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

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***The evolution of debtor-
creditor relationships within
a monetary union: Trade
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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.

JEL CLASSIFICATION NUMBERS: E12, F41, F45, G01, G18

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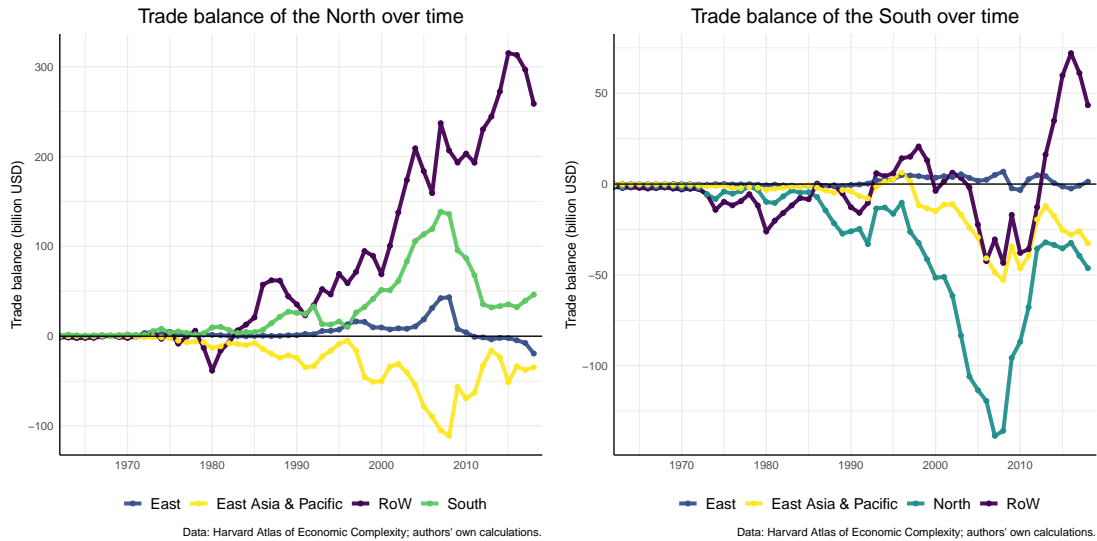
1 Introduction

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](#)).¹

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 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

¹Other 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.



(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 C)

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.

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 ensued afterwards. Most of these contributions focus on a single economy and do not explicitly take international interrelations into account.² 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

²Among 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](#)) and agent-based stock-flow consistent models (see e.g. [Ricchetti *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](#)).

consumption motives and access to credit can lead to current account imbalances in a 3-country-setup. They 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 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). Finally, [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.

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. Finally, in contrast to [Caiani *et al.* \(2018\)](#), [Caiani *et al.* \(2019\)](#), [Dawid *et al.* \(2018\)](#) and [Godley & Lavoie \(2007a\)](#), we focus on the emergence of financial crises and its implications within a monetary union.

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](#)). 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).

$$Y_i = C_i + I_i + G_i + X_i - M_i \quad (1)$$

For simplicity, we assume that consumption demand consists of an autonomous part and a part that depends on household disposable income from the previous period. Government expenditure is assumed to be equal to net government income from the previous period (consisting of income tax paid by households plus central bank profits minus interest expenses). Firms' investment demand depends on an autonomous part ($i_{0,i}$) and the previous period's degree of utilization of the capital stock (Z_i). 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 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.

$$I_{D,i} = \begin{cases} \Pi_{F,i}(t-1) - \theta_{F,i}(t-1) \geq 0 : i_{0,i} + i_1 \cdot Z_i(t-1) \\ \text{otherwise} : rcr \cdot (i_{0,i} + i_1 \cdot Z_i(t-1)) \end{cases} \quad (2)$$

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 period in which bankruptcies occur. Furthermore, the margin of safety also depends on changes in firm equity in previous periods ($V_{F,i}$), measured relative to GDP.

$$\theta_{F,i} = \theta_{F,i}(t-1) + \mu_{F,i} * |\theta_{F,i}(t-1)| - \zeta_{F,i} * \Delta \frac{V_{F,i}(t-1)}{Y_i(t-1)} \quad (3)$$

$$\mu_{F,i} = \begin{cases} CANCE_{F,i} = 0 : -\gamma_F \\ \text{otherwise} : \tau_F \end{cases} \quad (4)$$

Bankruptcy occurs when firm profits are insufficient to cover debt payments (i.e. firm profits $\Pi_{F,i}$ turn negative). Whenever this happens, banks have to cancel a certain proportion (χ) of outstanding loans:

$$CANCE_{F,i} = \begin{cases} L_{F,i} > 0 \wedge \Pi_{F,i} - \theta_{F,i} < 0 \wedge \Pi_{F,i} < 0 : \chi \cdot L_{F,i} \\ \text{otherwise} : 0 \end{cases} \quad (5)$$

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 they receive 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, while any deficits lead to new bank loans.³ 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. 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 . 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 (reserves 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

³In 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. \(2018\)](#).

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 profits ($\Pi_{B,i}$) 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 bankruptcies of the foreign banking sector occurs). Furthermore these margins of safety also depend on changes in the net value of the banking sector in previous periods (measured in percent of GDP):

$$\theta_{B_i} = \theta_{B,i}(t-1) + \mu_{B,i} * |\theta_{B,i}| - \zeta_{B,i} * \Delta \frac{V_{B,i}}{Y_i} \quad (6)$$

$$\mu_{B_i} = \begin{cases} CANCE_{B,i} = 0 : -\gamma_B \\ \text{otherwise} : \tau_B \end{cases} \quad (7)$$

Whenever banking sector i is credit constrained and its income is insufficient to cover debt payments (i.e. bank profits Π_{B_i} are negative), it goes bankrupt and lenders have to cancel a certain proportion χ of outstanding loans:

$$CANCE_{B,i} = \begin{cases} L_{IB,i} > 0 \wedge \Pi_{B,i} - \theta_{B,i} < 0 \wedge \Pi_{B,i} < 0 : \chi \cdot L_{IB,i} \\ \text{otherwise} : 0 \end{cases} \quad (8)$$

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 existing reserves 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 llr ('lender of last resort 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.

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

Table 1: Stock matrix

	North				South				CB	RoW	Σ
	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	$K_{G,n}$			K_s	$K_{G,s}$				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	$-R_F$	
Balance (net-worth)	$-V_{H,n}$	$-V_{F,n}$	$-V_{G,n}$	$-V_{B,n}$	$-V_{H,s}$	$-V_{F,s}$	$-V_{G,s}$	$-V_{B,s}$	$-V_{CB}$	$-V_{RoW}$	$-K$
Σ	0	0	0	0	0	0	0	0	0	0	0

Table 2: Flow matrix

	North						South						Central Bank						Σ
	Households		Firms		Government		Banks		Households		Firms		Government		Banks		Central Bank		
	Curr.	Cap.	Curr.	Cap.	Curr.	Cap.	Curr.	Cap.	Curr.	Cap.	Curr.	Cap.	Curr.	Cap.	Curr.	Cap.	Curr.	Cap.	
[1]	$-C_n$		$(1 - m_n) \cdot C_n$																
[2]			$m_{n,s} \cdot C_s$																
[3]			$(1 - m_n) \cdot I_n$		$-I_n$														
[4]			$m_{n,s} \cdot I_s$																
[5]			$(1 - m_n) \cdot G_n$		$-G_n$														
[6]			$m_{n,s} \cdot G_s$																
[7]			$m_{n,w} \cdot Y_w$																
[8]			$[Y_n]$																
[9]	$w \cdot E_n$		$-w \cdot E_n$																
[10]	$-T_n$																		
[11]	$i_D \cdot MH_n$																		
[12]	$-i_L \cdot LH_n$		$-i_L \cdot LF_n$																
[13]																			
[14]																			
[15]																			
[16]																			
[17]																			
[18]																			
[19]	$-REPH_n$		$REPH_n$		$REPF_n$		$REPF_n$		$REPH_n$		$REPF_n$		$REPF_n$		$REPG_n$		$REPG_n$		
[20]			$CANCF_n$																
[21]																			
[22]																			
[23]	$\Pi_{F,n}$		$-\Pi_{F,n}$																
[24]	$\Pi_{B,n}$																		
[25]																			
[26]	$-SH_n$		SH_n																
[27]	$-\Delta MH_n$																		
[28]	ΔLH_n																		
[29]																			
[30]																			
[31]																			
[32]																			
[33]																			
Σ	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

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. Given the other parameter values (see the appendix for a complete list), we start with an economic system that shows a stable level of GDP in all regions (left panel in figure 2). Firm profits are also stable, while banks slowly reduce their margin of safety since the economic situation is perceived as stable (right panel in figure 2).

4.1 Scenario 1: Investment boom in the South

In our first scenario, we simulate an investment boom in the South. In order to do so, we assume a permanent increase in exogenous investment ($i0_s$) taking place solely in the South. The result is depicted in figures 3 and 4 respectively: 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 firm profits, after an initial increase, are on a steady downward path throughout the subsequent recession (figure 4), as lower revenues and increasing debt payments take its toll. At some point, firm profits decline 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 profits recover. At some point firm profits have

Figure 2: GDP and its components (left) and firm profits ($\Pi_{F,s}$) and margin of safety ($\theta_{F,s}$) (right): Baseline scenario (South; results for North differ only in magnitude)

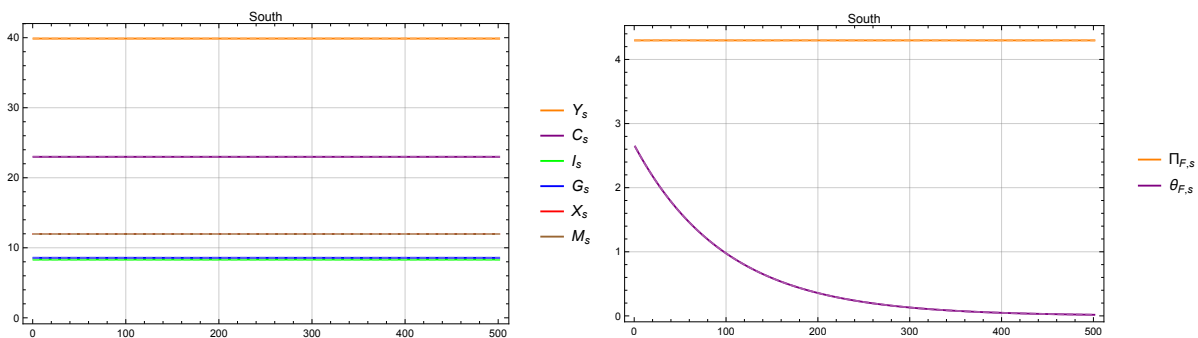


Figure 3: GDP and its components: Investment boom in the South (baseline scenario depicted with dashed lines)

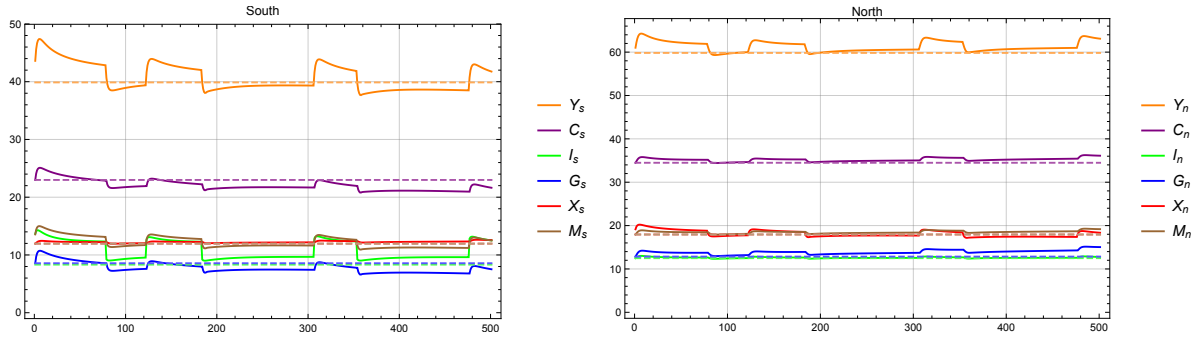
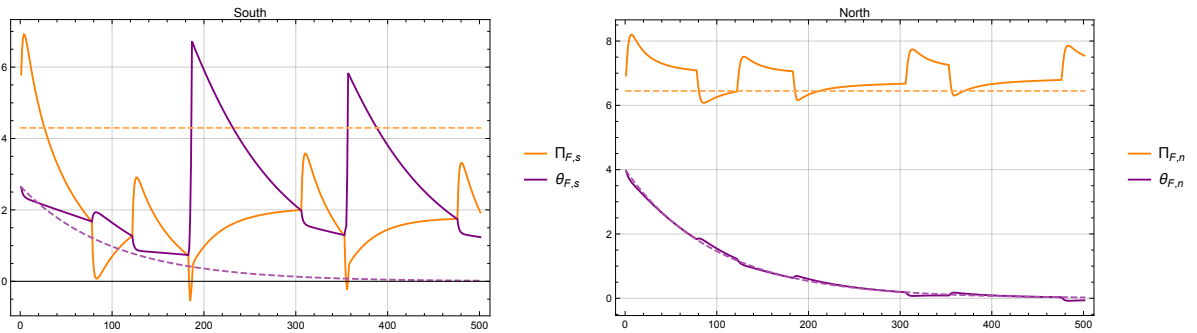


Figure 4: Firm profits ($\Pi_{F,i}$) and margin of safety ($\theta_{F,i}$): Investment boom in the South (baseline scenario depicted with dashed lines)



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 those boom phases go along with trade deficits in the South. The North in turn experiences trade surpluses due to southern import demand. Southern trade deficits decline during recessions and turn into surpluses once the economy enters the phase of being credit constrained. The North experiences trade deficits during the latter stage.

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 incurred by the South). Since we assume that northern banks can only lend existing surpluses, the southern banks obtain the rest through central bank loans, which also increase.

Northern banks in turn experience a 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

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

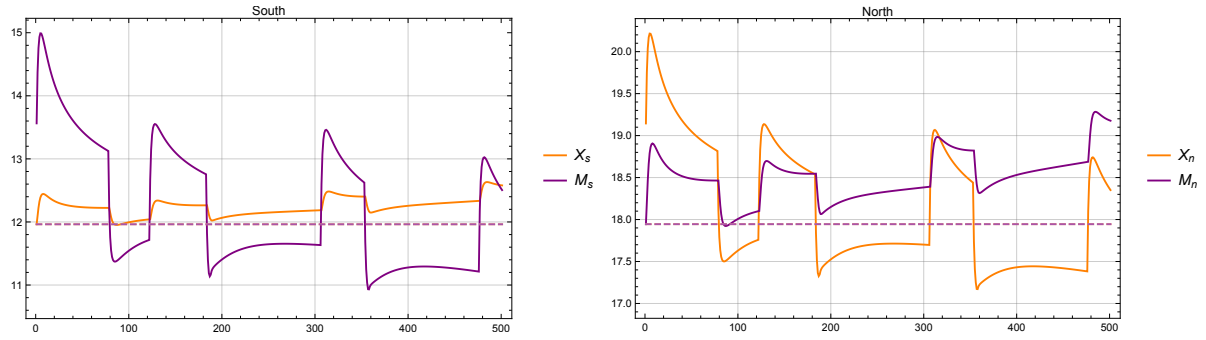
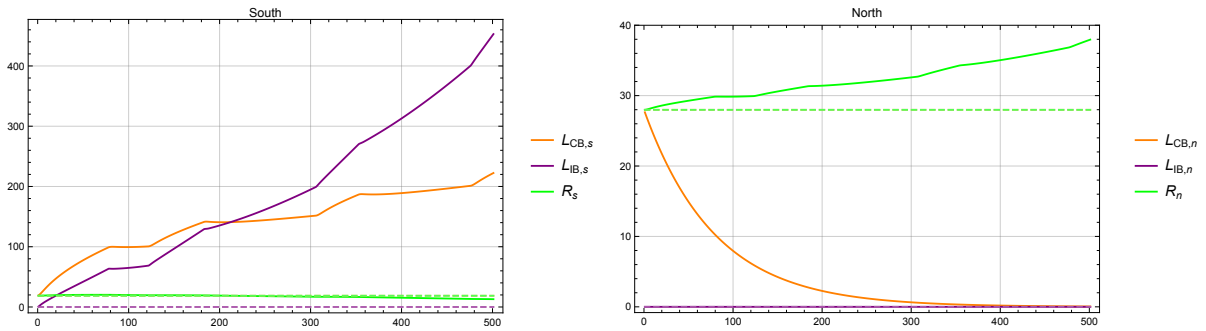


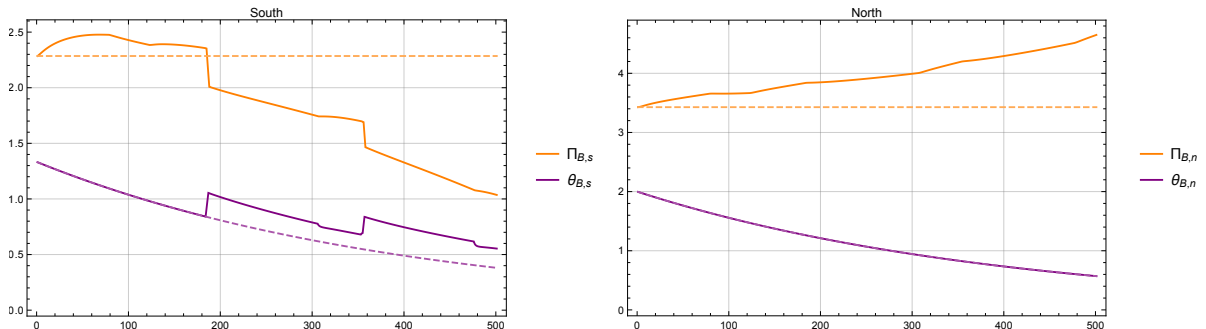
Figure 6: Interbank loans ($L_{IB,i}$), central bank loans ($L_{CB,i}$) and reserves (R_i) (baseline scenario depicted with dashed lines)



existing central bank loans. What is left is lent to southern banks.

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 7: Bank profits ($\Pi_{B,i}$) and margin of safety ($\theta_{B,i}$): Investment boom in the South (baseline scenario depicted with dashed lines)



4.2 Scenario 2: Southern Europe 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. 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).

Here, it is interesting to see that while the southern economy finds itself on a downward trajectory from now on, the northern economy initially returns to an upward trajectory. The reason for the latter is the recovery of government expenditure in the North, which is fuelled by redistributed central bank profits. These profits increase over time, since – due to the trade deficits – both banking sectors experiencing 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). The majority of these loans goes to the South, which causes a steady indirect flow of interest payments going from South to North. These interest payments are also at the root of the widening trade deficit that can be observed in the North.

Note that another result of this scenario is 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.

The crisis towards the end of the observation period emerges when southern bank profits have fallen below northern banks' margin of safety (figure 11). As soon as this happens, southern banks lose access to credit. Unable to borrow reserves, the southern economy has to make due with the reserves it has. As a consequence, demand in the South is reduced to a level that corresponds to the amount of reserves available for imports. The southern trade deficit as a result turns into a surplus (the surplus is needed to repay its external creditors). Due to the massive decline of demand for its exports, the northern economy also experiences a drop in its GDP level.

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

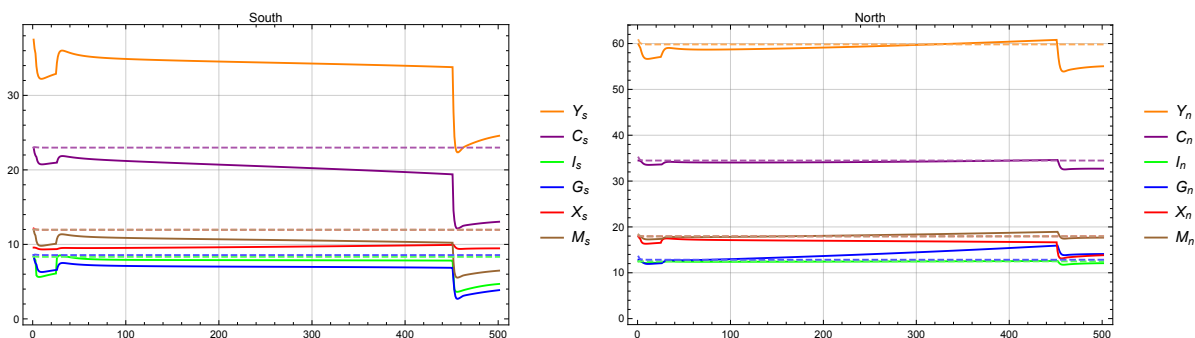


Figure 9: Exports and imports: Southern Europe loses competitiveness relative to the RoW (baseline scenario depicted with dashed lines)

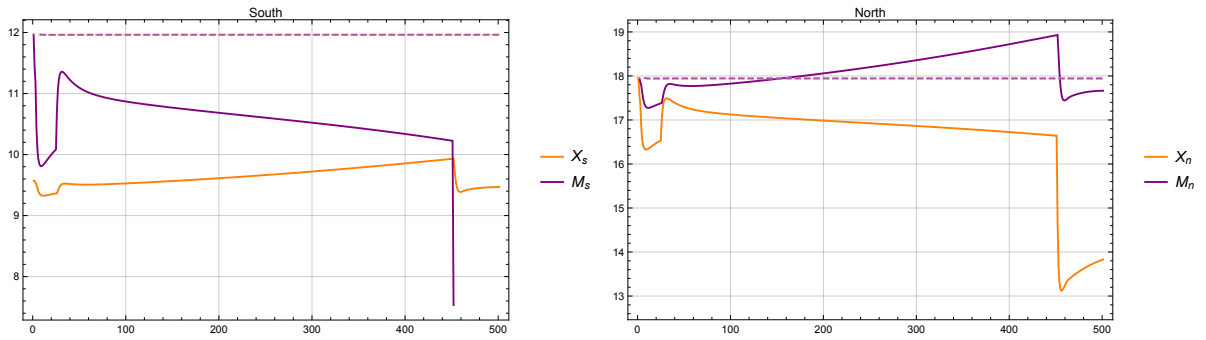


Figure 10: Interbank loans ($L_{IB,i}$), central bank loans ($L_{CB,i}$) and reserves (R_i): Southern Europe loses competitiveness relative to the RoW (baseline scenario depicted with dashed lines)

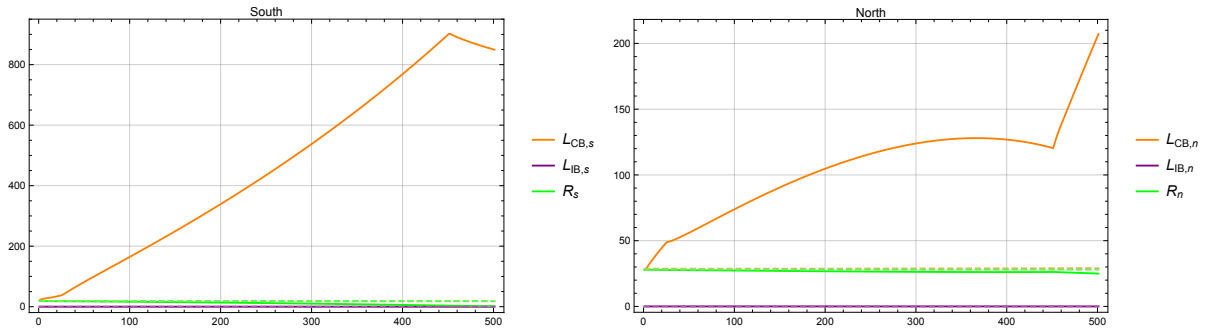
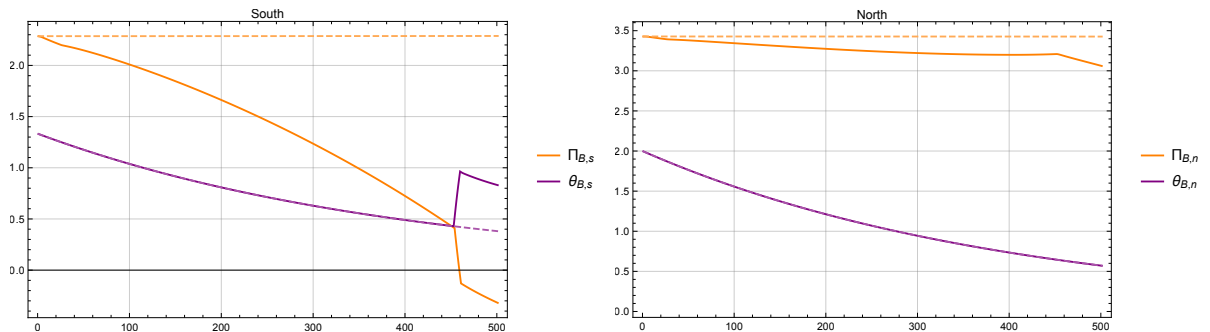


Figure 11: Bank profits ($\Pi_{B,i}$) and margin of safety ($\theta_{B,i}$): Southern Europe loses competitiveness relative to the RoW (baseline scenario depicted with dashed lines)



4.3 Scenario 3: Southern Europe 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 3 – 7, 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 couple of periods, being followed by a recession. As the recession continues, firm profits decline below banks' margin of safety. Once banks stop lending, the economy enters a financial crisis and firms remain credit constrained for a prolonged period. When this period is over and credit supply increases again, boom-bust dynamics reemerge. However, the difference is that the financial crisis is now followed by an international financial crisis like the one observed at the end of scenario 2. At this stage, 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 hardly able 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 12: GDP and its components: Investment boom in the South (baseline scenario depicted with dashed lines: Southern Europe loses competitiveness relative to the RoW)

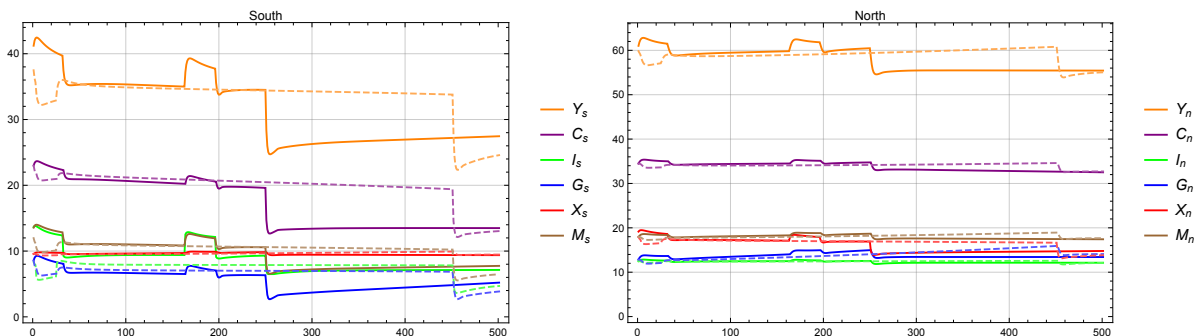


Figure 13: Investment boom in the South (baseline scenario depicted with dashed lines: Southern Europe loses competitiveness relative to the RoW)

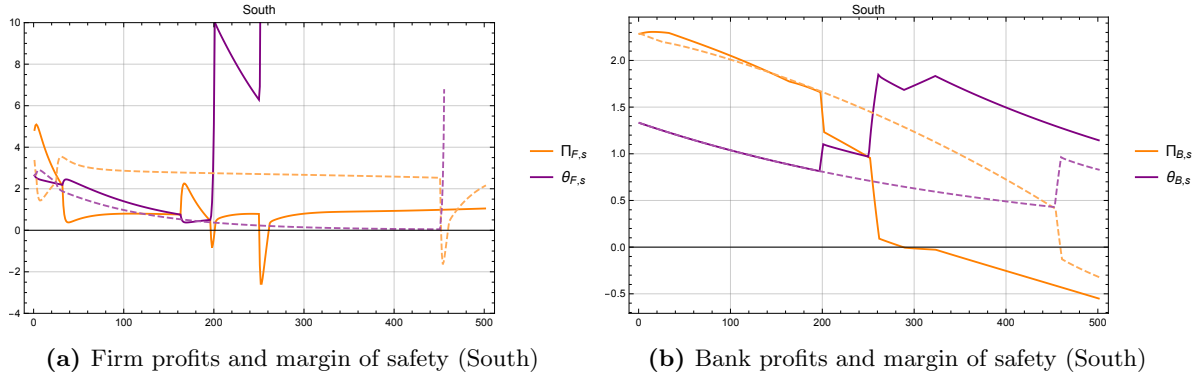


Figure 14: Exports and imports: Investment boom in the South (baseline scenario depicted with dashed lines: Southern Europe loses competitiveness relative to the RoW)

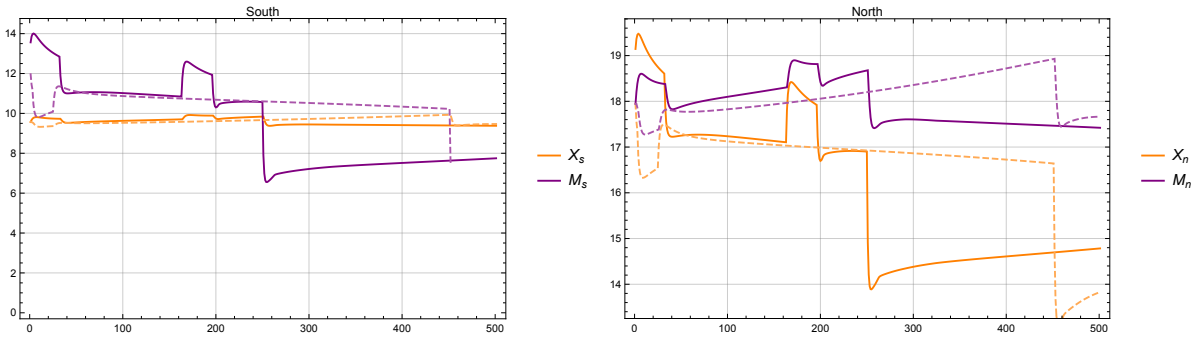
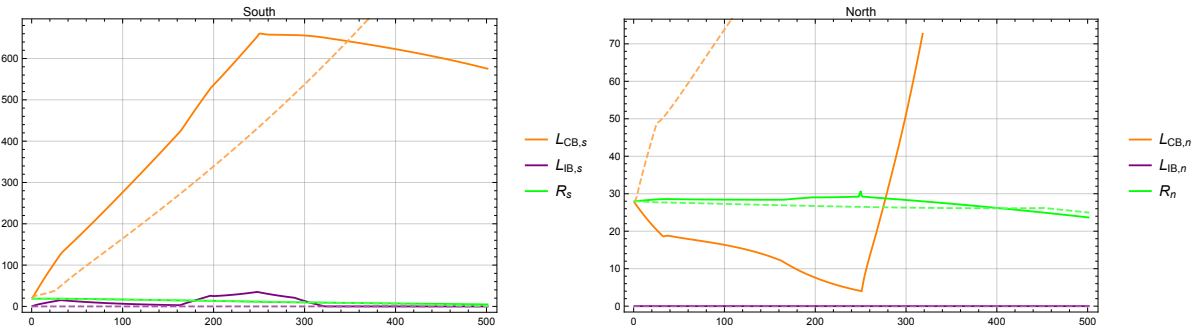


Figure 15: Interbank loans ($L_{IB,i}$), central bank loans ($L_{CB,i}$) and reserves (R_i): Investment boom in the South (baseline scenario depicted with dashed lines: Southern Europe loses competitiveness relative to the RoW)



4.4 Scenario 4: Northern mercantilism

In this scenario, we take scenario 3 as our baseline and 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. In particular, we assume that after each period in which the southern economy is credit constrained, the RoW's import propensity for goods from the North increases by xs .

$$m_{n,w} = \begin{cases} \Pi_{F,s}(t-1) - \theta_{F,s}(t-1) \geq 0 : m_{n,w} \\ \text{otherwise} : m_{n,w}(t-1) + x \end{cases} \quad (9)$$

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 ($\sum \Delta m_{n,w} \leq m_{s,w}$).

We can see in figures 16 – 19 that, unsurprisingly, the North recovers quite quickly after the initial recession triggered by the southern financial crisis. Due to the northern recovery, the South also recovers sooner, shortening the time interval between the first two booms. Once the second boom starts, events in the South evolve similarly to the previous scenario, with a national financial crisis followed by a much deeper international one. Things turn out a bit differently in the North, which is able to retain a high level of GDP despite some losses. This development in the North is due 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 19 that interbank loans decline as a result, although central bank loans start to increase at a rapid pace in the immediate aftermath. The latter is due to the fact that the southern contraction necessary to achieve the necessary trade surplus would be so large that the central bank has to step in as a lender of last resort in order to prevent the fallout from happening. With the central bank acting as a lender of last resort, interbank loans fall towards zero and are effectively replaced by central bank debt.

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 16: GDP and its components: Northern mercantilism (baseline scenario depicted with dashed lines: scenario 3)

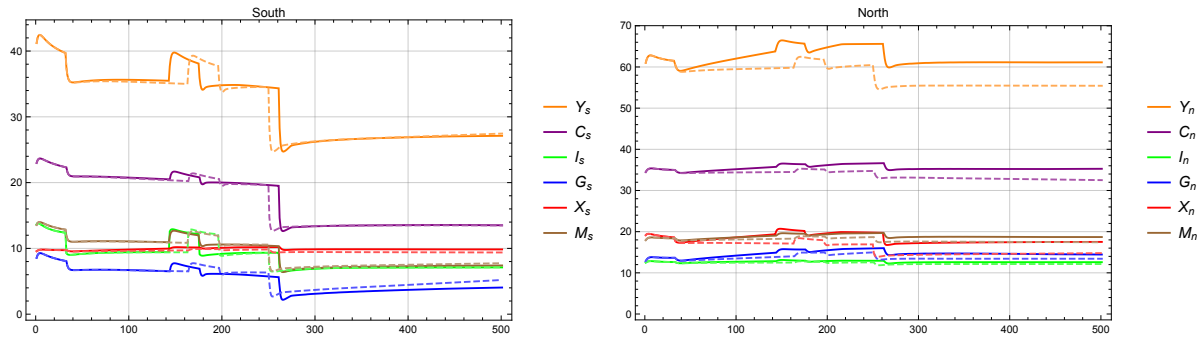


Figure 17: Northern mercantilism (baseline scenario depicted with dashed lines: scenario 3)

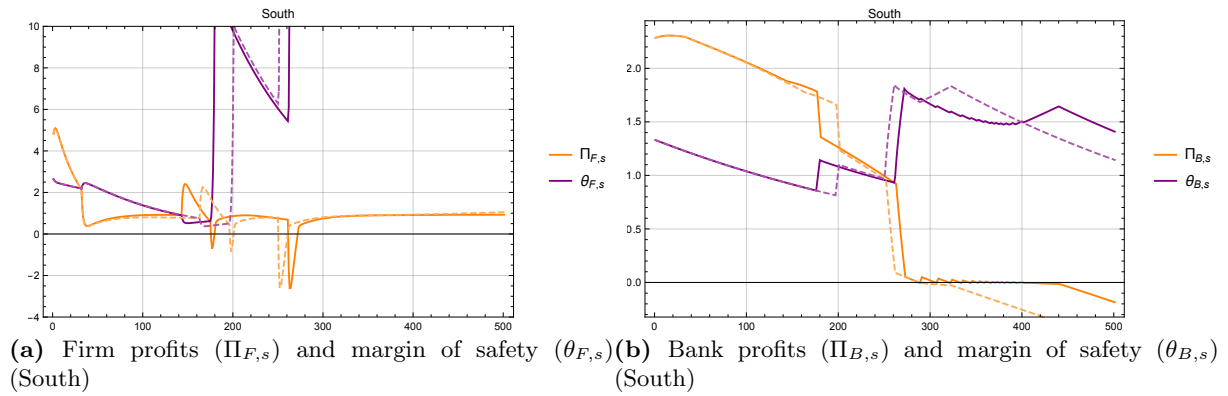


Figure 18: Exports and imports: Northern mercantilism (baseline scenario depicted with dashed lines: scenario 3)

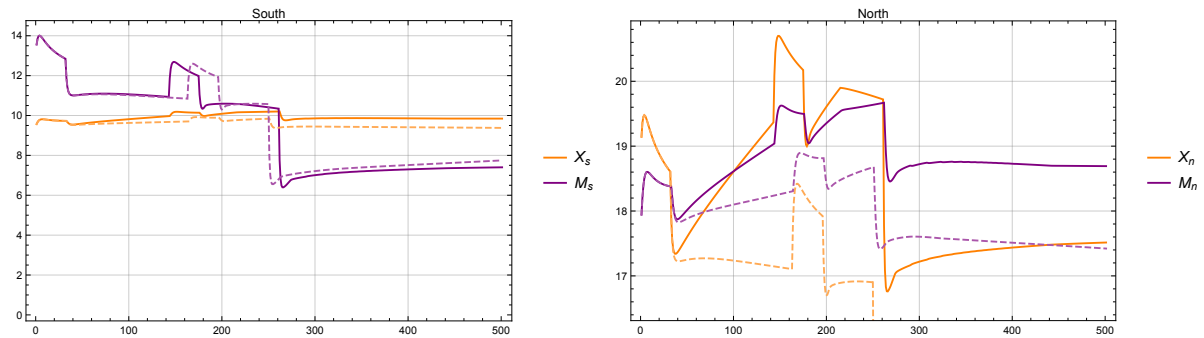
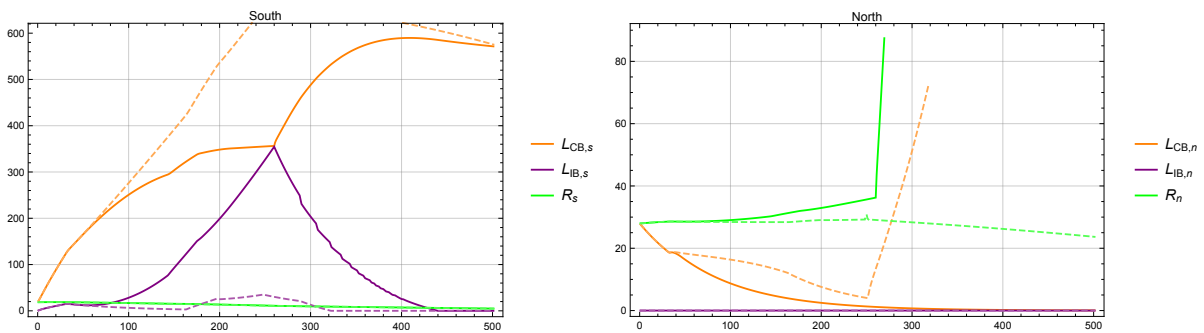


Figure 19: Interbank loans ($L_{IB,i}$), central bank loans ($L_{CB,i}$) and reserves (R_i): Northern mercantilism (baseline scenario depicted with dashed lines: scenario 3)



4.5 Scenario 5: Northern mercantilism at the expense of South

In a variant of the previous scenario, we assume that this increase in northern market share happens fully at the expense of the South, i.e. we assume that northern exports are gradually crowding out those of the South. In terms of our model, this means that the increase of $m_{n,w}$ by x (see equation 9) is accompanied by a corresponding fall of $m_{s,w}$.

$$m_{s,w} = \begin{cases} \Pi_{F,s}(t-1) - \theta_{F,s}(t-1) \geq 0 : m_{s,w} \\ \text{otherwise} : m_{s,w}(t-1) - x \end{cases} \quad (10)$$

The effects of this change are quite devastating for the South. Once the southern economy enters the first financial crisis, it finds itself in a downward spiral. The steady decline is eventually followed by an international financial crisis as southern banks become credit constrained. Southern exports reach their lowest point as exports to the RoW fall to zero. Without any policy intervention taking place, the southern economy is trapped in a state of very low output. The northern economy also suffers temporarily from the southern crises, but manages to recover and retain a high level of output due to its increased sales to the RoW. Unlike in the previous scenario 4, southern financial sector debt at the eve of the international financial crisis consists mainly of central bank loans. Similar to scenario 3, the reason for this lies in the fact that due to the sustained weakness of the southern economy, the North finds it difficult to accumulate trade surpluses, which means that the northern financial sector does not possess the necessary surplus reserves to provide interbank loans. Once the international financial crisis starts, we observe an ongoing flow of central bank loans to the South (figure 23), since the central bank has to step in as a lender of last resort in order to avoid an even larger contraction of the southern economy.

Similar to what we observed in scenarios 1, 2 and 3, the North does not establish itself as a creditor of the South. We can conclude from this that in order for this kind of dependence to emerge, a northern export policy that is solely built on crowding out the South is insufficient. The reason for the latter is that by crowding out its neighbour's exports, the North deprives itself from the revenues it would need to establish the necessary financial foundation.

Figure 20: GDP and its components: Northern mercantilism at expense of South (baseline scenario depicted with dashed lines: scenario 4)

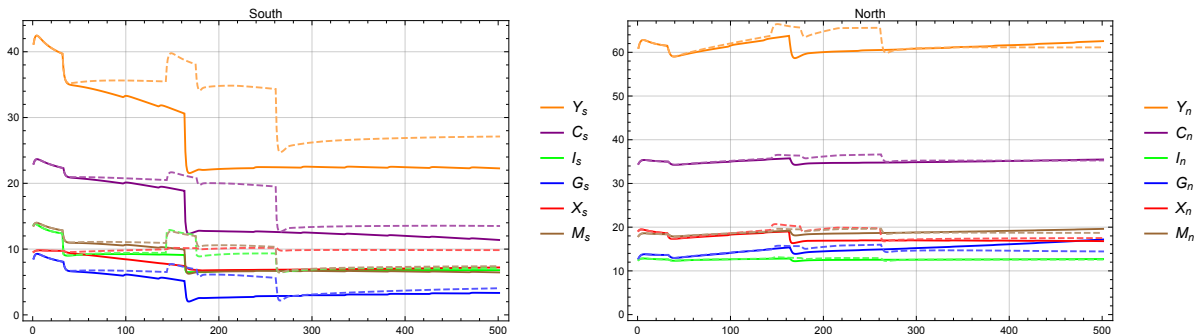


Figure 21: Northern mercantilism at expense of South (baseline scenario depicted with dashed lines: scenario 4)

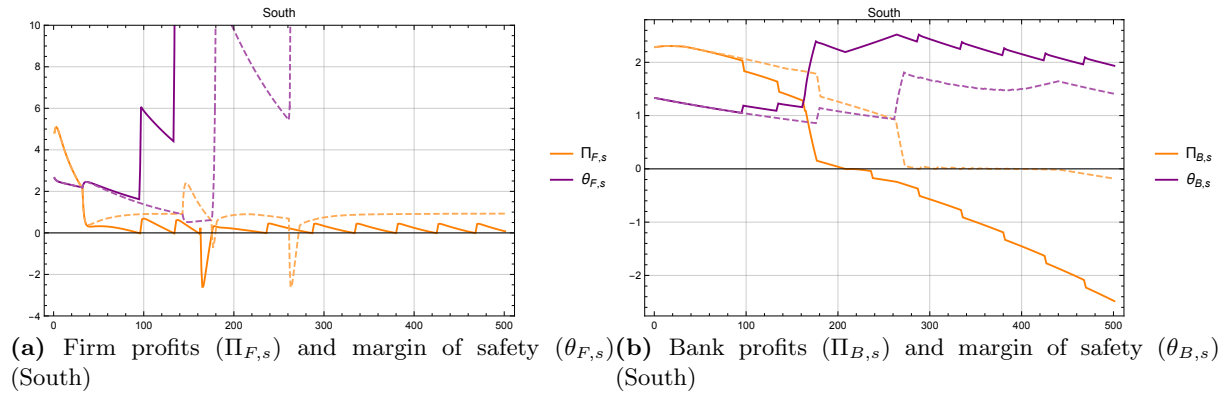


Figure 22: Exports and imports: Northern mercantilism at expense of South (baseline scenario depicted with dashed lines: scenario 4)

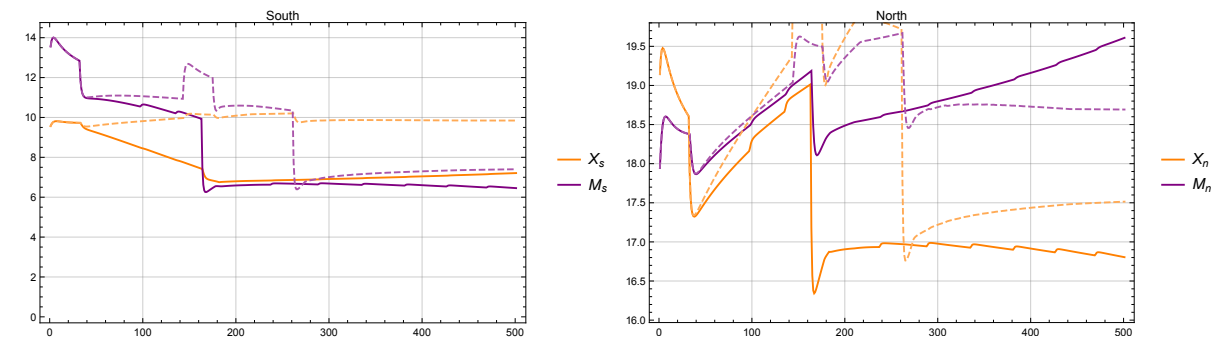
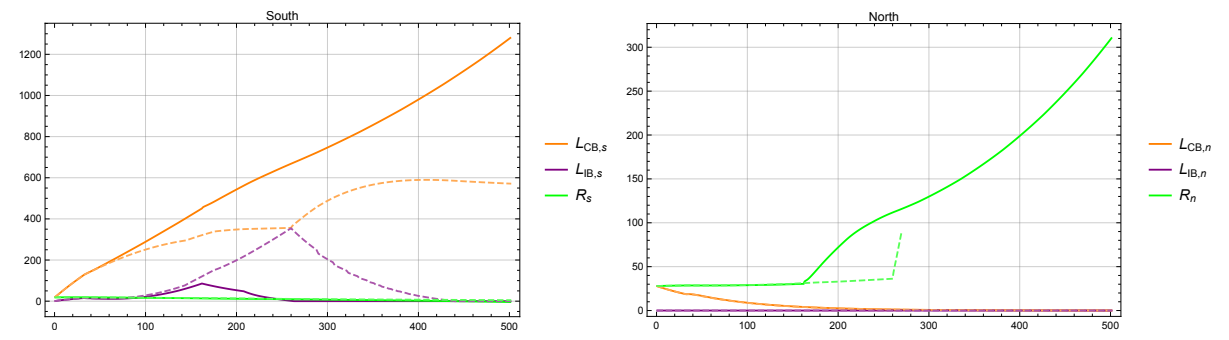


Figure 23: Interbank loans ($L_{IB,i}$), central bank loans ($L_{CB,i}$) and reserves (R_i): Northern mercantilism at expense of South (baseline scenario depicted with dashed lines: scenario 4)



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: counter-cyclical fiscal policy and the central bank as a lender of last resort. We discuss these policies for both mercantilist scenarios (4 and 5).

5.1 Counter-cyclical fiscal policy

When the crisis hit the economic activity in 2008 and 2009, the several governments across the Eurozone – including northern countries such as Germany as well as southern countries such as Spain (e.g. [Khatiwada, 2009](#)) – reacted by introducing fiscal stimulus measures to counteract the downturn. In this policy scenario, the motivation is to gain a better understanding of the impact of counter-cyclical fiscal policy. 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 from the previous period by the rate σ and that government spending cannot drop below 75% of its spending in period $t = 0$. In order to avoid infinite fiscal expansions, we finally assume that this kind of stimulus cannot exceed the government's historical maximum spending.

$$G_{D,i}(t) = \begin{cases} \Pi_{F,i}(t-1) - \theta_{F,i}(t-1) \geq 0 : & \begin{aligned} & T_i(t-1) + \rho_i \cdot \Pi_{CB}(t-1) \\ & - i_L \cdot L_{G,i}(t-1) \end{aligned} \\ \text{otherwise} : \text{Min} \left[\begin{array}{l} \text{Max}[G_{D,n}(t-1) \cdot (1 + \sigma), 0.75 \cdot G_n(t=0)], \\ \text{Max}[G_{D,n}(1), \dots, G_{D,n}(t-1)] \end{array} \right] \end{cases} \quad (11)$$

5.1.1 Scenario 6: Northern mercantilism

Under the assumption that northern mercantilism does not have a negative impact on southern exports, counter-cyclical policy is able to stabilize southern output over a prolonged period of time (see figures 24 – 28): whenever a domestic financial crisis emerges, the rise in the government deficit (figure 25) is sufficient to bring the economy back on track, meaning that firm profits recover and domestic lending proceeds (figure 26a). At the same time, the northern economy is able to remain on an upward trajectory throughout this period.

However, successive episodes of domestic financial crises lead to a gradual deterioration of southern banks' profits (figure 26b). At a point around period 380, financial sector profits fall below the corresponding margin of safety, meaning that the southern financial sector becomes internationally credit constrained. As a result, the southern economy contracts significantly, leading to a southern trade surplus. In the subsequent period, interbank loans decline, whereas

Figure 24: GDP and its components: Fiscal policy (baseline scenario depicted with dashed lines: Northern mercantilism)

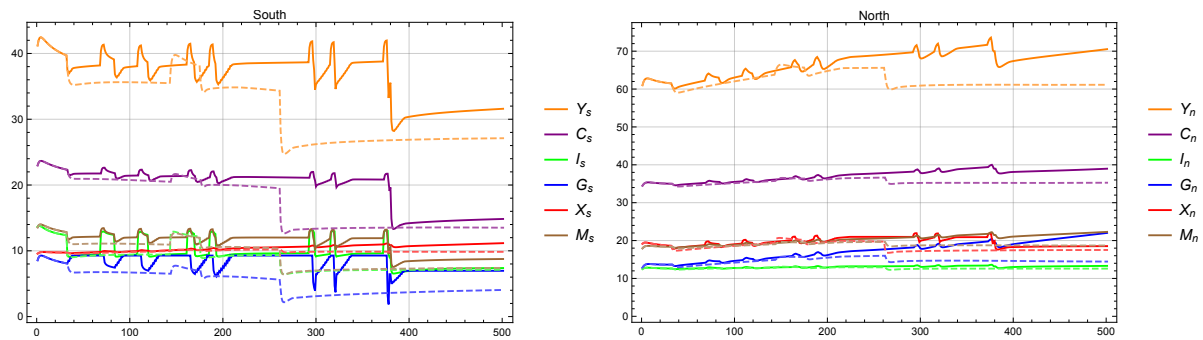
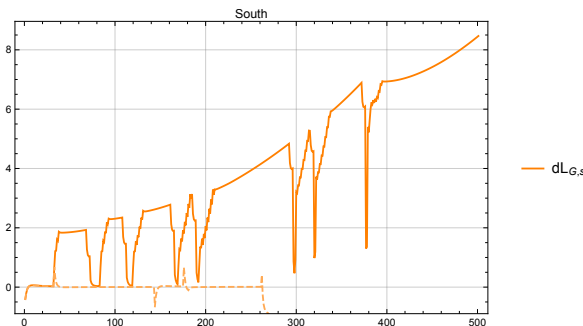


Figure 25: Change in government debt ($dL_{G,s}$) (South): Fiscal policy (baseline scenario depicted with dashed lines: Northern mercantilism)



southern central bank loans continue to increase. The reason for the latter is again that the central bank has to step in as a lender of last resort in order to avoid an even larger contraction.

With the South being able to stabilize output through fiscal policy, the North-South debtor relationship thrives (figure 28); on the eve of the international financial crisis, interbank loans make up the largest part of southern international debt. This shows once again how the North benefits from the fiscal action of the South, as it provides the North with an even larger surplus of financial funds that can in turn be lent back to the South. When the international financial crisis starts, the northern economy takes a hit, but its level of output remains substantially above those in previous scenarios. The root of this development lies in the central bank stepping in as lender of last resort, which guarantees a steady flow of interest payments from South to North. In sum, the South borrows from the central bank in order to pay for its pre-crisis loans granted from the North. This inflow of capital income to the North leaves the North with substantial trade deficits over the course of the whole aftermath of the international financial crisis.

Figure 26: Fiscal policy (baseline scenario depicted with dashed lines: Northern mercantilism)

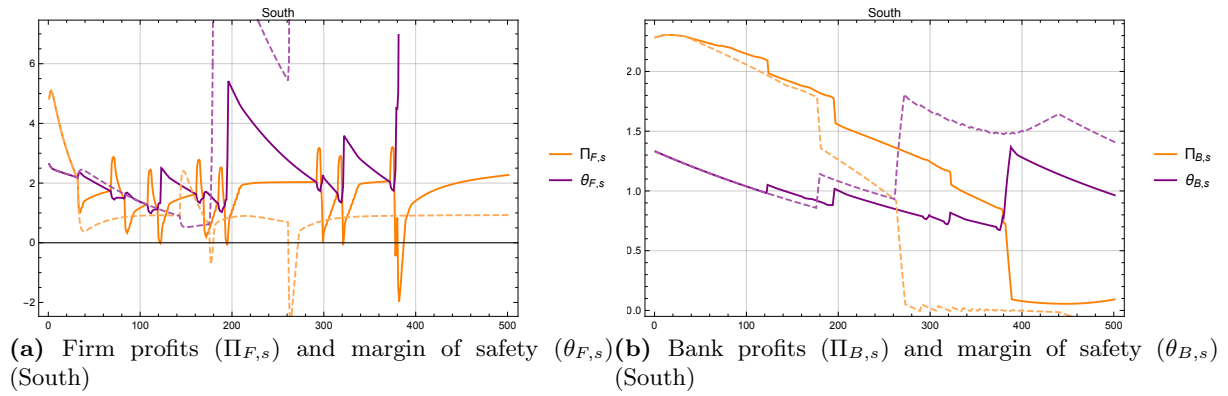


Figure 27: Exports and imports: Fiscal policy (baseline scenario depicted with dashed lines: Northern mercantilism)

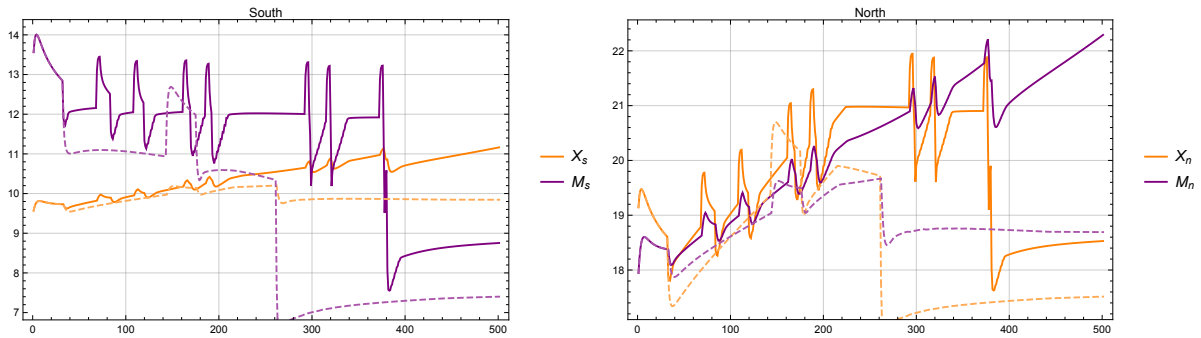
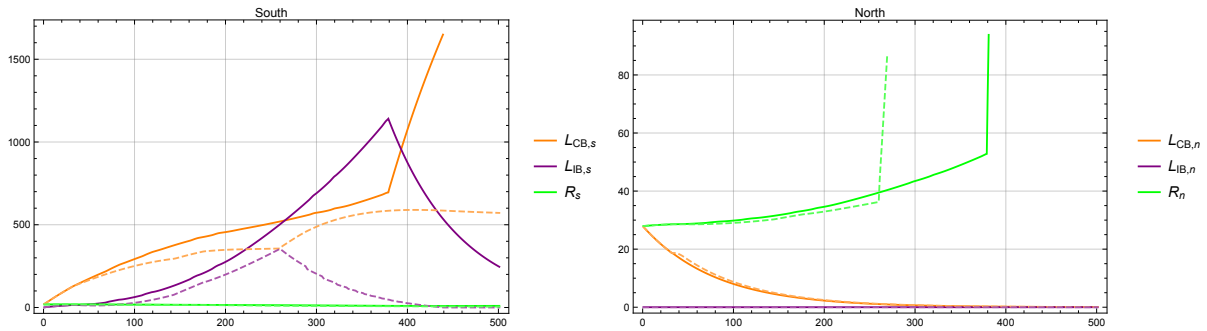


Figure 28: Interbank loans ($L_{IB,i}$), central bank loans ($L_{CB,i}$) and reserves (R_i): Fiscal policy (baseline scenario depicted with dashed lines: Northern mercantilism)



5.1.2 Scenario 7: Northern mercantilism at the expense of South

The scenario in which northern exports increase at the expense of the South also improves through the imposition of counter-cyclical fiscal policy (figures 29 – 33): the South is able to slow down its economic decline for quite a while, but eventually also runs into an international debt crisis (around period 290). The impact of the latter is similar to what we have seen in the previous scenarios: the North continues to thrive, experiencing only temporary setbacks, with the northern performance also significantly enhanced compared to the same scenario without southern deficit spending (see dashed lines in the right panel of figure 29).

With counter-cyclical fiscal policy in place in the South, the North is able to exercise the role of creditor to the South, which it could not do in the same scenario without fiscal policy because it was unable to accumulate sufficient excess funds (see scenario 5). The North's creditor position, together with the central bank stepping in as lender of last resort, assures that the North attains a high level of GDP even after the crisis due to the ongoing stream of interest payments that compensate for the decline of demand for its exports.

Figure 29: GDP and its components: Fiscal policy (baseline scenario depicted with dashed lines: Northern mercantilism at the expense of South)

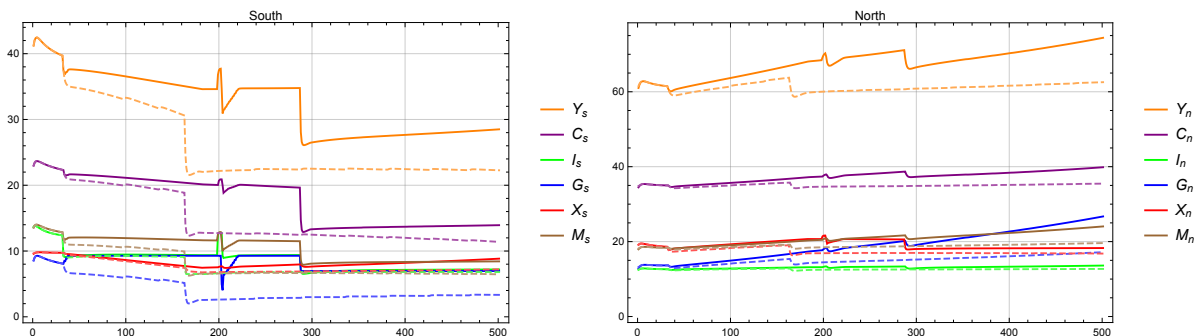


Figure 30: Change in government debt ($dL_{G,s}$) (South): Fiscal policy (baseline scenario depicted with dashed lines: Northern mercantilism at the expense of South)

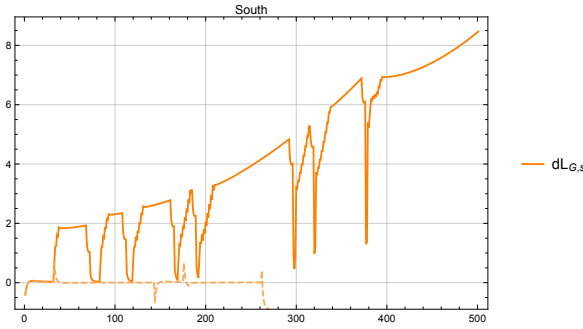


Figure 31: Fiscal policy (baseline scenario depicted with dashed lines: Northern mercantilism at the expense of South)

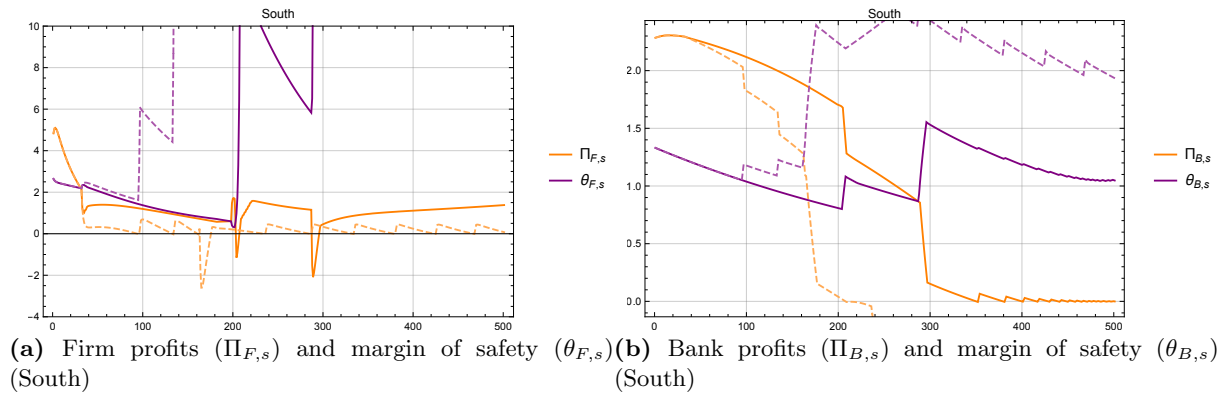


Figure 32: Exports and imports: Fiscal policy (baseline scenario depicted with dashed lines: Northern mercantilism at the expense of South)

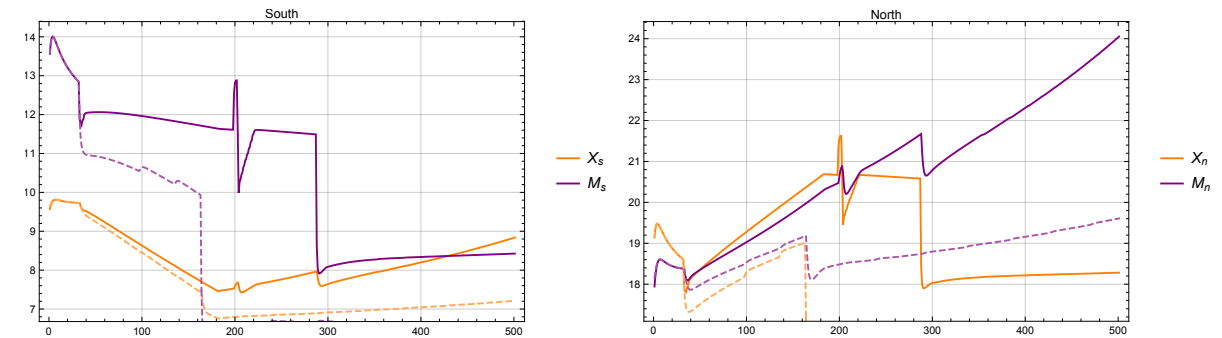
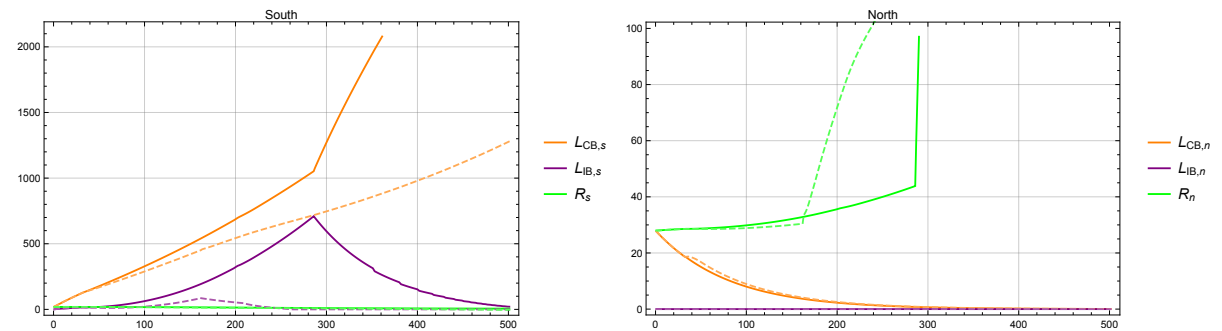


Figure 33: Interbank loans ($L_{IB,i}$), central bank loans ($L_{CB,i}$) and reserves (R_i): Fiscal policy (baseline scenario depicted with dashed lines: Northern mercantilism at the expense of South)



5.2 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 previous scenario analysis 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. Fisher 1999). To gain a better understanding of what happens when the central bank steps in as lender of last resort, this scenario assumes that the central bank provides immediate unlimited access to credit as soon as a national financial sector becomes credit constrained; 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). Now that the central bank serves as unconditional lender of last resort, we obtain an important finding: the introduction of counter-cyclical fiscal policy in combination with the central bank acting as an unconditional lender of last resort allows policy-makers to fully avoid long depressions in both mercantilist scenarios (see figure 34 and 35).

Figure 34: GDP and its components: unconditional lender of last resort (baseline scenario depicted with dashed lines: Northern mercantilism and counter-cyclical fiscal policy)

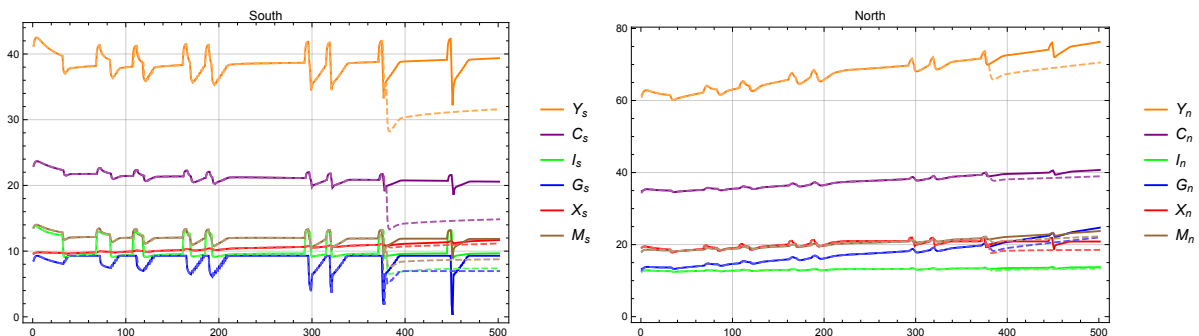
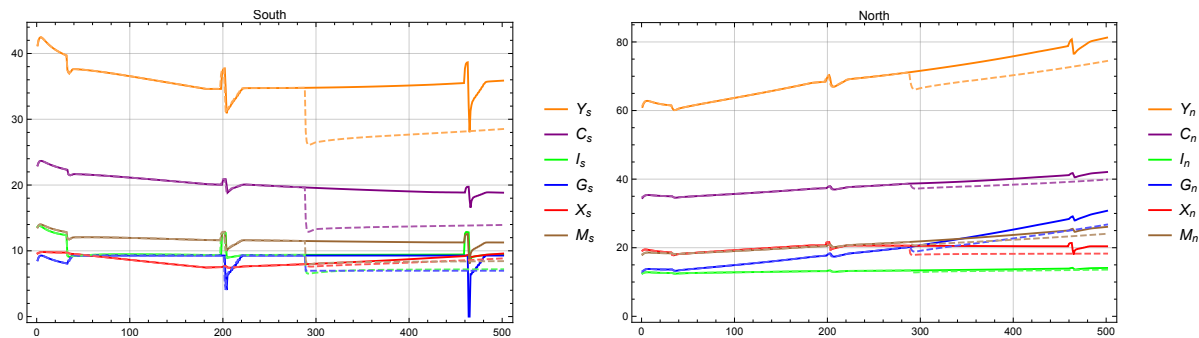


Figure 35: GDP and its components: lender of last resort (baseline scenario depicted with dashed lines: Northern mercantilism at the expense of South and counter-cyclical fiscal policy))



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. The latter only happens if the rise in northern export performance does not happen at the expense of the South, i.e. does not fully crowd out southern exports to the Rest of the World.

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 even in the case in which its own exports crowd out southern exports. 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.

Finally, our simulations show that the North is able to obtain a relatively high level of income even in the aftermath of an international financial crisis. This result is due to the fact that southern debt accumulated pre-crisis leads to long lasting streams of South-North interest payments. The latter result is only possible if the central bank steps in as a lender of last resort to the South.

These findings indicate that while fiscal policy and an unconditional lender of last resort 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

The section of the appendix provides a full list of the equations used in the model.

Consumption demand C_D , investment demand I_D and demand by the government G_D are defined by equations 12 – 14. Household demand for consumption depends on an autonomous part ($c0_i$) and disposable income (Y_H) in the previous period. Firms' investment demand depends on an autonomous part ($i_{0,i}$) and the previous period's degree of utilization of the capital stock (Z_i). 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 profit ($\Pi_{F,i}$) is above a certain margin of safety ($\theta_{F,i}$). 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 r_{cr} (rate of credit restriction) of investment demand gets financed, which we refer to as a situation of financial distress. 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 $t = 0$.

$$C_{D,i} = c_{0,i} + c_1 \cdot Y_{H,i}(t-1) \quad (12)$$

$$I_{D,i} = \begin{cases} \Pi_{F,i}(t-1) - \theta_{F,i}(t-1) \geq 0 : i_{0,i} + i_{1,i} \cdot Z_i(t-1) \\ \text{otherwise} : r_{cr} \cdot (i_{0,i} + i_{1,i} \cdot Z_i(t-1)) \end{cases} \quad (13)$$

$$G_{D,i} = T_i(t-1) + \rho \cdot \Pi_{CB}(t-1) - i_L \cdot L_{G,i}(t-1) \quad (14)$$

In our policy scenarios the government switches to counter-cyclical fiscal spending, therefore equation 14 gets replaced by equation 15. In this setting we assume that in times of crisis, the government increases its spending from previous period by a certain rate σ (fiscal policy factor) and that government spending cannot drop beneath 75% of its spending in period $t = 0$. In order to avoid infinite fiscal expansions, we finally assume that this kind of stimulus cannot exceed the government's historical maximum spending.

$$G_{D,i}(t) = \begin{cases} \Pi_{F,i}(t-1) - \theta_{F,i}(t-1) \geq 0 : \begin{matrix} T_i(t-1) + \rho \cdot \Pi_{CB}(t-1) \\ -i_L \cdot L_{G,i}(t-1) \end{matrix} \\ \text{otherwise} : \text{Min} \left[\begin{matrix} \text{Max}[G_{D,i}(t-1) \cdot (1 + \sigma), 0.75 \cdot G_{D,i}(t=0)], \\ \text{Max}[G_{D,i}(1), \dots, G_{D,i}(t-1)] \end{matrix} \right] \end{cases} \quad (15)$$

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. Furthermore it also depends on previous period's changes in firm equity ($V_{F,i}$) measured relative to GDP.

$$\theta_{F,i} = \theta_{F,i}(t-1) + \mu_{F,i} \cdot |\theta_{F,i}(t-1)| - \zeta_{F,i} \cdot \Delta \frac{V_{F,i}(t-1)}{Y_i(t-1)} \quad (16)$$

$$\mu_{F,i} = \begin{cases} CANCE_{F,i} = 0 : -\gamma_F \\ \text{otherwise} : \tau_F \end{cases} \quad (17)$$

The same logic applies for interbank loans: Interbank loans are only provided when the margin of safety $\theta_{B,i}$ is met. 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).

$$\theta_{B,i} = \theta_{B,i}(t-1) + \mu_{B,i} \cdot |\theta_{B,i}| - \zeta_{B,i} \cdot \Delta \frac{V_{B,i}}{Y_i} \quad (18)$$

$$\mu_{B,i} = \begin{cases} CANCE_{B,i} = 0 : -\gamma_B \\ \text{otherwise} : \tau_B \end{cases} \quad (19)$$

Cancellation of firm debt in region i ($CANCE_{F,i}$) and bank debt in region i ($CANCE_{B,i}$) are defined by equations 20 and 21 respectively. Banks have to cancel proportion χ of their outstanding debt if firms are credit constrained (firm profits $\Pi_{F,i}$ have 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 (bank profits $\Pi_{B,i}$ have 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).

$$CANCE_{F,i} = \begin{cases} L_{F,i} > 0 \wedge \Pi_{F,i} - \theta_{F,i} < 0 \wedge \Pi_{F,i} < 0 : \chi \cdot L_{F,i} \\ \text{otherwise} : 0 \end{cases} \quad (20)$$

$$CANCE_{B,i} = \begin{cases} L_{IB,i} > 0 \wedge \Pi_{B,i} - \theta_{B,i} < 0 \wedge \Pi_{B,i} < 0 : \chi \cdot L_{IB,i} \\ \text{otherwise} : 0 \end{cases} \quad (21)$$

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 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 , see equation 25) is distributed proportionately among the demand categories C , I and G .⁴ 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).

⁴Equation 25 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: $m_i \cdot (C_i + I_i + G_i) = EXP_i + \rho_i \cdot \Pi_{CB} + i_D \cdot R_i + i_L \cdot (L_{IB,j} - L_{IB,i} - L_{CB,i}) + a \cdot (L_{IB,j} - L_{IB,i} - L_{CB,i}) + R_i - rrr \cdot M_{H,i}$.

$$C_i = \begin{cases} \Pi_{B,i} - \theta_{B,i} \geq 0 : C_{D,i} \\ \text{otherwise} : \text{Max}[\text{Min}[C_{D,i}, RCC_i \cdot \frac{C_{D,i}}{C_{D,i}+I_{D,i}+G_{D,i}}], elr \cdot C_{D,i}] \end{cases} \quad (22)$$

$$I_i = \begin{cases} \Pi_{B,i} - \theta_{B,i} \geq 0 : I_{D,i} \\ \text{otherwise} : \text{Max}[\text{Min}[I_{D,i}, RCC_i \cdot \frac{I_{D,i}}{C_{D,i}+I_{D,i}+G_{D,i}}], elr \cdot I_{D,i}] \end{cases} \quad (23)$$

$$G_i = \begin{cases} \Pi_{B,i} - \theta_{B,i} \geq 0 : G_{D,i} \\ \text{otherwise} : \text{Max}[\text{Min}[G_{D,i}, RCC_i \cdot \frac{G_{D,i}}{C_{D,i}+I_{D,i}+G_{D,i}}], elr \cdot G_{D,i}] \end{cases} \quad (24)$$

$$RCC_i = \frac{(X_i + \rho \cdot \Pi_{CB} + i_D \cdot R_i + i_L \cdot (L_{IB,j} - L_{IB,i} - L_{CB,i}) + a \cdot (L_{IB,j} - L_{IB,i} - L_{CB,i}) + (R_i - rrr \cdot M_{H,i}))}{m_i} \quad (25)$$

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

$$X_{w,i} = m_{i,w} \cdot Y_w \quad (26)$$

This import elasticity is initially constant, but becomes exogenous for the North in the first mercantilist scenario (equation 27 and endogenous for both regions in the second mercantilist scenario (equations 27 and 28).

$$m_{n,w} = \begin{cases} \Pi_{F,s}(t-1) - \theta_{F,s}(t-1) \geq 0 : m_{n,w} \\ \text{otherwise} : m_{n,w}(t-1) + x \end{cases} \quad (27)$$

$$m_{s,w} = \begin{cases} \Pi_{F,s}(t-1) - \theta_{F,s}(t-1) \geq 0 : m_{s,w} \\ \text{otherwise} : m_{s,w}(t-1) - x \end{cases} \quad (28)$$

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:

$$M_{j,i} = m_{j,i} \cdot (C_i + I_i + G_i) \quad (29)$$

$$M_{w,i} = m_{w,i} \cdot (C_i + I_i + G_i) \quad (30)$$

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

$$M_i = M_{j,i} + M_{w,i} \quad (31)$$

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

$$X_i = M_{j,i} + EXP_{w,i} \quad (32)$$

This provides us with GDP (Y):

$$Y_i = C_i + I_i + G_i + X_i - M_i \quad (33)$$

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

$$E_i = \frac{Y_i}{\lambda_i} \quad (34)$$

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

$$W_i = w \cdot E_i \quad (35)$$

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

$$REP_{H,i} = a \cdot L_{H,i} \quad (36)$$

$$REP_{F,i} = a \cdot L_{F,i} \quad (37)$$

$$REP_{G,i} = a \cdot L_{G,i} \quad (38)$$

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

$$\Pi_{F,i} = Y_i - W_i - i_L \cdot L_{F,i} - REP_{F,i} \quad (39)$$

Subtracting banking sector i 's interest expenditures from interest income yields its profits (equation 40). The same can be done for the central bank (equation 41).

$$\Pi_{B,i} = i_L \cdot (L_{H,i} + L_{F,i} + L_{G,i} - L_{CB,i} - L_{IB,i} + L_{IB,j}) - i_D \cdot (M_{H,i} - R_i) \quad (40)$$

$$\Pi_{CB} = i_L \cdot (L_{CB,i} + L_{CB,i}) - i_D \cdot (R_i + R_s) \quad (41)$$

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

$$T_i = t \cdot (W_i + i_D \cdot M_{H,i} - i_L \cdot L_{H,i} - REP_{H,i} + \Pi_{F,i} + \Pi_{B,i}) \quad (42)$$

Subtracting taxes yields household disposable income:

$$Y_{H,i} = W_i + i_D \cdot M_{H,i} - i_L \cdot L_{H,i} - REP_{H,i} + \Pi_{F,i} + \Pi_{B,i} - T_i \quad (43)$$

Disposable income minus consumption expenditure yields household saving:

$$S_{H,i} = Y_{H,i} - C_i \quad (44)$$

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

$$S_{G,i} = T_i + \rho_i \cdot \Pi_{CB} - G_i - i_L \cdot L_{G,i} - REP_{G,i} \quad (45)$$

Potential output is a function of the capital stock K .

$$Y_{P,i} = K_i \cdot \kappa \quad (46)$$

This gives us the rate of capacity utilization.

$$Z_i = \frac{Y_i}{Y_{P,i}} \quad (47)$$

Household savings go to their savings account M_H . In case household savings are 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 .

$$dM_{H,i} = \begin{cases} S_{H,i} \geq 0 : S_{H,i} \\ \text{otherwise} : \text{Min}[\frac{S_{H,i}}{2}, M_{H,i}] \end{cases} \quad (48)$$

$$dL_{H,i} = -REP_{H,i} + \begin{cases} S_{H,i} < 0 : -(S_{H,i} - dM_{H,i}) \\ \text{otherwise} : 0 \end{cases} \quad (49)$$

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

$$dL_{F,i} = -REP_{F,i} - CANCE_{F,i} + I_i \quad (50)$$

$$dL_{G,i} = -REP_{G,i} - S_{G,i} \quad (51)$$

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:

$$R_{D,i} = M_i - X_i - \rho_i \cdot \Pi_{CB} - i_D \cdot R_i + (i_L + a) \cdot (L_{IB,i} + L_{CB,i} - L_{IB,j}) + rrr \cdot M_{H,i} - R_i \quad (52)$$

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

$$LIB_{D,i} = \begin{cases} \Pi_{B,i} - \theta_{B,i} \geq 0 \wedge R_{D,i} > 0 \wedge R_{D,j} < 0 : \text{Min}[R_{D,i}, -R_{D,j}] \\ \text{otherwise} : 0 \end{cases} \quad (53)$$

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 by⁵

⁵Remember 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 22 – 24). 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 54.

$$L_{CB,D,i} = \begin{cases} R_{D,i} - L_{IB,D,i} > 0 : R_{D,i} - L_{IB,D,i} \\ \text{otherwise} : 0 \end{cases} \quad (54)$$

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

$$dR_i = -M_i + X_i + \rho_i \cdot \Pi_{CB,i} + iD \cdot R_i + (i_L + a) \cdot (L_{IB,s} - L_{IB,i} - L_{CB,i}) \\ + L_{IB,D,i} - L_{IB,D,j} + L_{CB,D,i} \quad (55)$$

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 ($R_{F,CB}$).

$$FRT_w = \begin{cases} R_w + M_{w,n} + M_{w,s} \\ -X_{w,n} - X_{w,s} \geq 0 : 0 \\ \text{otherwise} : -(M_{w,n} + M_{w,s} \\ -X_{w,n} - X_{w,s}) - R_w \end{cases} \quad (56)$$

$$dR_w = M_{w,n} + M_{w,s} - X_{w,n} - X_{w,s} + FRT_w \quad (57)$$

$$dR_{F,CB} = FRT_w \quad (58)$$

$$R_w = R_w + dR_w \quad (59)$$

$$R_{F,CB} = R_{F,CB} + dR_{F,CB} \quad (60)$$

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

$$dL_{IB,i} = L_{IB,D,i} - a \cdot L_{IB,i} - CANC_{B,i} \quad (61)$$

$$dL_{CB,i} = L_{CB,D,i} - a \cdot L_{CB,i} \quad (62)$$

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}) and central bank loans (L_{CB}).

$$M_{H,i} = M_{H,i} + dM_{H,i} \quad (63)$$

$$L_{H,i} = L_{H,i} + dL_{H,i} \quad (64)$$

$$L_{F,i} = L_{F,i} + dL_{F,i} \quad (65)$$

$$L_{G,i} = L_{G,i} + dL_{G,i} \quad (66)$$

$$R_i = R_i + dR_i \quad (67)$$

$$L_{IB,i} = L_{IB,i} + dL_{IB,i} \quad (68)$$

$$L_{CB,i} = L_{CB,i} + dL_{CB,i} \quad (69)$$

Investment (I) adds to the capital stock, which depreciates by δ each period. Government expenditure adds to the government's capital stock K_G , which also depreciates each period by the same rate.

$$K_i = K_i - \delta \cdot K_i + I_i \quad (70)$$

$$K_{G,i} = K_{G,i} - \delta \cdot K_{G,i} + G_i \quad (71)$$

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

$$V_{H,i} = M_{H,i} - L_{H,i} \quad (72)$$

$$V_{F,i} = M_{F,i} - L_{F,i} \quad (73)$$

$$V_{G,i} = M_{G,i} - L_{G,i} \quad (74)$$

$$V_{B,i} = -M_{H,i} + L_i + R_n - L_{CB,i} + L_{IB,j} - L_{IB,i} \quad (75)$$

$$V_{CB} = -R_n - R_s + L_{CB,n} + L_{CB,s} + R_{F,CB} \quad (76)$$

$$V_w = M_w + R_w - R_{F,CB} \quad (77)$$

B Parameters and starting values

B.1 General parameters

$i_L = 0.02$	interest rate on loans*
$i_D = 0.03$	interest rate on deposits*
$a = 0.05$	installment rate*
$\kappa = 0.2$	potential output to capital stock ratio
$\delta = 0.125$	rate of depreciation of the capital stock*
$\chi = 0.025$	proportion of loans that have to be cancelled in each period of bankruptcies
$\zeta_F = 0.25$	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)
$\zeta_B = 0.125$	margin of safety parameter (interbank loans)
$\gamma_B = 0.0025$	margin of safety parameter (interbank loans)
$\tau_B = 0.0025$	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
$t = 0.3$	income tax rate
$\sigma = 0.05$	rate at which government expenditure increases during crises
$elr = 0.75$	CB emergency lending ratio
$w = 0.6$	wage rate workers
$\lambda = 1$	labor productivity
$c_1 = 0.42$	household propensity to consume

*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

$Y_w = 4/3 \cdot Y_n$	aggregate income RoW
$i_{0,n} = 5$	autonomous investment**
$i_{1,n} = 10$	investment parameter**
$c_{0,n} = 20$	autonomous consumption**

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

B.3 Starting values

$Y_n = 59.82$	output**
$M_{H,n} = 1399.02$	household deposits**
$L_{H,n} = 0$	household debt**
$L_{G,n} = 400.17$	government debt**
$L_{F,n} = M_H - L_H - L_G$	firm debt**
$K_n = 399.54$	capital stock**
$R_n = rrr \cdot M_{H,n}$	reserves**
$L_{IB,n} = 0$	interbank loans**
$L_{CB,n} = R_n$	central bank loans**
$\theta_{F,n} = 4$	margin of safety (firm loans)**
$\theta_{B,n} = 2$	margin of safety (interbank loans)**
$R_w = 0$	reserve holdings RoW
$R_{F,CB} = 0$	foreign reserves held by the central bank

**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
$m_{s,n} = 0.5 \cdot m_n$	Northern import propensity for southern products
$m_{n,s} = 0.75 \cdot m_s$	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 scenario investment boom South
 $x = 0.00025$ scenario parameter northern mercantilism

C 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

Table 8: The country grouping used in figure 1.



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