The Case for a Multi-Speed Europe
A Stock-Flow Consistent Approach

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Abstract

Until 2007 the introduction of the euro seemed to be a success. However, since 2008 the darkness of both the global financial crisis and the European sovereign debt crisis has jeopardized the continuity of the integration process launched in the 1950s. As many critics of the monetary unification have been arguing, the structure of the Eurozone was based upon very weak foundations that would eventually end up being crucial. In this article we aim at building a four-country stock-flow consistent model aimed at testing the alternative of a multi-speed Europe , i.e., a Eurozone with two euros: a southern euro and a northern euro, each with a value that is consistent with both the internal and external equilibrium of the corresponding sub-regions. We run some simulation exercises that show how this alternative institutional structure could work.

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1 Introduction

After a period of a seemingly successful implementation of the euro (2002-2007) the Eurozone has been immersed in a crisis of equal length (2008-2013). One of the immediate impacts of the crisis, as in most countries in the world, was the sore of budget deficits since the governments attempted to mitigate the effect of the global financial crisis on production and employment. As a result, the dominant paradigm in economics interpreted the crisis as a process directly linked to profligate behaviour by deficit countries. The problem of this explanation of the crisis is that it neglects the role played by financial liberalization in the periphery of the Eurozone (Spain, Portugal, Greece, Ireland, etc) combined with the export-led growth strategy pursued by the core (Germany, the Netherlands, Austria, Finland). In this regard, as Lapavitsas (2012) explains, the introduction of the euro and the parities at which each of the member countries joined the Eurozone, as well as the differential wage policies implemented by each of the members states, have been playing a major role in the determination of macroeconomic imbalances within the Eurozone which would eventually arise under the form of current account and budget deficits in the periphery and surpluses in the core.

According to this second vision, the order of causation has been the opposite, meaning that it was the weak external performance (derived from the unfavourable conditions at which southern countries joined the Eurozone) what produced the imbalances that end up emerging as large budget deficits. Thus, if these imbalances are to be reduced, instead of tackling the symptom the real source of the crisis must be solved. In this regard, many alternatives have been being put forward since the beginning of the crisis, like a wider role for the ECB and a higher degree of fiscal union. In our view, these proposal, apart from being unlikely from a political point of view, would not solve the real problem, i.e., the structural differences that make impossible for southern countries to compete against Germany at the same nominal exchange rate parity. Hence, an adjustment of exchange rates within the Eurozone may imply an immediate positive competitiveness shock that may help some of the troubled countries to deal with the crisis and, in the medium run, stay at the Eurozone in a sustainable way.

This is the idea of what may be called a *Multi-Speed* Europe, i.e., a Eurozone with two euros: a southern euro and a northern euro, each with a value that is consistent with both the internal and external equilibrium of the corresponding sub-regions. In the next section we present a brief description of the view that states that the main sources of instability in the Eurozone are linked to the macroeconomic imbalances that arose as a result of the introduction of the euro. In section 3 we build a stock-flow consistent model that describes the structure of the Eurozone and explains how the idea of a multi-speed Europe could be introduced. In section 4 we run some simulations aimed at testing the viability of the framework developed in section 3. Finally, in section 5 we present some of our preliminary conclusions.

2 Macroeconomic Imbalances in the Eurozone

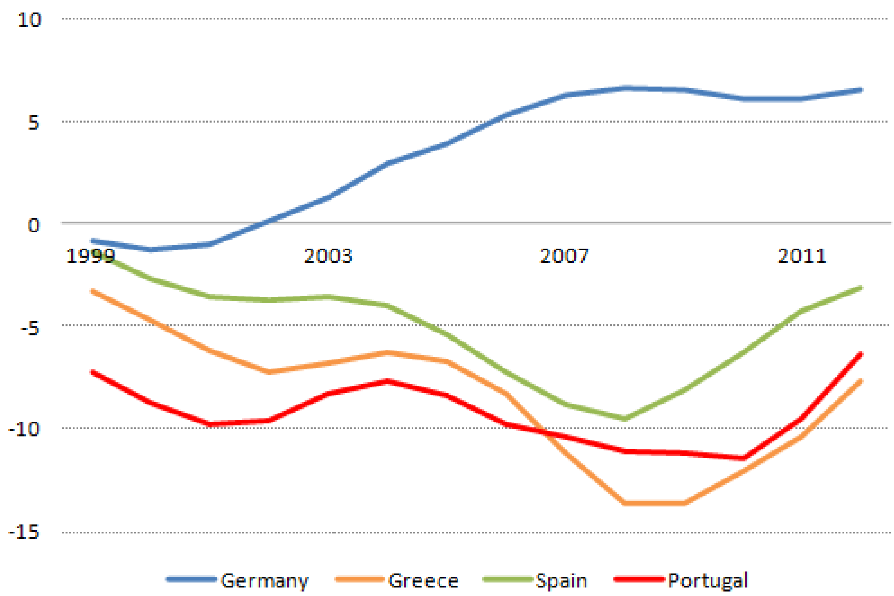
After a period of a seemingly successful implementation of the euro (2002-2007) the Eurozone has been immersed in a crisis of equal length (2008-2013). One of the immediate impacts of the crisis, as in most countries in the world, was the sore of budget deficits since the governments attempted to mitigate the effect of the global financial crisis on production and employment. As a result, the dominant paradigm in economics interpreted the crisis as a process directly linked to profligate behaviour by deficit countries. Wyplosz (2010) presents the to views that summarized the ideas of the mainstream regarding the courses of action that should be applied to solve the current crisis and, more importantly, prevent a new one in the future. On the one hand, what he calls the *German view* proposes the tightening of the provisions of the Stability and Growth Pact and the reduction of the discretion with which sanctions are applied when those provisions are not fulfilled. On the other hand, he presents the *Institution view*, which states that the pact cannot work because it has the wrong objective and the European Treaties identify fiscal policy as a matter of national sovereignty. Hence, either a new treaty is required or fiscal institutions at the national level must me modified.

The problem of these two explanations of the crisis is that they neglect the role played by financial liberalization in the periphery of the Eurozone (Spain, Portugal, Greece, Ireland, etc) combined with the export-led growth strategy pursued by the core (Germany, the Netherlands, Austria, Finland). In this regard, as Lapavitsas (2012) explains, the introduction of the euro and the parities at which each of the member countries joined the Eurozone, as well as the differential wage policies implemented by each of the members states, have been playing a major role in the determination of macroeconomic imbalances within the Eurozone which would eventually arise under the form of current account and budget deficits in the periphery and surpluses in the core. According to this view, which we consider more accurate, the focus of the current debate regarding the causes of the crisis is misguided and hence all the economic policies derived from it (for instance, the so-called Fiscal Compact) will be misleading.

In an article the follows the same line of Lapavitsas, Vernengo (2011) describes the historical process of financial liberalization in Europe. One of the indexes he uses to measure the intensity of this process is the Chinn-Ito index of capital account liberalization. If the evolution of this index during the last two decades is analysed, it is possible to see that whereas the core economies have always exhibited a high degree of financial liberalization (in the period 1990-1994 the index registered 83.2%, reaching 100% in 2005-2009, being 100% equivalent to complete liberalization), the non-core economies went through a process of very fast liberalization (the index was 19.5% in 1990-1994 and 100% in 2005-2009) which probable did not comply with all the recommended steps that need to be taken in order to ensure that the increased liquidity does not produce any by-products that can eventually lead to a crisis.

Both Lapavitsas and Vernengo (we are taking them just as representatives of a non-exhaustive assembly of the alternative visions of the European crisis) coincide in the fact that after the introduction of the euro two differential growth patterns emerged. On the one hand, core economies pursued an export-led growth strategy mainly based on exports to the non-core economies of the Eurozone (it should be born in mind that the Eurozone is the most integrated region in the world in regard to trade flows). On the other hand, peripheral economies based their growth mainly on domestic demand (either private consumption, housing booms, etc.). This differential growth pattern and its macroeconomic implications can be observed in Figure 1, where we plot the current account to GDP ratio of Germany and some of the non-core economies. As it is clear from the picture, whereas Germany started to register large surpluses after the introduction of the euro, southern countries ran a deficit. Basic macroeconomic identities imply that if a country is running a current account deficit of almost 14% (like Greece in 2008) either the domestic private sector or the government (or probably both) must be running a financial deficit of equal size. Thus, the order of causation goes from a weak external performance to the domestic imbalances that the Fiscal Compact is aiming to tackle as if they were the ultimate source of the crisis.

Figure 1: Current Account to GDP ratio



But, if the nature of the crisis in the Eurozone is more related to financial deregulation and external imbalances, why have these imbalances emerged? In a recent study by Duwicquet et al (2012) estimate a sort of *equilibrium* exchange rate based on the Fundamental equilibrium Exchange Rate approach, which yields the exchange rate that would prevail when the economy simultaneously reaches internal and external equilibrium. According to their results, since the introduction of the euro, Germany exhibited an undervaluation that oscillated within the interval comprising 8% and 24% of undervaluation. The opposite situation is found in the cases of Spain, Portugal and Greece, which currencies present an overvaluation that in some cases reaches 48%. There are, in principle, two reasons that explain this exchange rate misalignement. On the one hand, as Lapavitsas suggests, the parities at which southern countries entered the Eurozone were clearly unfavourable. On the other hand, differential wage policies among Eurozone's member states implies divergent unit labor costs, which in turn reinforced the aforementioned unfavourable parities. The combination of these two factors was translated into a major loss of competitiveness, which was added to the differential industrial potential of the north and the south. Figures 2 and 3 illustrate this situation by showing the evolution of the real effective exchange rate and unit labor costs.

Since an increase in Figure 2 must me interpreted as an appreciation, it is clear that after the introduction of the euro, Germany's real effective exchange rate appreciated less that Spain's, Greece's and Portugal's same index. This can be explained by the much slower increase in nominal unit labor costs that Germany registered during the same time span. Based on OECD statistics, Lapavitsas shows that this lower increase in labor costs is not explained by a larger productivity growth in Germany, but by a lower increase of nominal wages. It must me now clear that the institutional setting of the Eurozone, one where there are no adjustment mechanisms aimed at solving the structural differences between member countries and, more importantly, one where there is no policy coordination regarding wage policies, is doomed to produce macroeconomic imbalances that may end up emerging under the form of a crisis.

Based on the heterodox vision presented by Vernengo and Lapavitsas, which we summarized very broadly in this section, we propose what may be called a *multi-speed* Europe, i.e., a situation where the euro is split into two regional euros, being the southern euro consistent with some measure of an equilibrium exchange rate (in the line of Duwicquet et al). We have the intuition that such a situation could help southern countries to continue being part of the Eurozone without the undesirably high cost that they are now paying to remain in the club. This proposal is not free of critiques and potential difficulties, be them related to implementation or macroeconomic stability issues. In the remaining of this paper we aim at building a stock-flow consistent model that is able to represent the current crisis in the Eurozone. Once we have done this, we examine how a multi-speed Eurozone could work.

3 A SFC representation of the Europe

In Section 2 we presented a brief description of the real exchange rate misalignments to which the introduction of the euro gave rise and how these contributed to the generation of internal imbalances within the Eurozone. We concluded that section with some of the proposals that have been put forward to solve these misalignments in such a way that many of the features of the European integration process are conserved. In this section we attempt to build a four country stock-flow consistent model that represents how such proposals could be implemented, as well as the results that they could produce. The model is based on the one that we have already constructed to simulate the emergence of internal imbalances after the introduction of the euro, which can be found in Mazier and Valdecantos (2013). In the remaining of this section we will refer to that model and will introduce changes any time it is necessary, such that the the multi-speed nature of this proposal is accurately represented. Some previous studies upon which this model

Figure 2: Real Effective Exchange Rate - Percentage Change

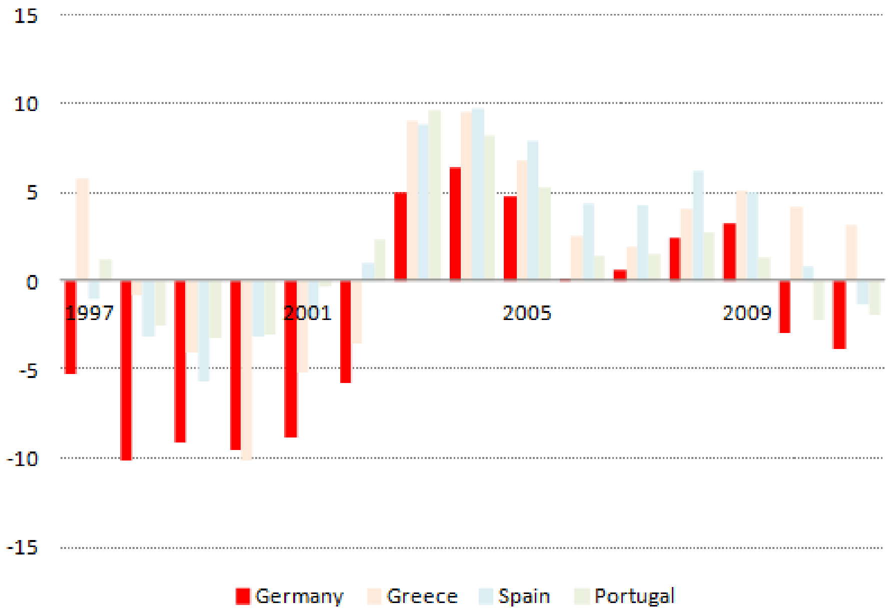
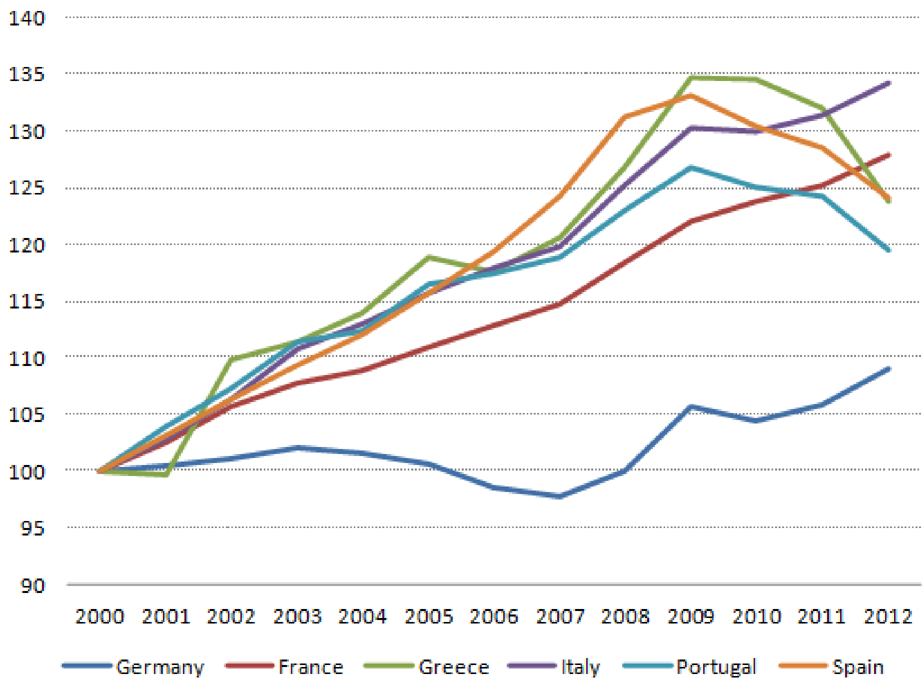


Figure 3: Nominal Unit Labor Costs - Percentage Change



is based are those of Godley and Lavoie (2007), which deal with three countries, two of them sharing a common currency and a single central bank, and Duwicquet et al (2012), which aims at developing a more sophisticated financial structure within a two-country model representing the Eurozone. Other attempts to describe the adjustment process in a monetary union can be found in Duwicquet and Mazier (2010). Finally, we take Daigle and Lavoie (2009) approach to exchange rate expectations. In this section, we intend to build a four-country model with the following features:

- ⋆ The countries are: the US, Germany, Spain and the rest of the world. Whereas Spain represents the Eurozone's periphery, i.e., the countries that have been accumulating persistent current account and budget deficits since the introduction of the euro, Germany represents the surplus countries of the Eurozone.
- ⋆ Spain and Germany are engaged in a fixed but adjustable exchange rate arrangement, being the Spanish euro the national currency of Spain and the German euro the national currency of Germany. These currencies are used only for domestic purposes. All international transactions, real and financial and intra and extra-European are undertaken in international currencies (euros or dollars). The euro floats against the dollar and the currency of the rest of the world.
- ⋆ The rest of the world fixes its currency against the US dollar.
- ⋆ Since each "country" has monetary sovereignty, the national central bank is able to keep domestic bond prices at a desired level. Thus, the long-term interest rate (the interest rate earned on bond holdings) is assumed constant. Since the euro/dollar exchange rate is flexible, the interest rate on euro-denominated bonds will also be constant (in other words, the exchange rate will ensure market clearing).
- ⋆ Unlike our previous model, the ECB is eliminated since monetary policy is no longer unified within the Eurozone. Thus, the Banco de España and the Bundesbank are considered as the central banks of the southern and northern regions of the two-speed Eurozone.

Figure X shows the balance sheet of Spain's institutional sectors. As it happens in every SFC model, every financial asset has its counterpart. Thus, the only genuine source of wealth is given by the stock of capital, which is owned by the firms. Note that Spain's purchases of German bonds are denominated in euros and not in German euros. Thus, these holdings appear in the row corresponding to euro-denominated bonds. Additionally, Spain issues part of its debt in Spanish euros (the debt that is acquired by domestic banks) and the remaining in euros. Thus, unlike most SFC models, Spain's bonds supply is split into two different rows. Let us now take a look at the balance sheet of the extra-European countries. Finally, even though in this first version of the model we will not make use of the ECB, in the future some specific functions will be assigned to it.

As it can be observed in Figure X, the purchases of Spanish and German bonds by US' banks are denominated in euros, an not in local currencies. This is why the rows corresponding to $Bonds^{SP}$ and $Bonds^{GE}$ are empty. The same applies to the balance sheet of the rest of the world. Also, as it is usual in every SFC model, there is a social accounting matrix and a flow of funds table from which many of the accounting identities that make up the model are derived. The reader can find these matrices in the annex.

Since the bilateral exchange rates will be used right from the beginning of the model it is worth starting by defining the ten bilateral exchange rates that are considered.

Figure 4: Balance Sheet Spain

	Spain					
	Households	Firms	Commercial Banks	Government	Central Bank	ECB
Capital		$+K_t^{SP}$				
Cash	$+Hd_t^{SP}$				$-Hs, cb_t^{SP}$	
Deposits	$+Md_t^{SP}$		$-Md_t^{SP}$			
Reserves			$+R_t^{SP}$		$-R_t^{SP}$	
Advances			$-A_t^{SP}$		$+A_t^{SP}$	
Loans		$-L_t^{SP}$	$+L_t^{SP}$			
$Bonds^{SP}$			$+Bd, b_{SP_t}^{SP}$	$-Bs_{SP_t}^{SP}$	$+Bd, cb_{SP_t}^{SP}$	
$Bonds^{GE}$						
$Bonds^{EZ}$			$+Bd, b_{SP_t}^{GE}$	$-Bs_{SP_t}^{SP}$		
$Bonds^{US}$			$+Bd, b_{SP_t}^{US}$		$+Bd, cb_{SP_t}^{US}$	$+Bd_{ECB_t}^{US}$
$Bonds^{RW}$			$+Bd, b_{SP_t}^{RW}$			
Wealth	$+Vh_t^{SP}$	$+Vf_t^{SP}$	$+Vb_t^{SP}$	$-Bs_{SP_t}^{SP}$	$+Vcb_t^{SP}$	$+V_t^{ECB}$

Figure 5: Balance Sheet US

	United States				
	Households	Firms	Commercial Banks	Government	Central Bank
Capital		$+K_t^{US}$			
Cash	$+Hd_t^{US}$				$-Hs_t^{US}$
Deposits	$+Md_t^{US}$		$-Md_t^{US}$		
Reserves			$+R_t^{US}$		$-R_t^{US}$
Advances			$-A_t^{US}$		$+A_t^{US}$
Loans		$-L_t^{US}$	$+L_t^{US}$		
$Bonds^{SP}$					
$Bonds^{GE}$					
$Bonds^{EZ}$			$+Bd, b_{US_t}^{GE} + Bd, b_{US_t}^{SP}$		
$Bonds^{US}$			$+Bd, b_{US_t}^{US}$	$-Bs_{US_t}^{US}$	$+Bd, cb_{US_t}^{US}$
$Bonds^{RW}$			$+Bd, b_{US_t}^{RW}$		
Wealth	$+Vh_t^{US}$	$+Vf_t^{US}$	$+Vb_t^{US}$	$-Bs_{US_t}^{US}$	$+Vcb_t^{US}$

$$1\$ = E1.GE = E2.SP = E4\# = E9.€$$

$$1€ = E7.SP = E8.GE = E10\#$$

$$1GE = E3.SP = E6\#$$

$$1\# = E5.SP$$

Let us take E1 as an example. This variable should be interpreted as the German euro/dollar exchange rate. Thus, if E1 goes up (down), this means that the German euro depreciates (appreciates) against the dollar. The nine remaining exchange rates have an identical interpretation. Now we are able to proceed to the system of equations that conform the model that, as in every stock-flow consistent model, is constituted by both accounting identities and behavioural equations. In the remaining of this section only the equations that are required to provide a general intuition of the structure of the model are presented. The complete system of equations can be found in the annex.

3.1 Good's Market Equilibrium and International Trade

Equilibrium in the good's market is given by the identity that states that aggregate supply or total production, Y_t, is equal to aggregate demand, which in turn is given by the sum of household's consumption, C_t, firm's investment, I_t, government spending, G_t, and net exports (i.e., the difference between exports, X_t, and imports, IM_t). Thus, our model is one in which economic growth is demand-led.

$$Y_t^i = C_t^i + I_t^i + G_t^i + X_t^i - IM_t^i \qquad \forall i = US, RW, SP, GE \qquad \text{(1-4)}$$

All the components of aggregate demand, except for government spending (which is given by the following equations) are considered endogenous and will be defined shortly. Unlike the previous versions of the model, in which we incorporated that rule stating that member countries cannot run deficits larger that 3% of GDP, we now assume that the division of the Eurozone in two sub-regions allows each of them to manage their fiscal policy with more freedom. Thus, government spending can be considered fully exogenous (although a more detailed description of this component of aggregate demand should account for automatic stabilizers).

$$G_t^i = Go_t^i + (1 + g^i).G_{t-1}^i \qquad \forall i = US, RW, SP, GE \qquad \text{(5-8)}$$

Hence, government spending in each period, G_t, is given by a constant term, Go_t, plus an exogenous rate of growth, g. The constant term is initially set equal to zero, but its presence will be useful later on when we introduce an exogenous shock on aggregate demand through government spending.

We now turn to the equations that describe international trade transactions. Since the four economies that we are considering embody the whole world economy, the sum of total exports (i.e., $\sum X^i \forall i = US, RW, SP, GE$) has to be equal to total imports (i.e.,$\sum IM^i \forall i = US, RW, SP, GE$). Otherwise, there would be leaks and the model would turn out to be inconsistent. Thus, we can define only the equations corresponding to one of the two trade flows (either exports or imports) and, since one is the mirror of the other, we can obtain the value for the other flow implicitly. The equations describing international trade flows (9 - 20) are the ones usually used in the literature, which account for both income and price effects (the latter being both direct and indirect). Note that in this model the relevant exchange rate regarding Spain's bilateral trade flows vis-à-vis Germany (and the other way around) will be the Spanish euro/German euro, $E3$. It should also be born in mind that as regards international trade between each European country and the US and the rest of the world, the relevant exchange rate is the euro/dollar and euro/rest of the world exchange rate, and not the local ones. In order to give the reader a general idea, we present the three import equations of the US (9 - 11) - the rest are to be found in the annex.

$$log(IM_{US}^{GE}) = \mu_0^{US} + \mu_1^{US}.log(Y_t^{US}) + \mu_2^{US}.log(E9_t) + \mu_3^{US}.log(\frac{1}{E4_t}\frac{1}{E9_t}) \tag{9}$$

$$log(IM_{US}^{SP}) = \mu_4^{US} + \mu_5^{US}.log(Y_t^{US}) + \mu_6^{US}.log(E9_t) + \mu_7^{US}.log(\frac{1}{E9_t}\frac{1}{E4_t}) \tag{10}$$

$$log(IM_{US}^{RW}) = \mu_8^{US} + \mu_9^{US}.log(Y_t^{US}) + \mu_{10}^{US}.log(E4_t) + \mu_{11}^{US}.log(\frac{1}{E9_t}) \tag{11}$$

Total imports can then be obtained by adding up bilateral import flows.

$$IM_t^i = \sum IM_{-i_t}^i \qquad \forall i = US, RW, GE, SP \tag{21-24}$$

As it was mentioned before, a trade flow is the mirror of the other. Thus, IM_{US}^{RW} has to be equal to X_{RW}^{US}. Since it is required that every trade flow is written in the domestic currency of the corresponding country, the following conversion is applied. As it was done before, only the conversion for the US, equation (25 - 27) are presented in this section - the rest, i.e., equations (28 - 36) are written in the annex.

$$X_{US_t}^{GE} = IM_{GE_t}^{US}.(1/E1_t) \tag{25}$$

$$X_{US_t}^{RW} = IM_{RW_t}^{US}.(1/E4_t) \tag{26}$$

$$X_{US_t}^{SP} = IM_{SP_t}^{US}.(1/E2_t) \tag{27}$$

Finally, we did with imports, we can obtain aggregate exports by adding up bilateral exports flows.

$$X_t^i = \sum X_{i_t}^{-i} \qquad \forall i = US, RW, GE, SP \tag{37-40}$$

3.2 Household's Income and Consumption

According to national accounting, total income, Y_t is distributed between firms and households in return for their participation in the production process. Households supply their labour and in exchange receive a wage, W_t - firms contribute to the production process with their capital goods, and they earn a profit, P_t. Normally, the proportion of national income that is taken by each sector is endogenous and depends not only on exogenous variables such as the wage level or the profit rate, but also on inflation. Nevertheless, given that in this model prices are fixed, income distribution is assumed to be exogenous and given by the parameter ψ, which represents the share of wages out of total income.

$$W_t^i = \psi^i.Y_t^i \qquad \forall i = US, RW, GE, SP \tag{41-44}$$

Although labour income may constitute the main source of income that finances household's consumption, there are other processes that need to be taken into account. On the one hand, households may earn income out of other activities. In this model, households are assumed to hold two types of assets: bank deposits, Md_t, which earn a yield, rd_t , and cash, Hd_t, which earns no yield whatsoever. Regarding tax payments, in this model, it is assumed that a fraction θ_h of total income is levied, leading to the total amount of taxes that households pay, Th_t.

$$Th_t^{US} = \theta_h^{US}.(W_t^{US} + rd_{t-1}^{US}.Md_{t-1}^{US}) \qquad \forall i = US, RW, GE, SP \qquad (45\text{-}48)$$

It is the after-tax income what households use to finance consumption, though not entirely (unless the savings rate is null). Thus, disposable income can be written as follows:

$$YD_t^i = W_t^i + rd_{t-1}^i.Md_{t-1}^i - Th_t^i \qquad \forall i = US, RW, GE, SP \qquad (49\text{-}52)$$

The consumption function that is used in this model is a Modigliani type function that incorporates the propensity to consume and additional term to account for wealth effects. It is worth mentioning that the propensity to consume on disposable income is much bigger than that on past accumulated wealth $\alpha 1 > \alpha 2$.

$$C_t^i = \alpha 1^i.YD_t^i + \alpha 2^i.Vh_{t-1}^i \qquad \forall i = US, RW, GE, SP \qquad (53\text{-}56)$$

The part of disposable income that is not used to finance consumption is saved. Hence, the change in household's wealth is given by the flow of savings, which in turn is given by the difference between disposable income and consumption.

$$\Delta Vh_t^i = YD_t^i - C_t^i \qquad \forall i = US, RW, GE, SP \qquad (57\text{-}60)$$

Households can hold their wealth in two kinds of assets: bank deposits and cash, which were previously defined as Md_t and Hd_t. We assume that households keep a constant share of their wealth, φ, under the form of cash in order to finance daily consumption expenditures. The rest of their wealth is held as deposits at the commercial banks.

$$Hd_t^i = \varphi^i.Vh_t^i \qquad \forall i = US, RW, GE, SP \qquad (61\text{-}64)$$

$$Md_t^i = Vh_t^i - Hd_t^i \qquad \forall i = US, RW, GE, SP \qquad (65\text{-}68)$$

3.3 Firm's Investment and Credit Demand

As it was mentioned before, income distribution is considered exogenous. Since total income is divided into wage and profits, the latter can be defined as a residual:

$$P_t^i = Y_t^i - W_t^i \qquad \forall i = US, RW, GE, SP \qquad (69\text{-}72)$$

However, P_t are nothing but gross profits. Firms also have to pay interests on the loans taken in the past. Thus, net profits, Pf_t, result from the difference between gross profits and the sum of interest payments and taxes.

$$Pf_t^i = P_t^i - rl_{t-1}^i.L_{t-1}^i - Tf_t^i \qquad \forall i = US, RW, GE, SP \qquad (73\text{-}76)$$

$$Tf_t^i = \theta_f^i.(P_t^i - rl_{t-1}^i.L_{t-1}^i) \qquad \forall i = US, RW, GE, SP \qquad (77\text{-}80)$$

The investment decision of the firms will be assumed to take the form of a Kaleckian-type formula, which accounts for crucial features that determine the accumulation of the capital stock. Hence, the profit rate (given by the ratio of gross profits to the stock of capital), the structure of the debt of the firms (given by the loans that they demanded to finance past investment) and the utilization rate, u_t, are incorporated into the model. Each term of this function is accompanied by a constant, z, which measures the sensibility of investment to each of its components.

$$\frac{I_t^i}{K_{t-1}^i} = z_0^i + z_1^i.\frac{Pf_t^i}{K_{t-1}^i} - z_2^i.\frac{rl_{t-1}^i.L_{t-1}^i}{K_{t-1}^i} + z_3^i.u_{t-1}^i \qquad \forall i = US, RW, GE, SP \qquad (81\text{-}84)$$

The utilization function, which represents the proportion of the total physical capital available in the economy that is used in the production process, is written as follows:

$$u_t^i = \frac{Y_t^i}{K_t^i}.v^i \qquad \forall i = US, RW, GE, SP \qquad (85\text{-}88)$$

Capital accumulation follows the traditional rule, given by the previously accumulated capital stock adjusted for its depreciation plus de current investment flow.

$$K_t^i = (1-\delta^i).K_{t-1}^i + I_t^i \qquad \forall i = US, RW, GE, SP \qquad (89\text{-}92)$$

Finally, firms finance their investment through net profits. If the latter are not sufficient to cover for the whole value of the current investment flow, firms obtain the lacking funds in the credit market, thereby acquiring a liability. In this model we assume that the totality of credit demand is fulfilled, i.e., there is no credit rationing.

$$\Delta L_t^i = I_t^i - Pf_t^i \qquad \forall i = US, RW, GE, SP \qquad (93\text{-}96)$$

Firm's wealth is computed as the difference between their assets (given by the capital stock) and liabilities (given by the total loans that they have been granted in the past).

$$Vf_t^i = K_t^i - L_t^i \qquad \forall i = US, RW, GE, SP \qquad (97\text{-}100)$$

3.4 The Government

Many features of the behaviour of the government have already been introduced. Government spending, as defined by equations (5-8), was considered exogenous. Taxes on households and firms have been defined in equations (45-48) and (77-80), respectively. Finally, it is assumed that commercial banks transfer their profits, which are defined in the following subsection, to the government as taxes payments. Thus, total tax income by the government is given by the sum of taxes on households, firms and banks.

$$T_t^i = Th_t^i + Tf_t^i + Pb_t^i \qquad \forall i = US, RW, GE, SP \qquad (101\text{-}104)$$

The government is assumed to finance its consumption not only via tax collection, but also through the profits that the central bank transfers yearly, which are result of the interest payments that the monetary authority earns on its bond holdings as well as on any valuation effect that could occur as a result of exchange rate movements. Moreover, there is an additional expenditure that the government needs to finance each year: the interest payments on its debt. Should the value of public spending be higher than the sum of tax collection and central bank profits, the government finances the gap through bond issuances. It is worth mentioning that in the cases of Spain and Germany, since part of their debt is issued in foreign currency (the euro) interest payments must also be paid in two different currencies. Hence, supply of government bonds can be defined as follows:

$$\Delta Bs_t^i = G_t^i - T_t^i + rb_{t-1}^i.Bs_{t-1}^i - Pcb_t^i \forall i = US, RW \tag{105-106}$$

$$\Delta Bs_t^{SP} = G_t^{SP} - T_t^{SP} + rb_{t-1}^{SP}.Bs_{t-1}^{SP} + rb_{t-1}^{SP}.Bs_{SP_t}^e.E7_t - Pcb_t^{SP} \tag{107}$$

$$\Delta Bs_t^{GE} = G_t^{GE} - T_t^{GE} + rb_{t-1}^{GE}.Bs_{t-1}^{GE} + rb_{t-1}^{GE}.Bs_{GE_t}^e.E8_t - Pcb_t^{GE} \tag{108}$$

3.5 Commercial Banks

Thus far, commercial banks have been introduced implicitly and in a passive manner. It was shown that households could hold their wealth under different types of assets, both issued by commercial banks. Moreover, firms demanded loans in order to finance the part of their investment that could not be paid with current profits. However, the role that commercial banks were hitherto playing is passive since the supply of credit to firms and deposits to households is totally demand-led, i.e., banks supply as much credit and deposits as are demanded.

However, banks play an active role in the financial sphere in the economy, since they buy and sell securities. These capital movements play major roles determining both long-term interest rates and exchange rates. In this model, is is assumed that long-term interest rates are constant since, as it is shown in the next subsection, each government will have the tools to achieve this goal. The decision regarding how many bonds to buy from each government is a portfolio decision mainly driven by the return of each type of bond, given by the interest rate, plus the expectation on the movement of the exchange rate, which in turn will determine gains or losses due to valuation effects. These portfolio decision can thus be written using Tobin and Godley's criteria, which are standard in the SFC literature. Regarding the introduction of expectations in the foreign exchange market, we follow the approch proposed by Daigle and Lavoie (2009). For the sake of simplicity, only the portfolio equations of the US, i.e., equations (109 - 112), are written in this section. The portfolio equations of the remaining three countries, i.e, equations (113 - 124), can be found in the annex.

$$Bd,b^{GE}_{US_t} = (M^{US}_t - R^{US}_t).(\gamma^{US}_{10} + \gamma^{US}_{11}.rb^{US}_t + \gamma^{US}_{12}.(rb^{GE}_t + \Delta\frac{1}{E9^{US}_{e_t}}) + \gamma^{US}_{13}.(rb^{SP}_t + \Delta\frac{1}{E9^{US}_{e_t}}) + \gamma^{US}_{14}.(rb^{RW}_t + \Delta\frac{1}{E4^{US}_{e_t}})) \tag{155}$$

$$Bd,b^{SP}_{US_t} = (M^{US}_t - R^{US}_t).(\gamma^{US}_{20} + \gamma^{US}_{21}.rb^{US}_t + \gamma^{US}_{22}.(rb^{GE}_t + \Delta\frac{1}{E9^{US}_{e_t}}) + \gamma^{US}_{23}.(rb^{SP}_t + \Delta\frac{1}{E9^{US}_{e_t}}) + \gamma^{US}_{14}.(rb^{RW}_t + \Delta\frac{1}{E4^{US}_{e_t}})) \tag{156}$$

$$Bd,b^{RW}_{US_t} = (M^{US}_t - R^{US}_t).(\gamma^{US}_{30} + \gamma^{US}_{31}.rb^{US}_t + \gamma^{US}_{32}.(rb^{GE}_t + \Delta\frac{1}{E9^{US}_{e_t}}) + \gamma^{US}_{33}.(rb^{SP}_t + \Delta\frac{1}{E9^{US}_{e_t}}) + \gamma^{US}_{34}.(rb^{RW}_t + \Delta\frac{1}{E4^{US}_{e_t}})) \tag{157}$$

$$Bd,b^{US}_{US_t} = (M^{US}_t - R^{US}_t) - Bd,b^{GE}_{US_t} - Bd,b^{SP}_{US_t} - Bd,b^{RW}_{US_t} \tag{158}$$

In order to facilitate the understanding of the notation used above, let us take equation (155) as an example. This equation states that the demand of US' commercial banks of bonds denominated in euros issued by Germany $Bd,b^{GE}_{US_t}$ is financed by funds which are available at the commercial banks, i.e., household's deposits less the reserves that banks are forced to keep at the central bank, R_t. The parameters γ represent the sensibility of the demand of each type of bond to changes on the relative returns that these assets yield. These parameters are written in such a way that they fulfil Tobin-Godley criteria.

Let us now describe how exchange rate expectations are formed. Following the contributions of behavioural finance applied to the exchange rate determination proposed by De Grauwe and Grimaldi (2006), Harvey (1991), Harvey (2009) and Daigle and Lavoie (2009), we assume that there two types of speculators interacting in the foreign exchange market. On the one hand, fundamentalists consider that there is one "fundamental" exchange rate towards which the spot exchange rate should tend. This "fundamental" exchange rate may be given by a set of variables that analysts consider relevant (for instance, the rate of inflation, the current account balance, etc.). On the other hand, chartists believe that the exchange rate follows a random walk. Thus, each movement of the spot exchange rate will determine the future path. This kind of expectation formation, which is strongly related to bandwagon effects, tends to generate bubbles in financial markets. In sum, the market's expectation of the future spot exchange rate is a weighted average of the expectation of fundamentalists and chartist. As it was shown by Daigle and Lavoie (2009) in order to get stable results it is required that the proportion of fundamentalists is larger than the one of chartists.

Equations (125 - 126) describe the process of expectation formation of US' fundamentalists and chartists speculators, respectively. These expectations concern only the euro/dollar exchange rate. Additional equations need to be written for expectations that other countries' speculators make on the remaining relevant bilateral exchange rates. All these equations can be found in the annex. The equation that we do present here is equation (127), which describes the market's expectation of the euro/dollar exchange rate, which is in turn the variable that was introduced in equations (155 - 157).

$$\Delta E1^{F,US}_{e_t} = -\omega.(E1_{t-1} - E1^*) \tag{125}$$

$$\Delta E1^{C,US}_{e_t} = \beta \Delta E1_{t-1} \tag{126}$$

$$\Delta E1^{US}_{e_t} = \tau \Delta E1^{F,US}_{e_t} + (1-\tau)\Delta E1^{C,US}_{e_t} \tag{127}$$

As it happened before with international trade of goods (exports and imports) it is necessary to define the supply side of the international trade of bonds. Based on bilateral demands, supply can be obtained by transforming the former through the bilateral exchange rate. We do this for the case of the US, i.e., equations (155 - 158). The remaining equations, (158 - 169) are written in the annex.

$$Bs, b^{US}_{GE_t} = Bd, b^{US}_{GE_t}/E1_t \tag{155}$$

$$Bs, b^{US}_{SP_t} = Bd, b^{US}_{SP_t}/E2_t \tag{156}$$

$$Bs, b^{US}_{RW_t} = Bd, b^{US}_{RW_t}/E4_t \tag{157}$$

$$Bs, b^{US}_{US_t} = Bd, b^{US}_{US_t} \tag{158}$$

As it was mentioned before, in many countries commercial banks are obliged to hold a certain proportion of the deposits that households make under the form of reserves at the central bank. This model incorporates this phenomenon by stating that commercial banks' demand for reserves are given by a proportion ρ of household's deposits. These reserves constitute an asset in the balance sheet of commercial banks and a liability on the balance sheet of the central bank. It is worth mentioning that in reality banks may hold a stock of reserves that exceed the legal one. In this case, we neglect the existence of surplus reserves.

$$R^{US}_t = \rho^{US}.M^{US}_t \qquad \forall i = US, RW, GE, SP \tag{171-174}$$

Having defined almost all the components of banks' balance sheet (it only remains to describe how Advances from the central bank are determined, which will be a residual), we are ready to describe the origin of banks' profits. These will be the result of two sources: interest earnings/payments and valuation effects due to exchange rate movements. We write the equation of US' banks profits, equation (175), and the three remaining ones, i.e., equations (176 - 178) are written in the annex.

$$\begin{aligned} Pb_t^{US} = {} & rb_{t-1}^{US}.Bd, b_{US_{t-1}}^{US} + rb_{t-1}^{RW}.Bs, b_{US_{t-1}}^{RW}/E4_t + rb_{t-1}^{SP}.Bs, b_{US_{t-1}}^{SP}/E9_t \\ & + rb_{t-1}^{GE}.Bs, b_{US_{t-1}}^{GE}/E9_t + Bs, b_{US_{t-1}}^{RW}.\Delta(1/E4_t) + Bs, b_{US_{t-1}}^{GE}.\Delta(1/E9_t) \\ & + Bs, b_{US_{t-1}}^{SP}.\Delta(1/E9_t) + rl_{t-1}^{US}.L_{t-1}^{US} + rs_{t-1}^{US}.R_{t-1}^{US} - rd_{t-1}^{US}.M_{t-1}^{US} \\ & - r_{t-1}^{US}.A_{t-1}^{US} \end{aligned} \tag{175}$$

Taking into account that the totality of banks' profits are transferred to the government under the form of taxes, their net worth is null.

$$\Delta V b_t^{US} = 0 \qquad \forall i = US, RW, GE, SP \tag{179-182}$$

It is now possible to define Advances from the central bank as a residual which ensures that the balance sheet of commercial banks is always in equilibrium.

$$A_t^i = L_t^i + R_t^i + Bd, b_{i_t}^i + Bd, b_{i_t}^{-i} - M_t^i - Vb_t^i \qquad \forall i = US, RW, GE, SP \tag{183-186}$$

3.6 Central Bank

Following the Post Keynesian approach to the monetary system, the central bank is considered to be a passive actor in the economy. This includes the notion of endogenous money, i.e., the central bank does not choose how much money to pump into the system but it supplies as much money as it is demanded by creditworthy firms. Since Spain and Germany have recovered their monetary sovereignty, the totality of the cash supplied constitutes a liability for the national central bank (unlike the current state of affairs in the Eurozone, where 8% of the banknotes in circulation constitute a liability for the ECB, whereas the remaining 92% is divided between the member countries according to a predefined key). Regarding the short-term interest rate, it constitutes the policy tool that the central bank can use to achieve its objectives. In line with this theoretical approach to monetary policy, the following equations can be written.

$$r_t^i = \bar{r_t^i} \qquad \forall i = US, RW, GE, SP \qquad (187\text{-}190)$$

$$Hs_t^i = Hd_t^i \qquad \forall i = US, RW, GE, SP \qquad (191\text{-}194)$$

Normally, a distinction should be made between the short-run and the long-run interest rate. Whereas the former is the policy tool of the central bank and can be set exogenously by the monetary authority, the latter is determined in the bond market as a result of bond's supply and demand adjustments. However, if the country issues its own currency, the central bank could intervene in the bond market in order to achieve a certain target for the long-term rate of interest. In this model, it is assumed that all the long-term interest rates are kept constant (we will shortly explain how this is achieved in each particular case).

$$rb_t^{US} = r\bar{b_t^{US}} \qquad \forall i = US, RW, GE, SP \qquad (195\text{-}198)$$

Traditional SFC models, as developed by Godley-Lavoie, describe the clearing of the bond market via exchange rate adjustments (when they are flexible, of course). Therefore, those countries that have a fixed exchange rate will require central bank interventions in the bond market in order to guarantee the clearing of the domestic market. Those cases where the exchange rate is flexible, central bank interventions will not be required since the exchange rate moves in any direction that is necessary such that the market is always cleared.

In this model the rest of the world has a fixed exchange rate vis-a-vis the US dollar, whereas Spain and Germany are engaged in a monetary agreement that states that there is a fixed but adjustable exchange rate for bilateral transactions, but a flexible exchange rate for the Eurozone's transactions vis-à-vis the US and the rest of the world. This allows us to introduce the idea of a multi-speed Eurozone, since Spain would be able to have a weaker exchange rate vis-à-vis Germany, which would compensate for the structural differences within the Eurozone.

The only component of the balance sheet of the Banco de España and the Bundesbank that is left to be defined is the stock of foreign reserves. Thus, this variable can be used to close their balance sheet. The reason why these two countries will accumulate reserves is that they are aiming at keeping a fixed exchange rate. We make the assumption that Spain accumulates reserves under the form of euro-denominated bonds issued by Germany, whereas Germany keeps its reserves under the form of dollar-denominated bonds issued by the US.

$$\Delta Bs, cb^{GE}_{SP_t} = \Delta R^{SP}_t + \Delta Hs^{SP}_t - \Delta A^{SP}_t \quad (199)$$

$$\Delta Bs, cb^{GE}_{GE_t} = \Delta R^{GE}_t + \Delta Hs^{GE}_t - \Delta A^{GE}_t \quad (200)$$

$$\Delta Bd, cb^{GE}_{SP_t} = \Delta Bs, cb^{GE}_{SP_t}.E3_t + Bs, cb^{GE}_{SP_{t-1}}.\Delta E3_t \quad (201)$$

$$\Delta Bd, cb^{US}_{GE_t} = \Delta Bs, cb^{US}_{GE_t}.E1_t + Bs, cb^{US}_{GE_{t-1}}.\Delta E1_t \quad (202)$$

It is necessary to determine how much of the financing needs are satisfied via issuances of bonds denominated in national currencies and in euros. In order to do so, we consider that the domestic bond market is always in equilibrium since the government supplies as many bonds as domestic banks demand. Thus, long-term interest rates of domestic bonds are constant. The remaining part of the financing needs must be financed by foreign investors, which demand euro-denominated bonds.

$$Bs^e_{SP_t} = \frac{Bs^{SP}_{SP_t} - Bs, b^{SP}_{SP_t}}{E7_t} \quad (203)$$

$$Bs^e_{GE_t} = \frac{Bs^{GE}_{GE_t} - Bs, b^{GE}_{GE_t}}{E8_t} \quad (204)$$

Since the euro/dollar exchange rate is flexible, the market of bonds denominated in euros is cleared via the movements in the exchange rate. This means that the German and Spanish governments can supply bonds at a determined price (and hence, at a certain exogenous long-term interest rate) and depending on the supply and demand for these assets the exchange rate will adjust. Thus, we can define the euro/dollar exchange rate based on the supply and demand of bonds denominated in euros to the US.

$$E9_t = \frac{Bs^e_{SP_t} + Bs^e_{GE_t} - Bs, b^{GE}_{SP_t} - Bs, b^{SP}_{GE_t} - Bs, b^{SP}_{RW_t} - Bs, b^{GE}_{RW_t} - Bs, cb^{GE}_{SP_t}}{Bd, b^{SP}_{US_t} + Bd, b^{GE}_{US_t}} \quad (205)$$

The multi-speed feature of this model implies that Germany and Spain can have adjustable exchange rates according to their external performance vis-à-vis its regional trading partner. Thus, we define the Spanish/euro and German euro/euro exchange rate based on the sum of the intra-European current and financial accounts. We have chosen this variable as the criterion determining the intra-European exchange rate since it reflects the overall performance of the Spanish (German) external sector vis-à-vis the German (Spanish) counterpart. The criterion consists of keeping exchange rates fixed as long as the intra-European balance of payments is in surplus or, if in deficit, only for a certain period of time (we base this criterion on the fact that in principle a country cannot accumulate persistent balance of payments deficit indefinitely). If a bad external performance yields a balance of payments deficit for three consecutive periods, then the national currency is allowed to be adjusted. Once these intra-European have been defined, it is also possible to derive the exchange rates vis-à-vis the dollar.

$$E7_t = \begin{cases} E7_{t-1}, & \text{if } \frac{CA^{GE}_{SP_{t-i}} + FA^{GE}_{SP_{t-i}}}{Y^{SP}_{t-i}} < 0, \forall i = 1,2,3 \\ E7_{t-1}.(1+\pi), & \text{if } \frac{CA^{GE}_{SP_{t-i}} + FA^{GE}_{SP_{t-i}}}{Y^{SP}_{t-i}} \geq 0, \forall i = 1,2,3 \end{cases} \tag{206}$$

$$E8_t = \begin{cases} E8_{t-1}, & \text{if } \frac{CA^{SP}_{GE_{t-i}} + FA^{SP}_{GE_{t-i}}}{Y^{GE}_{t-i}} < 0, \forall i = 1,2,3 \\ E8_{t-1}.(1+\pi), & \text{if } \frac{CA^{SP}_{GE_{t-i}} + FA^{SP}_{GE_{t-i}}}{Y^{GE}_{t-i}} \geq 0, \forall i = 1,2,3 \end{cases} \tag{207}$$

$$E1_t = E8_t.E9_t \tag{208}$$

$$E2_t = E7_t.E9_t \tag{209}$$

$$E3_t = E2_t/E1_t \tag{210}$$

Let us now turn to the description of the closure of the bond market of the rest of the world, given the fixed exchange rate against the US dollar. This can be achieved through central bank interventions in the domestic bond market. Note that this mechanism is quite realistic since in a context of free capital movements and a fixed exchange rate, the domestic central bank should intervene if interest rates are kept at a certain predetermined target set by the monetary authority.

$$E4_t = \bar{E}4 \tag{211}$$

$$Bd, cb^{RW}_{RW_t} = Bs^{RW}_t - Bs, b^{RW}_{US_t} - Bs, b^{RW}_{SP_t} - Bs, b^{RW}_{GE_t} - Bs, b^{RW}_{RW_t} \tag{212}$$

Since, as equation (211) describes, the rest of the world has a fixed exchange rate against the US dollar the exchange rate $E4$ becomes exogenous. As a result, it is the demand of US government bonds by the rest of the world's central bank, $Bd, cb^{US}_{RW_t}$, what becomes endogenous. This demand is written in such a way that the equilibrium in the balance sheet of the rest of the world's central bank is fulfilled.

$$\Delta Bd, cb^{US}_{RW_t} = \Delta H^{RW}_t + \Delta R^{RW}_t - \Delta A^{RW}_t - \Delta Bd, cb^{RW}_{RW_t} \tag{213}$$

The three remaining exchange rates are endogenously determined through the consistency condition.

$$E5_t = E2_t/E4_t \tag{214}$$

$$E6_t = E4_t/E1_t \tag{215}$$

$$E10_t = E4_t/E9_t \tag{216}$$

Regarding the dollar-denominated bond market, the reader should note that not only total supply has already been defined in the sub-section corresponding to the government, but also all the sources of demand have been defined both in the portfolio equations and in the stock of foreign reserves accumulated by the rest of the world. In order to ensure that this market is in equilibrium (otherwise, the price of bonds and the long-term interest rate would have to make the adjustment) the central bank of the US must intervene.

$$Bd, cb^{US}_{US_t} = Bs^{US}_t - Bs, b^{US}_{US_t} - Bs, b^{US}_{SP_t} - Bs, b^{US}_{GE_t} - Bs, b^{US}_{RW_t} - Bs, cb^{US}_{RW_t} - Bs, cb^{US}_{GE_t} \tag{219}$$

$$Bs, cb^{US}_{RW_t} = Bd, cb^{US}_{RW_t}/E4 \tag{217}$$

Given that the national central banks also hold assets and liabilities they also make profits. These profits must include the adjustment for valuation effects due to the variation of the exchange rate, interest rates earned on advances, interest payments paid on reserves, etc. As it was already mentioned, these profits are transferred each period to the government as an additional source of financing.

$$Pcb^{US}_t = rb^{US}_{t-1}.Bd, cb^{US}_{US_{t-1}} + r^{US}_{t-1}.A^{US}_{t-1} - rs^{US}_{t-1}.R^{US}_{t-1} \tag{218}$$

$$\begin{aligned} Pcb^{RW}_t = {} & rb^{RW}_{t-1}.Bd, cb^{RW}_{RW_{t-1}} + r^{RW}_{t-1}.A^{RW}_{t-1} - rs^{RW}_{t-1}.R^{RW}_{t-1} + rb^{US}_{t-1}.Bs, cb^{US}_{RW_{t-1}}.E4_t \\ & + Bs, cb^{US}_{RW_{t-1}}.\Delta E4_t \end{aligned} \tag{219}$$

$$Pcb^{SP}_t = r^{SP}_{t-1}.A^{SP}_{t-1} - rs^{SP}_{t-1}.R^{SP}_{t-1} + rb^{GE}_{t-1}.Bs, cb^{GE}_{SP_{t-1}}.E3_t + Bs, cb^{GE}_{SP_{t-1}}.\Delta E3_t \tag{220}$$

$$Pcb^{GE}_t = r^{GE}_{t-1}.A^{GE}_{t-1} - rs^{GE}_{t-1}.R^{GE}_{t-1} + rb^{US}_{t-1}.Bs, cb^{US}_{GE_{t-1}}.E1_t + Bs, cb^{US}_{GE_{t-1}}.\Delta E1_t \tag{221}$$

As it can be checked in the SAM and the flow of funds, all the accounting identities have been explicitly written except for one: the one that describes the budget constrain of the central bank of the US. As it may seem evident, all the components of the balance sheet of the FED have already been defined. Therefore, it must be the case, if the model is consistent, that this budget constrain is satisfied automatically. This is going to be our "missing equation", i.e., the equation that every SFC model has which does not need to be written (otherwise the model would be overdetermined) and is therefore used to verify that the model is consistent.

$$\Delta R_t^{US} + \Delta H_t^{US} - \Delta A_t^{US} - \Delta Bd, cb_{US_t}^{US} = 0 \tag{222}$$

Equations (1-221) conform the system that has to be solved in order to simulate how a multi-speed Eurozone would work. This is the subject of the next section.

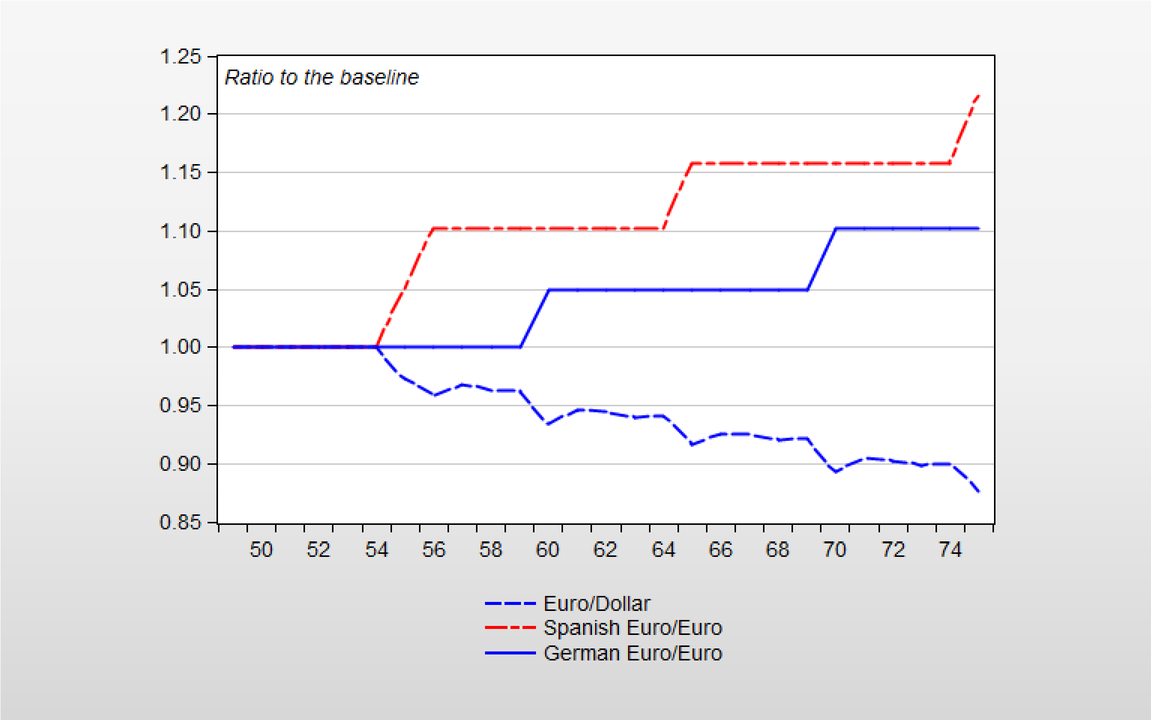
4 Simulations

We now turn to some experiments that will allow us to examine how a system like the one described in the previous section would work. Given the complexity of the model there are several experiments that could be tried. In this version, we attempt to reproduce the immediate effects of the introduction of the euro in order to assess what would have been the evolution of internal imbalances (which laid the foundations for the current crisis) should there have been a system of fixed but adjustable exchange rates, that accounted for the structural differences between the member states. Similarly, these simulations can be interpreted as a theoretical assessment of the proposals that have been being put forward in the line of splitting up the Eurozone into two sub-regions, each with its own currency.

Our first simulation of the model produces unstable results. The instability of the model is derived from the fact that when a country (in our case, Spain) devalues its currency, the associated improvement in its current account implies the worsening of the current account of another country (in this case Germany, since the devaluation is against the euro and the hence the German euro). As a result, after some periods of accumulating deficits, the country meets the requirements to devalue its currency, thereby improving its current account and worsening that of its trading partner (Spain). This would take the system to a vicious circle in which Spain needs to devalue its currency once more, and so on. The representation of this unstable dynamic behaviour can be seen in Figure X. As it is clear, after the negative shock on its current account, Spain is forced to devalue its currency. This erodes Germany's performance, which is forced to devalue the German euro several periods after. Thenceforth, both countries engage in a self-reinforcing competitive devaluation dynamic.

It is worth mentioning that the dynamics of the model imply that after the competitiveness shock in Spain there is a dominance of real over financial transactions that end up yielding a negative external balance of Spain vis-á-vis Germany. The reason is that even though the increase in wealth in Germany as a result of the positive competitiveness shock

Figure 6: Loss of Competitiveness in Spain



produces a higher demand for Spanish bonds, the increased demand for bonds by German banks is split also into bonds from the US, Germany and the rest of the world. Thus, in sum, the current account deficit exceeds the capital account surplus in Spain, thereby generating a balance of payments deficit which is matched by a decrease in the stock of foreign reserves held by the Banco de España. Regarding the evolution of the euro/dollar exchange rate, it appreciates because both Germany and Spain exhibit a surplus in their overall current account balances (recall that Spain's deficit is against Germany) which, in turn, ends up improving public finances to the extent that there is a reduction in the supply of euro-denominated bonds. Hence, if supply becomes more scarce the price that clears the market should go up (the euro appreciates). However, this result is striking since while each domestic euro is depreciating against the dollar, the global euro is appreciating.

Figure 7: Loss of Competitiveness in Spain

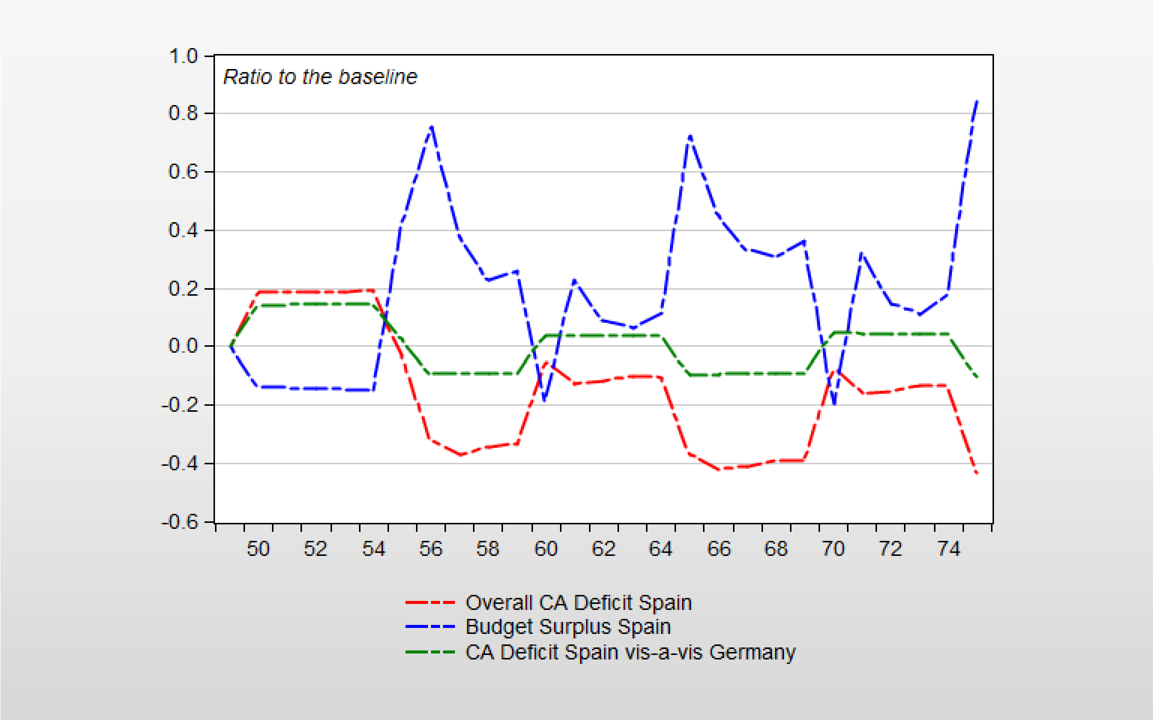


Figure X provides us another way of analysing the sources of the appreciation of the global euro. Basically, the initial shock produces both an intra-regional and an overall current account deficit in Spain which after some periods triggers a devaluation of the Spanish euro which, in the end, produces the dynamics described above. If we take the evolution of Spain's current account and fiscal balance, it can be seen that there is a tendency to an overall current account surplus and a bilateral balance vis-á-vis Germany, while the fiscal balance goes into surplus. This implies that the financing needs of the Spanish government decrease, thereby reducing the supply of bonds denominated in euros. Taking the equation that determines the euro/dollar exchange rate it can be observed that if supply goes down, the exchange rate will tend to appreciate.

Nevertheless, it was shown that the adjustment criterion of this model produces unstable dynamics. Thus, it would be desirable to examine other adjustment criteria that may make of a multi-speed Europe a viable solution to the structural problems of the Eurozone. A first alternative to the criterion described in our model would be to change the balance of payments threshold below which a devaluation is triggered. Thus, if we allowed for permanent but small current account deficits, the impact of the same competitiveness shock could produce more stable results. This can be observed in Figure X.

$$E7_t = \begin{cases} E7_{t-1}, & \text{if } \frac{CA^{GE}_{SP_{t-i}} + FA^{GE}_{SP_{t-i}}}{Y^{SP}_{t-i}} < -0.005, \forall i = 1,2,3 \\ E7_{t-1}.(1+\pi), & \text{if } \frac{CA^{GE}_{SP_{t-i}} + FA^{GE}_{SP_{t-i}}}{Y^{SP}_{t-i}} \geq -0.005, \forall i = 1,2,3 \end{cases} \tag{206}$$

$$E8_t = \begin{cases} E8_{t-1}, & \text{if } \frac{CA^{SP}_{GE_{t-i}} + FA^{SP}_{GE_{t-i}}}{Y^{GE}_{t-i}} < -0.005, \forall i = 1,2,3 \\ E8_{t-1}.(1+\pi), & \text{if } \frac{CA^{SP}_{GE_{t-i}} + FA^{SP}_{GE_{t-i}}}{Y^{GE}_{t-i}} \geq -0.005, \forall i = 1,2,3 \end{cases} \tag{207}$$

As it can be observed, when the adjustment criterion allows for a certain (small) balance of payments deficit of Spain vis-á-vis Germany the model produces stable dynamics over time. This is explained by the fact that at the new parity between the Spanish and the German euros (the one that results from the devaluation of the Spanish euro) Spain runs a deficit with respect to Germany but the size of it is such that the threshold is not surpassed. The depreciation of the Spanish euro against the dollar ends up offsetting the initial loss of competitiveness , thereby producing and overall current account surplus (regardless the bilateral deficit with respect to Germany). It can be seen then that just a small change in the adjustment criterion is sufficient to make the system stable. It should be born in mind, however, that in this model we are giving the US and the rest of the world a passive role. Results could change should they undertake policies aimed at preventing their current account balances from going to deficit. However, this is not a problem inherent to the structure of the Eurozone but a more general one, related to the impossibility of a world in which all the economies pursue export-led growth strategies at the same time.

Figure 8: Loss of Competitiveness in Spain

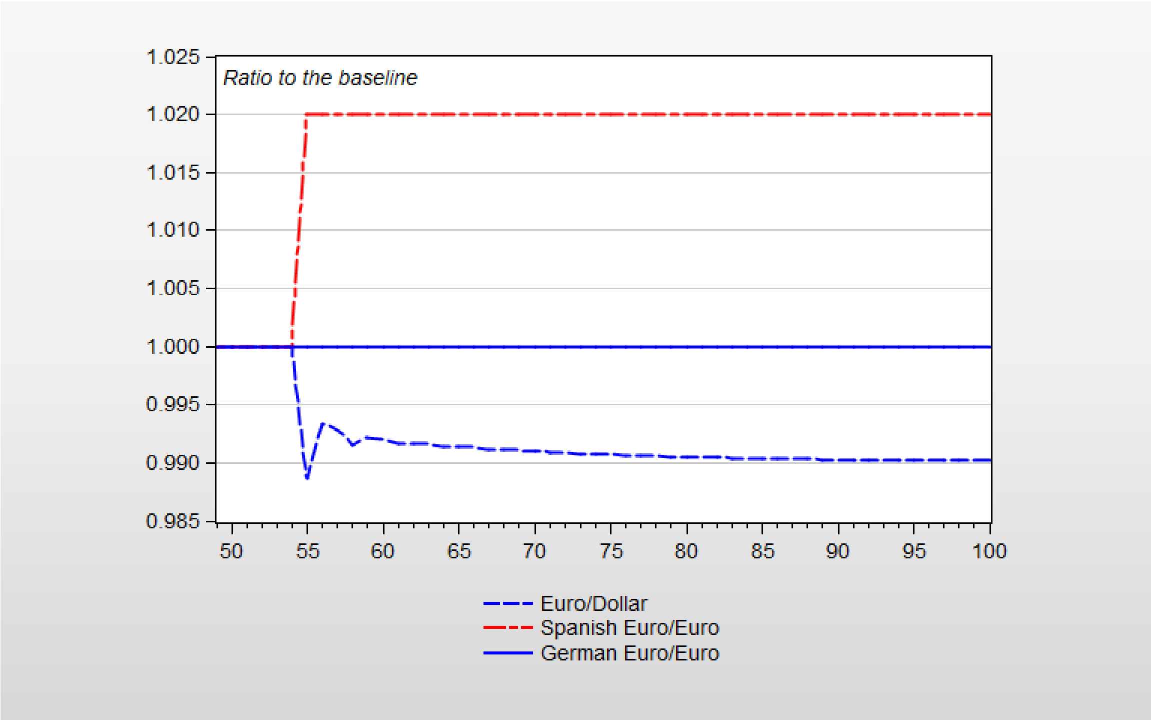


Figure 9: Loss of Competitiveness in Spain

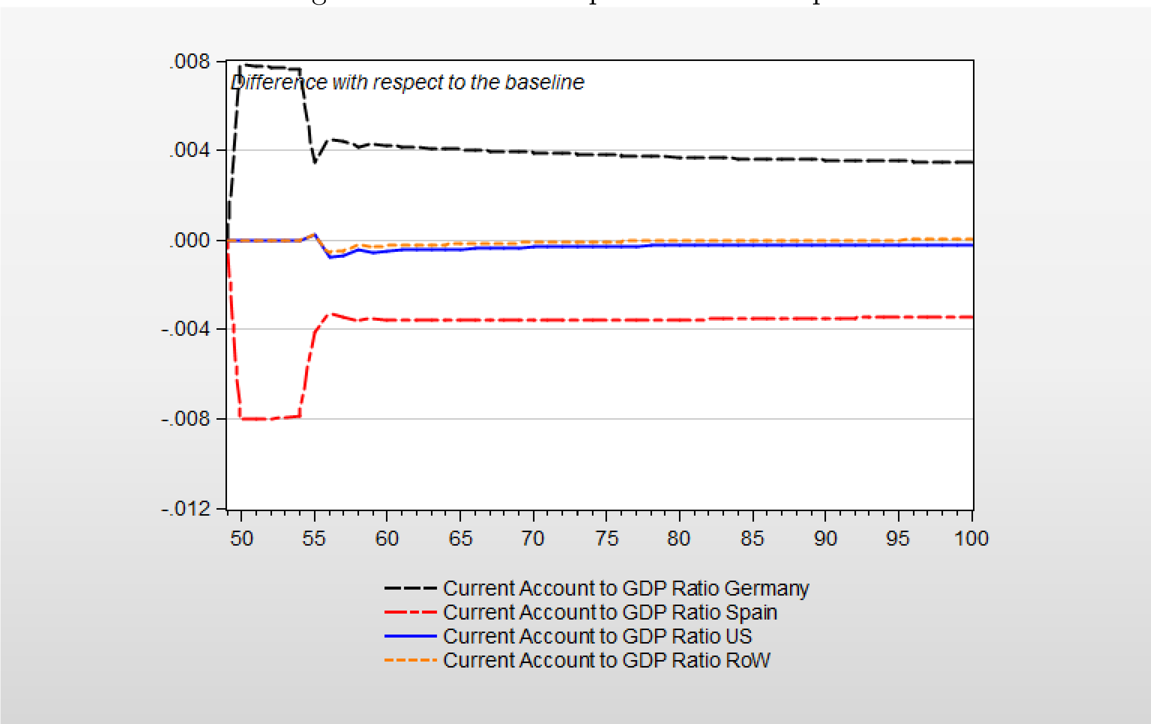
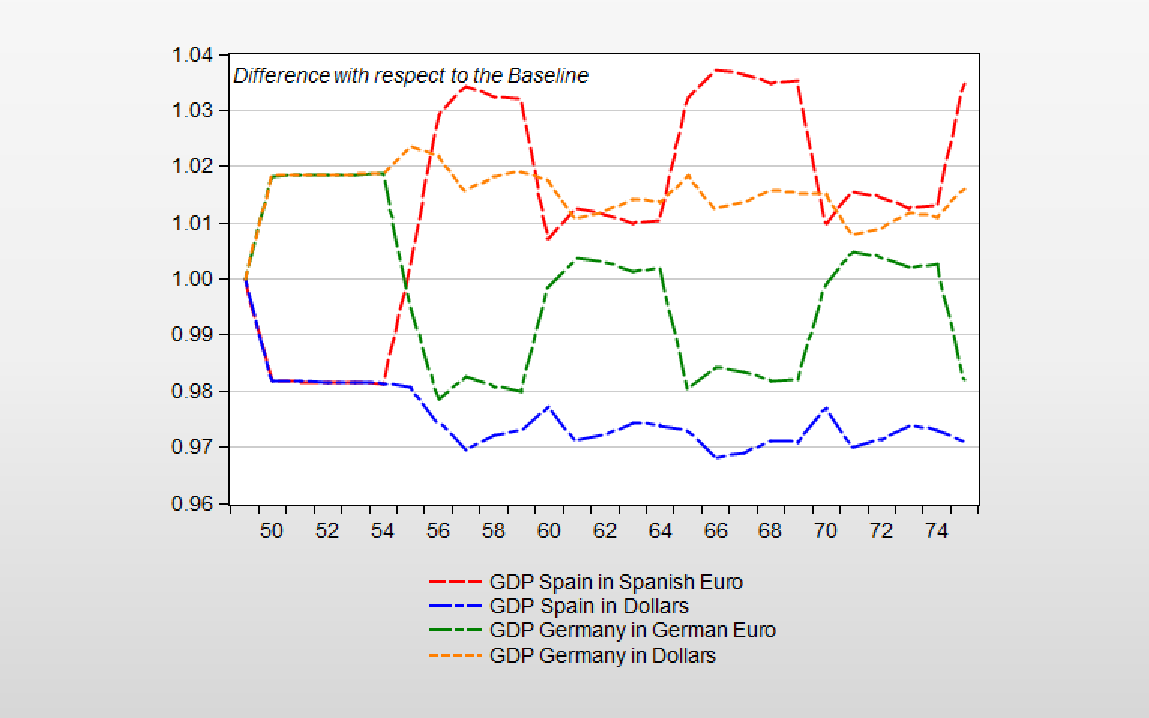


Figure 10: Loss of Competitiveness in Spain



Another interesting point that needs to be taken into account when deciding to devalue a currency is related to the effect that this policy may have on the level of activity and the international purchasing power of the country in question. Figure X provides us with a clear representation of this issue. First, it can be seen that after the initial shock Spain's GDP falls and Germany's increase. Thus far, no changes are registered in bilateral exchange rates. However, the trajectories of GDP change when the Spanish euro is devalued, which in turn produces movements in the euro/dollar exchange rate. From period 54 onwards (when the Spanish euro is devalued) Spain's GDP increases when measured in domestic currency (it even becomes higher than in the baseline scenario) but decreases when measured in dollars. This implies that the devaluation is beneficial for increasing the domestic level of activity but at the expense of the international purchasing power of the Spanish consumer. The opposite picture is observed in Germany, which level of activity is reduced but whose consumers have become richer.

Even if the criterion proposed above, i.e., one where the Spanish euro is devalued against the euro if the balance of payments falls below a certain (negative) threshold, produces stable results, it is interesting to assess the viability of an alternative criterion based on stocks. Thus, the exchange rates of the Spanish and the German euros with respect to the global euro could be written in such a way that a devaluation takes place only if the stock of foreign reserves held by each national central bank falls below a certain threshold (for simplicity, we may assume that this threshold is equal to zero, meaning that a fixed exchange rate can be maintained as long as there is a positive stock of reserves at the central bank to intervene in the foreign exchange market).

$$E7_t = \begin{cases} E7_{t-1}, & \text{if } Bs, cb^{GE}_{SP_t} > 0 \\ E7_{t-1}.(1+\pi), & \text{if } Bs, cb^{GE}_{SP_t} \leq 0 \end{cases} \quad (208)$$

$$E8_t = \begin{cases} E8_{t-1}, & \text{if } Bs, cb^{US}_{GE_t} > 0 \\ E8_{t-1}.(1+\pi), & \text{if } Bs, cb^{US}_{GE_t} \leq 0 \end{cases} \quad (209)$$

Figure X shows that even if the competitiveness shock occurs in period 50, the Spanish euro is only devalued several periods after. The reason is that in this case what really matters is the initial stock of reserves held by the central bank of Spain, which in the end will determine how long the parity against the global euro can be maintained. Thus, Spain can accumulate persistent current account deficits until the moment its central bank runs out of reserves to keep the exchange rate fixed. The results produced by this alternative criterion only differ from the previous one in the length of the unsustainable growth regime, but in the end the result is the same, i.e., an adjustment has to be made. When the adjustment criterion is based on a certain flow that cannot fall below a certain threshold during a predetermined number of periods, the negative competitiveness shock is quickly adjusted since the condition for the devaluation is rapidly met. On the other hand, if the criterion for the devaluation of the exchange rate is based on a the fact that foreign reserves (a stock) cannot be negative, it may take a long time until the persistent current account deficits combined with a fixed exchange rate regime end up depleting the stock of reserves. In the end, what really matters when we adopt a criterion based on stocks is their initial value.

Another important point can be derived from Figure X, which traces the evolution of the current account to GDP ratios of the four countries. What is interpreted from the figure is that when Spain pegs it currency to the German one, this implies that Germany would have to accept to run persistent current account deficits. However, such a situation cannot persist forever since the Bundesbank would eventually run out of foreign reserves to keep the exchange rate vis-á-vis the global euro stable. What figures X and Y show is basically the same unstable dynamics that were observed above when we adopted adjustment criteria based on flows (the balance of payments to GDP ratio) but on larger time span. It can be clearly seen in Figure Y that after the initial devaluation of the Spanish euro the current account of Spain starts exhibiting a surplus which is translated into an accumulation of foreign reserves. Thus, the new exchange rate parity seems to be stable. However, the new parity becomes unsustainable for Germany, which starts running persistent current account deficits which eventually lead to a devaluation of the German euro. Hence, a different adjustment criterion is required if it is desired to use stock as the variable upon which decisions are made.

Figure 11: Loss of Competitiveness in Spain

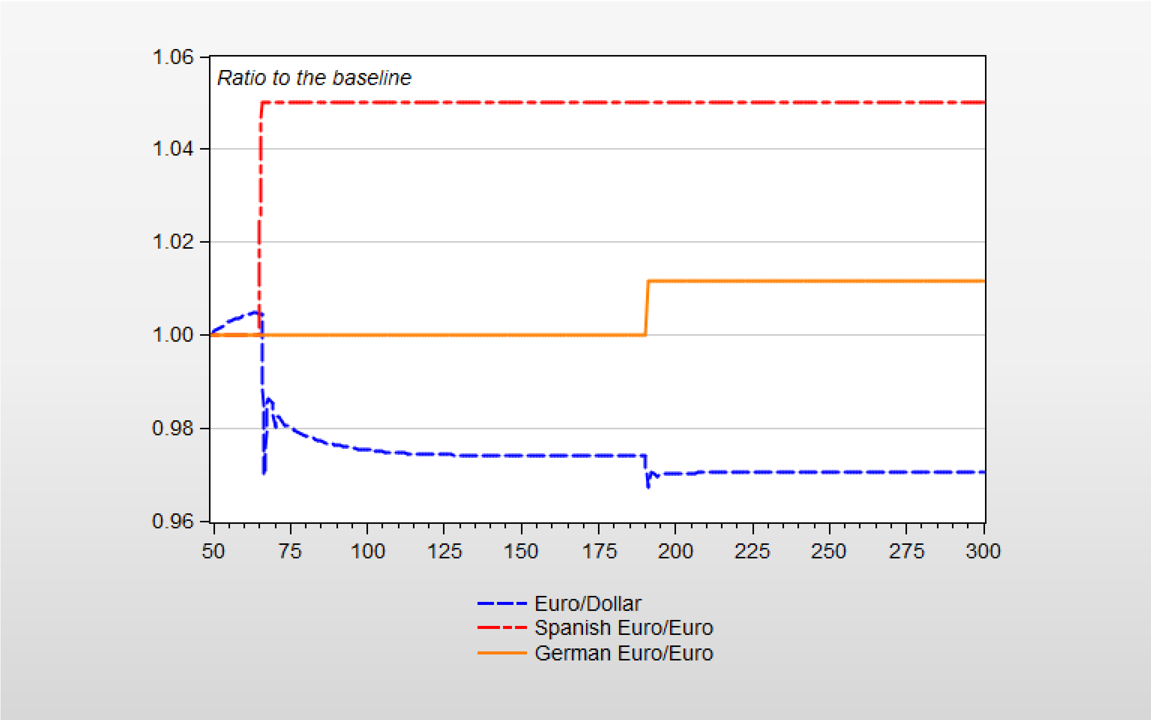


Figure 12: Loss of Competitiveness in Spain

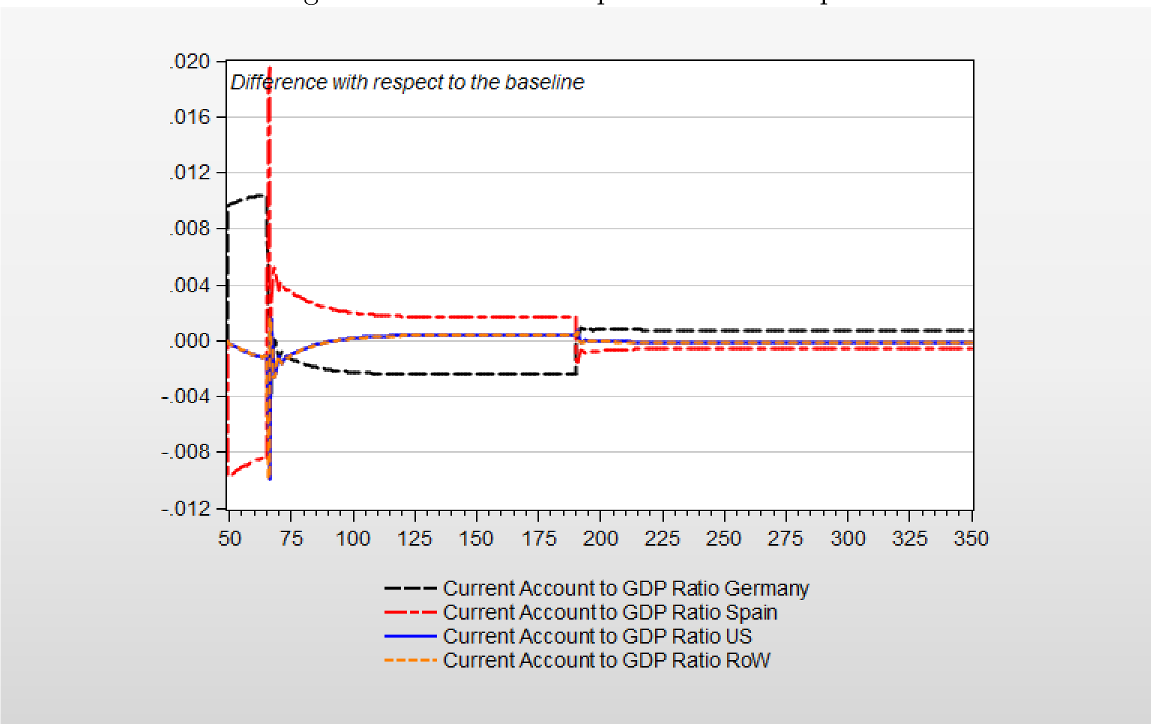
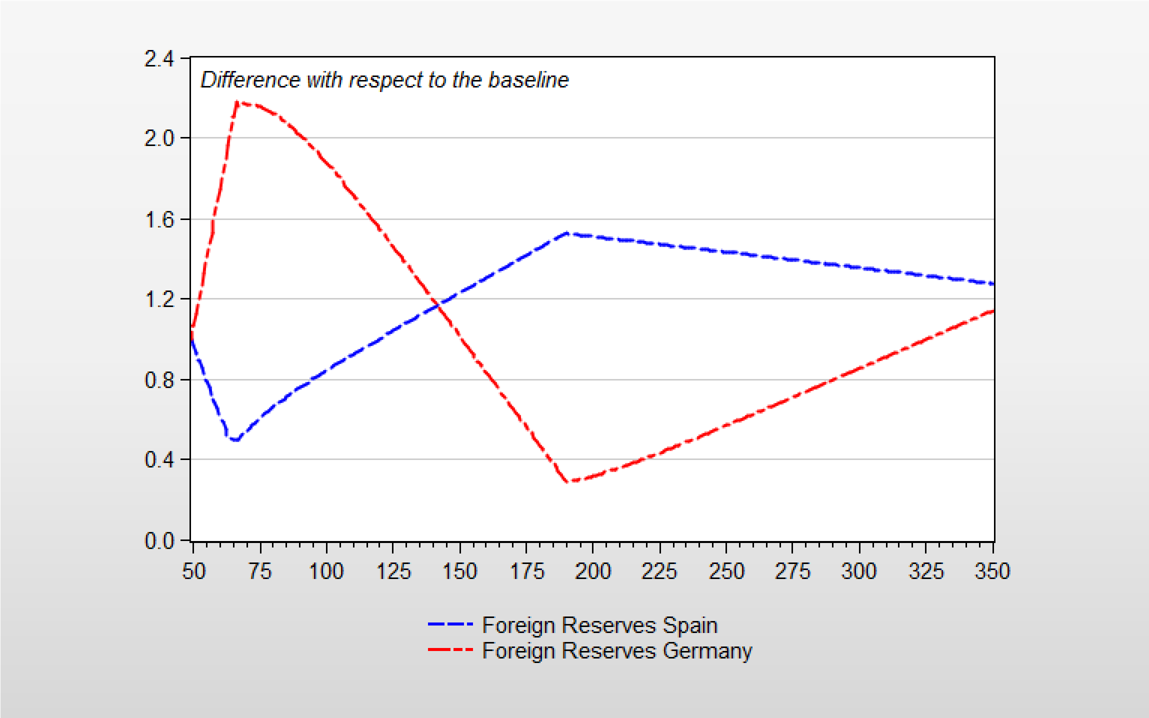


Figure 13: Loss of Competitiveness in Spain



One of the alternatives that has been put forward by George Soros (2012) and Frédéric Lordon (2013) among others is a situation in which Germany leaves the Eurozone and lets its currency float, while the remaining European countries keep the euro which could either be pegged to the German currency or float freely. The examination of this alternative does not require many changes with respect to the set up that was presented in the previous section. First, it is required to delete the notion of the global euro, $E9$, and its associated exchange rates $E7$, $E8$ and $E10$. Second, the German currency/dollar exchange rate, $E1$, which was previously defined implicitly using $E8$ and $E9$ can now be defined explicitly as the ratio of the supply of German bonds to the US and the demand for German bonds by the US. Finally, the euro/German currency exchange rate, $E3$, can be pegged according to the rule that states that it will remain fixed as long as there is a sufficient stock of reserves to defend the parity.

$$E1_t = \frac{Bs_t^{GE} - Bs,b_{GE_t}^{GE} - Bs,cb_{GE_t}^{GE} - Bs,b_{SP_t}^{GE} - Bs,cb_{SP_t}^{GE} - Bs,b_{RW_t}^{GE}}{Bd,b_{US_t}^{GE}} \tag{208}$$

$$E3_t = \begin{cases} E3_{t-1}, & \text{if } Bs,cb_{SP_t}^{GE} > 0 \\ E3_{t-1}.(1+\pi), & \text{if } Bs,cb_{SP_t}^{GE} \leq 0 \end{cases} \tag{210}$$

This new setting requires some small changes in the closure of the model. Basically, the German central bank will no longer purchase foreign assets since there is no exchange rate to be defended. Thus, its balance sheet will be closed through purchases/sales of domestic bonds. Since the exchange rate floats, the domestic bond market is cleared in the process of the determination of the exchange rate (equation 208). As regards the central bank of Spain, there are no major changes since its exchange rate is still fixed. Thus, the monetary authority keeps on purchasing/selling German bonds in such a way that the exchange rate is fixed at every point of time. What does need to be changed are all the equations in which valuation effects are computed (mainly private and central banks' profits) since all the abolished exchange rates must be substituted by the new ones. Once all these modifications have been made, it is possible to assess the viability of this alternative. Figures X and Y describe the dynamics of this new system.

Before interpreting the results of the simulations the following caveat must be made. Thus far, we have been unable to run a model in which the devaluation after the stock of reserves is about to be depleted is of the same size as in the previous models (5%). If the devaluation is larger than 1% the solver stalls and no simulations are obtained. Thus, we introduced an adjustment criterion where in each period the devaluation, if needed, is of 0.5%. As the reader may imagine, such a small devaluation may not be enough to restore the external equilibrium. That is the reason why in Figure X it is observed a process of continuous devaluations of the euro with respect to the German currency, until it reaches a point where the central bank of Spain is able to start accumulating foreign reserves. However, we believe that this should not alter the interpretation of the underlying dynamics of this particular system.

As it happened in the previous simulations, the initial shock produces a recession in Spain which is mainly explained by the trade deficit. The opposite happens in Germany, the main beneficiary of the competitiveness shock. As the stock of foreign reserves held at the central bank of Spain is being depleted, the exchange rate is devalued. Once it reaches a level such that the current account is once again in surplus, the exchange rate remains stable. However, Spain's external performance seems to be completely reliant on the level of the exchange rate, since after the stabilization of the latter the current account tends to go into deficit once again. The reason why Spain does not need to devalue the exchange rate towards the end of our simulation periods, where it is clearly showing a current account deficit, is that it is simultaneously exhibiting a capital account surplus which more than compensates the current account deficit. In other words, the country is being a net recipient of foreign capital (a situation that does not differ much from the one observed in the 2000s, before the crisis). This mechanism is what allows Spain to keep its currency pegged to the German currency. But, as the current crisis has proven, such a process cannot be sustainable. Hence, it would be interesting to know if this lack of sustainability could be solved by a more aggressive devaluation of the euro wih respect to the German currency, such that the exchange rate reaches a level that is compatible with an equilibrium in the current account of Spain.

Finally, the alternative in which Germany leaves the Eurozone and lets its currency

Figure 14: Loss of Competitiveness in Spain

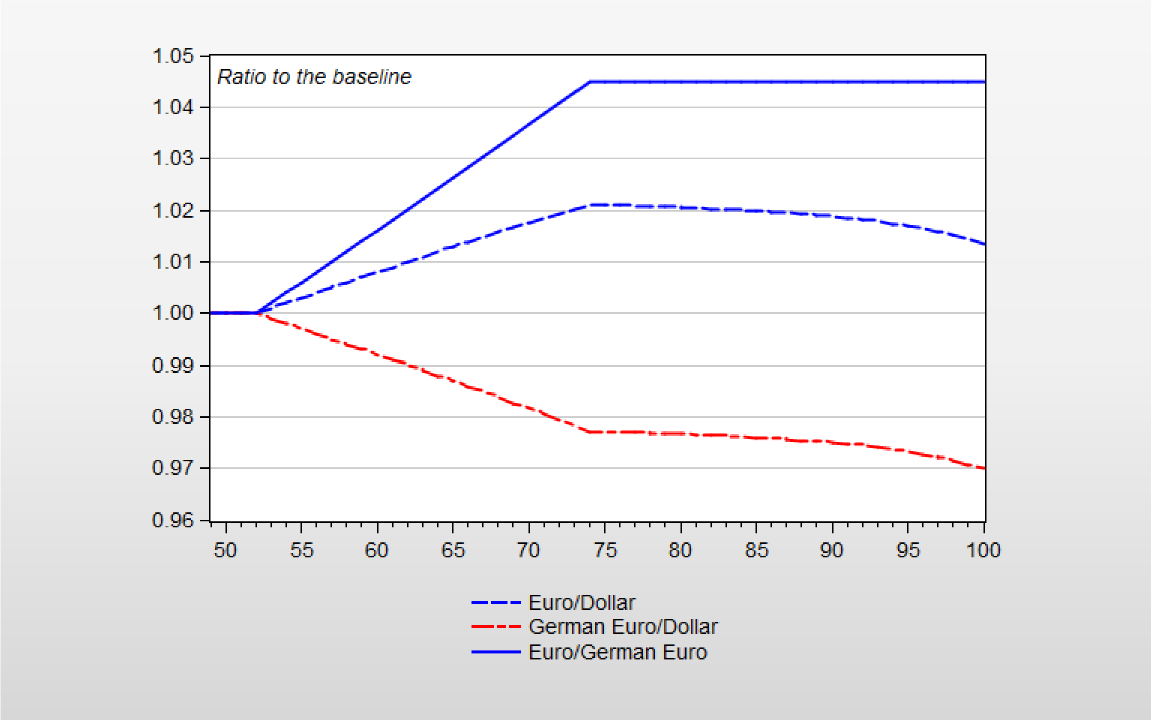
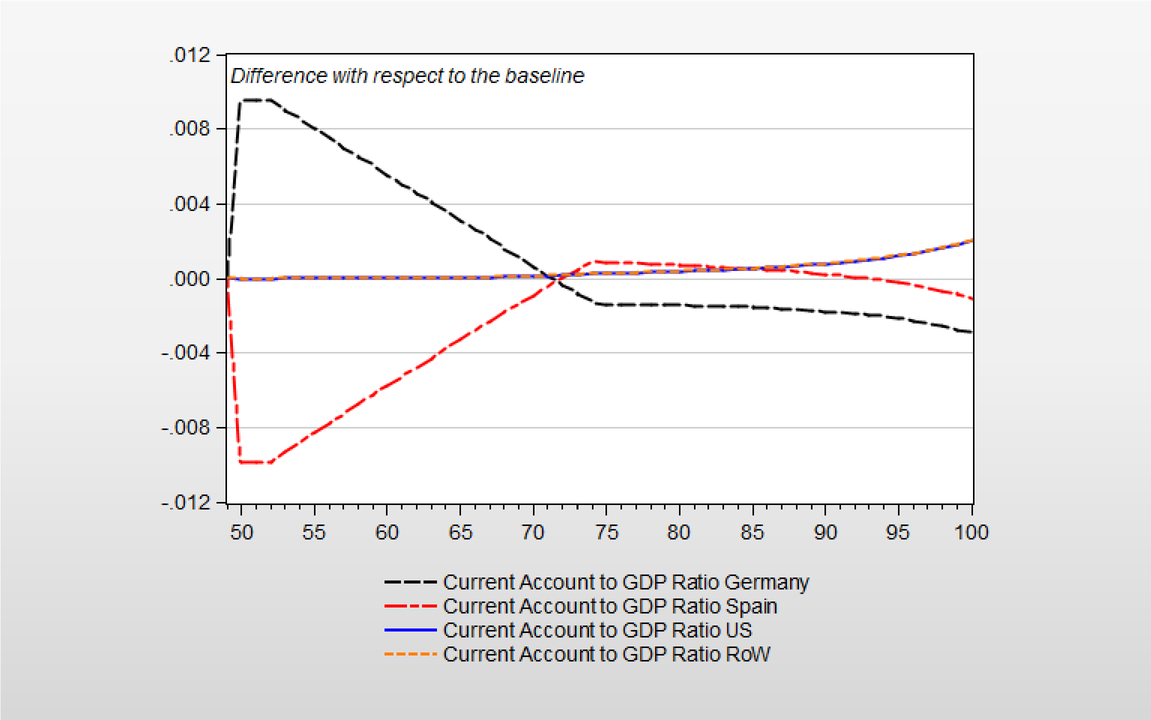


Figure 15: Loss of Competitiveness in Spain



float could be tried in a setting where the Euro, instead of being pegged to the German currency, floats freely. As it is shown in the following figures, the results are more stable since there are less rigidities (there are no fixed exchange rates that can lead to unsustainable processes). After the initial competitiveness shock, the exchnage rates adjust according to the sizes of the current accounts. Spain, who suffers from the worst current account deficit, exhibits the larger depreciation. Germany, who benefits the most from the competitiveness shock, sees its currency appreciated (as predicted by those who claim that the Germany euro is under-valued). Hence, the results of this last set of simulations provides us with an interesting possibility of reform for the current setting of the Eurozone. However, it should be noted that such a solution would imply a great loss for Germany, both in terms of economic activity and financial wealth. Hence, these potential drawbacks of this solution (which makes the emphasis on medium term external sustainability) should be taken into account when making a final proposal for reform.

5 Conclusions

We began this paper by presenting some of the alternative explanations to the current crisis in the Eurozone and showed that the one based on exchange rate misalignements and macroeconomic imbalances seems to be more plausible that the one that focuses on fiscal profligacy in the south. We then build a four-country stock-flow consistent model that represents the Eurozone under the hypothetical scenario a split up of the euro into a northern and a southern euro, each of them consistent with the equilibrium exchange rate of the corresponding sub-regions. Our simulations show under which conditions such an institutional framework could work, which we consider an interesting contribution to the debate on the ways out of the crisis. However, our model needs to be refined in order to account for variable interest rates and flexible prices. We intend to present a more complete version of the model in the near future.

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Figure 16: Loss of Competitiveness in Spain

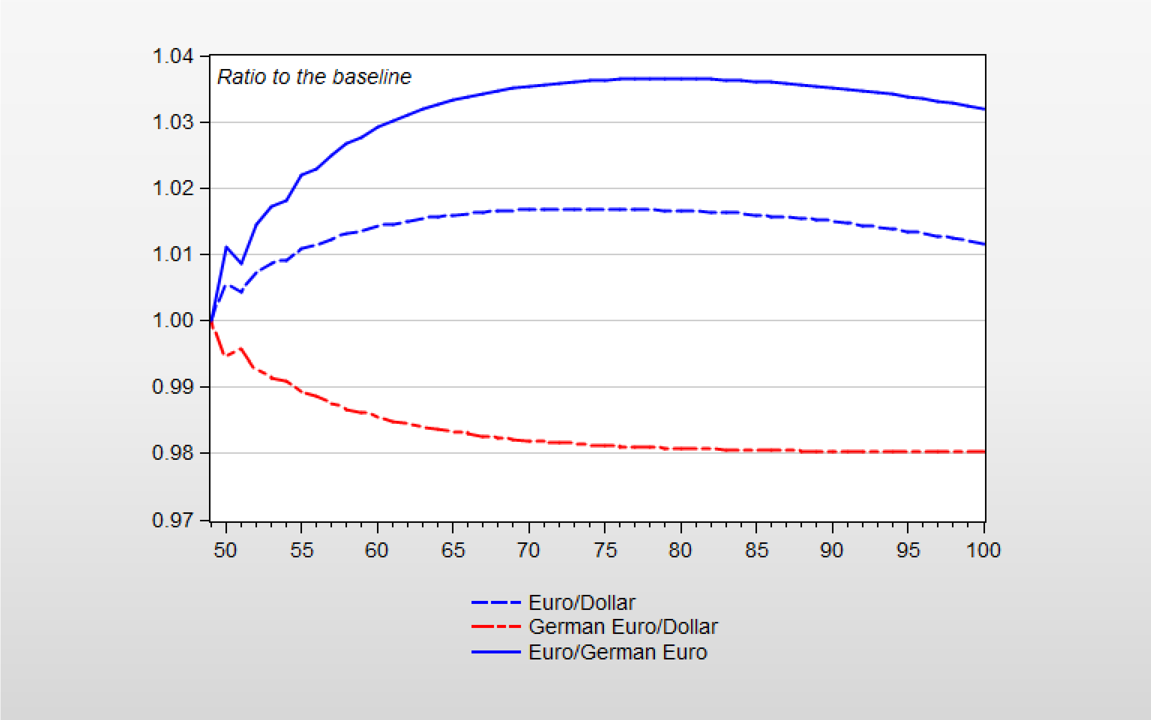
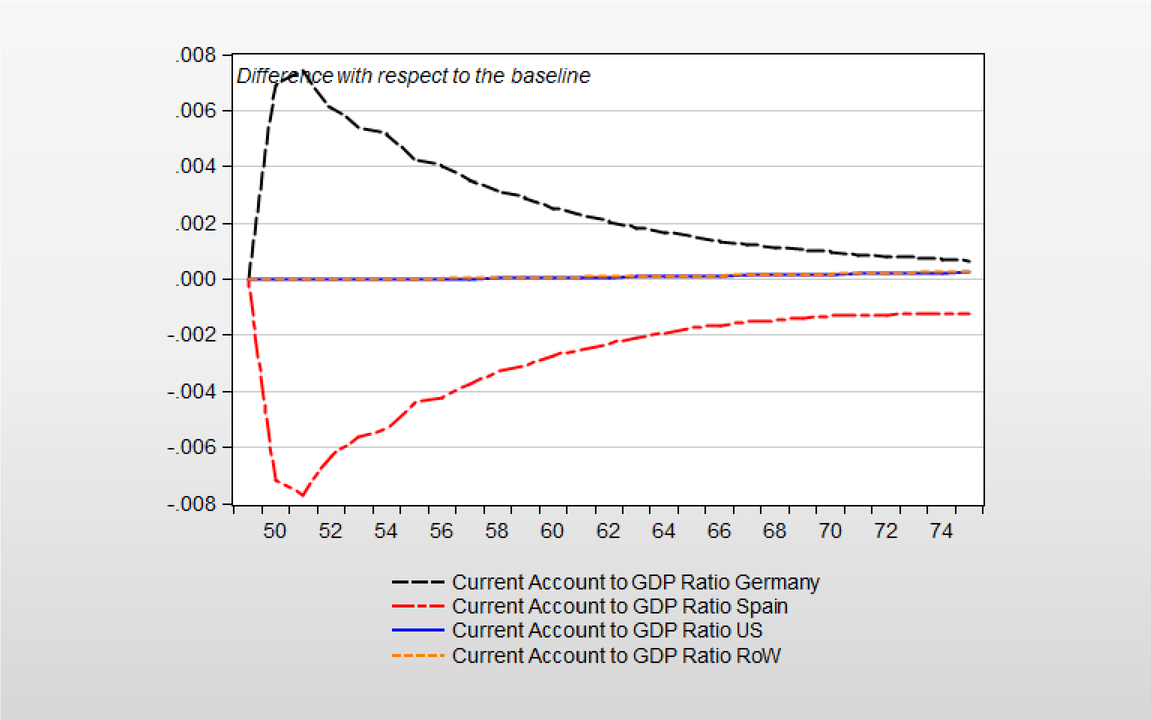


Figure 17: Loss of Competitiveness in Spain



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