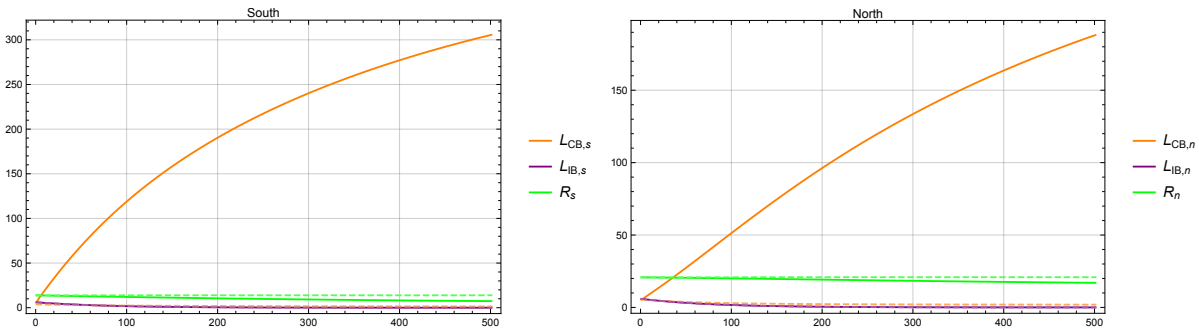


Figure 10: Interbank loans ($L_{IB,i}$), central bank loans ($L_{CB,i}$) and reserves (R_i: South loses competitiveness relative to the RoW (baseline scenario depicted with dashed lines)



4.3 Scenario 3: South loses competitiveness relative to the RoW and investment boom South

In our next scenario, we take the decline in relative southern competitiveness from the previous scenario as a starting point, but assume that it is taking place at the same time as the southern investment boom described in scenario 1. The result is displayed in figures 11 – 14, where the dashed lines show the previous outcomes from scenario 2. With the investment boom taking place simultaneously, the South experiences a boom despite the loss in relative competitiveness. Similar to scenario 1, the boom fades after a while, being followed by a recession. As the recession continues, the profit rate of firms declines below banks' margin of safety (figure 12b). Once banks stop lending, the economy enters a financial crisis and firms become credit constrained. In contrast to scenario 1 however, firms never fully recover and remain credit constrained for the remaining periods. Moreover, the financial crisis is followed by an international financial crisis as Southern banks become internationally credit constrained. Once this occurs, the southern economy has to run a trade surplus in order to finance the repayment of international debt, which mainly consists of central bank loans. Interbank loans from the North are in short supply, since the northern economy lacks the necessary surplus of reserves due to its own trade deficit. Trade deficits are due to the ongoing state of depression of the southern economy, which means that the northern exports cannot reach their pre-crisis levels.

Notably, in this scenario the investment boom is unable to generate growing indebtedness of the South towards the North, since the North itself lacks the necessary funds due to the ongoing weakness of the southern economy. Interbank loans are at very low levels, whereas the bulk of debt in both countries is financed through the central bank. As both regions suffer from chronic trade deficits, the RoW is running a trade surplus accommodated by increasing reserve deposits.

Figure 11: GDP and its components: Scenario 3 (scenario 2 depicted with dashed lines)

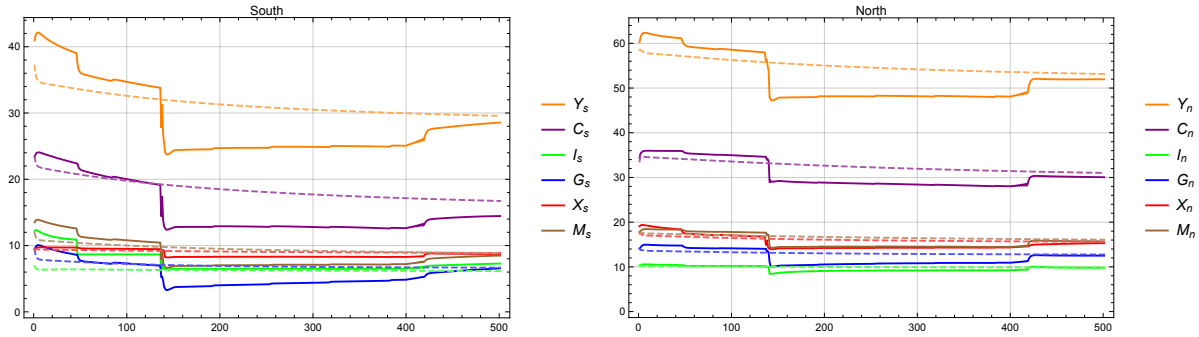
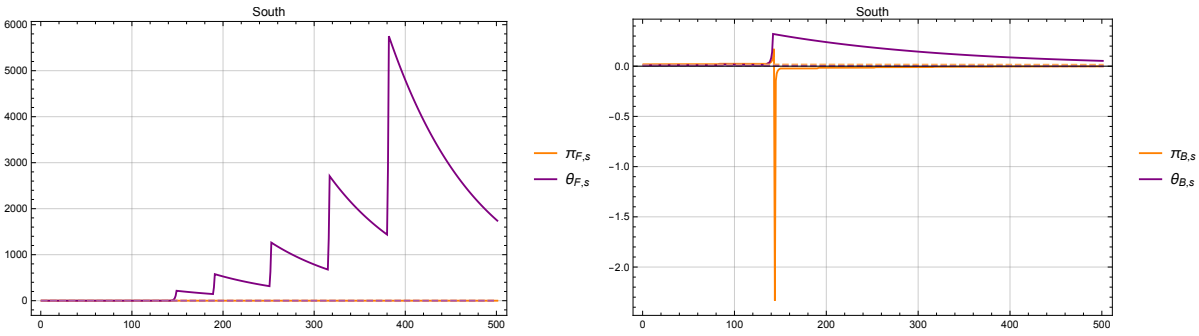


Figure 12: Scenario 3 (scenario 2 depicted with dashed lines)



(a) Firms' rate of profit and margin of safety (South) **(b)** Banks' rate of profit and margin of safety (South)

Figure 13: Exports and imports: Scenario 3 (scenario 2 depicted with dashed lines)

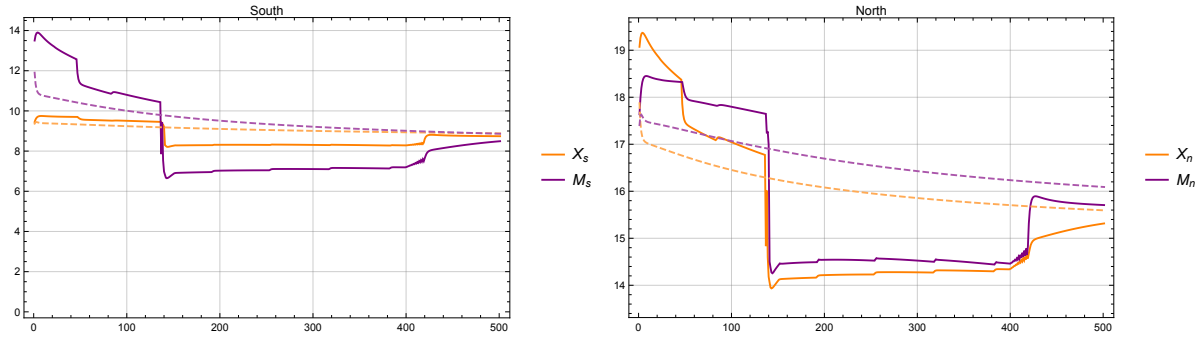
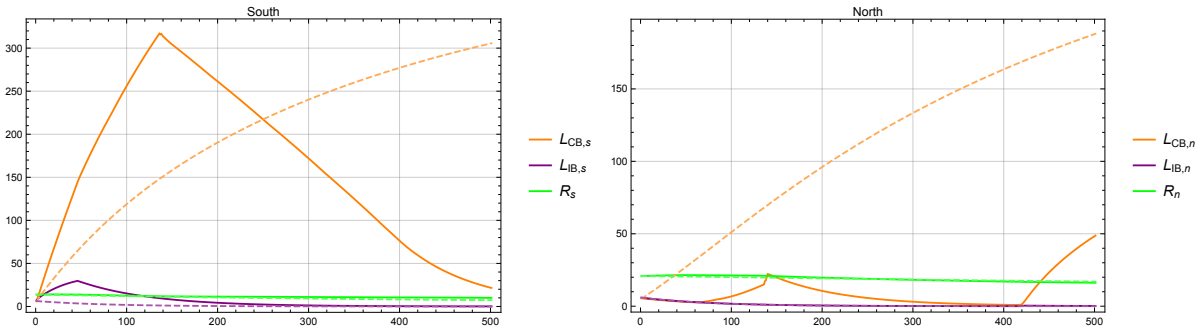


Figure 14: Interbank loans ($L_{IB,i}$), central bank loans ($L_{CB,i}$) and reserves (R_i): Scenario 3 (scenario 2 depicted with dashed lines)



4.4 Scenario 4: Northern mercantilism

In this scenario, we take scenario 3 as our point of departure, but assume that during times of financial distress in the South, the North is capable of compensating the loss in import demand from the South by instead increasing its exports to the RoW. This covers the feature that EU-Northern countries benefited from quite high demand for their export products (specifically capital goods and mid-to-high technology products) by emerging economies (China in particular) which allowed them to decouple to some extent from developments within the Eurozone. In the following, we assume that after each period in which the Southern economy faces a financial crisis (i.e. firms in the South are credit constrained), the RoW's import propensity for goods from the North increases by an exogenous amount x. Furthermore, in order to limit the impact of this channel, we assume that cumulative changes in the income elasticity of RoW imports from the North cannot exceed its income elasticity with respect to southern goods ($\sum \Delta mn_w \leq ms_w$):

$$m_{n,w} = \begin{cases} \pi_{F,s}(t-1) - \theta_{F,s}(t-1) \geq 0 \vee \sum \Delta mn_w \geq ms_w : m_{n,w} \\ \text{otherwise} : m_{n,w}(t-1) + x \end{cases} \tag{15}$$

We can see in figures 15 – 18 that, unsurprisingly, the North recovers quite quickly after the initial recession triggered by the southern financial crisis. Due to the northern recovery, the southern financial sector is able to retain its solvency for a longer period of time. However, eventually the southern financial sector becomes credit constrained, leading to the kind of international financial crisis witnessed in the previous scenario.

Things turn out a bit differently in the North, which is able to retain a high level of GDP despite some intermediate losses. This development in the North is due to its ability to increase exports to the RoW.

At the eve of the international financial crisis, the southern financial sector has accumulated significant amounts of international interbank loans. This stands in contrast to the previous scenario, in which financial sector debt mainly took the form of central bank loans. This difference is due to the fact that the North is able to run trade surpluses throughout most of the pre-crisis period, which means that the northern financial sector possesses excess reserves. These surpluses are in turn lent to the southern financial sector.

Once the international financial crisis starts, the southern financial sector turns credit constrained. As a result, the southern economy contracts, leading to the trade surplus that is necessary to repay international debts. We can see in figure 18 that interbank loans decline as a result.

The conclusion that we can draw from this scenario is that an investment boom and weakening export performance in the South only establish a North-South debtor relationship if it is accompanied by increasing strength of the northern export industry. The corresponding reason is that only the latter will provide the northern financial sector with the necessary surplus of financial funds.

Figure 15: GDP and its components: Northern mercantilism (scenario 3 depicted with dashed lines)

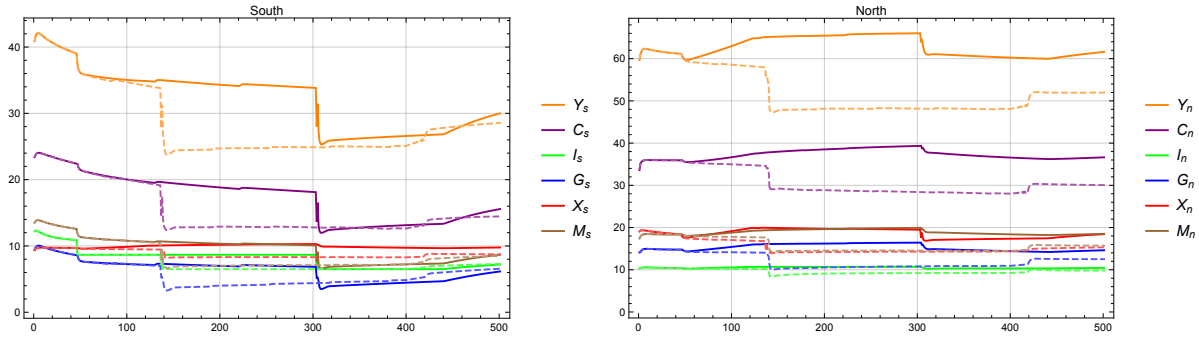
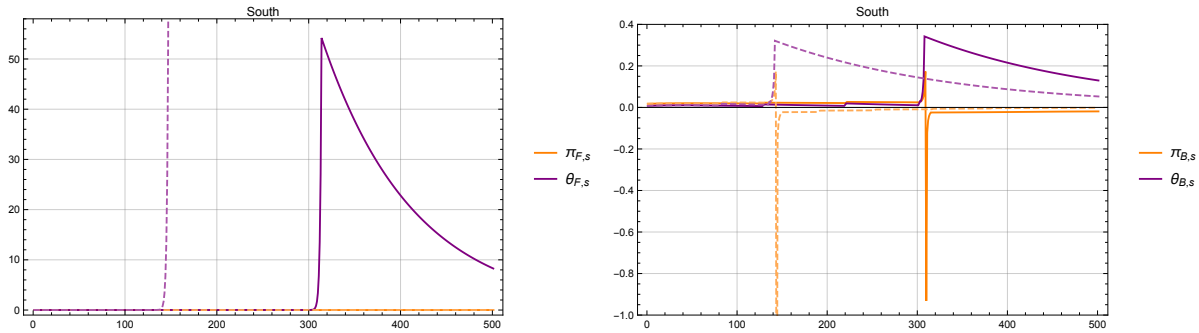


Figure 16: Northern mercantilism (scenario 3 depicted with dashed lines)



(a) Firms' rate of profit ($\pi_{F,s}$) and the margin of safety ($\theta_{F,s}$) (South)

(b) Bank profits ($\Pi_{B,s}$) and margin of safety ($\theta_{B,s}$) (South)

Figure 17: Exports and imports: Northern mercantilism (scenario 3 depicted with dashed lines)

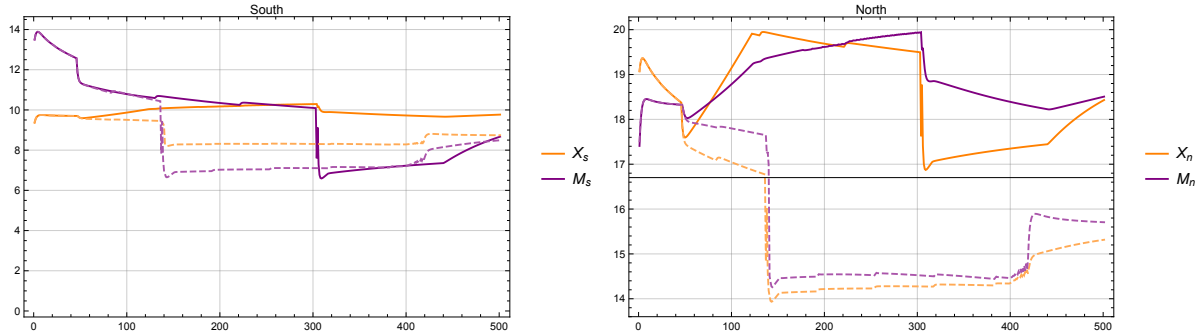
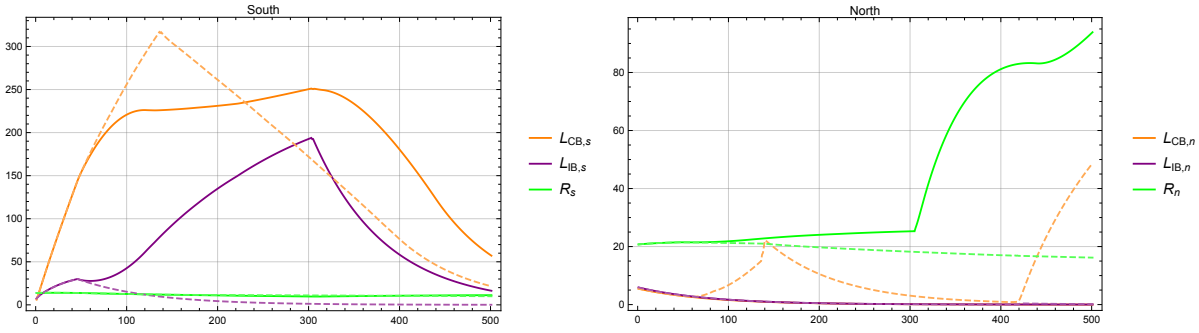


Figure 18: Interbank loans ($L_{IB,i}$), central bank loans ($L_{CB,i}$) and reserves (R_i): Northern mercantilism (scenario 3 depicted with dashed lines)



5 Policy scenarios

So far we have assumed that policy makers remained rather passive during crisis. Next we want to see how the scenarios shown above interact with different policy choices. In particular, we want to look at two policy measures: the central bank as a lender of last resort and counter-cyclical fiscal policy. We discuss these policies for the mercantilist scenario (4).

5.1 Scenario 5: Central bank as unconditional lender of last resort

The role of central banks as lender of last resort – i.e. as the institution that should offer loans to banks and other eligible institutions experiencing severe liquidity issues in times of financial stress – has led to intense policy debates. In earlier stages of the Eurozone crisis, the ECB was criticised for failing to act as a credible lender of last resort, especially in the government bond markets (e.g. De Grauwe, 2011). But as a consequence of ECB president Mario Draghi's announcement that the ECB would do "whatever it takes" to save the Euro – which was widely interpreted as a reinvigoration of the ECB's role as lender of last resort – did financial market turbulence fade (e.g. Saka *et al.*, 2015).

The type of international financial crisis observed towards the end of the mercantilist scenario (scenario 4) can be avoided by installing a lender of last resort that provides ample liquidity to avoid self-fulfilling crisis dynamics that may lead into solvency crisis (e.g. Fischer, 1999). Whereas in previous scenarios we had assumed that the central bank only steps in as a lender of last resort when the economic contraction exceeds a certain level (therefore only providing a floor), this scenario assumes that the central bank provides immediate unlimited access to credit as soon as a national financial sector becomes credit constrained. This means that domestic demand can no longer be constrained by an unavailability of reserves, turning equations (11)-(13) into:

$$C_i = C_{D,i} \tag{16}$$

$$I_i = I_{D,i} \tag{17}$$

$$G_i = GD_i \tag{18}$$

The key finding here is that once the central bank serves as unconditional lender of last resort, we are able to avoid the kind of deep and long lasting international financial crisis observed before (see figure 19), since it circumvents the contraction of imports (see figure 21), and consequentially output, that goes along with a limited amount of reserves. Though firms still remain credit credit constrained once the first financial crisis occurs (figure 20a), unconditional access to central bank lending is even sufficient to restore interbank lending rather quickly (see figures 20 and 22) as the fallout of an international banking crisis is avoided.

Figure 19: GDP and its components: unconditional lender of last resort (scenario 4 depicted with dashed lines)

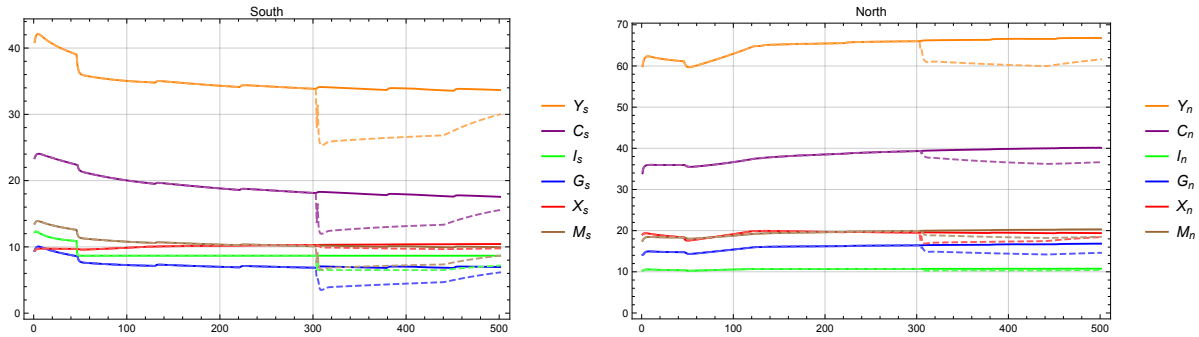
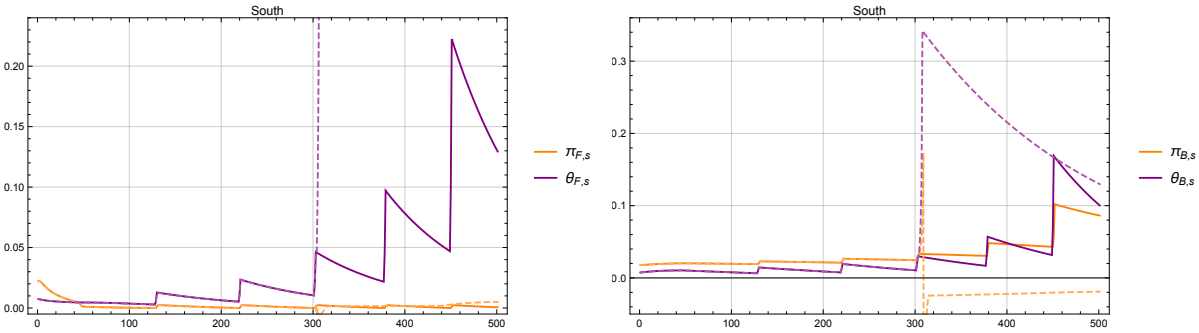


Figure 20: Unconditional lender of last resort (scenario 4 depicted with dashed lines)



(a) Firms' rate of profit ($\pi_{F,s}$) and the margin of safety ($\theta_{F,s}$) (South)

(b) Bank profits ($\Pi_{B,s}$) and margin of safety ($\theta_{B,s}$) (South)

Figure 21: Exports and imports: unconditional lender of last resort (scenario 4 depicted with dashed lines)

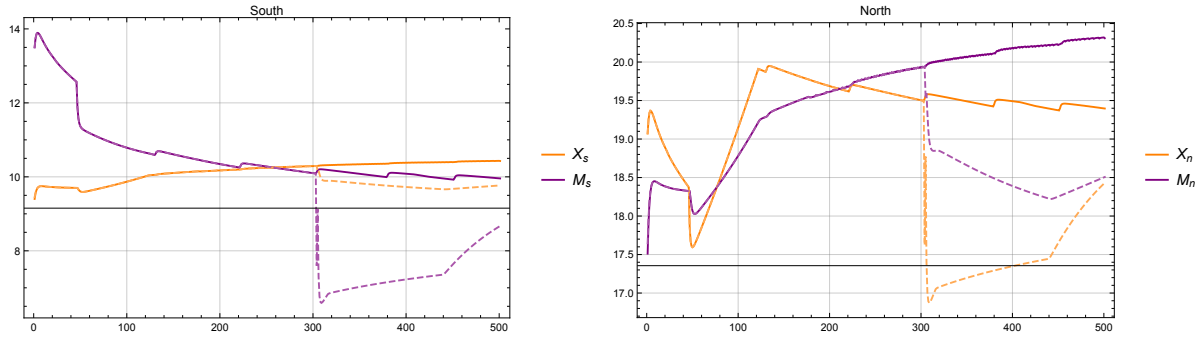
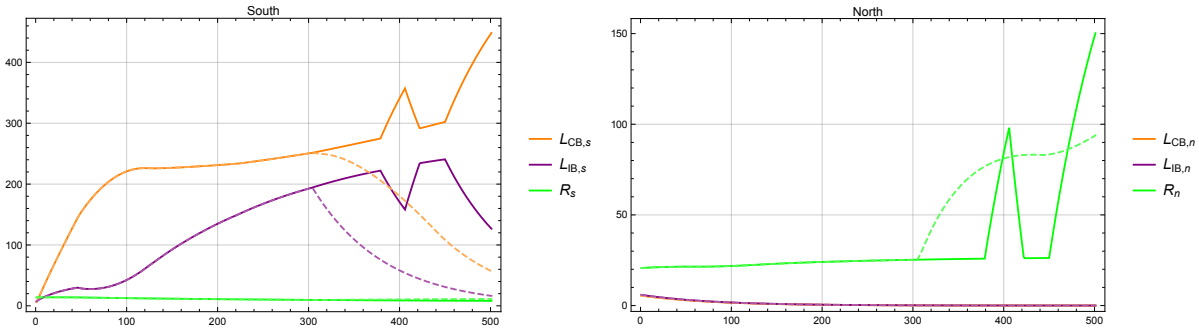


Figure 22: Interbank loans ($L_{IB,i}$), central bank loans ($L_{CB,i}$) and reserves (R_i): unconditional lender of last resort (scenario 4 depicted with dashed lines)



5.2 Scenario 6: Counter-cyclical fiscal policy

When the crisis hit economic activity in 2008 and 2009, several governments across the Eurozone initially reacted by introducing some fiscal stimulus measures to counteract the downturn (e.g. Khatiwada, 2009). However, initial expansionary measures soon gave way to austerity policies in most countries, especially in the southern countries where austerity measures were part of the conditions set up by the Troika (see e.g. Storm & Naastepad, 2015). In this policy scenario, the motivation is to gain a better understanding of the impact of counter-cyclical fiscal policy in a financial crisis. Moreover, we also use this scenario to see how things could have turned out differently if countries had not eventually walked the path of austerity.

For our analytical purposes, we assume that the government departs from its initial spending pattern: While in normal times it still tries to keep a balanced budget based on its net earnings from the previous period (tax income T plus its share of central bank profits Π_{CB} minus interest i_L on government debt L_G), it switches to counter-cyclical spending in times of financial crisis. In particular, we assume that in times of crisis, the government increases spending by an additional fiscal stimulus (FS_i) modeled as a proportion of $GDP(t=0)$.

$$G_{D,i} = T_i(t-1) + \rho_i \cdot \Pi_{CB}(t-1) - i_L \cdot L_{G,i}(t-1) + \begin{cases} \Pi_{F,i}(t-1) - \theta_{F,i}(t-1) \geq 0 : 0 \\ \text{otherwise} : FS_i \end{cases} \tag{19}$$

Like in the previous policy scenario, we take the scenario of northern mercantilism (scenario 4) as our point of departure. What we find is that counter-cyclical policy is able to stabilize southern output over a prolonged period of time (see figures 23 – 27): whenever a domestic financial crisis emerges, the fall in the government primary balance (figure 24) is sufficient to bring the economy back on track, meaning that firm profits recover and domestic lending proceeds (figure 25a). At the same time, the northern economy is able to remain on an upward trajectory throughout this period. The negative side-effect of this policy is that the South faces rising debt payments (figure 24), which forces the southern government to realise primary budget surpluses over time in order to repay that debt.

Moreover, by immediately counteracting those domestic financial crises, fiscal policy is also able to avoid the kind of international financial crisis witnessed in the reference scenario without fiscal policy (scenario 4).

With the South being able to stabilize output through fiscal policy, the North-South debtor relationship intensifies (figure 27), as it provides the North with an even larger surplus of financial funds that are in turn lent back to the South.

Figure 23: GDP and its components: Fiscal policy (scenario 4 depicted with dashed lines)

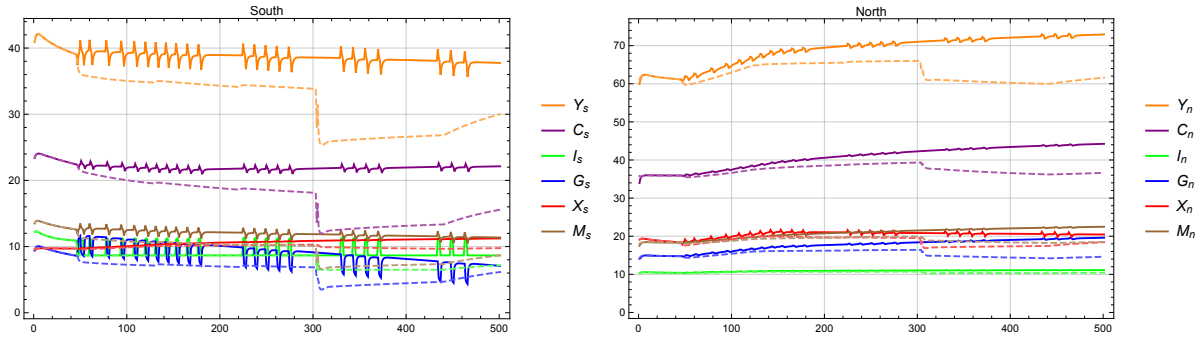


Figure 24: Government primary deficit and debt payments relative to GDP: Fiscal policy (scenario 4 depicted with dashed lines)

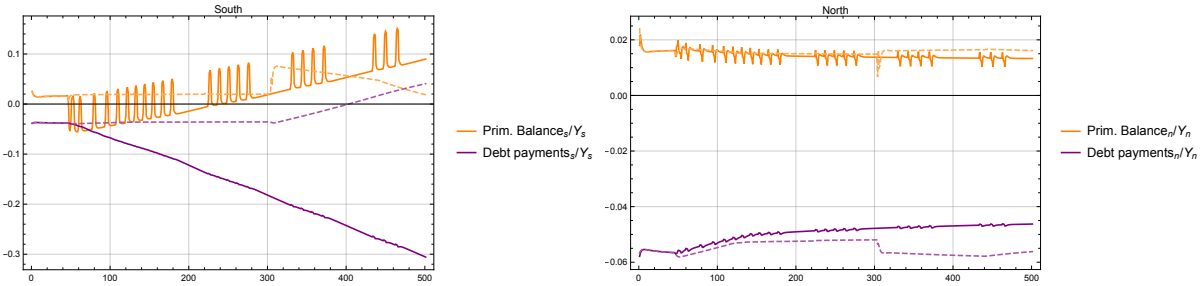
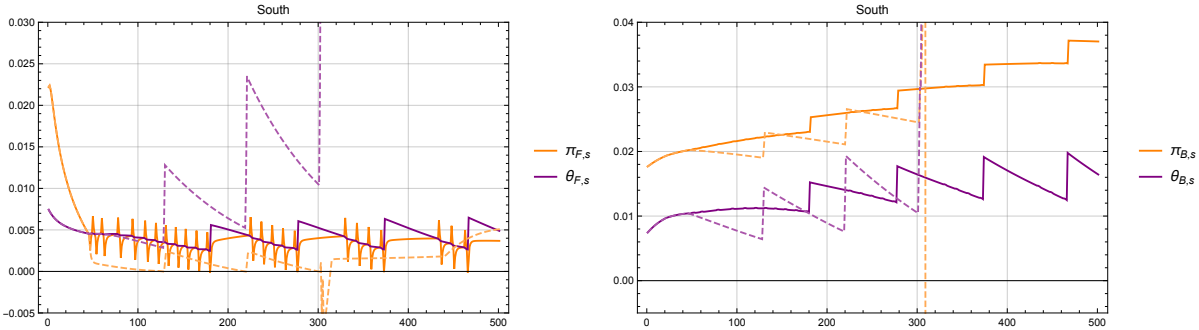


Figure 25: Fiscal policy (scenario 4 depicted with dashed lines)



(a) Firms' rate of profit ($\pi_{F,s}$) and the margin of safety ($\theta_{F,s}$) (South)

(b) Banks' rate of profit ($\pi_{B,s}$) and the margin of safety ($\theta_{B,s}$) (South)

Figure 26: Exports and imports: Fiscal policy (scenario 4 depicted with dashed lines)

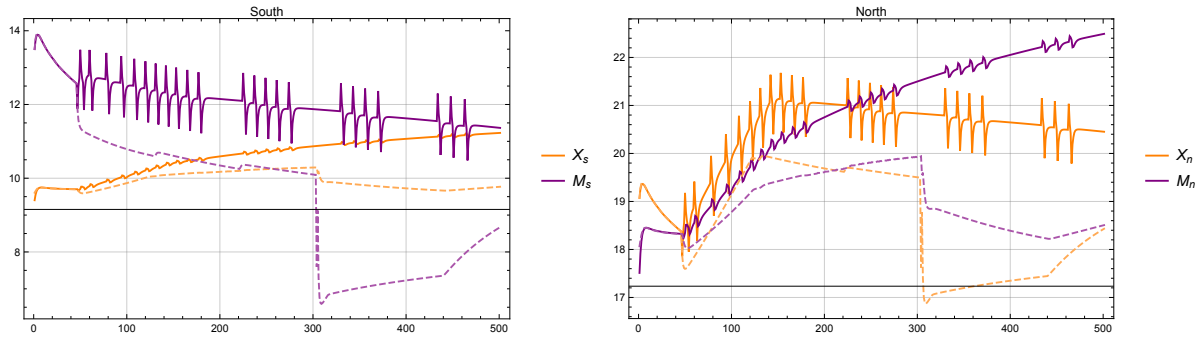
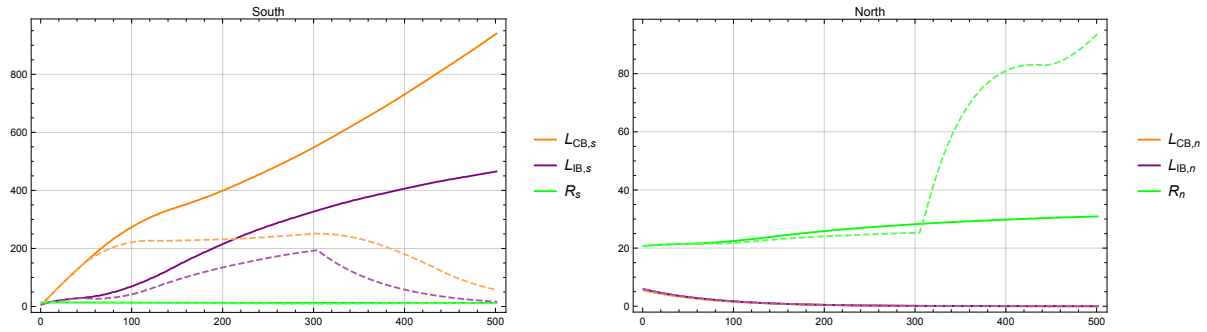


Figure 27: Interbank loans ($L_{IB,i}$), central bank loans ($L_{CB,i}$) and reserves (R_i): Fiscal policy (scenario 4 depicted with dashed lines)



6 Conclusions

This paper has shown how the simultaneous presence of investment booms, declining export performance and mercantilist policies within a monetary union can interact in order to create Minsky-type boom-bust cycles. We illustrate that within a stylised currency union consisting of a northern and a southern region, the North establishes itself as a creditor of the South if the latter experiences an investment boom. However, the North fails to become a notable creditor if the South simultaneously experiences a decline in its ability to sell exports to the Rest of the World. In this case, missing earnings from exports in the South translate into lower export revenues for the North. Subsequently, the North lacks the necessary excess financial funds to become a dominant lender.

However, the situation changes once we assume that the North is able to run a successful mercantilist policy. If the North increases its exports to the Rest of the World while an investment boom is happening in the South, it again possesses the necessary excess funds to become the internal lender of the monetary union.

From a policy perspective, we find that if the central bank acts as an unconditional lender of last resort, it is able to avoid the occurrence of international financial crises. Regarding fiscal policy our simulations show that if the South is allowed to conduct counter-cyclical fiscal policy, it stabilizes output in the South as well as in the North. Moreover, with fiscal policy firmly in place in the South, the North is able to take on a dominant creditor role. The reason for the latter is that deficit spending in the South stabilizes northern export revenues and thereby allows the North to accumulate surplus financial funds.

These findings indicate that while an unconditional lender of last resort and fiscal policy help to stabilize output within a monetary union, these policy measures can only support economic life that is shaped by existing imbalances, but they cannot eliminate the root causes of boom-bust patterns. Therefore, a sustainable long term solution must also tackle the underlying structural imbalances, which also means that existing discrepancies in export competitiveness have to be dealt with. The latter can of course (and possibly will have to) be linked with fiscal policy and involve some kind of supranational lending facility. While these issues are very important, they probably demand a slightly adapted model framework that represents a fruitful avenue for future research.

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A Model equations

This section of the appendix provides a full account of all model equations and variable definitions. Consumption demand C_D, investment demand I_D and demand by the government G_D are defined by equations 20 – 22. Household demand for consumption depends on an autonomous part ($c0_i$) as well as last period's disposable income (Y_H) and net wealth (V_H)(see e.g. Godley & Lavoie, 2007a; Greenwood-Nimmo, 2014; Nikolaidi, 2014; Mazier & Valdecantos, 2014). Firms' investment demand depends on an autonomous part ($i_{0,i}$), the previous period's degree of utilization of the capital stock ($z_i = Y_i/Y_{P,i}$ where $Y_{P,i} = K_i \cdot \kappa$ and Y_i, $Y_{P,i}$, K_i and κ denote GDP, potential output, the capital stock and the potential output to capital ratio respectively) and the rate of return ($\pi_{F,i} = \Pi_{F,i}/K_{F,i}$, where $\Pi_{F,i}$ denotes the level of firm profits) (see e.g. Caiani *et al.*, 2016; Kapeller & Schütz, 2014), as well as the debt ratio ($DR_{F,i} = L_{F,i}/K_i$, where $L_{F,i}$ and K_i denote firm loans and the capital stock respectively) (see e.g. Duwicquet & Mazier, 2010). We assume for simplicity that firms distribute all their profits to households, which results in investment being financed through bank loans. Here we make the critical assumption that banks accommodate firms' credit demand as long as the firm sectors rate of profit ($\pi_{F,i}$) is above a certain margin of safety ($\theta_{F,i}$)(Minsky, 1986). However, whenever this condition is not fulfilled, banks become cautious and restrict lending to the firm sector. The latter means that only a certain proportion rcr (rate of credit restriction) of investment demand gets financed, which we refer to as a situation of financial distress.[10] In normal times the government tries to keep a balanced budget. For this purpose its expenditure is based on net earnings from the previous period, consisting of tax revenues (T_i) and its share ρ_i of central bank profits (Π_{CB}) minus interest (i_L) on outstanding debt ($L_{G,i}$). Central bank profits are distributed according to the regions' relative GDPs in period $t = 0$.

$$C_{D,i} = c_{0,i} + c_1 \cdot Y_{H,i}(t-1) + c_2 \cdot V_{H,i}(t-1) \tag{20}$$

$$I_{D,i} = \begin{cases} \pi_{F,i}(t-1) - \theta_{F,i}(t-1) \geq 0 : i_{0,i} + i_{1,i} \cdot z_i(t-1) + i_{2,i} \cdot \pi_i(t-1) + i_{3,i} \cdot DR_i(t-1) \\ \text{otherwise} : rcr \cdot (i_{0,i} + i_{1,i} \cdot z_i(t-1) + i_{2,i} \cdot \pi_i(t-1) + i_{3,i} \cdot DR_i(t-1)) \end{cases} \tag{21}$$

$$G_{D,i} = T_i(t-1) + \rho \cdot \Pi_{CB}(t-1) - i_L \cdot L_{G,i}(t-1) \tag{22}$$

In our policy scenarios the government switches to counter-cyclical fiscal spending, therefore equation 22 gets replaced by equation 23. In this setting we assume that while in normal times the government still tries to keep a balanced budget based on its net earnings from the previous period, it switches to counter-cyclical spending in times of financial crisis. In particular, we assume that in times of crisis, the government increases spending by an additional fiscal stimulus (FS_i) modeled as a proportion of $GDP(t = 0)$.

$$G_{D,i} = T_i(t-1) + \rho_i \cdot \Pi_{CB}(t-1) - i_L \cdot L_{G,i}(t-1) + \begin{cases} \Pi_{F,i}(t-1) - \theta_{F,i}(t-1) \geq 0 : 0 \\ \text{otherwise} : FS_i \end{cases} \tag{23}$$

Following the work of Minsky (1986) the margin of safety applying for firm loans ($\theta_{F,i}$) is endogenous: it slowly declines in periods of perceived financial stability, only to shoot up in a situation of financial distress. We define that latter as period in which bankruptcies occur (see Kapeller & Schütz, 2014; Kapeller *et al.*, 2018). Furthermore, the margin of safety also depends on changes in the indebtedness of firms measured by their debt ratio ($DR_{F,i}$) (see Duwicquet &

[10] For a similar mechanism see Kapeller & Schütz (2014) and Kapeller *et al.* (2018).

Mazier, 2010; Nikolaidi, 2014) as well as changes in the borrowing banks' risk exposure measured by their leverage ratio ($LR_{B,i} = \Sigma Assets_{B,i}/V_{B,i}$, where $Assets_{B,i}$ and $V_{B,i}$ denote bank assets and bank equity) (see Kapeller *et al.*, 2018).[11]

$$\theta_{F,i} = \theta_{F,i}(t-1) + \mu_{F,i} \cdot |\theta_{F,i}(t-1)| + \zeta_1 \cdot \Delta DR_{F,i} + \zeta_2 \cdot \Delta LR_{B,i} \tag{24}$$

$$\mu_{F,i} = \begin{cases} CANC_{F,i} = 0 : -\gamma_F \\ \text{otherwise} : \tau_F \end{cases} \tag{25}$$

The same logic applies for interbank loans: Interbank loans are only provided when banks' rate of return on equity ($\pi_{B,i} = \Pi_{B,i}/V_{B,i}$, where $\Pi_{B,i}$ denotes bank profits) exceeds a margin of safety $\theta_{B,i}$. The latter is again endogenous: it slowly declines in normal times and rapidly increases in periods of distress (i.e. when banks have to cancel loans provided to other banks). Furthermore it also depend on changes in the risk exposure of the borrowing bank (measured by the leverage ratio $LR_{B,i}$) and the lending bank (measured by the leverage ratio $LR_{B,j}$):

$$\theta_{B,i} = \theta_{B,i}(t-1) + \mu_{B,i} \cdot |\theta_{B,i}| + \eta_1 \cdot \Delta LR_{B,i} + \eta_2 \cdot \Delta LR_{B,j} \tag{26}$$

$$\mu_{B,i} = \begin{cases} CANC_{B,i} = 0 : -\gamma_B \\ \text{otherwise} : \tau_B \end{cases} \tag{27}$$

Cancellation of firm debt in region i ($CANC_{F,i}$) and bank debt in region i ($CANC_{B,i}$) are defined by equations (28) and (29) respectively (see Kapeller & Schütz, 2014; Kapeller *et al.*, 2018). Banks have to cancel proportion χ of their outstanding debt if firms are credit constrained (firms' rate of profit $\pi_{F,i}$ has fallen below the margin of safety $\theta_{F,i}$) and firm profits have turned negative (i.e. firms cannot service debt payments out of profits). By the same logic banks in region j have to cancel a proportion χ of the interbank loans given to the banking sector in region i if banks are credit constrained (the rate of profit $\pi_{B,i}$ has fallen below the margin of safety $\theta_{B,i}$) and bank profits have turned negative (i.e. banks cannot service debt payments out of profits).

$$CANC_{F,i} = \begin{cases} L_{F,i}(t-1) > 0 \wedge \pi_{F,i}(t-1) - \theta_{F,i}(t-1) < 0 \wedge \Pi_{F,i}(t-1) < 0 : \\ \chi \cdot L_{F,i}(t-1) \\ \text{otherwise} : 0 \end{cases} \tag{28}$$

$$CANC_{B,i} = \begin{cases} L_{IB,i}(t-1) > 0 \wedge \pi_{B,i}(t-1) - \theta_{B,i}(t-1) < 0 \wedge \Pi_{B,i}(t-1) < 0 : \\ \chi \cdot L_{IB,i}(t-1) \\ \text{otherwise} : 0 \end{cases} \tag{29}$$

Whether the demand for goods can actually be turned in the effective purchase of goods depends on the amount of available reserves and the state of credit restriction of the financial

[11] $\Sigma Assets_{B,i} = L_{F,i} + L_{G,i} + L_{H,i} + L_{IB,j} + R_i + R\Pi_{B,i}$, where $L_{F,i}$, $L_{G,i}$, $L_{H,i}$, $L_{IB,j}$, R_i and $R\Pi_{B,i}$ denote loans given to firms, the government, households and other banks through interbank lending, central bank reserves and the stock of retained profits.

sector. As long as the financial sector in region i has access to international credit, actual consumption expenditure C will correspond to consumption demand C_D. If the financial sector loses access to international credit, expenditure on imports cannot exceed export revenues plus reserves accumulated in the past. In order to meet this condition, aggregate expenditure has to be reduced accordingly. Therefore, the amount of reserves available when credit constrained (RCC) is distributed proportionately among the demand categories C, I and G.[12] In order to limit the contractionary potential of such a scenario, we assume that once expenditure threatens to be reduced below a certain rate elr ('emergency lending rate'), the central bank steps in as a lender of last resort to prevent further contraction. The same principles apply for investment expenditure I and government expenditure G.

$$C_i = \begin{cases} \pi_{B,i}(t-1) - \theta_{B,i}(t-1) \geq 0 : C_{D,i} \\ \text{otherwise} : Max[Min[C_{D,i}, RCC_i \cdot \frac{C_{D,i}}{C_{D,i}+I_{D,i}+G_{D,i}}], elr \cdot C_{D,i}] \end{cases} \tag{30}$$

$$I_i = \begin{cases} \pi_{B,i}(t-1) - \theta_{B,i}(t-1) \geq 0 : I_{D,i} \\ \text{otherwise} : Max[Min[I_{D,i}, RCC_i \cdot \frac{I_{D,i}}{C_{D,i}+I_{D,i}+G_{D,i}}], elr \cdot I_{D,i}] \end{cases} \tag{31}$$

$$G_i = \begin{cases} \pi_{B,i}(t-1) - \theta_{B,i}(t-1) \geq 0 : G_{D,i} \\ \text{otherwise} : Max[Min[G_{D,i}, RCC_i \cdot \frac{G_{D,i}}{C_{D,i}+I_{D,i}+G_{D,i}}], elr \cdot GD_i] \end{cases} \tag{32}$$

$$\begin{aligned} RCC_i = \; & \big[X_i(t-1) + \rho \cdot \Pi_{CB}(t-1) + i_D \cdot R_i(t-1) + i_L \cdot \big(L_{IB,j}(t-1) \\ & - L_{IB,i}(t-1) - L_{CB,i}(t-1)\big) + a \cdot \big(L_{IB,j}(t-1) - L_{IB,i}(t-1) \\ & - L_{CB,i}(t-1)\big) + R_i(t-1) - rrr \cdot M_{H,i}(t-1)\big]/m_i \end{aligned} \tag{33}$$

In scenario 5 (central bank as unconditional lender of last resort) equations (30)-(32) become:

$$C_i = C_{D,i} \tag{34}$$

$$I_i = I_{D,i} \tag{35}$$

$$G_i = GD_i \tag{36}$$

Total exports to the RoW depend on the RoW's (exogenous) income Y_w and its import elasticity for products from region i ($m_{i,w}$)

$$X_{w,i} = m_{i,w} \cdot Y_w \tag{37}$$

[12] Equation 33 follows from the fact that when internationally credit constrained, the demand for imports has to be equal to the net inflow of reserves plus the stock of reserves accumulated in the past minus the amount needed to fulfill official reserve requirements: $m_i \cdot (C_i + I_i + G_i) = EXP_i(t-1) + \rho_i \cdot \Pi_{CB}(t-1) + i_D \cdot R_i(t-1) + i_L \cdot (L_{IB,j}(t-1) - L_{IB,i}(t-1) - L_{CB,i}(t-1)) + a \cdot (L_{IB,j}(t-1) - L_{IB,i}(t-1) - L_{CB,i}(t-1)) + R_i(t-1) - rrr \cdot M_{H,i}(t-1)$. Note that since actual exports in period t are not yet known, $EXP_i(t-1)$ is used as a proxy.

This import elasticity is initially constant, but becomes endogenous for the North in the first mercantilist scenario:

$$m_{n,w} = \begin{cases} \pi_{F,s}(t-1) - \theta_{F,s}(t-1) \geq 0 : m_{n,w} \\ \text{otherwise} : m_{n,w}(t-1) + x \end{cases} \tag{38}$$

Region i's import demand for region j's ($M_{j,i}$) and the RoW's products ($M_{w,i}$) are correspondingly defined as follows:

$$M_{j,i} = m_{j,i} \cdot (C_i + I_i + G_i) \tag{39}$$

$$M_{w,i} = m_{w,i} \cdot (C_i + I_i + G_i) \tag{40}$$

The latter add up to region i's total import demand:

$$M_i = M_{j,i} + M_{w,i} \tag{41}$$

By the same logic, region i's exports are equal to

$$X_i = M_{j,i} + EXP_{w,i} \tag{42}$$

This provides us with GDP (Y):

$$Y_i = C_i + I_i + G_i + X_i - M_i \tag{43}$$

Employment (E) depends on production Y and (constant) labor productivity λ.

$$E_i = \frac{Y_i}{\lambda} \tag{44}$$

Multiplying employment E with the wage rate w gives us the wage bill W.

$$W_i = w \cdot E_i \tag{45}$$

Households, firms and governments have to repay a certain share a of their outstanding loans each period.

$$REP_{H,i} = a \cdot L_{H,i}(t-1) \tag{46}$$

$$REP_{F,i} = a \cdot L_{F,i}(t-1) \tag{47}$$

$$REP_{G,i} = a \cdot L_{G,i}(t-1) \tag{48}$$

Subtracting the wage bill, interest expenses and debt repayments from total revenues Y provides us with distributable firm profits:

$$\Pi_{F,i} = Y_i - W_i - i_L \cdot L_{F,i}(t-1) - REP_{F,i} \tag{49}$$

Subtracting banking sector i's interest expenditures from interest income yields its profits (equation 50). The same can be done for the central bank (equation 51).

$$\Pi_{B,i} = \begin{array}{l} i_L \cdot (L_{H,i}(t-1) + L_{F,i}(t-1) + L_{G,i}(t-1) - L_{CB,i}(t-1) \\ -L_{IB,i}(t-1) + L_{IB,j}(t-1)) - i_D \cdot (M_{H,i}(t-1) - R_i(t-1)) \end{array} \tag{50}$$

$$\Pi_{CB} = i_L \cdot (L_{CB,n}(t-1) + L_{CB,s}(t-1)) - i_D \cdot (R_n(t-1) + R_s(t-1)) \tag{51}$$

Firms distribute all their profits to households. Banks do the same as long as their leverage ratio ($LR_{B,i}$) is positive and within the target range. If leverage becomes too high or negative (as equity turns negative), they retain a certain share (ϕ) of their profits, which adds to their stock of retained profits ($R\Pi_{B,i}$). Once leverage falls below the target range, banks start to distribute part of those retained earnings:

$$\Pi^{dist}_{B,i} = \begin{cases} LR_{TL} \leq LR_{B,i}(t-1) \leq LR_{TH} : \Pi_{B,i} \\ LR_{B,i}(t-1) > LR_{TH} \vee LR_{B,i}(t-1) < 0 : (1-\phi) \cdot \Pi_{B,i} \\ 0 < LR_{B,i}(t-1) < LR_{TL} : (1+\phi) \cdot \Pi_{B,i} \end{cases} \tag{52}$$

The difference between total profits and distributed profits yields saving by the bank ($S_{B,i}$):

$$S_{B,i} = \Pi_{B,i} - \Pi^{dist}_{B,i} \tag{53}$$

We assume that taxes are solely derived from a proportional taxation of net household income:

$$T_i = t_H \cdot (W_i + i_D \cdot M_{H,i}(t-1) - i_L \cdot L_{H,i}(t-1) - REP_{H,i} + \Pi_{F,i} + \Pi^{dist}_{B,i}) \tag{54}$$

Subtracting taxes yields household disposable income:

$$Y_{H,i} = W_i + i_D \cdot M_{H,i}(t-1) - i_L + L_{H,i}(t-1) - REP_{H,i} + \Pi_{F,i} + \Pi^{dist}_{B,i} - T_i \tag{55}$$

Disposable income minus consumption expenditure yields household saving:

$$S_{H,i} = Y_{H,i} - C_i \tag{56}$$

Subtracting government expenditure, interest payments and installment payments from government income yields government savings.

$$S_{G,i} = T_i + \rho_i \cdot \Pi_{CB} - G_i - i_L \cdot L_{G,i}(t-1) - REP_{G,i} \tag{57}$$

Potential output is a function of the capital stock K.

$$Y_{P,i} = K_i \cdot \kappa \tag{58}$$

This gives us the rate of capacity utilization.

$$z_i = \frac{Y_i}{Y_{P,i}} \tag{59}$$

Household saving goes to their savings account M_H. In case household saving is negative, they finance half of that deficit by using past savings (if they have any) and the rest through bank loans. This provides us with the change in household deposits dM_H and household loans dL_H.

$$dM_{H,i} = \begin{cases} S_{H,i} \geq 0 : S_{H,i} \\ \text{otherwise} : Min[\frac{S_{H,i}}{2}, M_{H,i}] \end{cases} \tag{60}$$

$$dL_{H,i} = -REP_{H,i} + \begin{cases} S_{H,i} < 0 : -(S_{H,i} - dM_{H,i}) \\ \text{otherwise} : 0 \end{cases} \tag{61}$$

The change in firm debt (dL_F) and government debt (dL_G) are given as follows:

$$dL_{F,i} = -REP_{F,i} - CANC_{F,i} + I_i \tag{62}$$

$$dL_{G,i} = -REP_{G,i} - S_{G,i} \tag{63}$$

The change in the stock of retained bank profits ($R\Pi_{B,i}$) is given by bank savings:

$$dR\Pi_{B,i} = S_{B,i} \tag{64}$$

Bank sector's demand for reserves in country i (R_D, i) is the difference between all those transactions related with reserve outflows (imports, paid interest and repayments) and those related with reserve inflows (exports, received interest and repayments), plus the amount of reserves necessary to cover minimum requirements and reserves accumulated in the past:

$$R_{D,i} = \begin{array}{l} M_i - X_i - \rho_i \cdot \Pi_{CB} - i_D \cdot R_i(t-1) + (i_L + a) \cdot (L_{IB,i}(t-1) \\ +L_{CB,i}(t-1) - L_{IB,j}(t-1)) + rrr \cdot M_{H,i}(t-1) - R_i(t-1) \end{array} \tag{65}$$

When the banking sector in country i has excess demand for reserves ($R_{D,i} > 0$), it can get these reserves from the banking sector in country j as long as it fulfills the necessary requirements ($\pi_{B,i} - \theta_{B,i} \geq 0$) and the banking sector in country j has excess reserves ($R_{D,j} < 0$). Demand for interbank loans in region i ($LIB_{D,i}$) is therefore equal to

$$LIB_{D,i} = \begin{cases} \pi_{B,i}(t-1) - \theta_{B,i}(t-1) \geq 0 \wedge R_{D,i}(t-1) > 0 \wedge R_{D,j}(t-1) < 0 : \\ Min[R_{D,i}(t-1), -R_{D,j}(t-1)] \\ \text{otherwise} : 0] \end{cases} \tag{66}$$

In case that banking sector in country i is eligible for credit but the banking sector in country j has insufficient reserves to provide interbank credit, the banking sector in country i gets the wanting amount from the central bank. The demand for central bank loans ($L_{CB,D,i}$) is therefore defined by[13]

[13]Remember that we assume that usually the central bank does not act as a lender of last resort. This means that in those cases in which banks in i are not eligible for interbank loans, aggregate demand is immediately reduced in such a way that the economy's demand for imports does not exceed the amount of available reserves (see equations 11 – 13). The central bank only steps in as a lender of last resort when economic contraction threatens to reduce output below a certain rate elr. In the latter case, output is only contracted by elr and the corresponding reserve deficit is financed by the central bank through equation 67.

$$L_{CB,D,i} = \begin{cases} R_{D,i} - L_{IB,D,i} > 0 : R_{D,i} - L_{IB,D,i} \\ \text{otherwise} : 0 \end{cases} \tag{67}$$

The total change in reserves of the banking sector in country i hence becomes

$$dR_i = \begin{array}{l} -M_i + X_i + \rho_i \cdot \Pi_{CB,i} + iD \cdot R_i(t-1) + (i_L + a) \cdot (L_{IB,s}(t-1) \\ -L_{IB,i}(t-1) - L_{CB,i}(t-1)) + L_{IB,D,i} - L_{IB,D,j} + L_{CB,D,i} \end{array} \tag{68}$$

We assume that transactions with the RoW are carried out in the common currency of region N and S. Furthermore we assume that in case that the RoW has insufficient such reserves, it can get them from the CB through foreign reserve transactions (FRT). Foreign reserve transactions increase the RoW's reserve holdings (R_w) and the CB's holdings of foreign reserves ($R_{F,CB}$).

$$FRT_w = \begin{cases} R_w(t-1) + M_{w,n} + M_{w,s} - X_{w,n} - X_{w,s} \geq 0 : 0 \\ \text{otherwise} : -(M_{w,n} + M_{w,s} - X_{w,n} - X_{w,s}) - R_w \end{cases} \tag{69}$$

$$dR_w = M_{w,n} + M_{w,s} - X_{w,n} - X_{w,s} + FRT_w \tag{70}$$

$$dR_{F,CB} = FRT_w \tag{71}$$

$$R_w = R_w(t-1) + dR_w \tag{72}$$

$$R_{F,CB} = R_{F,CB}(t-1) + dR_{F,CB} \tag{73}$$

The changes in interbank loans (L_{IB}) and central bank loans (L_{CB}) are defined as follows:

$$dL_{IB,i} = L_{IB,D,i} - a \cdot L_{IB,i} - CANC_{B,i} \tag{74}$$

$$dL_{CB,i} = L_{CB,D,i} - a \cdot L_{CB,i} \tag{75}$$

These changes add up to the stocks of household deposits (M_H), the outstanding loans of households (L_H), firms (L_F) and the government (L_G), reserve holdings (R), interbank loans (L_{IB}), central bank loans (L_{CB}) and retained bank profits ($R\Pi_{B,i}$).

$$M_{H,i} = M_{H,i}(t-1) + dM_{H,i} \tag{76}$$

$$L_{H,i} = L_{H,i}(t-1) + dL_{H,i} \tag{77}$$

$$L_{F,i} = L_{F,i}(t-1) + dL_{F,i} \tag{78}$$

$$L_{G,i} = L_{G,i}(t-1) + dL_{G,i} \tag{79}$$

$$R_i = R_i(t-1) + dR_i \tag{80}$$

$$L_{IB,i} = L_{IB,i}(t-1) + dL_{IB,i} \tag{81}$$

$$L_{CB,i} = L_{CB,i}(t-1) + dL_{CB,i} \tag{82}$$

$$R\Pi_{B,i} = R\Pi_{B,i}(t-1) + dR\Pi_{B,i} \tag{83}$$

Investment (I) adds to the capital stock, which depreciates by δ each period.

$$K_i = K_i(t-1) - \delta \cdot K_i(t-1) + I_i(t-1) \tag{84}$$

Finally, we can calculate the net value of each sector:

$$V_{H,i} = M_{H,i} - L_{H,i} \tag{85}$$

$$V_{F,i} = K_i - L_{F,i} \tag{86}$$

$$V_{G,i} = -L_{G,i} \tag{87}$$

$$V_{B,i} = -M_{H,i} + L_i + R_n - L_{CB,i} + L_{IB,j} - L_{IB,i} + R\Pi_{B,i} \tag{88}$$

$$V_{CB} = -R_n - R_s + L_{CB,n} + L_{CB,s} + R_{F,CB} \tag{89}$$

$$V_w = M_w + R_w - R_{F,CB} \tag{90}$$

B Parameters and starting values

B.1 General parameters

$i_L = 0.02$	interest rate on loans*	average of pre-crisis Euro area long term rate (2006) and its contemporary value (2019): 2.2%[14]
$i_{L,B} = 0.01$	interbank interest rate*	contemporary spread (2019) between long term rate and interbank rate: 1.07%[15]
$i_D = 0.005$	interest rate on deposits*	average of pre-crisis Euro area overnight interest rate (2006) and its contemporary value (2019): 0.43%[16]
$a = 0.05$	installment rate*	Kapeller & Schütz (2014); Kapeller *et al.* (2018)

[14] OECD Economic Outlook Database; authors' calculations
[15] OECD Economic Outlook Database; authors' calculations
[16] Euro Area Statistics; authors' calculations

$\kappa = 0.34$	potential output to capital stock ratio	average ratio of GDP to productive capital stock, Germany 2002-2006: 0.39;[17] slightly lowered to fit with the other parameters
$\delta = 0.125$	rate of depreciation of the capital stock*	Baldwin *et al.* (2005) find depreciations rates ranging between 10% for buildings and 20% for machinery and equipment
$\chi = 0.025$	proportion of loans that have to be cancelled in each period of bankruptcies	
$\zeta_1 = 0.005$	margin of safety parameter (firm loans)	
$\zeta_2 = 0.001$	margin of safety parameter (firm loans)	
$\gamma_F = 0.01$	margin of safety parameter (firm loans)	
$\tau_F = 1$	margin of safety parameter (firm loans)	
$\eta_1 = 0.005$	margin of safety parameter (interbank loans)	
$\eta_2 = 0.001$	margin of safety parameter (interbank loans)	
$\gamma_B = 0.005$	margin of safety parameter (interbank loans)	
$\tau_B = 1$	margin of safety parameter (interbank loans)	
$rcr = 0.75$	rate of credit restriction when firms are credit constrained	
$rrr = 0.02$	official reserve requirement ratio	minimum Eurozone reserve requirement ratio until January 2012
$t_H = 0.3$	tax rate on household income	composite effective average tax rate in the Eurozone (2019) between 12% (Ireland) and 32% (France)[18]
$elr = 0.75$	CB emergency lending ratio	
$w_n = 0.65$	wage rate workers	together with $\lambda = 1$ yields a wage share of 65%[19]
$\lambda = 1$	labor productivity	Assumption taken from Kapeller & Schütz (2014); Kapeller *et al.* (2018)
$c_1 = 0.42$	household propensity to consume (income)	Together with $i_{1,n}$ and $i_{2,n}$ yields a fiscal multiplier of roughly 2[20]

[17] OECD Economic Outlook Database; authors' calculations
[18] OECD.Stat
[19] See e.g. ILO & OECD (2015) for the range of wage shares across different countries.
[20] Heimberger (2017) finds cumulative fiscal multipliers in the range of 1.4–2.1 over the respective period.

$c_2 = 0.01$	household propensity to consume (wealth)	marginal propensity to consume out of wealth in Euro area generally estimated between 1%-3%[21]
$LR_{TH} = 6.5$	upper bound target leverage ratio banks	
$LR_{TL} = 4$	lower bound target leverage ratio banks	
$\phi = 0.02$	distributed bank profits parameter	

*We assume one model period to correspond to one quarter; all interest, installment and depreciation rates are therefore divided by four before entering the simulation;

B.2 Region specific parameters

$Y_w = 4/3 \cdot Y_n(t = 0)$	aggregate income RoW	
$i_{0,n} = 5$	autonomous investment**	Parameters were chosen to provide investment to GDP ratios and fiscal multipliers of roughly 1/6 and 2 respectively[22]
$i_{1,n} = 7$	investment parameter**	
$i_{2,n} = 39$	investment parameter**	
$i_{3,n} = 0.32$	investment parameter**	
$c_{0,n} = 10$	autonomous consumption**	Parameter was chosen such that the share of consumption in GDP is roughly 60%[23]

**Parameter for the South is 2/3 of the size of the North.

B.3 Starting values

$Y_n = 59.64$	output**	results of burn-in period
$M_{H,n} = 1037.03$	household deposits**	
$L_{H,n} = 9.97$	household debt**	
$L_{G,n} = 198.28$	government debt**	
$L_{F,n} = 809.85$	firm debt**	
$L_{IB,n} = 5.97$	interbank loans	
$L_{IB,s} = 5.97$	interbank loans	
$R\Pi_{B,n} = 219$	retained bank profits**	
$R_n = rrr \cdot M_{H,n}$	reserves**	
$L_{CB,n} = 5.54$	central bank loans**	
$K_n = 329.34$	capital stock**	
$\theta_{F,n} = 0.0075$	margin of safety (firm loans)**	
$\theta_{B,n} = 0.0075$	margin of safety (interbank loans)**	
$R_w = 100$	reserve holdings RoW	
$R_{F,CB} = R_n + R_s + R_w - L_{CB,n} - L_{CB,s}$	foreign reserves held by the central bank	

[21] See on this Paiella (2007).

[22] For the range of gross capital formation (% of GDP) see data.worldbank.org. Heimberger (2017) finds cumulative fiscal multipliers in the range of 1.4–2.1 over the respective period.

[23] For the range of private final consumption expenditure (% of GDP) see data.worldbank.org.

**Parameter for the South 2/3 of the size of the North.

B.4 Import propensities – Baseline scenario

$m_n = m_s = 0.3$	aggregate import propensity North and South	average ratio of imports to GDP, Germany 2002-2008[24]
$m_{s,n} = 0.5 \cdot m_n$	Northern import propensity for southern products	Calibrated to yield balanced trade in the baseline scenario
$m_{n,s} = 0.75 \cdot m_s$	Southern import propensity for northern products	
$m_{w,n} = m_n - m_{s,n}$	Northern import propensity for products from the RoW	
$m_{w,s} = m_s - m_{n,s}$	Southern import propensity for products from the RoW	
$m_w = 0.5 \cdot m_n$	aggregate import propensity RoW	
$m_{n,w} = 0.75 \cdot m_w$	RoW's import propensity for products from the North	
$m_{s,w} = m_w - m_{n,w}$	RoW's import propensity for products from the South	

B.5 Scenario-specific parameters

$i_{0,s} = 8.67$	autonomous investment (scenarios 1, 3-6)	
$m_{s,n} = 0.11$	Northern import propensity for southern products (scenarios 2-6)	
$m_{w,n} = 0.19$	Northern import propensity for products from the RoW (scenarios 2-6)	
$x = 0.0005$	scenario parameter northern mercantilism	
$fsf = 0.075$	relative size of the fiscal stimulus	
$FS_s = fsf \cdot Y_s(t = 0)$	fiscal stimulus	relative to size of GDP in period 0

C Sensitivity analysis

In this section we want to check the sensitivity of our results with respect to a set of model parameters. Doing so, we take those variables that we deem critical for the creation of the Minskyan cycles shown in the paper and pursue the following bootstrap strategy: For each critical parameter x_k we draw a random value out of a normal distribution with mean x_k and standard deviation $x_k/10$. The respective set includes the following parameters: the proportion of loans that have to be cancelled in each period of bankruptcies (χ), all margin of safety parameters for firm loans (ζ_1, ζ_2, γ_F and τ_F) and interbank loans (η_1, η_2, γ_B and τ_B) the rate of credit restriction when firms are credit constrained (rcr), the central bank's energency lending ratio (elr), all consumption function parameters (c_0, c_1, c_2), all investment function parameters (i_0, i_1, i_2, i_3) and the relative size of the fiscal stimulus (fsf). Then, we run each of the 6 scenarios using these newly assigned parameter values. We repeat this step 10.000 times. The individual runs as well as their mean ($\pm 2SD$) for GDP_s and GDP_n are reported in figures 28 –

[24] OECD Economic Outlook Database; authors' calculations

Figure 28: Baseline scenario: Individual and mean results ($\pm 2SD$) for GDP over 10.000 runs

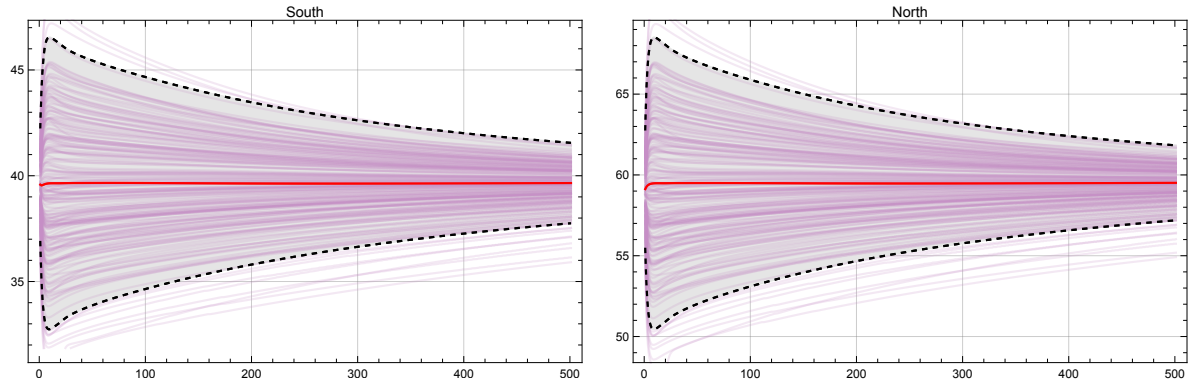
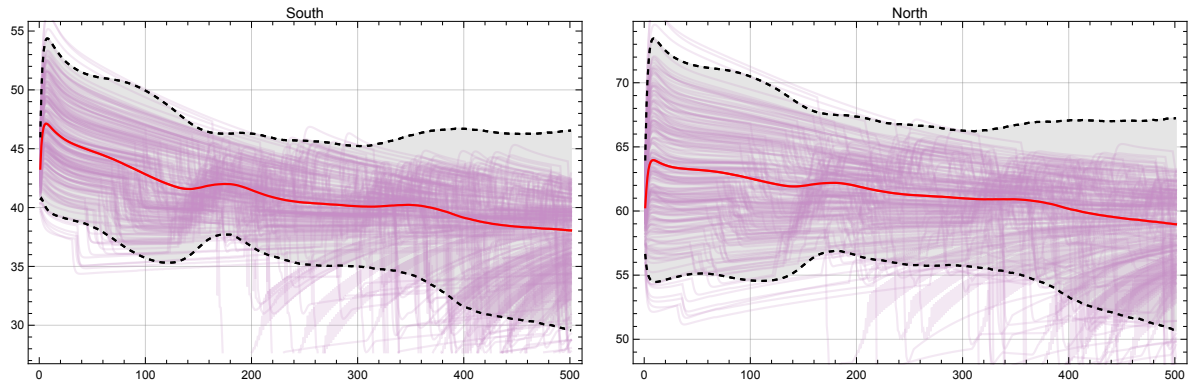


Figure 29: Scenario 1 (Investment boom in the South): Individual and mean results ($\pm 2SD$) for GDP over 10.000 runs



34. The model proves to be very stable throughout these runs. Moreover, the mean values over the respective scenarios resemble our initial results quite well, providing us with confidence that our results are indeed quite robust to changes in critical parameter values.

Figure 30: Scenario 2 (South loses competitiveness relative to the RoW): Individual and mean results ($\pm 2SD$) for GDP over 10.000 runs

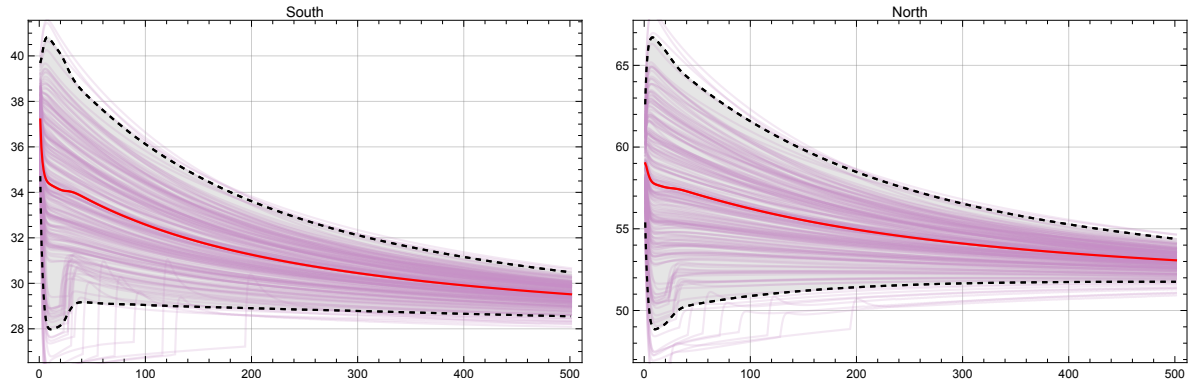


Figure 31: Scenario 3 (Investment boom in the South and South loses competitiveness relative to the RoW): Individual and mean results ($\pm 2SD$) for GDP over 10.000 runs

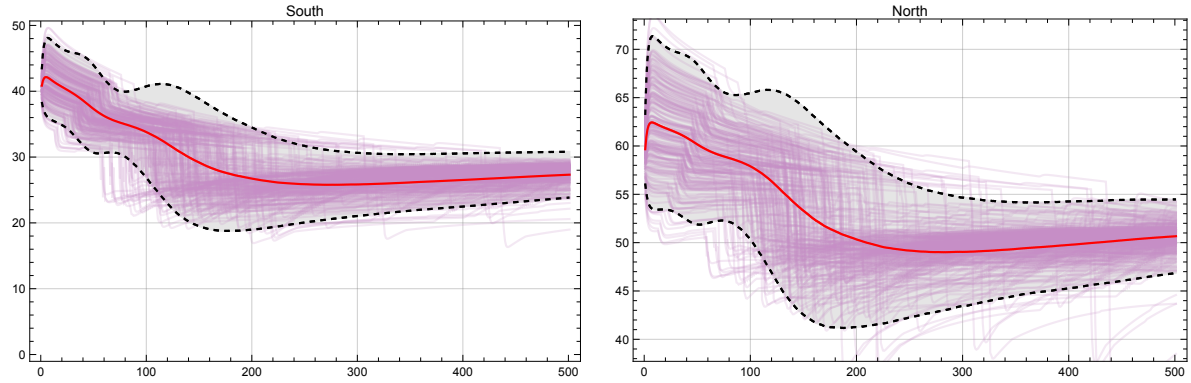


Figure 32: Scenario 4 (Northern mercantilism): Individual and mean results ($\pm 2SD$) for GDP over 10.000 runs

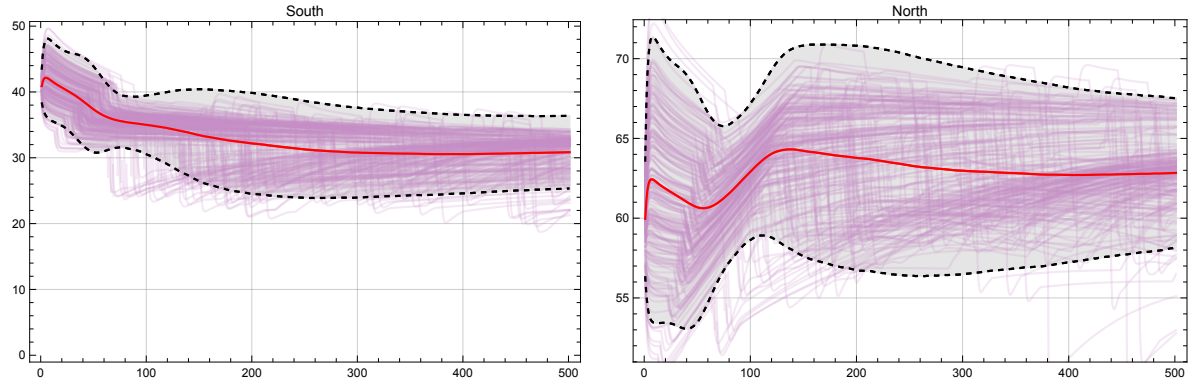


Figure 33: Scenario 5 (Unconditional lender of last resort): Individual and mean results ($\pm 2SD$) for GDP over 10.000 runs

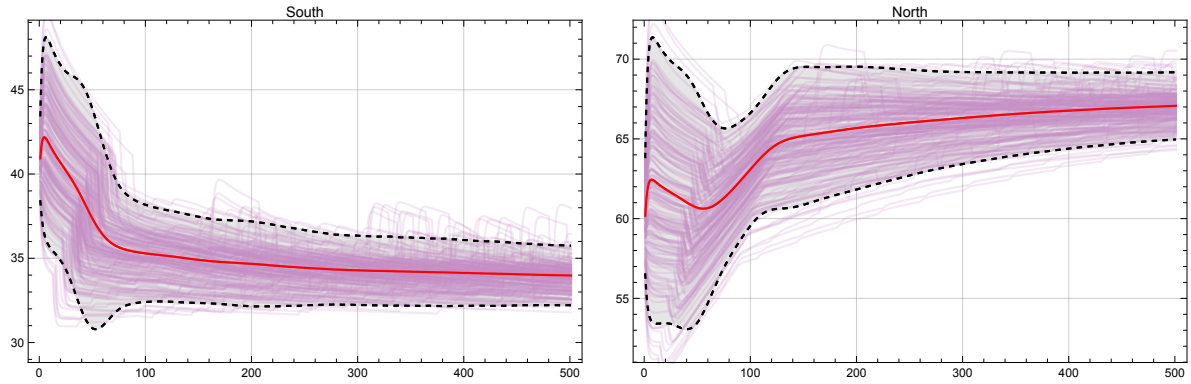
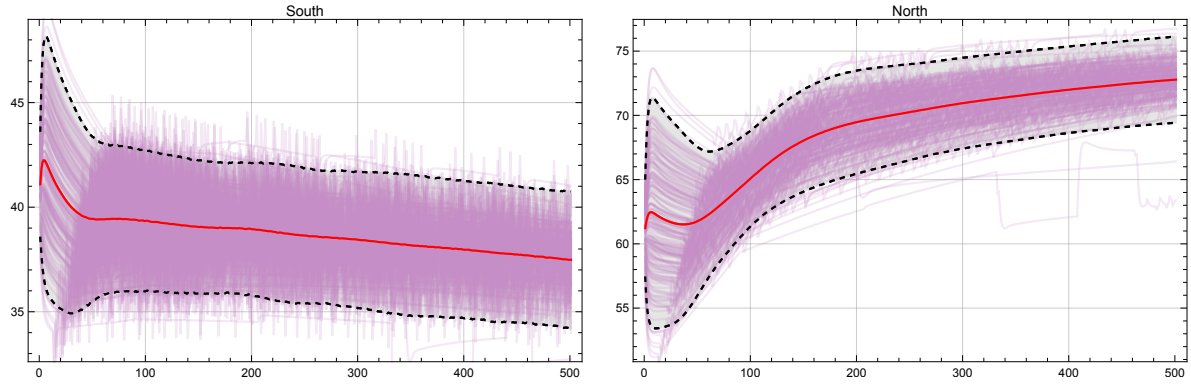


Figure 34: Scenario 6 (Fiscal policy): Individual and mean results ($\pm 2SD$) for GDP over 10.000 runs



D Country grouping used in figure 1

North
Austria, Belgium, Denmark, Finland, Germany, Sweden, Netherlands, France, Luxembourg, Malta, Ireland
South
Cyprus, Greece, Italy, Portugal, Spain
East
Bulgaria, Romania, Czech Republic, Estonia, Latvia, Lithuania, Hungary, Poland, Slovenia, Slovakia
East Asia & Pacific
Australia, China, Hong Kong SAR China, Indonesia, Japan, Cambodia, South Korea, Laos, Philippines, Papua New Guinea, Singapore, Vietnam, Taiwan, Malaysia, New Zealand, Thailand, Macao SAR China, French Polynesia, Myanmar (Burma), Mongolia, New Caledonia, Brunei, North Korea, Micronesia, Kiribati, Marshall Islands, Christmas Island, Fiji, Nauru, Palau, Solomon Islands, Tuvalu, Vanuatu, Samoa, Cook Islands, Cocos (Keeling) Islands, Norfolk Island, Niue, Tongam Northern Mariana Islands, Tokelau, Timor-Leste, Pitcairn Islands, American Samoa, Guam, Heard & McDonald Islands, South Georgia, South Sandwich Islands
Rest of the World (RoW)
Aruba, Albania, United Arab Emirates, Burundi, Bosnia and Herzegovina, Belarus, Bolivia, Brazil, Canada, Switzerland, Cote d'Ivoire, Cameroon, Congo - Kinshasa, Congo - Brazzaville, Colombia, Costa Rica, Cuba, Dominica, Ecuador, Egypt, Ethiopia, Gabon, United Kingdom, Georgia, Ghana, Guinea, Guatemala, Honduras, Croatia, India, Israel, Jamaica, Kazakhstan, Kenya, Lebanon, Libya, Sri Lanka, Moldova, Madagascar, Mexico, North Macedonia, Malawi, Nigeria, Nicaragua, Panama, Peru, Russia, Rwanda, Saudi Arabia, Sierra Leone, El Salvador, Turkey, Tanzania, Uganda, Ukraine, United States, Venezuela, Zambia, Zimbabwe, Angola, Argentina, Armenia, Benin, Central African Republic, Dominican Republic, Algeria, Guadeloupe, Gambia, Haiti, Iran, Jordan, Martinique, Mauritius, Norway, Oman, Qatar, Senegal, Togo, Tunisia, South Africa, Andorra, Chile, Cape Verde, Greenland, French Guiana, Iceland, Kuwait, Morocco, Paraguay, Sudan, Suriname, Syria, Uruguay, St. Lucia, St. Vincent and Grenadines, Belize, Cayman Islands, Azerbaijan, Bahrain, Bahamas, Bermuda, Guyana, Kyrgyzstan, Liberia, Maldives, Mauritania, Somalia, St. Pierre and Miquelon, Uzbekistan, Faroe Islands, Gibraltar, Equatorial Guinea, Mozambique, Trinidad and Tobago, Anguilla, Burkina Faso, Comoros, Djibouti, Mali, Niger, Chad, British Virgin Islands, Bangladesh, Falkland Islands, Pakistan, Seychelles, Antigua and Barbuda, Turkmenistan, Nepal, Guinea-Bissau, Sao Tome and Principe, Barbados, Grenada, St. Kitts and Nevis, Turks and Caicos Islands, Yemen, Eritrea, Iraq, Afghanistan, Tajikistan, Montserrat, Bhutan

The country grouping used in figure 1.