# A Multi-Speed Europe: is it viable? A Stock-Flow Consistent Approach 

Jacques Mazier*and Sebastian Valdecantos ${ }^{\dagger}$

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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. This is no surprise since the governments attempted to mitigate the effects of the global financial crisis on production and employment. However, the dominant paradigm in economics interpreted the crisis as a process directly linked to profligate behavior 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 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 unfavorable conditions at which southern countries joined the Eurozone) what produced the imbalances that ended 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. A wider role of the ECB, the convergence towards a banking union and a higher degree of fiscal integration are among the mostly discussed proposals. In our view, these proposals, 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 in 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 present some of the ways in which the proposal of a Multi-Speed Europe could be introduced. Our analytical tool will be a four-country stockflow consistent model specifically adapted to the study of the phenomenon in question. In section 4 we run some simulations aimed at testing the viability of each of the alternatives developed in section 3. Finally, in section 5 we present our main 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. This is no surprise since the governments attempted to mitigate the effects of the global financial crisis on production and employment. However, the dominant paradigm in economics interpreted the crisis as a process directly linked to profligate behavior 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 these 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 be 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. The analysis of this index during the last two decades shows 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 probably 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 nonexhaustive 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 contributed to emergence of the current account imbalances that were observed during the last decade - whereas Germany started to register large surpluses after the introduction of the euro, southern countries were running a deficit. Basic macroeconomic identities show 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 may also go 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. Since accounting identities lack of any kind of causal sense, each specific case must be analyzed independently in order to find out where the roots of the disequilibrium are.

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 unfavorable. On the other hand, differential wage policies among Eurozone's member states implied divergent unit labor costs, which in turn reinforced the aforementioned unfavorable parities. The combination of these two factors was translated into a significant loss of competitiveness, which was added to the differential industrial potential of the north and the south. Figures 1 and 2 illustrate this situation by showing the evolution of the real effective exchange rate and unit labor costs.

Since an increase in Figure 1 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 in 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.

Figure 1: Real Effective Exchange Rate - Percentage Change


Figure 2: Nominal Unit Labor Costs - Percentage Change


## External Adjustment in a Monetary Union

A monetary union is the most extreme case of a fixed exchange rate arrangement since nominal exchange rates are abolished there is no possibility of any kind of adjustment. A currency board, for instance, is a more flexible system since the country keeps its own currency, thereby always having the possibility of introducing adjustments if the economy finds itself running unsustainable deficits. When a country that keeps its monetary sovereignty decides to peg the exchange rate, the accumulation of current account
deficits must be matched by either financial account surpluses (which in turn implies increases in the stock of foreign debt) or by the depletion of the stock of foreign reserves. Thus, the sustainability of the regime is given by the willingness of foreigners to finance persistent deficits or by the size of the stock of foreign reserves.

The process of external adjustment changes significantly when the institutional arrangement is that of the monetary union. Since in this context there are no more exchange rates (within the region) it is no longer necessary to defend a certain parity either by capital inflows or by the sale of foreign reserves - the exchange rate is fixed by definition. Thus, a country that is running a current account deficit must be simultaneously running a financial account surplus. Regardless of the order of causation (that may vary according to the specific situation of each economy) the length of these imbalances will be determined by the continuity of financial inflows from abroad. If a sudden stop happened, the current account deficit would have to be automatically reduced. In a context in which the exchange rate cannot be devalued, the only way to balance the current account is through a recession (which, in most of the cases, is induced via fiscal austerity). This is, indeed, what has been going on lately in the Eurozone's periphery.

Moreover, the sudden stop (which should be reflected in an increase of the interest rates on domestic bonds) may drive the indebted country into a default since no-one would be willing to provide financing for rolling-over the debt. Even if it was possible to get some funds, the cost would be such that the debt service would become unsustainable in the long run.

Hence, in order to assess the external sustainability of an economy that has chosen to belong to a monetary union, a very simple taxonomy can be built. Taking into account the current account balance and the financing costs that each country faces, the following situations can be identified. First, there may be countries that are running a current account surplus. This implies that these economies are financing the rest of the world, i.e., they are increasing their net international investment position (NIIP). Thus, these countries could be said to be showing a sustainable external position, either because their NIIP is positive or, if it is negative, they are producing an annual cash flow that allows them to cancel their debt commitments. Figure 3 shows different combinations of current account balances and interest rates on domestic bonds. As explained above, if the current account is in surplus and the interest rate is below a certain sustainability threshold, the country would be in a sustainable position. It could be said that this quadrant is the virtuous one, the one where everybody would want to be.

A second possibility is one where a country is running a current account deficit, i.e., it is borrowing from the rest of the world, but it can easily find financing in the international capital markets. As time goes by, the country keeps on accumulating current account deficits and the stock of debt increases. As long as capital markets are willing to finance this debt scheme, the country may continue living "beyond its means". This situation corresponds to the south-west quadrant of the figure. The sustainability of such a situation is weak, since any shock that increases the financing costs may drive the coun-

Figure 3: A Taxonomy of External Sustainability

try into a default and/or a strong adjustment that may produce a recession. This is the case of the north-west quadrant. By a time a certain country gets to this region of the figure, it is likely that it is already going through a recession. Thus, it is recommendable that countries that find themselves in the south-west quadrant start to take actions to be closer to the region of sustainability.

Let us take a quick look at the situation in the Eurozone in 2005. Figure 4 plots the member countries according to the taxonomy described above. The colors of the dots reflect the sign of the NIIP - while green dots correspond to creditor countries, red dots represent debtor countries. The size of the dots is proportional to the absolute value of the NIIP as a percentage of GDP. As it can be observed, in 2005 all the members of the Eurozone were in the domain of sustainability (either weak or strong). Some of them, like Spain, Greece and Portugal, were running current account deficits and were showing a negative NIIP, but they were finding no trouble to roll-over their debts. Malta and Cyprus were also running current account deficits, but their NIIP were positive and they were also able to get funds in international capital markets. The other side of the coin was Germany, which was not only exhibiting a positive NIIP but was also running current account surpluses.

Finally, Figure 5 shows the situation in 2011. First, it is observed that three countries laid above the interest rate threshold. These are countries that after not being able to pay their debts (i.e., their went from a weakly sustainable position to an unsustainable one) were bailed-out. These bail-outs were not free of charge. In order to get the funds, they had to go through a tough internal adjustment process, which was accompanied by

Figure 4: The Eurozone in 2005

a slump in economic activity and an increase in the rates of unemployment. After some years of internal devaluation, competitiveness may be restored and, combined with the decrease in imports produced by the recession, the current account may turn into surplus. This is the case of Ireland. Even if Spain and Cyprus did not surpass the threshold, they were also bailed-out, which means that their regimes also became unsustainable. However, without this type if aid, they would have surely tuned to the north-west quadrant.

Based on the heterodox vision presented by Vernengo and Lapavitsas, which we summarized very broadly in this section and taking into account the lack of sustainability of the growth pattern observed in the Eurzone during the last decade (with the associated crises and recessions), 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 with different closures, each of them associated to the different ways in which a multi-speed Europe could be implemented.

Figure 5: The Eurozone in 2011


## 3 A Multi-Speed Europe: Alternative Closures

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. In this section we describe the different ways in which the idea of a multi-speed Europe could be introduced. To do so, we first describe each of the proposals and then specify how the closure would be in each of the cases. This study is purely theoretical and makes use of the stock-flow consistent models developed by Godley \& Lavoie (2006). Basically, we build a four-country model where we identify the following country blocks: 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. The structure of the model is quite standard since our aim is to try out different closures to see which alternative (if any) of a multi-speed Europe is viable. Thus, we only present the different closures of the model in order to give the intuition of how the model works in each of the cases. Those readers that are interested in the full specification of the model can find it in the annex.

Some previous studies upon which this model 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.

### 3.1 The current situation

The monetary unification that was materialized in 2002 implied that all the members of the Eurozone shared a common monetary and exchange rate policy. Thenceforth, there would be no more fluctuations in bilateral exchange rates. National central banks resigned their autonomy in favor of the European Central Bank (ECB). Together, the ECB and national central banks make up the so-called Eurosystem ${ }^{1}$.

In the institutional arrangement that has been in place since the introduction of the euro, the exchange rate vis- $\widetilde{\mathrm{A}}$-vis the US dollar has been flexible. Within the framework of a stock-flow consistent model, this flexibility implies that the domestic bond market is cleared via exchange rate adjustments. For instance, if there is a sudden increase in foreign demand of euro-denominated bonds (which may be Spanish or German) this will imply and excess demand of foreign exchange, that needs to be changed to euros in order to purchase the desired stock of bonds. As a result, the euro will appreciate. This process is described in equations (208) and (209) of our model, were both $E 1$ and $E 2$ represent the euro/dollar exchange rate (that is why both equations are identical). The reason why we write one equation for each country ( $E 1$ for Germany and $E 2$ for $S$ pain) is that in what follows we will split the Eurozone into two different regions, giving rise to two different exchange rates.

$$
\begin{align*}
E 1_{t} & =\frac{B s_{t}^{G E}+B s_{t}^{S P}-D_{t}}{B d, b_{U S_{t}}^{S P}+B d, b_{U S_{t}}^{G E}}  \tag{208}\\
E 2_{t} & =\frac{B s_{t}^{G E}+B s_{t}^{S P}-D_{t}}{B d, b_{U S_{t}}^{S P}+B d, b_{U S_{t}}^{G E}} \tag{209}
\end{align*}
$$

$D_{t}=B s, b_{S P_{t}}^{S P}+B s, b_{G E_{t}}^{G E}+B s, b_{S P_{t}}^{G E}+B s, b_{G E_{t}}^{S P}+B s, b_{R W_{t}}^{S P}+B s, b_{R W_{t}}^{G E}+B s, c b_{G E_{t}}^{G E}+B s, c b_{S P_{t}}^{S P}+B s_{E C B_{t}}^{S P}+B s_{E C B_{t}}^{G E}$

[^1]Following the tradition closure of and open economy stock-flow consistent model, if the bond market is cleared through exchange rate adjustments, the central bank does not need to accumulate any kind of foreign asset to defend a certain parity. Even if the exchange rate of Spain vis-á-vis Germany is fixed, the central bank of Spain does not need to defend the parity since in practice, from the moment that exchange rates were abolished, there is no parity at all. Thus, each national central bank can maintain the equilibrium in its balance sheet (i.e., the fact that the total change in assets minus the total change in liabilities is equal to the profits earned on the same period) through purchases/sales of domestic bonds. These interventions can be thought of as the daily interventions in the interbank market in order to achieve the policy rate set by the Eurosystem. This has nothing to do with potential interventions in the bond market in order to stabilize long-term interest rates (like the Outright Monetary Transactions program launched by the ECB in 2012). The equilibrium in the balance sheets of the central banks of Spain and Germany can be written as follows:

$$
\begin{align*}
& \Delta B s, c b_{S P_{t}}^{S P}=\Delta R_{t}^{S P}+\Delta H s_{t}^{S P}-\Delta A_{t}^{S P}  \tag{213}\\
& \Delta B s, c b_{G E_{t}}^{G E}=\Delta R_{t}^{G E}+\Delta H s_{t}^{G E}-\Delta A_{t}^{G E} \tag{214}
\end{align*}
$$

Equations (213) and (214) state that the change in the stock of domestic bonds held by each central bank of the Eurozone is given by the change of the the sum of liabilities (reserves and money) minus the other asset that the monetary authority may hold (advances to commercial banks). As it can be observed in the social accounting matrix and the flow of funds presented in the annex, national central banks transfer their profits to the government, which implies that their stock of wealth is constant over time. Equations (213) and (214) guarantee that there is a permanent balance between the change in assets and liabilities of the monetary authorities of the Eurozone.

This is how, in broad terms, the Eurosystem has been working thus far. We have also written a paper aimed at describing the working of the Eurosystem in a very detailed way, but for the purposes of this study this level of depth will suffice ${ }^{2}$

### 3.2 A Eurozone with three Euros

The brief description of the causes of the crisis in the Eurozone that we described in section 2 induced us to think that on of the ways-out of the crisis could consist of a restoring national exchange rates. This would not require that each country would regain its monetary and exchange rate policy, but that the Eurozone could be split into two blocks, each of them gathering countries that are more similar. For instance, it seems more reasonable that Portugal shares a common exchange rate with Greece than with Germany or Fin-

[^2]land. Thus, what we propose in this subsection is a scenario where there are two regional euros, each of them associated to a certain sub-region within the Eurozone (we call those sub-regions Spain and Germany). Moreover, there would also be a global euro aimed at keeping the role of the current euro as an international store of value. The exchange rate of the global euro vis-á-vis the US dollar would be determined as usual, i.e., as a result of the interaction between supply and demand for euro-denominated bonds. We call the global euro/dollar exchange rate $E 9$, in order to keep $E 1$ and $E 2$ as the exchange rates between Germany and Spain, vis-á-vis the US.
$$
E 9_{t}=\frac{B s_{S P_{t}}^{e}+B s_{G E_{t}}^{e}-B s, b_{S P_{t}}^{G E}-B s, b_{G E_{t}}^{S P}-B s, b_{R W_{t}}^{S P}-B s, b_{R W_{t}}^{G E}-B s_{E C B_{t}}^{G E}-B s_{E C B_{t}}^{S P}}{B d, b_{U S_{t}}^{S P}+B d, b_{U S_{t}}^{G E}}
$$

Since in this institutional framework each sub-region would regain its monetary sovereignty, the government debt could be denominated in national euros. This is indeed the case. But it should be born in mind that those countries that do not issue reserve currencies (like the national euros would be) may find limits to get external financing by issuing bonds denominated in domestic currency. In those cases, the gap between the financing needs and the total demand for bonds denominated in domestic currency is filled with issues of bonds denominated in a reserve currency. In this case, should there be any gap, it would be filled with issues of bonds denominated in global euros. These supplies are the ones that enter the equation of $E 9$.

$$
\begin{aligned}
B s_{S P_{t}}^{e} & =\frac{B s_{S P_{t}}^{S P}-B s, b_{S P_{t}}^{S P}}{E 7_{t}} \\
B s_{G E_{t}}^{e} & =\frac{B s_{G E_{t}}^{G E}-B s, b_{G E_{t}}^{G E}}{E 8_{t}}
\end{aligned}
$$

The multi-speed feature of this model implies that Germany and Spain can have adjustable exchange rates according to their external performance vis-á-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.

$$
\begin{aligned}
& E 7_{t}= \begin{cases}E 7_{t-1}, & \text { if } \frac{C A_{S P_{t-i}}^{G E}+F A_{S P_{t-i}}^{G E}}{Y_{t-i}^{S P}}<0, \forall i=1,2,3 \\
E 7_{t-1} \cdot(1+\pi), & \text { if } \frac{C A_{S P_{t-i}}^{G E}+F A A_{S P_{t-i}}}{Y_{t-i}^{S P}} \geq 0, \forall i=1,2,3\end{cases} \\
& E 8_{t}= \begin{cases}E 8_{t-1}, & \text { if } \frac{C A_{G E_{t-i}}^{S P}+F A_{G E_{t-i}}^{S P}}{Y_{t-i}^{G E}}<0, \forall i=1,2,3 \\
E 8_{t-1} \cdot(1+\pi), & \text { if } \frac{C A_{G E_{t-i}}^{S P}+F A_{G E_{t-i}}^{S P}}{Y_{t-i}^{G E}} \geq 0, \forall i=1,2,3\end{cases} \\
& E 1_{t}=E 8_{t} \cdot E 9_{t} \\
& E 2_{t}=E 7_{t} \cdot E 9_{t} \\
& E 3_{t}=E 2_{t} / E 1_{t}
\end{aligned}
$$

Since Spain and Germany are now engaged in a fixed (but adjustable) exchange rate arrangement where bilateral nominal exchange rates indeed exist (not like in the current situation, where there are no nominal exchange rates within the Eurozone), national central banks must intervene in the foreign exchange markets in order to ensure that the parity holds over time. This interventions are carried out via purchases/sales of foreign reserves. We make the assumption that both countries accumulate these reserves under the form of dollar-denominated bonds issued by the US. As it is normal in stock-flow consistent models with fixed exchange rates, the central bank intervention that keeps the exchange rate constant is such that its balance sheet is always in equilibrium.

$$
\begin{aligned}
\Delta B s, c b_{S P_{t}}^{U S} & =\Delta R_{t}^{S P}+\Delta H s_{t}^{S P}-\Delta A_{t}^{S P}-\Delta B s, c b_{S P_{t}}^{S P} \\
\Delta B s, c b_{G E_{t}}^{U S} & =\Delta R_{t}^{G E}+\Delta H s_{t}^{G E}-\Delta A_{t}^{G E}-\Delta B s, c b_{G E_{t}}^{G E} \\
\Delta B d, c b_{S P_{t}}^{U S} & =\Delta B s, c b_{S P_{t}}^{U S} \cdot E 2_{t}+B s, c b_{S P_{t-1}}^{U S} \cdot \Delta E 2_{t} \\
\Delta B d, c b_{G E_{t}}^{U S} & =\Delta B s, c b_{G E_{t}}^{U S} \cdot E 1_{t}+B s, c b_{G E_{t-1}}^{U S} \cdot \Delta E 1_{t}
\end{aligned}
$$

These equations ensure that the model is consistent. In the next section we will run some simulation experiments in order to assess the economic viability of this proposal.

### 3.3 Taking up the European Monetary System

In a similar line to the one proposed in the previous scenario, the ideas embedded in the European Monetary System (EMS) could be taken up in order to give the Eurozone a higher degree of stability. The proposal would consist of a split-up of the Eurozone into two sub-regions (as we did in the previous case) but instead of keeping a global euro that would be used as an international currency, there would be a European Currency Unit (ECU) that would only play the role of being a unit of account. As it did in the past, it would be the reference to which the national currencies are pegged. Hence, the ECU could be written as follows:

$$
E 9_{t}=\frac{Y_{t}^{G E}}{Y_{t}^{G E}+Y_{t}^{S P}}+\frac{Y_{t}^{S P}}{Y_{t}^{G E}+Y_{t}^{S P}} . E 3_{t}
$$

The way the ECU is constructed implies that it is a basket currency constituted partly by the German currency and partly by the Spanish currency. It is expressed in ECUs with respect to units of the German currency (that is why the weight corresponding to the German currency is multiplied by one). The determination of each European currency vis-á-vis the ECU would be the same as the one described in the previous scenario, and would depend on the external performance of each country. However, even if Spain and Germany's currencies are pegged to the ECU, they would float against the US dollar. This implies that the bilateral nominal exchange rate could adjust in such a way that the domestic bond market is in equilibrium. We write this process explicitly for Germany $(E 1)$. As regards the exchange rates of the Spanish currency against the US dollar (E2) and the German currency ( $E 3$ ), they can be deduced from the other exchange rates.

$$
\begin{aligned}
& E 7_{t}= \begin{cases}E 7_{t-1}, & \text { if } \frac{C A G P_{t-i}+F A G P_{t-i}}{Y_{-1}^{S P}}<0, \forall i=1,2,3 \\
E 7_{t-1} \cdot(1+\pi), & \text { if } \frac{C A S P_{t-i}+F A G P_{t-i}}{Y_{t-i}^{S P}} \geq 0, \forall i=1,2,3\end{cases} \\
& E 8_{t}= \begin{cases}E 8_{t-1}, & \text { if } \frac{C A_{G E_{t-i}}^{S P}+F A_{G E_{t-i}}^{S P}}{Y_{--i}^{G E}}<0, \forall i=1,2,3 \\
E 8_{t-1} \cdot(1+\pi), & \text { if } \frac{C A_{G E_{t-i}}^{S P}+F A_{G E}^{S P}}{Y_{t-i}} \geq{ }_{t-i}^{G E} \geq 0, \forall i=1,2,3\end{cases} \\
& E 1_{t}=\frac{B s_{t}^{G E}-B s, b_{G E_{t}}^{G E}-B s, c b_{G E_{t}}^{G E}-B s, b_{G E_{t}}^{S P}-B s, b_{G E_{t}}^{R W}}{B d, b_{U S_{t}}^{G E}} \\
& E 3_{t}=E 7_{t} / E 8_{t} \\
& E 2_{t}=E 1_{t} \cdot E 3_{t}
\end{aligned}
$$

The adjustments of $E 1$ and $E 2$ ensure that the German and Spanish bond markets are always cleared. It is now necessary to explain how the balance sheet of the European national central banks are kept in equilibrium, taking into account that they are engaged in a fixed exchange rate arrangement with respect to the ECU. In practice, this does nor differ to the case presented in the previous scenario. Thus, the balance sheets are closed identically and stock-flow consistency is ensured in the same way.

$$
\begin{aligned}
\Delta B s, c b_{S P_{t}}^{U S} & =\Delta R_{t}^{S P}+\Delta H s_{t}^{S P}-\Delta A_{t}^{S P}-\Delta B s, c b_{S P_{t}}^{S P} \\
\Delta B s, c b_{G E_{t}}^{U S} & =\Delta R_{t}^{G E}+\Delta H s_{t}^{G E}-\Delta A_{t}^{G E}-\Delta B s, c b_{G E_{t}}^{G E} \\
\Delta B d, c b_{S P_{t}}^{U S} & =\Delta B s, c b_{S P_{t}}^{U S} \cdot E 2_{t}+B s, c b_{S P_{t-1}}^{U S} \cdot \Delta E 2_{t} \\
\Delta B d, c b_{G E_{t}}^{U S} & =\Delta B s, c b_{G E_{t}}^{U S} \cdot E 1_{t}+B s, c b_{G E_{t-1}}^{U S} \cdot \Delta E 1_{t}
\end{aligned}
$$

### 3.4 A Eurozone without Germany

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 these alternatives does not require many changes with respect to the set up that was presented in the previous scenarios. First, it is required to delete the notion of the global euro or the ECU, $E 9$, and its associated exchange rates E7 and E8. Second, the German currency/dollar exchange rate, $E 1$, which in the "three euros" case was defined implicitly using $E 8$ and $E 9$ 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 (as we did in the EMS scenario). Finally, what we called the Spanish currency/German currency exchange rate, E3, can be now be called euro/German currency exchange rate and could either be pegged or float freely.

$$
\begin{aligned}
& E 1_{t}=\frac{B s_{t}^{G E}-B s, b_{G E_{t}}^{G E}-B s, c b_{G E_{t}}^{G E}-B s, b_{S P_{t}}^{G E}-B s_{E C B_{t}}^{G E}-B s, b_{R W_{t}}^{G E}}{B d, b_{U S_{t}}^{G E}} \\
& E 3_{t}= \begin{cases}E 7_{t-1}, & \text { if } \frac{C A A_{S P_{t-i}}^{G E}+F A A S P_{t-i}}{Y_{t-i}^{S P}}<0, \forall i=1,2,3 \\
E 7_{t-1} \cdot(1+\pi), & \text { if } \frac{C A P_{S P_{t-i}}^{G E}+F A A_{S P_{t-i}}^{G E}}{Y_{t-i}^{S P}} \geq 0, \forall i=1,2,3\end{cases}
\end{aligned}
$$

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. 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.

$$
\begin{aligned}
\Delta B s, c b_{S P_{t}}^{U S} & =\Delta R_{t}^{S P}+\Delta H s_{t}^{S P}-\Delta A_{t}^{S P}-\Delta B s, c b_{S P_{t}}^{S P} \\
\Delta B s, c b_{G E_{t}}^{G E} & =\Delta R_{t}^{G E}+\Delta H s_{t}^{G E}-\Delta A_{t}^{G E} \\
\Delta B d, c b_{S P_{t}}^{U S} & =\Delta B s, c b_{S P_{t}}^{U S} \cdot E 2_{t}+B s, c b_{S P_{t-1}}^{U S} \cdot \Delta E 2_{t}
\end{aligned}
$$

Another way in which this alternative institutional framework could be introduced is one in which instead of being fixed, the euro floats against both the German currency and the US dollar. This alternative should ensure that every external imbalances are automatically corrected via exchange rate adjustments and would free the central bank from the task of accumulating reserves in order to be able to sustain a certain parity. The drawback of this scenario is that one of the main reasons why the euro was introduced (i.e., avoid the permanent fluctuations of intra-European exchange rates, with the associated adverse effects on international trade) would no longer be holding. It is worth mentioning, however, that all the countries that stay in the Eurozone would still be having a fixed exchange rate arrangement (since they would share the same currency), which means that at least between them the benefits of a stable exchange rate on international trade would be being reaped.

Adapting the model to this possible alternative is quite simple. We just need to let the euro/German currency exchange rate, $E 3$, float. In this case, the euro-bond market would be automatically cleared via exchange rate movements and the central bank would ensure the equilibrium in its balance sheet through purchases/sales of domestic bonds.

## 4 Assessing the viability of a Multi-Speed Europe

Now that several alternatives in which a Multi-Speed Europe could work were presented, it is time to examine their viability. In order to do so, we make use of the four country stockflow consistent model adapted to the institutional framework of the Eurozone (which can be found in the annex) with the corresponding modifications associated to each specific proposal. The aim of this section is to show the behavior of some key macroeconomic variables in each of the scenarios described in the previous section. Each simulation should
produce results that susceptible to be interpreted in the lines of the underlying proposal. In the remaining of this section we present a comparative analysis of the different scenarios after a negative competitiveness shock in Spain (which represents the introduction of the euro, in line with the evidence shown by Duwicquet et al (2012)). The corresponding graphs can be found in the annex.

### 4.1 The current system

The adoption of the euro by Spain implied, as mentioned before, a loss of competitiveness due to the unfavorable parity at which it entered the Eurozone. This can be represented in our model through a sudden increase in the autonomous component of Spain's imports equation and a decrease in the same component of German imports. This shock has a direct effect on the trade balance (as shown in figure 11). As it was observed during the years that preceded the crisis (and during the crisis itself), the lack of self-correcting mechanisms prevented the Spanish economy from reaching external equilibrium. As a result, persistent trade (and current account) deficits started to cumulate, which in turn implied an increase in the stock of debt (as shown in figure 12) - in some cases, like Greece, the debt was mostly public, whereas in other cases, like Spain, the debt was held by the private sector.

The impact on the exchange rate of the euro vis-á-vis the rest of the currencies is null (figures 13 and 14), since what is lost by Spain is gained by Germany, thereby leaving the overall current account of the Eurozone unaffected. Recall that under the current system, even though Spain and Germany are different countries from a political point of view, the fact that they share a same currency and central bank imply that from a macro-financial perspective they are part of the same entity, i.e., the Eurozone. Thus, the determination of the euro-dollar exchange rate is explained by both, factors that concern Spain and Germany. In the case of a small open economy that issues its own currency, following some years of current account deficits the exchange rate would depreciate. But the particular configuration of the Eurozone prevented this from happening, since the current account deficits of the South were compensated by the surpluses of the North. In fact, most of these imbalances were internal and were compensated by financial flows going from the North to the South.

The contractive impact of the loss of competitiveness in Spain can be observed in figures 7 and 8, which plot Spain's GDP in national currency and dollars, respectively. This distinction is not relevant under the present system since, as it was mentioned in the previous paragraph, the euro remains constant. As a result of the deterioration of the trade balance Spain's GDP drops by $1 \%$ and does not recover since there are no mechanisms that allow for a reversal of the recessionary impact of joining the Eurozone. This produces a negative effect on the level of employment and on investment, given the Kaleckian nature of the investment function specified in the model.

### 4.2 The three euros scenario

The first proposal that is worth analyzing in one where national currencies are restored and made coexist with the euro. The advantage of this setting is that each country (or group of countries, which would be grouped according to their economic structure) would have more degrees of freedom to conduct its fiscal and monetary policy. This gain of economic sovereignty would not come at the cost of destroying the achievements of the process of economic integration that took place during the last decades. In other words, the benefits of the unification would be kept, while the drawbacks would be replaced for newly designed institutions.

The negative impact of the competitiveness shock on Spain's GDP can be observed in Figures 7 and 8 (in national currency and US dollars, respectively), most of which is explained by the deterioration of the trade balance (Figure 11). Figures 9 and 10 clearly show that the effect is the opposite in Germany, i.e., the trade balance goes into surplus, which in turn increases the rate of growth. Since the positive effects in Germany are balanced out by the negative effects in Spain, there is no impact in the rate of growth of the global economy. Thus, the global euro remains unchanged vis-á-vis the US dollar.

However, the negative competitiveness shock implies that Spain starts to accumulate current account deficits. After five consecutive periods of deficits, the Spanish currency is devalued against the global euro. This adjustment is also observed in the exchange rate vis-á-vis the US dollar (Figure 13). This devaluation restores Spain's competitiveness, bringing the trade balance into surplus and the growth rate to a positive path. It should be mentioned, however, that if GDP is measured in dollars Spain experiences a further decrease, since the size of the devaluation offsets the increase in production. As a result of the higher level of activity, the government starts running a surplus, which implies that the supply of bonds decreases (since the financing needs of the Treasury had gone down). This lower supply of bonds denominated in euros is translated into an appreciated global euro, which also appreciates the German currency (recall that the German currency is pegged to the global euro).

The adjustment of the Spanish currency erodes Germany's competitiveness to such an extent that some periods after the German currency needs to be devalued. This improves Germany's external position, but worsens that of Spain. As a result, after some periods the Spanish currency is devalued once again. These dynamics are repeated infinitely. This implies that this setting does to produce stable results over time. Thus, it is worth exploring other alternatives that may provide policy-makers with more convenient set-ups for the Eurozone.

### 4.3 The EMS scenario

Another way in which the Eurozone could be reformed to obtain a more sustainable institutional framework could consist of the adoption of some of the ideas embedded in the European Monetary System (EMS). Under this setting all national currencies were
pegged to the European Currency Unit (ECU), which was a basket currency that only played the role of unit account. Hence, one way of restoring the competitiveness of the South could be based on the split-up of the euro into a northern euro and a southern euro, both pegged to the ECU, which would be a basket currency of these latter. The ECU would play no role whatsoever, but being the reference to which each regional euro is pegged. The structure of the European Central Bank would change: it would be split into a north and a south division, each of which would carry out the monetary policy of each region. Under this setting, each European currency would float freely against the US dollar. Thus, the exchange rate would be determined by the net inflows of foreign exchange resulting from real and financial transactions with the US.

Let us now analyze the impact of the same shock but in a context in which Spain has the capacity to devalue its currency against the ECU (and hence to the German currency) after some periods of accumulating current account deficits. Figure 5 shows that the immediate impact of the competitiveness shock is such that the Spanish currency appreciates. At first sight, this would seem counterintuitive since Spain is running a trade and current account deficit. However, it should be noted that the shock has an overall positive effect on global economic growth, thereby increasing the wealth of the private sector of all the country blocks except for Spain. As a result, portfolio investment increases, including the demand for bonds issued by the Spanish government. As long as the financial account surplus resulting from the demand for Spanish assets is larger than the current account deficit that arises from the loss of competitiveness, the exchange rate will appreciate. This is, indeed, what explains the downward movement of the exchange rate that is observed between periods 50 and 54. A similar behavior is observed for the case of the German currency.

According to the institutional setting of this model, Spain is allowed to devalue its currency against the ECU if it registers five consecutive periods of current account deficits. Hence, in period 55 a devaluation of $2 \%$ vis-á-vis the ECU is introduced. This gain of competitiveness against Germany improves its trade surplus (figure 11) thereby inducing an increase in the domestic level of activity (figure 7). However, the devaluation implies a loss of purchasing power in dollar terms (figure 8). As regards Germany, the appreciation of its currency vis-á-vis the Spanish currency erodes its competitiveness, thereby reducing its trade, current account and fiscal surpluses. As a consequence, the German government increases the supply of bonds (or reduces the pace at which bonds are withdrawn from the market, in the case the government is running a surplus), which is reflected in a slight depreciation of the German currency (figure 14). The global appreciation of the dollar that results from these movements ends up bringing about a larger devaluation of the Spanish currency vis-á-vis the US dollar (compared to the devaluation against the German currency), which is observed in figure 13.

The main conclusion that is drawn from this experiment is that in a context in which Spain is allowed to devalue its currency with respect to the ECU (and hence, to the German currency as well) the initial loss of competitiveness can be easily corrected, thereby preventing first a process of unsustainable current account deficits financed by financial
account surpluses and, more importantly, the recessionary effect that the trade deficit may have on the level of activity and employment. Since in economics there is no free lunch, the beneficial effects of the devaluation of the Spanish currency would come at the cost of a lower purchasing power of the Spanish consumers. However, we consider that this drawback is a minor detail as long as the domestic level of activity is strong and the rate of unemployment remains at low levels.

### 4.4 The Eurozone-without-Germany scenario

As it was described in the previous section, a possible way out of the current crisis put forward by many economists consists of a euro without Germany (and probably some of the other surplus countries). This would imply that Germany would regain its monetary and exchange rate policy, while the rest of the members of the Eurozone would keep the euro as their currency. This is another way in which the competitiveness problem could be solved, but it implies a lower level of macroeconomic coordination compared to the previous scenario, i.e., a newer version of the EMS. There are, in principle, two relevant experiments to be tested: one in which the euro is pegged to the German currency and another in which both currencies float. Let us start with the first case.

If the euro is pegged to the German currency, after having accumulated five consecutive balance of payments deficits Spain is allowed to devalue its currency $2 \%$. It should be noted that in this case there is a slightly larger appreciation of the European currencies after the shock and before the adjustment of the Spanish currency. This is explained by the fact that in the present scenario the shock produces a relatively higher growth effect on Germany (compared to the EMS scenario) which in turn improves the German fiscal balance (through increased tax collection). As a result, the supply of bonds decreases. In a context where both the US and the rest of the world are growing and hence exhibiting an increasing stock of wealth, there will be an excess demand for German bonds. This disequilibrium is solved through an appreciation of the German currency, which is larger than in the EMS scenario since public finances are better in the current case. As regards the euro, since it is pegged to the German currency, it will follow the trajectory of the latter.

The evolution of the rest of the variables (GDP, trade balance and public debt) until the adjustment that takes place in period 55 is the same than the one observed in the EMS scenario. Once the Spanish currency is devalued, it is observed a positive effect on the trade balance (figure 11) and economic growth (figures 7). However, the increase in the level of activity is not enough to compensate for the loss of purchasing power due to the devaluation (figure 8). This initial adjustment of the exchange rate contributes to the stabilization of the public debt (figure 4), which goes back to the same level observed in the baseline scenario. It should be noted that following the expansion brought about by the devaluation there is a contraction of GDP (figure 7). This is explained by the positive income effect on imports, which slightly erodes the trade balance (figure 11). After this adjustment has been made, Spain's overall trade balance is in surplus but deteriorating. However, the bilateral trade balance with Germany is in deficit. From this situation, it
could be deduced that a $2 \%$ devaluation is not enough to bring the intra-European exchanges rates back to equilibrium. Thus, in period 63 a new devaluation is introduced, after which the same effects that had occurred after period 55 take place. The only difference is that in this case the new exchange rate parity is sufficient to restore Spain's initial competitiveness. Thenceforth, no more adjustments take place.

Compared to the two previous scenarios, the case where Germany leaves the Eurozone and the remaining countries (in this case, they are all represented by Spain) are pegged to the German currency seems to provide the whole system with a higher level of stability and sustainability in the medium-long run. Moreover, as shown in figure 9, this higher stability in the south does not come at the cost of a recession in Germany, which exhibits a lower level of growth with respect to the baseline scenario, but positive growth still. The conclusion that can be drawn from this exercise is that a situation in which Germany leaves the Eurozone and the south is allowed to adjust its currency to a level that is more consistent with its external equilibrium can be beneficial for all: the south would not find itself immersed in a long-lasting recession with associated high level of unemployment and Germany would grow at a slower pace but it would avoid playing the uncomfortable political role that is now playing. Compared to a pure fiscal union or a scenario where Germany finances the bail-outs of the deficit countries, the institutional setting that was described in these simulations would also save Germany a significant fiscal cost.

### 4.5 The fully-floating scenario

Finally, it is worth examining the impact of an institutional setting where Germany leaves the Eurozone and the euro floats freely (instead of being pegged to the German currency, like in the previous scenario or to a currency unit, like in the case of the EMS). As figure 13 shows, soon after the competitiveness shock the euro starts to depreciate as a result of the current account deficits. The opposite behavior is observed in the case of the German currency. As it may be intuited, an exchange rate arrangement where everything floats freely is prone to produce situations where the variables return to equilibrium. This is indeed what happens, since the initial trade deficit of Spain is progressively corrected as the euro depreciates. Eventually, the trade balance reaches equilibrium and the exchange rate stabilizes at the corresponding level.

The results of these simulations show that such a system would also be sustainable in the long run, but it may take an unacceptably long time for the economy to return to the initial equilibrium in terms of output and employment. Despite this important caveat, this scenario should also be considered as an alternative compared to the present situation which, according to our simulations and reality itself, cannot perpetuate for longer, unless the European governments are willing to allow for a degree of social and heterogeneity among Europe that, in principle, was not part of the objectives of the process of integration.

A final point that is worth analyzing is the one that links the debate on the reform of the European system with the discussion on the reform of the international monetary
system. As it is widely known, since the signing of the Bretton Woods agreements (an even after its abandonment in 1971) the US dollar has played the role of being the key currency. One of the problems that arises from an setting in which a certain country issues the currency that the rest use to trade and accumulate reserves is the so-called Triffin dilemma, which basically states that there is a incompatibility between pursuing economic policies oriented to achieve certain domestic targets (for instance, exhibiting a balanced current account) and, at the same time, providing the whole international system with the level of liquidity that is required to attain a certain growth rate.

Figure 15 shows that under the present situation and the case in which Germany leaves the Eurozone and the euro is floating, there is no impact in the external performance of the US. This seems reasonable since in the first case, what is lost by Spain is entirely gained by Germany, with no major effects for the US economy. In the second case, since the euro floats freely, exchange rates move in such a way that external equilibrium holds permanently. However, the cases of the EMS and where Germany leaves the Eurozone and the euro is pegged to the German currency (i.e., the two most beneficial cases for Spain) imply that the US bears part of the cost of the adjustment of the European periphery. This case would not be very different to the case of China, which for a long period of time kept an artificially undervalued exchange rate which explained an important part of the current account deficit that the US has been accumulating during the last decades.

## 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 of a split up of the euro into different possible institutional settings, 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. We find that there are different alternatives to solve the causes that, from our point of view, explain the external fragility to which southern countries were exposed (and that finally materialized under the form of the crisis that has been affecting these economies lately). Some of these alternatives, like the take-up of the EMS, imply a high level of policy coordination between member states. Other possibilities, like the case of Germany leaving the Eurozone, would come at the cost of the loss of many of the benefits of the process of integration as a whole. In the end, the task consists of finding an institutional setting that produces more balances results and that can be therefore sustained over time.

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## 6 Annex

## Full specification of the baseline model

To give the reader a general idea of the financial assets that enter the model we present the balance sheet of Spain, which also includes the ECB. In the next pages, the whole
social accounting matrix and flow of funds (which includes all the real and financial transactions that take place between the four countries of the model) are presented. Finally, the reader will find the description of each of the equations of the model.

Figure 6: Balance Sheet Spain

|  | Spain |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Households | Firms | Commercial Banks | Government | Central Bank | ECB |
| Capital |  | $+K_{t}^{S P}$ |  |  |  |  |
| Cash | $+H d_{t}^{S P}$ |  |  |  | $-H s, c b_{t}^{S P}$ |  |
| Deposits | $+M d_{t}^{S P}$ |  | $-M d_{t}^{S P}$ |  |  |  |
| Reserves |  |  | $+R_{t}^{S P}$ |  | $-R_{t}^{S P}$ |  |
| Advances |  |  | $-A_{t}^{S P}$ |  | $+A_{t}^{S P}$ |  |
| Loans |  | $-L_{t}^{S P}$ | $+L_{t}^{S P}$ |  |  |  |
| Bonds ${ }^{\text {SP }}$ |  |  | $+B d, b_{S P_{t}}^{S P}$ | $-B s_{S P_{t}}$ | $+B d, c b_{S P_{\mathrm{t}}}^{S P}$ |  |
| Bonds ${ }^{\text {GE }}$ |  |  |  |  |  |  |
| Bonds ${ }^{\text {EZ }}$ |  |  | $+B d, b G E$ | $-B s_{S P_{t}}^{S P}$ |  |  |
| Bonds ${ }^{\text {US }}$ |  |  | $+B d, b_{S P_{t}}^{U S}$ |  | $+B d, c b_{S P_{\mathrm{t}}}^{U S}$ | $+B d_{E C B_{t}}^{U S}$ |
| Bonds ${ }^{\text {RW }}$ |  |  | $+B d, b_{S P_{t}}^{R W}$ |  |  |  |
| Wealth | $+V h_{t}^{S P}$ | $+V f_{t}^{S P}$ | $+V b_{t}^{S P}$ | $-B s_{S P} S_{t}$ | $+V c b_{t}^{S P}$ | $+V_{t}^{E C B}$ |


|  | Table 1：Matrix of Flows United States |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Households | Firm |  | Com．B |  | Government | Centr |  |  |
|  |  | Current | Capital | Current | Capital |  | Current | Capital |  |
| Consumption | $-C_{t}^{U S}$ | $C_{t}^{U S}$ |  |  |  |  |  |  |  |
| Investment |  | $I_{t}^{U S}$ | $-I_{t}^{U S}$ |  |  |  |  |  |  |
| Gov．Spending |  | $G_{t}^{U S}$ |  |  |  | $-G_{t}^{U S}$ |  |  |  |
| Net Exports |  | $N X_{t}^{U S}$ |  |  |  |  |  |  |  |
| Wages | $W_{t}^{U S}$ | $-W_{t}^{U S}$ |  |  |  |  |  |  |  |
| Taxes | $-T h_{t}^{U S}$ | $-T f_{t}^{U S}$ |  |  |  | $T_{t}^{U S}$ |  |  |  |
| Int．Deposits | $r d_{t-1}^{U S} \cdot M d_{t-1}^{U S}$ |  |  | $-r d_{t-1}^{U S} \cdot M d_{t-1}^{U S}$ |  |  |  |  |  |
| Int．Loans |  | $-r l_{t-1}^{U S} . L d_{t-1}^{U S}$ |  | $r l_{t-1}^{U S} \cdot L d_{t-1}^{U S}$ |  |  |  |  |  |
| Int．Reserves |  |  |  | $r s_{t-1}^{U S} \cdot R_{t-1}^{U S}$ |  |  | $-r s_{t-1}^{U S} \cdot R_{t-1}^{U S}$ |  |  |
| Int．Advances |  |  |  | $r_{t-1}^{U S} \cdot A_{t-1}^{U S}$ |  |  | $r_{t-1}^{U S} \cdot A_{t-1}^{U S}$ |  | $\stackrel{\widetilde{2}}{4}$ |
| Int．Bonds ${ }^{\text {US }}$ |  |  |  | $r b_{t-1}^{U S} \cdot B d, b_{U S}^{U S} S_{t-1}$ |  | $-r b_{t-1}^{U S} \cdot B s_{t-1}^{U S}$ |  |  | 炎 |
| Int．Bonds ${ }^{\text {RW }}$ |  |  |  | $r b_{t-1}^{R W} \cdot B d, b_{U S}^{R W} S_{t-1}$ |  |  |  |  | 居 |
| Int．Bonds ${ }^{\text {SP }}$ |  |  |  | $r b_{t-1}^{S P} \cdot B d, b_{U S S_{t-1}}^{S P}$ |  |  |  |  | 星 |
| Int．Bonds ${ }^{\text {GE }}$ |  |  |  | $r b_{t-1}^{G E} \cdot B d, b_{U S}^{G E}{ }_{t-1}$ |  |  |  |  | ${ }_{0}$ |
| Dividends |  |  |  |  |  |  |  |  |  |
| Profits |  | $-P f^{U S}$ | $P f^{U S}$ | $-P b^{U S}$ |  | $P c b^{U S}+P b^{U S}$ | $-P c b^{U S}$ |  |  |
| $\Delta$ Cash | $-\Delta H d^{U S}$ |  |  |  |  |  |  | $\Delta H s^{U S}$ |  |
| $\Delta$ Deposits | $-\Delta M d^{U S}$ |  |  |  | $\Delta M d^{U S}$ |  |  |  |  |
| $\Delta$ Loans |  |  | $\Delta L^{U S}$ |  | $-\Delta L^{U S}$ |  |  |  |  |
| $\Delta$ Reserves |  |  |  |  | $-\Delta R^{U S}$ |  |  | $\Delta R^{U S}$ |  |
| $\triangle$ Advances |  |  |  |  | $\Delta A^{U S}$ |  |  | $-\Delta A^{U S}$ |  |
| $\Delta$ Bonds $^{\text {US }}$ |  |  |  |  | $-\Delta B d, b_{U S}^{U S}$ | $\Delta B s^{U S}$ |  | $-\Delta B d, c b_{U S}^{U S}$ |  |
| $\Delta$ Bonds $^{\text {RW }}$ |  |  |  |  | $-\triangle B d, b_{U S}^{R W}$ |  |  |  |  |
| $\Delta$ Bonds $^{\text {SP }}$ |  |  |  |  | $-\Delta B d, b_{U S}^{S P}$ |  |  |  |  |
| $\Delta$ Bonds $^{\text {GE }}$ |  |  |  |  | $-\Delta B d, b_{U S}^{G E}$ |  |  |  |  |
| Total | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |  |

Table 1: Matrix of Flows

|  | Rest of the World |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Households | Firms |  | Com.B |  | Government | Central |  |  |
|  |  | Current | Capital | Current | Capital |  | Current | Capital |  |
| Consumption | $-C_{t}^{R W}$ | $C_{t}^{R W}$ |  |  |  |  |  |  |  |
| Investment |  | $I_{t}^{R W}$ | $-I_{t}^{R W}$ |  |  |  |  |  |  |
| Gov.Spending |  | $G_{t}^{R W}$ |  |  |  | $-G_{t}^{R W}$ |  |  |  |
| Net Exports |  | $N X_{t}^{R W}$ |  |  |  |  |  |  |  |
| Wages | $W_{t}^{R W}$ | $-W_{t}^{R W}$ |  |  |  |  |  |  |  |
| Taxes | $-T h_{t}^{R W}$ | $-T f_{t}^{R W}$ |  |  |  | $T_{t}{ }^{R W}$ |  |  |  |
| Int.Deposits | $r d_{t-1}^{R W} \cdot M d_{t-1}^{R W}$ |  |  | $-r d_{t-1}^{R W} \cdot M d_{t-1}^{R W}$ |  |  |  |  |  |
| Int.Loans |  | $-r l_{t-1}^{R W} . L d_{t-1}^{R W}$ |  | $r_{t-1}^{R W} \cdot L d_{t-1}^{R W}$ |  |  |  |  |  |
| Int.Reserves |  |  |  | ${ }_{r s} s_{t-1}^{R W} \cdot R_{t-1}^{R W}$ |  |  | $-r s_{t-1}^{R W} \cdot R_{t-1}^{R W}$ |  |  |
| Int.Advances |  |  |  | ${ }_{-r_{t-1}^{R W}}^{R W} \cdot A_{t-1}^{R W}$ |  |  | $r_{t-1}^{R W} \cdot A_{t-1}^{R W}$ |  | $\stackrel{\text { a }}{ }$ |
| Int.Bonds ${ }^{\text {US }}$ |  |  |  | $r b_{t-1}^{U S} \cdot B d, b_{R W_{t-1}}^{U S}$ |  |  |  |  | 范 |
| Int.Bonds ${ }^{R W}$ |  |  |  | ${ }^{\text {r }} b_{t-1}^{R W} \cdot B d, b_{R W_{t-1}}^{R W}$ |  | $-r b_{t-1}^{R W} \cdot B s_{t-1}^{R W}$ | ${ }^{\text {r }} b_{t-1}^{R W} \cdot B d, c b_{R W_{t-1}}^{R W}$ |  | \% |
| Int.Bonds ${ }^{\text {SP }}$ |  |  |  | $r_{t-1}^{S P} \cdot B d, b_{R W_{t-1}}^{S P}$ |  |  |  |  | , |
| Int.Bonds ${ }^{\text {GE }}$ |  |  |  | $r_{t-1}^{G E} \cdot B d, b_{R W_{t-1}}^{G E}$ |  |  |  |  | O |
| Dividends |  |  |  |  |  |  |  |  |  |
| Profits |  | $-P f^{R W}$ | $P f^{R W}$ | $-P b^{R W}$ |  | $P c b^{R W}+P b^{R W}$ | $-P c b^{R W}$ |  |  |
| $\Delta C a s h$ | $-\Delta H d^{R W}$ |  |  |  |  |  |  | $\Delta H s^{R W}$ |  |
| $\Delta$ Deposits | $-\Delta M d^{R W}$ |  |  |  | $\Delta M d^{R W}$ |  |  |  |  |
| $\Delta$ Loans |  |  | $\Delta L^{R W}$ |  | $-\Delta L^{R W}$ |  |  |  |  |
| $\Delta$ Reserves |  |  |  |  | $-\Delta R^{R W}$ |  |  | $\Delta R^{R W}$ |  |
| $\triangle$ Advances |  |  |  |  | $\Delta A^{R W}$ |  |  | $-\Delta A^{R W}$ |  |
| $\Delta$ Bonds $^{\text {US }}$ |  |  |  |  | $-\Delta B d, b_{R W}^{U S}$ |  |  | $-\Delta B d, c b_{R W}^{U S}$ |  |
| $\Delta$ Bonds $^{\text {RW }}$ |  |  |  |  | $-\Delta B d, b_{R W}^{R W}$ | $\Delta B s^{R W}$ |  | $-\Delta B d, c b_{R W}^{R W}$ |  |
| $\Delta$ onds $^{\text {SP }}$ |  |  |  |  | $-\Delta B d, b_{R W}^{S P}$ |  |  |  |  |
| $\Delta$ Bonds ${ }^{\text {GE }}$ |  |  |  |  | $-\Delta B d, b_{R W}^{G E}$ |  |  |  |  |
| Total | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |  |

Table 1: Matrix of Flows

|  | Spain |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Households | Firm |  | Com.B |  | Government | Central | Bank |  |
|  |  | Current | Capital | Current | Capital |  | Current | Capital |  |
| Consumption | $-C_{t}^{S P}$ | $C_{t}^{S P}$ |  |  |  |  |  |  |  |
| Investment |  | $I_{t}^{S P}$ | $-I_{t}^{S P}$ |  |  |  |  |  |  |
| Gov.Spending |  | $G_{t}^{S P}$ |  |  |  | $-G_{t}^{S P}$ |  |  |  |
| Net Exports |  | $N X_{t}^{S P}$ |  |  |  |  |  |  |  |
| Wages | $W_{t}^{S P}$ | $-W_{t}^{S P}$ |  |  |  |  |  |  |  |
| Taxes | $-T h_{t}^{S P}$ | $-T f_{t}^{S P}$ |  |  |  | $T_{t}^{S P}$ |  |  |  |
| Int.Deposits | $r d_{t-1}^{S P} \cdot M d_{t-1}^{S P}$ |  |  | $-r d_{t-1}^{S P} \cdot M d_{t-1}^{S P}$ |  |  |  |  |  |
| Int.Loans |  | $-r l_{t-1}^{S P} . L d_{t-1}^{S P}$ |  | $r l_{t-1}^{R W} \cdot L d_{t-1}^{R W}$ |  |  |  |  |  |
| Int.Reserves |  |  |  | $r s_{t-1}^{S P} \cdot R_{t-1}^{S P}$ |  |  | $-r s_{t-1}^{S P} \cdot R_{t-1}^{S P}$ |  |  |
| Int.Advances |  |  |  | ${ }_{-r_{t-1}^{G E} \cdot A_{t-1}^{S P}}$ |  |  | $r_{t-1}^{G E} \cdot A_{t-1}^{S P}$ |  | \% |
| Int.Bonds ${ }^{\text {US }}$ |  |  |  | $r b_{t-1}^{U S} \cdot B d, b_{S P_{t-1}}^{U S}$ |  |  | $r b_{t-1}^{U S} \cdot B d, c b_{S P_{t-1}}^{U S}$ |  | $\stackrel{\text { d }}{\text { d }}$ |
| Int.Bonds ${ }^{R W}$ |  |  |  | $r b_{t-1}^{R W} \cdot B d, b_{S P_{t-1}{ }^{R W}}$ |  |  |  |  | \% |
| Int.Bonds ${ }^{\text {SP }}$ |  |  |  | $r b_{t-1}^{S P} \cdot B d, b_{S P_{t-1}}^{S P}$ |  | $-r b_{t-1}^{S P} . B s_{t-1}^{S P}$ | $r b_{t-1}^{S P} . B d, c b_{S P_{t-1}}^{S P}$ |  | . |
| Int.Bonds ${ }^{\text {GE }}$ |  |  |  | $r b_{t-1}^{G E} \cdot B d, b_{S P_{t-1}}^{G E}$ |  |  |  |  | O |
| Dividinds |  |  |  |  |  |  |  |  |  |
| Profits |  | $-P f^{S P}$ | $P f^{S P}$ | $-P b^{S P}$ |  | $P c b^{S P}+\alpha P^{E C B}+P b^{S P}$ | $-P c b^{S P}$ |  |  |
| $\Delta$ Cash | $-\Delta H d^{S P}$ |  |  |  |  |  |  | $\Delta H s, c b^{S P}$ |  |
| $\Delta$ Deposits | $-\Delta M d^{S P}$ |  |  |  | $\Delta M d^{S P}$ |  |  |  |  |
| $\Delta$ Loans |  |  | $\Delta L^{S P}$ |  | $-\Delta L^{S P}$ |  |  |  |  |
| $\Delta$ Reserves |  |  |  |  | $-\Delta R^{S P}$ |  |  | $\Delta R^{S P}$ |  |
| $\Delta$ Advances |  |  |  |  | $\Delta A^{S P}$ |  |  | $-\Delta A^{S P}$ |  |
| $\Delta$ Bonds $^{\text {U }}$ S |  |  |  |  | $-\Delta B d, b_{S P}^{U S}$ |  |  |  |  |
| $\Delta$ Bonds ${ }^{\text {RW }}$ |  |  |  |  | $-\Delta B d, b_{S P}^{R W}$ |  |  |  |  |
| $\Delta$ Bonds $^{\text {SP }}$ |  |  |  |  | $-\triangle B d, b_{S P}^{S P}$ | $\Delta B s^{S P}$ |  | $-\Delta B d, c b_{S P}^{S P}$ |  |
| $\Delta$ Bonds $^{\text {GE }}$ |  |  |  |  | $-\Delta B d, b_{S P}^{G E}$ |  |  |  |  |
| Total | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |  |


|  | Table 1: Matrix of Flows |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Germany |  |  |  |  |  |  |  | ECB |  | Total |
|  | Households | Firm |  | Com.B |  | Government | Central | ank |  |  |  |
|  |  | Current | Capital | Current | Capital |  | Current | Capital | Current | Capital |  |
| C | $-C_{t}^{G E}$ | $C_{t}^{G E}$ |  |  |  |  |  |  |  |  | 0 |
| I |  | $I_{t}^{G E}$ | $-I_{t}^{G E}$ |  |  |  |  |  |  |  | 0 |
| G |  | $G_{t}^{G E}$ |  |  |  | $-G_{t}^{G E}$ |  |  |  |  | 0 |
| $X-I M$ |  | $N X_{t}^{G E}$ |  |  |  |  |  |  |  |  | 0 |
| W | $W_{t}^{G E}$ | $-W_{t}^{G E}$ |  |  |  |  |  |  |  |  | 0 |
| T | $-T h_{t}^{G E}$ | $-T f_{t}^{G E}$ |  |  |  | $T_{t}^{G E}$ |  |  |  |  | 0 |
| rd.Md | $r d_{t-1}^{G E} \cdot M d_{t-1}^{G E}$ |  |  | $-r d_{t-1}^{G E} \cdot M d_{t-1}^{G E}$ |  |  |  |  |  |  | 0 |
| $r l . L$ |  | $-r l_{t-1}^{G E} \cdot L d_{t-1}^{G E}$ |  | $r l_{t-1}^{G E} \cdot L d_{t-1}^{G E}$ |  |  |  |  |  |  | 0 |
| $r s . R$ |  |  |  | $r s_{t-1}^{G E} \cdot R_{t-1}^{G E}$ |  |  | $-r s_{t-1}^{G E} \cdot R_{t-1}^{G E}$ |  |  |  | 0 |
| $r . A$ |  |  |  | ${ }_{-r t-1}^{G E} \cdot A_{t-1}^{G E}$ |  |  | $r_{t-1}^{G E} \cdot A_{t-1}^{G E}$ |  |  |  | 0 |
| $r b^{U S} \cdot B^{U S}$ |  |  |  | $r b_{t-1}^{U S} \cdot B d, b_{G E_{t-1}}^{U S}$ |  |  | $r b_{t-1}^{U S} . B d, c b_{G E_{t-1}}^{U S}$ |  | $r b_{t-1}^{U S} \cdot B d_{E C B_{t-1}}^{U S}$ |  | 0 |
| $r b^{R W} \cdot B^{R W}$ |  |  |  | $r b_{t-1}^{R W} \cdot B d, b_{G E_{t-1}}^{R W}$ |  |  |  |  |  |  | 0 |
| $r b^{S P} \cdot B^{S P}$ |  |  |  | $r b_{t-1}^{S P} \cdot B d, b_{G E_{t-1}}^{S P}$ |  |  |  |  | $r b_{t-1}^{S P} \cdot B d_{E C B_{t-1}}^{S P}$ |  | 0 |
| $r b^{G E} \cdot B^{G E}$ |  |  |  | $r b_{t-1}^{G E} \cdot B d, b_{G E_{t-1}}^{G E}$ |  | $-r b_{t-1}^{G E} \cdot B s_{t-1}^{G E}$ | $r b_{t-1}^{G E} . B d, c b_{G E_{t-1}}^{G E}$ |  | $r b_{t-1}^{G E} \cdot B d_{E C B_{t-1}}^{G E}$ |  | 0 |
|  |  |  |  |  |  |  | $r_{t-1}^{G E} \cdot T G 2_{t-1}^{G E}$ |  | $r_{t-1}^{G E} \cdot T G 2_{t-1}^{E C B}$ |  |  |
| Profits |  | $-P f^{G E}$ | $P f^{G E}$ | $-P b^{G E}$ |  | + $Z$ | $-P c b^{G E}$ |  | $-P c b^{E C B}$ |  | 0 |
| $\Delta H$ | $-\Delta H d^{G E}$ |  |  |  |  |  |  | $\Delta H s, c b^{G E}$ |  | $\Delta H s^{E C B}$ | 0 |
| $\Delta M d$ | $-\Delta M d^{G E}$ |  |  |  | $\Delta M d^{G E}$ |  |  |  |  |  | 0 |
| $\Delta L$ |  |  | $\Delta L^{G E}$ |  | $-\Delta L^{G E}$ |  |  |  |  |  | 0 |
| $\Delta R$ |  |  |  |  | $-\Delta R^{G E}$ |  |  | $\Delta R^{G E}$ |  |  | 0 |
| $\Delta A$ |  |  |  |  | $\Delta A^{G E}$ |  |  | $-\Delta A^{G E}$ |  |  | 0 |
| $\Delta B^{U S}$ |  |  |  |  | $-\triangle B d, b_{G E}^{U S}$ |  |  |  |  |  | 0 |
| $\Delta B^{S P}$ |  |  |  |  | $-\Delta B d, b_{G E}^{S P}$ |  |  |  |  |  | 0 |
| $\Delta B^{G E}$ |  |  |  |  | $-\Delta B d, b_{G E}^{G E}$ | $\Delta B s^{G E}$ |  | $-\Delta B d, c b_{G E}^{G E}$ |  |  | 0 |
| $\begin{gathered} \text { Total } \\ Z=P c b^{G E}+(1 \end{gathered}$ | $\begin{gathered} 0 \\ \text { a) } P^{E C B}+P b^{C} \end{gathered}$ | $0$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

## The baseline model

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.

$$
\begin{gathered}
1 \$=E 1 \cdot G E=E 2 \cdot S P=E 4 \#=E 9 . € \\
1 G E=E 3 \cdot S P=E 6 \# \\
1 \#=E 5 \cdot S P
\end{gathered}
$$

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.

## 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, $I M_{t}$ ). Thus, our model is one in which economic growth is demand-led.

$$
\begin{equation*}
Y_{t}^{i}=C_{t}^{i}+I_{t}^{i}+G_{t}^{i}+X_{t}^{i}-I M_{t}^{i} \quad \forall i=U S, R W, S P, G E \tag{1-4}
\end{equation*}
$$

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).

$$
\begin{equation*}
G_{t}^{i}=G o_{t}^{i}+\left(1+g^{i}\right) \cdot G_{t-1}^{i} \quad \forall i=U S, R W, S P, G E \tag{5-8}
\end{equation*}
$$

Hence, government spending in each period, $G_{t}$, is given by a constant term, $G o_{t}$, 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., $\sum X^{i} \forall i=U S, R W, S P, G E$ ) has to be equal to total imports (i.e., $\sum I M^{i} \forall i=U S, R W, S P, G E$ ). 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).

$$
\begin{align*}
& \log \left(I M_{U S}^{G E}\right)=\mu_{0}^{U S}+\mu_{1}^{U S} \cdot \log \left(Y_{t}^{U S}\right)+\mu_{2}^{U S} \cdot \log \left(E 1_{t}\right)+\mu_{3}^{U S} \cdot \log \left(\frac{1}{E 4_{t}} \frac{1}{E 2_{t}}\right)  \tag{9}\\
& \log \left(I M_{U S}^{S P}\right)=\mu_{4}^{U S}+\mu_{5}^{U S} \cdot \log \left(Y_{t}^{U S}\right)+\mu_{6}^{U S} \cdot \log \left(E 2_{t}\right)+\mu_{7}^{U S} \cdot \log \left(\frac{1}{E 1_{t}} \frac{1}{E 4_{t}}\right)  \tag{10}\\
& \log \left(I M_{U S}^{R W}\right)=\mu_{8}^{U S}+\mu_{9}^{U S} \cdot \log \left(Y_{t}^{U S}\right)+\mu_{10}^{U S} \cdot \log \left(E 4_{t}\right)+\mu_{11}^{U S} \cdot \log \left(\frac{1}{E 1_{t}} \frac{1}{E 2_{t}}\right)  \tag{11}\\
& \log \left(I M_{G E}^{U S}\right)=\mu_{0}^{G E}+\mu_{1}^{G E} \cdot \log \left(Y_{t}^{G E}\right)+\mu_{2}^{G E} \cdot \log \left(\frac{1}{E 1_{t}}\right)+\mu_{3}^{G E} \cdot \log \left(\frac{1}{E 3_{t}} \cdot \frac{1}{E 6_{t}}\right)  \tag{12}\\
& \log \left(I M_{G E}^{S P}\right)=\mu_{4}^{G E}+\mu_{5}^{G E} \cdot \log \left(Y_{t}^{G E}\right)+\mu_{6}^{G E} \cdot \log \left(E 3_{t}\right)+\mu_{7}^{G E} \cdot \log \left(\frac{1}{E 1_{t}} \cdot \frac{1}{E 6_{t}}\right)  \tag{13}\\
& \log \left(I M_{G E}^{R W}\right)=\mu_{8}^{G E}+\mu_{9}^{G E} \cdot \log \left(Y_{t}^{G E}\right)+\mu_{10}^{G E} \cdot \log \left(E 6_{t}\right)+\mu_{11}^{G E} \cdot \log \left(\frac{1}{E 3_{t}} \cdot E 1_{t}\right)  \tag{14}\\
& \log \left(I M_{S P}^{U S}\right)=\mu_{0}^{S P}+\mu_{1}^{S P} \cdot \log \left(Y_{t}^{S P}\right)+\mu_{2}^{S P} \cdot \log \left(E 2_{t}\right)+\mu_{3}^{S P} \cdot \log \left(E 3_{t} \cdot E 5_{t}\right)  \tag{15}\\
& \log \left(I M_{S P}^{G E}\right)=\mu_{4}^{S P}+\mu_{5}^{S P} \cdot \log \left(Y_{t}^{S P}\right)+\mu_{6}^{S P} \cdot \log \left(E 3_{t}\right)+\mu_{3}^{S P} \cdot \log \left(E 2_{t} \cdot E 5_{t}\right)  \tag{16}\\
& \log \left(I M_{S P}^{R W}\right)=\mu_{8}^{S P}+\mu_{9}^{S P} \cdot \log \left(Y_{t}^{S P}\right)+\mu_{10}^{S P} \cdot \log \left(E 5_{t}\right)+\mu_{11}^{S P} \cdot \log \left(E 2_{t} \cdot E 3_{t}\right)  \tag{17}\\
& \log \left(I M_{R W}^{U S}\right)=\mu_{0}^{R W}+\mu_{1}^{R W} \cdot \log \left(Y_{t}^{R W}\right)+\mu_{2}^{R W} \cdot \log \left(E 4_{t}\right)+\mu_{3}^{R W} \cdot \log \left(\frac{1}{E 5_{t}} \cdot E 6_{t}\right)  \tag{18}\\
& \log \left(I M_{R W}^{S P}\right)=\mu_{4}^{R W}+\mu_{5}^{R W} \cdot \log \left(Y_{t}^{R W}\right)+\mu_{6}^{R W} \cdot \log \left(\frac{1}{E 5_{t}}\right)+\mu_{7}^{R W} \cdot \log \left(E 4_{t} \cdot E 6_{t}\right)  \tag{19}\\
& \log \left(I M_{R W}^{G E}\right)=\mu_{8}^{R W}+\mu_{9}^{R W} \cdot \log \left(Y_{t}^{R W}\right)+\mu_{10}^{R W} \cdot \log \left(E 6_{t}\right)+\mu_{11}^{R W} \cdot \log \left(E 4_{t} \cdot \frac{1}{E 5_{t}}\right) \tag{20}
\end{align*}
$$

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

$$
\begin{equation*}
I M_{t}^{i}=\sum I M_{-i_{t}}^{i} \quad \forall i=U S, R W, G E, S P \tag{21-24}
\end{equation*}
$$

As it was mentioned before, a trade flow is the mirror of the other. Thus, $I M_{U S}^{R W}$ has to be equal to $X_{R W}^{U S}$. Since it is required that every trade flow is written in the domestic currency of the corresponding country, the following conversion is applied.

$$
\begin{align*}
& X_{U S_{t}}^{G E}=I M_{G G t}^{U S} \cdot\left(1 / E 1_{t}\right)  \tag{25}\\
& X_{U S_{t}}^{R W}=I M_{R W_{t}}^{U S} \cdot\left(1 / E 4_{t}\right)  \tag{26}\\
& X_{U S_{t}}^{S P}=I M_{S P_{t}}^{U S} \cdot\left(1 / E 2_{t}\right)  \tag{27}\\
& X_{G E_{t}}^{U S}=I M_{U S_{t}}^{G E} \cdot E 1_{t}  \tag{28}\\
& X_{G E_{t}}^{S P}=I M_{S P_{t}}^{G E} \cdot\left(1 / E 3_{t}\right)  \tag{29}\\
& X_{G E_{t}}^{R W}=I M_{R W_{t}}^{G E} \cdot\left(1 / E 6_{t}\right)  \tag{30}\\
& X_{S P_{t}}^{U S}=I M_{U S_{t}}^{S P} \cdot E 2_{t}  \tag{31}\\
& X_{S P_{t}}^{G E}=I M_{G E_{t}}^{S P} \cdot E 3_{t}  \tag{32}\\
& X_{S P_{t}}^{R W}=I M_{R W_{t}}^{S P} \cdot E 5_{t}  \tag{33}\\
& X_{R W_{t}}^{U S}=I M_{U S_{t}}^{R W} \cdot E 4_{t}  \tag{34}\\
& X_{R W_{t}}^{G E}=I M_{G E_{t}}^{R W} \cdot E 6_{t}  \tag{35}\\
& X_{R W_{t}}^{S P}=I M_{S P_{t}}^{R W} \cdot\left(1 / E 5_{t}\right) \tag{36}
\end{align*}
$$

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

$$
\begin{equation*}
X_{t}^{i}=\sum X_{i_{t}}^{-i} \quad \forall i=U S, R W, G E, S P \tag{37-40}
\end{equation*}
$$

## 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 $\psi$, which represents the share of wages out of total income.

$$
\begin{equation*}
W_{t}^{i}=\psi^{i} \cdot Y_{t}^{i} \quad \forall i=U S, R W, G E, S P \tag{41-44}
\end{equation*}
$$

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, $M d_{t}$, which earn a yield, $r d_{t}$, and cash, $H d_{t}$, which earns no yield whatsoever. Regarding tax payments, in this model, it is assumed that a fraction $\theta_{h}$ of total income is levied, leading to the total amount of taxes that households pay, $T h_{t}$.

$$
\begin{equation*}
T h_{t}^{U S}=\theta_{h}^{U S} \cdot\left(W_{t}^{U S}+r d_{t-1}^{U S} \cdot M d_{t-1}^{U S}\right) \quad \forall i=U S, R W, G E, S P \tag{45-48}
\end{equation*}
$$

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:

$$
\begin{equation*}
Y D_{t}^{i}=W_{t}^{i}+r d_{t-1}^{i} \cdot M d_{t-1}^{i}-T h_{t}^{i} \quad \forall i=U S, R W, G E, S P \tag{49-52}
\end{equation*}
$$

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 $\alpha 1>\alpha 2$.

$$
\begin{equation*}
C_{t}^{i}=\alpha 1^{i} . Y D_{t}^{i}+\alpha 2^{i} . V h_{t-1}^{i} \quad \forall i=U S, R W, G E, S P \tag{53-56}
\end{equation*}
$$

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.

$$
\begin{equation*}
\Delta V h_{t}^{i}=Y D_{t}^{i}-C_{t}^{i} \quad \forall i=U S, R W, G E, S P \tag{57-60}
\end{equation*}
$$

Households can hold their wealth in two kinds of assets: bank deposits and cash, which were previously defined as $M d_{t}$ and $H d_{t}$. We assume that households keep a constant share of their wealth, $\varphi$, 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.

$$
\begin{array}{ll}
H d_{t}^{i}=\varphi^{i} \cdot V h_{t}^{i} & \forall i=U S, R W, G E, S P \\
M d_{t}^{i}=V h_{t}^{i}-H d_{t}^{i} & \forall i=U S, R W, G E, S P \tag{65-68}
\end{array}
$$

## 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:

$$
\begin{equation*}
P_{t}^{i}=Y_{t}^{i}-W_{t}^{i} \quad \forall i=U S, R W, G E, S P \tag{69-72}
\end{equation*}
$$

However, $P_{t}$ are nothing but gross profits. Firms also have to pay interests on the loans taken in the past. Thus, net profits, $P f_{t}$, result from the difference between gross profits and the sum of interest payments and taxes.

$$
\begin{array}{ll}
P f_{t}^{i}=P_{t}^{i}-r l_{t-1}^{i} \cdot L_{t-1}^{i}-T f_{t}^{i} & \forall i=U S, R W, G E, S P \\
T f_{t}^{i}=\theta_{f}^{i} \cdot\left(P_{t}^{i}-r l_{t-1}^{i} \cdot L_{t-1}^{i}\right) & \forall i=U S, R W, G E, S P \tag{77-80}
\end{array}
$$

The investment decision of the firms will be assumed to take the form of a Kaleckiantype 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.

$$
\begin{equation*}
\frac{I_{t}^{i}}{K_{t-1}^{i}}=z_{0}^{i}+z_{1}^{i} \cdot \frac{P f_{t}^{i}}{K_{t-1}^{i}}-z_{2}^{i} \cdot \frac{r l_{t-1}^{i} \cdot L_{t-1}^{i}}{K_{t-1}^{i}}+z_{3}^{i} \cdot u_{t-1}^{i} \quad \forall i=U S, R W, G E, S P \tag{81-84}
\end{equation*}
$$

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:

$$
\begin{equation*}
u_{t}^{i}=\frac{Y_{t}^{i}}{K_{t}^{i}} \cdot v^{i} \quad \forall i=U S, R W, G E, S P \tag{85-88}
\end{equation*}
$$

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

$$
\begin{equation*}
K_{t}^{i}=\left(1-\delta^{i}\right) \cdot K_{t-1}^{i}+I_{t}^{i} \quad \forall i=U S, R W, G E, S P \tag{89-92}
\end{equation*}
$$

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.

$$
\begin{equation*}
\Delta L_{t}^{i}=I_{t}^{i}-P f_{t}^{i} \quad \forall i=U S, R W, G E, S P \tag{93-96}
\end{equation*}
$$

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).

$$
\begin{equation*}
V f_{t}^{i}=K_{t}^{i}-L_{t}^{i} \quad \forall i=U S, R W, G E, S P \tag{97-100}
\end{equation*}
$$

## 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.

$$
\begin{equation*}
T_{t}^{i}=T h_{t}^{i}+T f_{t}^{i}+P b_{t}^{i} \quad \forall i=U S, R W, G E, S P \tag{101-104}
\end{equation*}
$$

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 issues. Hence, supply of government bonds can be defined as follows:

$$
\begin{align*}
& \Delta B s_{t}^{i}=G_{t}^{i}-T_{t}^{i}+r b_{t-1}^{i} \cdot B s_{t-1}^{i}-P c b_{t}^{i} \forall i=U S, R W  \tag{105-106}\\
& \Delta B s_{t}^{S P}=G_{t}^{S P}-T_{t}^{S P}+r b_{t-1}^{S P} \cdot B s_{t-1}^{S P}-P c b_{t}^{S P}  \tag{107}\\
& \Delta B s_{t}^{G E}=G_{t}^{G E}-T_{t}^{G E}+r b_{t-1}^{G E} \cdot B s_{t-1}^{G E}-P c b_{t}^{G E} \tag{108}
\end{align*}
$$

## 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 longterm 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 approach proposed by Daigle and Lavoie (2009).

$$
\begin{align*}
& B d, b_{U S t}^{G E}=\left(M_{t}^{U S}-R_{t}^{U S}\right) \cdot\left(\gamma_{10}^{U S}+\gamma_{11}^{U S} \cdot r b_{t}^{U S}+\gamma_{12}^{U S} \cdot\left(r b_{t}^{G E}+\Delta \frac{1}{E 1_{e_{t}}^{U S}}\right)\right. \\
& \left.+\gamma_{13}^{U S} \cdot\left(r b_{t}^{S P}+\Delta \frac{1}{E 2_{e_{t}}^{U S}}\right)+\gamma_{14}^{U S} \cdot\left(r b_{t}^{R W}+\Delta \frac{1}{E 4_{e_{t}}^{U S}}\right)\right)  \tag{109}\\
& B d, b_{U S_{t}}^{S P}=\left(M_{t}^{U S}-R_{t}^{U S}\right) \cdot\left(\gamma_{20}^{U S}+\gamma_{21}^{U S} \cdot r b_{t}^{U S}+\gamma_{22}^{U S} \cdot\left(r b_{t}^{G E}+\Delta \frac{1}{E 1_{e_{t}}^{U S}}\right)\right. \\
& \left.+\gamma_{23}^{U S} \cdot\left(r b_{t}^{S P}+\Delta \frac{1}{E 2_{e_{t}}^{U S}}\right)+\gamma_{14}^{U S} \cdot\left(r b_{t}^{R W}+\Delta \frac{1}{E 4_{e_{t}}^{U S}}\right)\right)  \tag{110}\\
& B d, b_{U S_{t}}^{R W}=\left(M_{t}^{U S}-R_{t}^{U S}\right) \cdot\left(\gamma_{30}^{U S}+\gamma_{31}^{U S} \cdot r b_{t}^{U S}+\gamma_{32}^{U S} \cdot\left(r b_{t}^{G E}+\Delta \frac{1}{E 1_{e_{t}}^{U S}}\right)\right.  \tag{111}\\
& \left.+\gamma_{33}^{U S} \cdot\left(r b_{t}^{S P}+\Delta \frac{1}{E 2_{e_{t}}^{U S}}\right)+\gamma_{34}^{U S} \cdot\left(r b_{t}^{R W}+\Delta \frac{1}{E 4_{e_{t}}^{U S}}\right)\right) \\
& B d, b_{U S_{t}}^{U S}=\left(M_{t}^{U S}-R_{t}^{U S}\right)-B d, b_{U S_{t}}^{G E}-B d, b_{U S_{t}}^{S P}-B d, b_{U S_{t}}^{R W}  \tag{112}\\
& B d, b_{G E_{t}}^{U S}=\left(M_{t}^{G E}-R_{t}^{G E}\right) \cdot\left(\gamma_{10}^{G E}+\gamma_{11}^{G E} \cdot\left(r b_{t}^{U S}+\Delta E 1_{e_{t}}^{G E}\right)+\gamma_{12}^{G E} \cdot r b_{t}^{G E}\right. \\
& \left.+\gamma_{13}^{G E} \cdot\left(r b_{t}^{S P}+\Delta \frac{1}{E 3_{e_{t}}^{G E}}\right)+\gamma_{14}^{G E} \cdot\left(r b_{t}^{R W}+\Delta \frac{1}{E 6_{e_{t}}^{G E}}\right)\right)  \tag{113}\\
& B d, b_{G E}^{S P}=\left(M_{t}^{G E}-R_{t}^{G E}\right) \cdot\left(\gamma_{20}^{G E}+\gamma_{21}^{G E} \cdot\left(r b_{t}^{U S}+\Delta E 1_{e_{t}}^{G E}\right)+\gamma_{22}^{G E} \cdot r b_{t}^{G E}\right. \\
& \left.+\gamma_{23}^{G E} \cdot\left(r b_{t}^{S P}+\Delta \frac{1}{E 3_{e_{t}}^{G E}}\right)+\gamma_{24}^{G E} \cdot\left(r b_{t}^{R W}+\Delta \frac{1}{E 6_{e_{t}}^{G E}}\right)\right)  \tag{114}\\
& B d, b_{G E}^{S P}=\left(M_{t}^{G E}-R_{t}^{G E}\right) \cdot\left(\gamma_{30}^{G E}+\gamma_{31}^{G E} \cdot\left(r b_{t}^{U S}+\Delta E 1_{e_{t}}^{G E}\right)+\gamma_{32}^{G E} \cdot r b_{t}^{G E}\right. \\
& \left.+\gamma_{33}^{G E} \cdot\left(r b_{t}^{S P}+\Delta \frac{1}{E 3_{e_{t}}^{G E}}\right)+\gamma_{34}^{G E} \cdot\left(r b_{t}^{R W}+\Delta \frac{1}{E 6_{e_{t}}^{G E}}\right)\right)  \tag{115}\\
& B d, b_{G E_{t}}^{G E}=\left(M_{t}^{G E}-R_{t}^{G E}\right)-B d, b_{G E_{t}}^{U S}-B d, b_{G E_{t}}^{S P}-B d, b_{G E_{t}}^{R W}  \tag{116}\\
& B d, b_{S P_{t}}^{U S}=\left(M_{t}^{S P}-R_{t}^{S P}\right) \cdot\left(\gamma_{10}^{S P}+\gamma_{11}^{S P} \cdot\left(r b_{t}^{U S}+\Delta E 2_{e_{t}}^{S P}\right)+\gamma_{12}^{S P} \cdot\left(r b_{t}^{G E}\right.\right.  \tag{117}\\
& \left.\left.+\Delta E 3_{e_{t}}^{S P}\right)+\gamma_{13}^{S P} . r b_{t}^{S P}+\gamma_{14}^{S P} .\left(r b_{t}^{R W}+\Delta E 5_{e_{t}}^{S P}\right)\right) \\
& B d, b_{S P_{t}}^{G E}=\left(M_{t}^{S P}-R_{t}^{S P}\right) \cdot\left(\gamma_{20}^{S P}+\gamma_{21}^{S P} \cdot\left(r b_{t}^{U S}+\Delta E 2_{e_{t}}^{S P}\right)+\gamma_{22}^{S P} \cdot\left(r b_{t}^{G E}\right.\right.  \tag{118}\\
& \left.\left.+\Delta E 3_{e_{t}}^{S P}\right)+\gamma_{23}^{S P} . r b_{t}^{S P}+\gamma_{24}^{S P} \cdot\left(r b_{t}^{R W}+\Delta E 5_{e_{t}}^{S P}\right)\right) \\
& B d, b_{S P_{t}}^{R W}=\left(M_{t}^{S P}-R_{t}^{S P}\right) \cdot\left(\gamma_{30}^{S P}+\gamma_{31}^{S P} \cdot\left(r b_{t}^{U S}+\Delta E 2_{e_{t}}^{S P}\right)+\gamma_{32}^{S P} \cdot\left(r b_{t}^{G E}\right.\right.  \tag{119}\\
& \left.\left.+\Delta E 3_{e_{t}}^{S P}\right)+\gamma_{33}^{S P} . r b_{t}^{S P}+\gamma_{34}^{S P} \cdot\left(r b_{t}^{R W}+\Delta E 5_{e_{t}}^{S P}\right)\right) \\
& B d, b_{S P_{t}}^{S P}=\left(M_{t}^{S P}-R_{t}^{S P}\right)-B d, b_{S P_{t}}^{U S}-B d, b_{S P_{t}}^{G E}-B d, b_{S P_{t}}^{R W} \tag{120}
\end{align*}
$$

$$
\begin{align*}
& B d, b_{R W_{t}}^{U S}=\left(M_{t}^{R W}-R_{t}^{R W}\right) \cdot\left(\gamma_{10}^{R W}+\gamma_{11}^{R W} \cdot\left(r b_{t}^{U S}+\Delta E 4_{e_{t}}^{R W}\right)+\gamma_{12}^{R W} \cdot\left(r b_{t}^{G E}\right.\right. \\
& \left.\left.+\Delta E 6_{e_{t}}^{R W}\right)+\gamma_{13}^{R W} \cdot\left(r b_{t}^{S P}+\Delta{\frac{1}{E 5_{e_{t}}}}^{R W}\right)+\gamma_{14}^{R W} \cdot r b_{t}^{R W}\right)  \tag{121}\\
& B d, b_{R W_{t}}^{G E}=\left(M_{t}^{R W}-R_{t}^{R W}\right) \cdot\left(\gamma_{20}^{R W}+\gamma_{21}^{R W} \cdot\left(r b_{t}^{U S}+\Delta E 4_{e_{t}}^{R W}\right)+\gamma_{22}^{R W} \cdot\left(r b_{t}^{G E}\right.\right. \\
& \left.\left.+\Delta E 6_{e_{t}}^{R W}\right)+\gamma_{23}^{R W} \cdot\left(r b_{t}^{S P}+\Delta{\frac{1}{E 5_{e_{t}}}}^{R W}\right)+\gamma_{24}^{R W} \cdot r b_{t}^{R W}\right)  \tag{122}\\
& B d, b_{R W_{t}}^{S P}=\left(M_{t}^{R W}-R_{t}^{R W}\right) \cdot\left(\gamma_{30}^{R W}+\gamma_{31}^{R W} \cdot\left(r b_{t}^{U S}+\Delta E 4_{e_{t}}^{R W}\right)+\gamma_{32}^{R W} \cdot\left(r b_{t}^{G E}\right.\right. \\
& \left.\left.+\Delta E 6_{e_{t}}^{R W}\right)+\gamma_{33}^{R W} \cdot\left(r b_{t}^{S P}+\Delta{\frac{1}{E 5_{e_{t}}}}^{R W}\right)+\gamma_{34}^{R W} \cdot r b_{t}^{R W}\right)  \tag{123}\\
& B d, b_{R W_{t}}^{R W}=\left(M_{t}^{R W}-R_{t}^{R W}\right)-B d, b_{R W_{t}}^{U S}-B d, b_{R W_{t}}^{G E}-B d, b_{R W_{t}}^{S P} \tag{124}
\end{align*}
$$

In order to facilitate the understanding of the notation used above, let us take equation (109) as an example. This equation states that the demand of US' commercial banks of bonds denominated in euros issued by Germany $B d, b_{U S_{t}}^{G E}$ 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 $\gamma$ 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 fulfill Tobin-Godley criteria.

Let us now describe how exchange rate expectations are formed. Following the contributions of behavioral 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. Equation (127) describes the market's expectation of the german currency/dollar exchange rate, which is in turn the variable that was introduced in the portfolio equations. These expectations concern only the german
currency/dollar exchange rate. Additional equations need to be written for expectations that other countries' speculators make on the remaining relevant bilateral exchange rates.

$$
\begin{align*}
& \Delta E 1_{e_{t}}^{F, U S}=-\omega \cdot\left(E 1_{t-1}-E 1^{*}\right)  \tag{125}\\
& \Delta E 1_{e_{t}}^{C, U S}=\beta \Delta E 1_{t-1}  \tag{126}\\
& \Delta E 1_{e_{t}}^{U S}=\tau \Delta E 1_{e_{t}}^{F, U S}+(1-\tau) \Delta E 1_{e_{t}}^{C, U S}  \tag{127}\\
& \Delta E 2_{e_{t}}^{F, U S}=-\omega \cdot\left(E 2_{t-1}-E 2^{*}\right)  \tag{128}\\
& \Delta E 2_{e_{t}}^{C, U S}=\beta \Delta E 2_{t-1}  \tag{129}\\
& \Delta E 2_{e_{t}}^{U S}=\tau \Delta E 2_{e_{t}}^{F, U S}+(1-\tau) \Delta E 2_{e_{t}}^{C, U S}  \tag{130}\\
& \Delta E 4_{e_{t}}^{F, U S}=-\omega \cdot\left(E 4_{t-1}-E 4^{*}\right)  \tag{131}\\
& \Delta E 4_{e_{t}}^{C, U S}=\beta \Delta E 4_{t-1}  \tag{132}\\
& \Delta E 4_{e_{t}}^{U S}=\tau \Delta E 4_{e_{t}}^{F, U S}+(1-\tau) \Delta E 4_{e_{t}}^{C, U S}  \tag{133}\\
& \Delta E 1_{e_{t}}^{F, G E}=-\omega \cdot\left(E 1_{t-1}-E 1^{*}\right)  \tag{134}\\
& \Delta E 1_{e_{t}}^{C, G E}=\beta \Delta E 1_{t-1}  \tag{135}\\
& \Delta E 1_{e_{t}}^{G E}=\tau \Delta E 1_{e_{t}}^{F, G E}+(1-\tau) \Delta E 1_{e_{t}}^{C, G E}  \tag{136}\\
& \Delta E 3_{e_{t}}^{F, G E}=-\omega \cdot\left(E 3_{t-1}-E 3^{*}\right)  \tag{137}\\
& \Delta E 3_{e_{t}}^{C, G E}=\beta \Delta E 3_{t-1}  \tag{138}\\
& \Delta E 3_{e_{t}}^{G E}=\tau \Delta E 3_{e_{t}}^{F, G E}+(1-\tau) \Delta E 3_{e_{t}}^{C, G E}  \tag{139}\\
& \Delta E 6_{e_{t}}^{F, G E}=-\omega \cdot\left(E 6_{t-1}-E 6^{*}\right)  \tag{140}\\
& \Delta E 6_{e_{t}}^{C, G E}=\beta \Delta E 6_{t-1}  \tag{141}\\
& \Delta E 6_{e_{t}}^{G E}=\tau \Delta E 6_{e_{t}}^{F, G E}+(1-\tau) \Delta E 6_{e_{t}}^{C, G E}  \tag{142}\\
& \Delta E 2_{e_{t}}^{F, S P}=-\omega \cdot\left(E 2_{t-1}-E 2^{*}\right)  \tag{143}\\
& \Delta E 2_{e_{t}}^{C, S P}=\beta \Delta E 2_{t-1}  \tag{144}\\
& \Delta E 2_{e_{t}}^{S P}=\tau \Delta E 2_{e_{t}}^{F, S P}+(1-\tau) \Delta E 2_{e_{t}}^{C, S P} \tag{145}
\end{align*}
$$

$$
\begin{align*}
& \Delta E 5_{e_{t}}^{F, S P}=-\omega \cdot\left(E 5_{t-1}-E 5^{*}\right)  \tag{146}\\
& \Delta E 5_{e_{t}}^{C, S P}=\beta \Delta E 5_{t-1}  \tag{147}\\
& \Delta E 5_{e_{t}}^{S P}=\tau \Delta E 5_{e_{t}}^{F, S P}+(1-\tau) \Delta E 5_{e_{t}}^{C, S P}  \tag{148}\\
& \Delta E 3_{e_{t}}^{F, S P}=-\omega \cdot\left(E 3_{t-1}-E 3^{*}\right)  \tag{149}\\
& \Delta E 3_{e_{t}}^{C, S P}=\beta \Delta E 3_{t-1}  \tag{150}\\
& \Delta E 3_{e_{t}}^{S P}=\tau \Delta E 3_{e_{t}}^{F, S P}+(1-\tau) \Delta E 3_{e_{t}}^{C, S P}  \tag{151}\\
& \Delta E 4_{e_{t}}^{F, R W}=-\omega \cdot\left(E 4_{t-1}-E 4^{*}\right)  \tag{152}\\
& \Delta E 4_{e_{t}}^{C, R W}=\beta \Delta E 4_{t-1}  \tag{153}\\
& \Delta E 4_{e_{t}}^{R W}=\tau \Delta E 4_{e_{t}}^{F, R W}+(1-\tau) \Delta E 4_{e_{t}}^{C, R W}  \tag{154}\\
& \Delta E 5_{e_{t}}^{F, R W}=-\omega \cdot\left(E 5_{t-1}-E 5^{*}\right)  \tag{155}\\
& \Delta E 5_{e_{t}}^{C, R W}=\beta \Delta E 5_{t-1}  \tag{156}\\
& \Delta E 5_{e_{t}}^{R W}=\tau \Delta E 5_{e_{t}}^{F, R W}+(1-\tau) \Delta E 5_{e_{t}}^{C, R W}  \tag{157}\\
& \Delta E 6_{e_{t}}^{F, R W}=-\omega \cdot\left(E 6_{t-1}-E 6^{*}\right)  \tag{158}\\
& \Delta E 6_{e_{t}}^{C, R W}=\beta \Delta E 6_{t-1}  \tag{159}\\
& \Delta E 6_{e_{t}}^{R W}=\tau \Delta E 6_{e_{t}}^{F, R W}+(1-\tau) \Delta E 6_{e_{t}}^{C, R W} \tag{160}
\end{align*}
$$

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.

$$
\begin{align*}
& B s, b_{G E_{t}}^{U S}=B d, b_{G E_{t}}^{U S} / E 1_{t}  \tag{161}\\
& B s, b_{S P_{t}}^{U S}=B d, b_{S P_{t}}^{U S} / E 2_{t}  \tag{162}\\
& B s, b_{R W_{t}}^{U S}=B d, b_{R W_{t}}^{U S} / E 4_{t}  \tag{163}\\
& B s, b_{U S_{t}}^{U S}=B d, b_{U S_{t}}^{U S} \tag{164}
\end{align*}
$$

$$
\begin{align*}
& B s, b_{U S_{t}}^{G E}=B d, b_{U S_{t}}^{G E} * E 1_{t}  \tag{165}\\
& B s, b_{S P_{t}}^{G E}=B d, b_{S P_{t}}^{G E} / E 3_{t}  \tag{166}\\
& B s, b_{R W_{t}}^{G E}=B d, b_{R W_{t}}^{G E} / E 6_{t}  \tag{167}\\
& B s, b_{G E_{t}}^{G E}=B d, b_{G E_{t}}^{G E}  \tag{168}\\
& B s, b_{U S_{t}}^{S P}=B d, b_{U S_{t}}^{S P} * E 2_{t}  \tag{169}\\
& B s, b_{G E_{t}}^{S P}=B d, b_{G E_{t}}^{S P} * E 3_{t}  \tag{170}\\
& B s, b_{R W_{t}}^{S P}=B d, b_{R W_{t}}^{S P} * E 5_{t}  \tag{171}\\
& B s, b_{S P_{t}}^{S P}=B d, b_{S P_{t}}^{S P}  \tag{172}\\
& B s, b_{U S_{t}}^{R W}=B d, b_{U S_{t}}^{R W} * E 4_{t}  \tag{173}\\
& B s, b_{G E_{t}}^{R W}=B d, b_{G E_{t}}^{R W} * E 6_{t}  \tag{174}\\
& B s, b_{S P_{t}}^{R W}=B d, b_{S P_{t}}^{R W} / E 5_{t}  \tag{175}\\
& B s, b_{R W_{t}}^{R W}=B d, b_{R W_{t}}^{R W} \tag{176}
\end{align*}
$$

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 $\rho$ 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.

$$
\begin{equation*}
R_{t}^{U S}=\rho^{U S} \cdot M_{t}^{U S} \quad \forall i=U S, R W, G E, S P \tag{177-180}
\end{equation*}
$$

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.

$$
\begin{align*}
& P b_{t}^{U S}= r b_{t-1}^{U S} \cdot B d, b_{U S_{t-1}}^{U S}+r b_{t-1}^{R W} \cdot B s, b_{U S t-1}^{R W} / E 4_{t}+r b_{t-1}^{S P} \cdot B s, b_{U S_{t-1}}^{S P} / E 2_{t} \\
&+r b_{t-1}^{G E} \cdot B s, b_{U S_{t-1}}^{G E} / E 1_{t}+B s, b_{U S_{t-1}}^{R W} \cdot \Delta\left(1 / E 4_{t}\right)+B s, b_{U S_{t-1}}^{G E} \cdot \Delta\left(1 / E 1_{t}\right)  \tag{181}\\
&+B s, b_{U S_{t-1}}^{S P} \cdot \Delta\left(1 / E 2_{t}\right)+r l_{t-1}^{U S} \cdot L_{t-1}^{U S}+r s_{t-1}^{U S} \cdot R_{t-1}^{U S}-r d_{t-1}^{U S} \cdot M_{t-1}^{U S} \\
&-r_{t-1}^{U S} \cdot A_{t-1}^{U S} \\
& P b_{t}^{G E}= r b_{t-1}^{U S} \cdot B s, b_{G E_{t-1}}^{U S} \cdot E 1_{t}+r b_{t-1}^{R W} \cdot B s, b_{G E_{t-1}}^{R W} / E 6_{t}+r b_{t-1}^{S P} \cdot B s, b_{G E_{t-1}}^{S P} / E 3_{t} \\
&+r b_{t-1}^{G E} \cdot B s, b_{G E-1}^{G E}+B s, b_{G E_{t-1}}^{U S} \cdot \Delta E 1_{t}+B s, b_{G E_{t-1}}^{S P} \cdot \Delta\left(1 / E 3_{t}\right)  \tag{182}\\
&+B s, b_{G E t-1}^{R W} \cdot \Delta\left(1 / E 6_{t}\right)+r l_{t-1}^{U S} \cdot L_{t-1}^{U S}+r s_{t-1}^{U S} \cdot R_{t-1}^{U S}-r d_{t-1}^{U S} \cdot M_{t-1}^{U S} \\
&-r_{t-1}^{U S} \cdot A_{t-1}^{U S} \\
& P b_{t}^{S P}=r b_{t-1}^{U S} \cdot B s, b_{S P_{t-1}}^{U S} \cdot E 2_{t}+r b_{t-1}^{R W} \cdot B s, b_{S P_{t-1}}^{R W} \cdot E 5_{t}+r b_{t-1}^{S P} \cdot B s, b_{S P_{t-1}}^{S P} \\
&+r b_{t-1}^{G E} \cdot B s, b_{S P_{t-1}}^{G E} \cdot E 3_{t}+B s, b_{S P_{t-1}}^{U S} \Delta E 2_{t}+B s, b_{S P_{t-1}}^{G E} \Delta E 3_{t}  \tag{183}\\
&+B s, b_{S P_{t-1}}^{R W} \Delta E 5_{t}+r l_{t-1}^{U S} \cdot L_{t-1}^{U S}+r s_{t-1}^{U S} \cdot R_{t-1}^{U S}-r d_{t-1}^{U S} \cdot M_{t-1}^{U S} \\
&-r_{t-1}^{U S} \cdot A_{t-1}^{U S} \\
& P b_{t}^{R W}=r b_{t-1}^{U S} \cdot B s, b_{R W_{t-1}}^{U S} \cdot E 4_{t}+r b_{t-1}^{R W} \cdot B s, b_{R W_{t-1}^{R W}}^{R W}+r b_{t-1}^{S P} \cdot B s, b_{R W_{t-1} S P}^{S P} / E 5_{t} \\
&+r b_{t-1}^{G E} \cdot B s, b_{R W_{t-1}}^{G E} \cdot E 6_{t}+B s, b_{R W_{t-1}}^{U S} \Delta E 4_{t}+B s, b_{R W_{t-1}}^{G E} \Delta E 6_{t}  \tag{184}\\
&+ \\
& B s, b_{R W_{t-1}}^{S P} \Delta\left(1 / E 5_{t}\right)+r l_{t-1}^{U S} \cdot L_{t-1}^{U S}+r s_{t-1}^{U S} \cdot R_{t-1}^{U S}-r d_{t-1}^{U S} \cdot M_{t-1}^{U S} \\
&-r_{t-1}^{U S} \cdot A_{t-1}^{U S}
\end{align*}
$$

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

$$
\begin{equation*}
\Delta V b_{t}^{U S}=0 \quad \forall i=U S, R W, G E, S P \tag{185-188}
\end{equation*}
$$

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.

$$
\begin{equation*}
A_{t}^{i}=L_{t}^{i}+R_{t}^{i}+B d, b_{i_{t}}^{i}+B d, b_{i_{t}}^{-i}-M_{t}^{i}-V b_{t}^{i} \quad \forall i=U S, R W, G E, S P \tag{189-192}
\end{equation*}
$$

## 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. 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.

$$
\begin{array}{ll}
r_{t}^{i}=\overline{r_{t}^{i}} & \forall i=U S, R W, G E, S P \\
H s_{t}^{i}=H d_{t}^{i} & \forall i=U S, R W, G E, S P \tag{197-200}
\end{array}
$$

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).

$$
\begin{equation*}
r b_{t}^{U S}=r b_{t}^{\bar{U} S} \quad \forall i=U S, R W, G E, S P \tag{201-204}
\end{equation*}
$$

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, which means that the equilibrium in the bond market is reached through central bank interventions. 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.

$$
\begin{align*}
& E 4_{t}=\bar{E} 4  \tag{205}\\
& B d, c b_{R W_{t}}^{R W}=B s_{t}^{R W}-B s, b_{U S_{t}}^{R W}-B s, b_{S P_{t}}^{R W}-B s, b_{G E_{t}}^{R W}-B s, b_{R W_{t}}^{R W} \tag{206}
\end{align*}
$$

Since, as equation (205) describes, the rest of the world has a fixed exchange rate against the US dollar the exchange rate $E 4$ becomes exogenous. As a result, it is the demand of US government bonds by the rest of the world's central bank, $B d, c b_{R W_{t}}^{U S}$, 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.

$$
\begin{equation*}
\Delta B d, c b_{R W_{t}}^{U S}=\Delta H_{t}^{R W}+\Delta R_{t}^{R W}-\Delta A_{t}^{R W}-\Delta B d, c b_{R W_{t}}^{R W} \tag{207}
\end{equation*}
$$

Spain and Germany are engaged in a superfixed monetary agreement, which is the euro itself. Thus, their exchange rates with respect to the US dollar can be written as follows (note that $E 1=E 2$ ):

$$
\begin{align*}
E 1_{t} & =\frac{B s_{t}^{G E}+B s_{t}^{S P}-D_{t}}{B d, b_{U S_{t}}^{S P}+B d, b_{U S_{t}}^{G E}}  \tag{208}\\
E 2_{t} & =\frac{B s_{t}^{G E}+B s_{t}^{S P}-D_{t}}{B d, b_{U S_{t}}^{S P}+B d, b_{U S_{t}}^{G E}} \tag{209}
\end{align*}
$$

$D_{t}=B s, b_{S P_{t}}^{S P}+B s, b_{G E_{t}}^{G E}+B s, b_{S P_{t}}^{G E}+B s, b_{G E_{t}}^{S P}+B s, b_{R W_{t}}^{S P}+B s, b_{R W_{t}}^{G E}+B s, c b_{G E_{t}}^{G E}+B s, c b_{S P_{t}}^{S P}+B s_{E C B_{t}}^{S P}+B s_{E C B_{t}}^{G E}$

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

$$
\begin{align*}
& E 3_{t}=E 2_{t} / E 1_{t}  \tag{210}\\
& E 5_{t}=E 2_{t} / E 4_{t}  \tag{211}\\
& E 6_{t}=E 4_{t} / E 1_{t} \tag{212}
\end{align*}
$$

Since Spain and Germany float their currency against the US dollar, equilibrium in the euro-bond market is reached through the movements of the euro/dollar exchange rate. Hence, the balance sheet of each national central bank is balanced through central bank purchases/sales of domestic bonds.

$$
\begin{align*}
& \Delta B s, c b_{S P_{t}}^{S P}=\Delta R_{t}^{S P}+\Delta H s_{t}^{S P}-\Delta A_{t}^{S P}  \tag{213}\\
& \Delta B s, c b_{G E_{t}}^{G E}=\Delta R_{t}^{G E}+\Delta H s_{t}^{G E}-\Delta A_{t}^{G E}  \tag{214}\\
& B d, c b_{S P_{t}}^{S P}=B s, c b_{S P_{t}}^{S P}  \tag{215}\\
& B d, c b_{G E_{t}}^{G E}=B s, c b_{G E_{t}}^{G E} \tag{216}
\end{align*}
$$

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.
$B d, c b_{U S_{t}}^{U S}=B s_{t}^{U S}-B s, b_{U S_{t}}^{U S}-B s, b_{S P_{t}}^{U S}-B s, b_{G E_{t}}^{U S}-B s, b_{R W_{t}}^{U S}-B s, c b_{R W_{t}}^{U S}-B s, c b_{G E_{t}}^{U S}-B s_{E C B_{t}}^{U S}$
$B s, c b_{R W_{t}}^{U S}=B d, c b_{R W_{t}}^{U S} / E 4$

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.

$$
\begin{align*}
P c b_{t}^{U S}= & r b_{t-1}^{U S} \cdot B d, c b_{U S_{t-1}^{U S}}^{U S}+r_{t-1}^{U S} \cdot A_{t-1}^{U S}-r s_{t-1}^{U S} \cdot R_{t-1}^{U S}  \tag{219}\\
P c b_{t}^{R W}= & r b_{t-1}^{R W} \cdot B d, c b_{R W_{t-1}}^{R W}+r_{t-1}^{R W} \cdot A_{t-1}^{R W}-r s_{t-1}^{R W} \cdot R_{t-1}^{R W}+r b_{t-1}^{U S} \cdot B s, c b_{R W_{t-1}}^{U S} \cdot E 4_{t}  \tag{220}\\
& \quad+B s, c b_{R W_{t-1}}^{U S} \cdot \Delta E 4_{t} \\
P c b_{t}^{S P}= & r_{t-1}^{S P} \cdot A_{t-1}^{S P}-r S_{t-1}^{S P} \cdot R_{t-1}^{S P}+r b_{t-1}^{S P} \cdot B s, c b_{S P_{t-1}}^{S P}  \tag{221}\\
P c b_{t}^{G E}= & r_{t-1}^{G E} \cdot A_{t-1}^{G E}-r s_{t-1}^{G E} \cdot R_{t-1}^{G E}+r b_{t-1}^{G E} \cdot B s, c b_{G E_{t-1}}^{G E} \tag{222}
\end{align*}
$$

Finally, it is required to write the equation of the profits of the ECB, which transfers them to the governments of Spain and Germany. Therefore, its stock of wealth is constant over time.

$$
\begin{align*}
P_{t}^{E C B}= & r b_{t-1}^{S P} \cdot B d_{E C B_{t-1}}^{S P}+r b_{t-1}^{G E} \cdot B d_{E C B_{t-1}}^{G E}+r b_{t-1}^{U S} \cdot B s_{E C B_{t-1}}^{U S} \cdot E 1_{t}  \tag{223}\\
& +B s_{E C B_{t-1}}^{U S} \cdot \Delta E 1_{t} \\
\Delta V^{E C B}= & 0 \tag{224}
\end{align*}
$$

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.

$$
\begin{equation*}
\Delta R_{t}^{U S}+\Delta H_{t}^{U S}-\Delta A_{t}^{U S}-\Delta B d, c b_{U S_{t}}^{U S}=0 \tag{225}
\end{equation*}
$$

### 6.1 Simulations

Figure 7: GDP Spain (national currency)
GDP Spain (national currency)


Figure 8: GDP Spain (US dollars)
GDP Spain (US dollars)


Figure 9: GDP Germany (national currency)
German GDP (national currency)


Figure 10: GDP Germany (US dollars)
German GDP (US dollars)


Figure 11: Trade Balance Spain (US dollars)
Trade Balance Spain (US dollars)


Figure 12: Public Debt Spain (national currency)
Public Debt


Figure 13: Spanish Currency (vs US dollar)
Spanish Currency vs US dollar


Figure 14: German Currency (vs US dollar)
German Currency vs US dollar


Figure 15: Current Account US



[^0]:    *Universite Paris XIII - mazier@univ-paris13.fr
    ${ }^{\dagger}$ Universite Paris XIII - sebastianvh@gmail.com

[^1]:    ${ }^{1}$ The Eurosystem is the monetary authority of the Eurozone, and is integrated by the European Central Bank (ECB) and the national central banks (NCB) of the 17 countries that have adopted the euro. The main goal of the Eurosystem is price stability. However, financial stability and integration are also part of its mandates. In order to achieve these objectives, the Eurosystem conducts the monetary policy of the Eurozone. Additionally, since the introduction of the euro as a medium of exchange, the Single Euro Payments Area (SEPA) has been established with the aim of integrating payments within the Eurozone. It was (and still is, since the implementation of the SEPA is a gradual process that is expected to be concluded in 2016) expected that the SEPA will contribute to efficiency in both goods and financial markets. In the remaining of this section, we present a brief description of both monetary policy and the payments mechanism in the Eurozone.

[^2]:    ${ }^{2}$ For those interested in the more detailed representation of the Eurosystem, please contact the authors.

