A Detailed Representation of the Eurosystem and the Current Crisis in the Eurozone

A stock-flow consistent approach

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Abstract

Until 2007 the introduction of the euro seemed to be a success. However, since 2008 the darkness of both the global financial crisis and the European sovereign debt crisis has jeopardized the continuity of the integration process launched in the 1950s. As many critics of the monetary unification have been arguing, the structure of the Eurozone was based upon very weak foundations that would eventually end up being crucial. In this article we aim at building a four-country stock-flow consistent model with fixed and flexible interest rates and multiple exchange rates arrangements that addresses most of the specific features of the Eurozone. This model is able to reproduce some of the events that have been occurring during the first ten years of the euro's existence. Further developments of it should allow for a detailed examination of the origins of the crisis and, more importantly, the potential effectiveness of the alternative solutions that are being proposed.
1 Introduction

Until 2007 the introduction of the euro seemed to be a success. Not only most of the countries were growing, some of them at unusually high rates, but it was also observed a deepening of intra-regional trade and financial flows. Moreover, southern countries, which had a history of inflation and sometimes found difficulties in getting access to international financial markets, were suddenly enjoying the benefits of being part of a larger and more important "state". The last step of the great European project, launched in 1957 with the Treaty of Rome, had finally become true.

By the beginning of 2008 hardly any analyst imagined a picture as the one it is presented in Figure 1. As it can be observed, since the bankruptcy of Lehman Brothers (a problem that apparently concerned only the American economy) everything went dark in the Eurozone. Not only five of its seventeen members had to be rescued, but also important countries such as France and Italy look vulnerable. As of October 2013, 19.3 million people were unemployed, yielding a record 12.1% unemployment rate. To make matters worse, most of the actions taken by the European governments proved insufficient, if not useless, to reverse the negative dynamic in which the Eurozone seems to be trapped.

The rosy tale that was told until 2007, which many believed, could not have turned into a nightmare overnight. Actually, the apparent stability observed in the period 2002-2007 was built upon very weak foundations. Countries with significant differences had to compete as if they were identical and the elimination of national currencies (which could work as and adjustment variable of those imbalances) was not complemented with other policies that could compensate for those differences. The lack of self-correcting mechanisms was reinforced by the tight and arbitrary rules established in the Maastricht and Lisbon treaties which, instead of giving countries under stress some relief, tended to deepen the contraction.

In this context, we consider that it is important to develop theoretical and empirical tools that correctly address the working of the Eurozone and that can eventually shed light on the underlying problems and potential solutions. Following the stock-flow consistent approach to open economies initiated by Godley & Lavoie (2003), we aim at building a four-country model that describes in detail the working of the Eurosystem. In the next section we provide the reader with a brief description of the institutional setting in which economic relations take place within the Eurozone. Section 3 presents an SFC model that accounts for most of the features described in Section 2. Section 4 and 5 attempt to reproduce some of the conditions that ultimately led the Eurozone to its present crisis. Finally, we present the conclusions of our study and our future lines of research.
Figure 1: The Crisis in the Eurozone
2 The Working of the Eurosystem - A General Overview

2.1 The Eurosystem

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 Monetary Operations within the Eurosystem

The way monetary policy is conducted in the Eurozone reflects the endogenous nature of money. In order to achieve a certain inflation rate target, the ECB sets an interest rate target. In doing so, the ECB can decide on a set of interest rates which will induce financial institutions to carry out monetary operations in such a way that the effective interest rate in the inter-bank market (EURIBOR), which has a significant impact on the real and financial spheres of European countries, is close to the target set by the ECB.

The huge amount of payments that are settled within the SEPA, which in 2011 reached an average of €2.5 trillion each working day, almost the size of Germany’s GDP (Bundesbank, 2012), added to the various liquidity management operations that are undertaken by the Eurosystem, can lead to strong fluctuations in the interbank market liquidity. In order to prevent this abundance (scarcity) of liquidity from moving the EURIBOR from the target set by the ECB, the Eurosystem offers two mechanisms that contribute to achieve a desired level of liquidity in the interbank market. On the one hand, if there are excess funds which cannot be allocated within the financial sector, those institutions that hold undesired liquidity can deposit it at the **deposit facility** of the ECB. On the other hand, if the interbank market is dry and banks can find no funds to meet their minimum reserve requirements, they may get those funds from the ECB’s **lending facility**. In both cases, the ECB is free to set the interest rate it will pay or charge, and the gap between these two interest rates determines the fluctuation margin of interbank interest rate.

Figure 2 shows the evolution of these two interest rates set by the ECB, together with the EONIA, which is a rate computed as a weighted average of all overnight unsecured lending transactions in the interbank market. As it can be observed from the figure, the EONIA never moves away from the fluctuation margins. Should there be an excess liquidity in the interbank market that tends to drive the EONIA downwards, below the lower boundary, those financial institutions that hold the excess liquidity will find it
more profitable to deposit the funds at the ECB (which pays the deposit facility rate) than placing them within the interbank system, in which case they would be earning an interest rate that is lower than the one offered by the ECB. Conversely, should there be a lack of liquidity such that the EONIA is driven upwards, those financial institutions that are seeking for funds to meet their minimum reserve requirements will find it cheaper to borrow from the ECB’s lending facility (thereby paying the lending facility rate) rather than getting the funds from the interbank market. In both cases, the ECB ensures that the EONIA will always stay within the pre-established limits. In the extreme case that the ECB wanted to hit the interest rate target on a permanent basis, it should have to set the deposit facility rate equal to the lending facility rate, thereby reducing to zero the fluctuation margin.

Figure 2: Eurozone’s Key Interest Rates

The aforementioned monetary policy instruments are generally used to meet the interest rate targets set by the ECB. However, there are other policy tools that are normally used to allow for the working of the financial system as a whole. For instance, commercial banks may need to borrow funds from the Eurosystem in order to grant credits to firms that want to undertake investment projects. As it has been widely discussed in the literature on endogenous money, such as Lavoie (1992) and Moore (1988), banks do not need to hold funds in order to lend. In other words, deposits do not create loans. Actually, in order to lend banks can go overdraft and expect to get the required funds to meet their reserve requirements at the end of the day through the deposits that are created as a result of the increased level of activity (thus, loans create deposits and not the other way around). In case banks do not get those funds, they can always appeal to the interbank
market or the ECB.

Those monetary policy operations that are undertaken to finance the daily working of the economic system are called refinancing operations. In the Eurozone there are basically two types of refinancing operations: Main Refinancing Operations (MRO) and Longer-Term Refinancing Operations (LTRO). The ECB defines MRO as "one-week euro liquidity-providing operations which serve to steer short-term interest rates, to manage the liquidity situation, and to signal the stance of monetary policy in the euro area". On the other hand, Longer-Term Refinancing Operations (LTRO) are "three-month euro liquidity-providing operations which aim to provide additional, longer-term refinancing to the financial sector". Currently, the regular operations are complemented by euro liquidity-providing operations with a maturity of (around) one, six, twelve and thirty-six months as well as US-dollar liquidity-providing operations.

Both, MRO and LTRO are conducted via an auction mechanism. The ECB specifies the amount of liquidity it wishes to auction (called the allotted amount) and asks banks for expressions of interest. In a fixed rate tender the ECB also specifies the interest rate at which it is willing to lend money; alternatively, in a variable rate tender the interest rate is not specified and banks bid against each other (subject to a minimum bid rate specified by the ECB) to access the available liquidity. Since mid-October 2008, however, the ECB has been following a different procedure on a temporary basis: the fixed rate MRO with full allotment. In this case the ECB specifies the rate but not the amount of credit made available, and banks can request as much as they wish (subject as always to being able to provide sufficient collateral). This procedure was made necessary due to the financial crisis of 2008 and is expected to end at some time in the future.

Finally, as a result of the global financial crisis that broke out in 2008 and the sovereign debt crisis that has been affecting the Eurozone since 2010, some extraordinary monetary policy measures were implemented. First, two Covered Bond Purchase Programmes (CBPP) were implemented in May 2009 and November 2011 for a total of €100 billion. The aim of these programmes was to purchase bank bonds backed by high-quality assets. This would increase the liquidity of banks, thereby expanding their capacity to lend. However, as it happened in the US with the QE programmes, it seems that the problem in the credit markets was more linked to the demand side than to a liquidity constrain. In fact, the stock of deposits at the deposit facility of the Eurosystem started to increase as these extraordinary monetary policy measures were implemented, which suggests that rather the banks did not find where to place that newly created liquidity, or if they did, they found it more profitable to use the funds for other (non-productive) purposes.

The second extraordinary measure was the Securities Market Programme (SMP) launched in May 2010. The aim of this programme was to reduce the tensions that were arising in the debt markets as a result of the sovereign debt crisis. According to this new mechanism, the ECB could buy in the secondary market the assets that it normally accepts as collateral. As of September 2012, when the programme was terminated, the Eurosystem held assets worth €218 billion as a result of its interventions. The countries
that benefited from this programme were Ireland (€14.2 billions), Greece (€33.9 billions), Spain (€44.3 billions), Italy (€102.8 billions) and Portugal (€22.8 billions). Once the monetary policy tools of the Eurosystem have been explained, we can observe in Figure 3 how they were used to expand liquidity during the crisis. It is worth mentioning that in the graph the contribution of the lending facility is not shown since its amount is very small (for instance, 0.7% of MRO and 0.1% of LTRO). The deposit facility, on the other hand, instead of providing liquidity it drains it out of the system. Thus, the area below the line that exhibits the trajectory of banks’ deposits in the Eurosystem should be deducted from the liquidity created by the MROs, LTROs, CBPPs, SMPs, etc.

Figure 3: Liquidity Management in the Eurosystem

In 2010 the European authorities perceived that both the aforementioned ordinary and extraordinary monetary policy instruments were proving insufficient to deal the extent of the sovereign debt crisis. As a consequence, the member states decided to create a temporary rescue mechanism, the European Financial Stability Facility (EFSF). Its main purpose is "to safeguard financial stability in Europe by providing financial assistance to member states under stress within a programme of macroeconomic adjustment". It has a borrowing capacity of €440 billion. However, there is an agreement with the European Commission and the IMF that states that the assistance to member countries can be shared. In this regard, the European Commission has committed to lend €60 billion under the provisions of the so-called European Financial Stabilization Mechanism (EFSM), whereas the IMF may contribute with additional €250 billion. In total,
Eurozone countries may receive aid for €750 billion.

In case a member country cannot borrow funds at acceptable costs in the financial markets, it can appeal to the ESFS for assistance. If the countries of the Eurozone agree on the conditions of the loan, the EFSF is allowed to raise the funds and disburse the loan. Although the EFSF was created as a temporary rescue mechanism, in October 2010 it was decided to create a permanent rescue mechanism, the **European Stability Mechanism** (ESM), which entered into force on 8 October 2012. Finally, in August 2012 the ECB launched the **Outright Monetary Transactions** (OMT) programme, which replaced the SMP. The OMT allows the ECB to purchase sovereign bonds of member states in the secondary markets in unlimited amounts (unlike the SMP). The main aim of this programme is to reduce the spreads between the yields of the bonds issued by southern countries with respect to those of surplus states. The ECB expects to achieve this goal by announcing a maximum spread that it will permit. Thus far, OMT have not been used, since the announcement of the ECB was enough to reduce the tension in the sovereign bond markets.

Figure 4 summarizes how the bail-outs to member states were financed given the different mechanisms that were created during the crisis.

<table>
<thead>
<tr>
<th>Country</th>
<th>IMF</th>
<th>Bilateral</th>
<th>GLF</th>
<th>EFSM</th>
<th>EFSF</th>
<th>ESM</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyprus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Greece</td>
<td>48.1</td>
<td></td>
<td>52.9</td>
<td></td>
<td>144.6</td>
<td></td>
<td>245.6</td>
</tr>
<tr>
<td>Ireland</td>
<td>22.5</td>
<td></td>
<td>22.5</td>
<td>17.7</td>
<td></td>
<td></td>
<td>67.5</td>
</tr>
<tr>
<td>Portugal</td>
<td></td>
<td>4.8</td>
<td></td>
<td></td>
<td>26</td>
<td>26</td>
<td>78</td>
</tr>
<tr>
<td>Spain</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>41/100</td>
<td>41/100</td>
</tr>
</tbody>
</table>

Source: ECB

It should be noted that in the case of Ireland €4.8 billion were lent from other European (non-Eurozone) countries (€3.8 by the UK, €0.6 by Sweden and €0.4 by Denmark) and that in the specific case of Greece €52.9 billion were provided by the so-called **Greek Loan Facility** (GLF), which was a system of bilateral loans created to deal with the Greek crisis before the EFSF and the ESM were established. Finally, a bail-out worth €100 billion was approved to rescue the Spanish financial sector. These funds were going to be distributed periodically according to the needs of the incumbent banks. As of March 2013, €41.4 billion had been disbursed.

### 2.3 The Payments System

The way in which commercial banks, NCBs and the ECB interact is ruled by the SEPA. In practice, the system that ensures the automatic clearing of all payments, real and financial, within the Eurosystem is called **TARGET 2** (Trans-European Automated Real-time Gross Settlement Express Transfer System). These payment transactions can take a wide
variety of forms, such as payment for a goods delivery, the purchase or sale of a security, the granting or repayment of a loan or the depositing of funds at a bank, among many others. Whenever the banks of a given country receive (make) payments from another economic agent of the Eurozone, the NCB in question records a positive (negative) TARGET2 balance, as is the case with the Bundesbank (Banco de España). This represents a claim (liability) not on another NCB but rather on the ECB, which acts as a clearing house that settles transactions among NCBs. Ultimately, the TARGET2 surpluses and deficits result from disequilibria in the balance of payments of several Eurozone countries. This may entail current account deficits or capital exports by the private sector, which are then reflected in liquidity outflows from these countries (Bundesbank (2011)).

In order to ensure that the way in which TARGET2 works is understood, we describe the process step by step. For the sake of simplicity, it is assumed that the Eurozone consists of two countries, Germany and Spain, and the ECB. Let us now suppose that a Spanish importer purchases cars from a German exporter. The amount of the transaction equals €100. The process through which the payment is settled can be described as follows:

Step 1: The account of the Spanish importer at its commercial bank is debited. Thus, assets of the Spanish firm decrease by €100 while liabilities of the Spanish bank decrease by €100 as well. Simultaneously, the Spanish bank transfers the payment to the German bank by means of a SWIFT (Society for Worldwide Interbank Financial Telecommunication) message.

Step 2: Based on the SWIFT message, the Banco de España debits the bank’s current account by €100. Thus, assets of the commercial bank decrease by €100 whereas liabilities of the Banco de España also decrease by €100. Note that after this step the Spanish commercial bank finds itself in a balanced position, i.e., this operation has no quantitative impact on its balance sheet since assets (the current account at the Banco de España) and liabilities (the importer’s deposit) have varied identically. This is reasonable since banks are playing nothing more than an intermediary role.

Step 3: The Banco de España reports a liability worth €100 vis-à-vis the Bundesbank which, conversely, reports a claim worth €100 against the Banco de España. At the end of the day, both the Banco de España and the Bundesbank offset all their bilateral claims and liabilities into a single net asset or liability position against the ECB. Note that since the ECB is being only a clearing house this operation should have no impact on its balance sheet. Moreover, note that the balance sheet of the Banco de España has also stayed unchanged in quantitative terms, since its liabilities (the bank’s current account) have decreased by the same amount that its assets (Target2 Spain).

Step 4: The Bundesbank credits the commercial banks’ current account by €100. Note that by the end of this step the balance sheet of the Bundesbank has not changed in quantitative terms, since its assets (Target2 Germany) would have increased by the same amount as its liabilities (the bank’s current account).
Step 5: Finally, the German commercial bank credits the exporter’s account by €100. Therefore, the bank finds no change in its final position, since its assets (the current account at the central bank) and liabilities (the exporter’s deposit) would have increased by the same amount. Note, however, that the exporter does find a positive impact on its balance sheet, since the €100 increase in its deposits is not matched by an increase in any liability.

Figure 5 shows the final TARGET2 position of some of the NCBs of the Eurosystem. As it can be seen, the number of operations that were undertaken within this system has been increasing steadily. Moreover, the balances are a mirror not only of intra-Eurozone imbalances, since those countries that have been accumulating current account surpluses present a positive TARGET2 balance, but also of the market’s perception regarding the safety of deficit countries. Much of the surplus (deficit) registered in the TARGET2 balances of northern (southern) countries in the years after the crisis is explained by the "flight to quality" effect.

To conclude, it is worth analysing an example from the real world that illustrates the working of the Eurosystem. This example is taken from Jobst et al (2012). First, consider the central bank of Greece, which has recorded continuing negative balances since 2008 as a result of capital outflows (domestic investors decided to put their money outside the country, while foreign investors who had originally invested in Greece decided to withdraw...
their funds). Owing to the capital outflows the central bank of Greece accumulated a negative TARGET2 balance vis-à-vis the ECB. As regards Greek commercial banks, which held fewer deposits at the central bank due to the transfers that they had previously sent to other Eurozone commercial banks, had to replenish these deposits raising loans through the Eurosystem’s refinancing operations. These loans appear as an asset for the central bank of Greece, as a counterpart of the negative TARGET2 balance. More detailed explanations of the payments system can also be found in Bindseil and Koenig (2011).

2.4 The Balance Sheets of the NCBs and the ECB

The peculiar structure of the Eurosystem implies that the balance sheets of the NCBs and the ECB are not straightforward, at least when compared to the traditional balance sheets of central banks. In order to describe the components and specificities of the balance sheets of the institutions within the Eurosystem, it is worth presenting the real balance sheet of the Banco de España, the Bundesbank and the ECB as of December 2011, which can be found in their annual reports of 2012. As we present the balance sheets, its items will be described and we will go into the details any time it is necessary.

Figure 6: Balance Sheet Banco de España

<table>
<thead>
<tr>
<th>ASSETS</th>
<th>LIABILITIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Claims in Foreign Currency</td>
<td>Banknotes in circulation</td>
</tr>
<tr>
<td>29,269</td>
<td>97,024</td>
</tr>
<tr>
<td>Claims on Non-EZ Residents (€)</td>
<td>Liabilities to EZ credit institutions</td>
</tr>
<tr>
<td>4,250</td>
<td>50,933</td>
</tr>
<tr>
<td>Intra-Eurosystem Accounts</td>
<td>Liabilities to other EZ residents</td>
</tr>
<tr>
<td>32,177</td>
<td>5,570</td>
</tr>
<tr>
<td>Lending to EZ Credit Institutions</td>
<td>Intra-Eurosystem Accounts (TARGET2)</td>
</tr>
<tr>
<td>168,195</td>
<td>174,826</td>
</tr>
<tr>
<td>Securities of EZ Residents (€)</td>
<td>Revaluation Accounts</td>
</tr>
<tr>
<td>106,385</td>
<td>12,012</td>
</tr>
</tbody>
</table>

Source: Banco de España

**Total claims in foreign currency:** this category is divided into the following subgroups: Receivables from the IMF (5,803), Balances with banks and security investments, external loans and other external assets; and Claims on Euro-area residents denominated in foreign currency (23,466).

**Claims on Non-EZ Residents (€):** this item consists of euro-denominated claims on non-euro area central banks in connection with agreements on repurchase transactions. Under these agreements the non-euro area central bank can borrow euros against eligible collateral in order to support its domestic liquidity-providing operations.

**Securities of EZ Residents (€):** this item is divided into two categories: euro-denominated securities held for monetary policy purposes (31,080) and other securities (75,305). The former consists mainly of claims that arose as a result of reverse repurchase
transactions, conducted in the context of covered bond lending operations. The latter is composed by euro-denominated securities which are not held for monetary policy reasons.

**Lending to EZ Credit Institutions:** this item comprises the various assets that the Banco de España holds against credit institutions of the Eurozone as a result of monetary policy operations. The assets are distributed according to the type of operation that was carried out. In this case, the distribution is the following: MRO (11,422), LTRO (156,667).

**Intra-Eurosystem Accounts (assets):** this item requires a more detailed explanation since monetary policy within the Eurosystem is a little bit more complicated than in the case of a traditional monetary system, in which there is only one central bank. In the Eurozone, if a commercial bank borrows money from the Eurosystem it does not do so from the ECB but from the corresponding NCB. Thus, the former will register a liability whereas the latter will register a claim. The same situation occurs if, for instance, the commercial bank deposits funds at its current account in the NCB. In this case, the former will register a claim and the latter a liability.

Thus far, the situation is the usual one. However, things get more complicated when banknotes are introduced. As it is explained below under the "banknotes in circulation" item, there may be differences between the effective amount of banknotes issued by each NCB and value of the liability that the Eurosystem allocates to that NCB under this item. As Jobst et al (2012) show, the result is that claims (net assets and net lending) and liabilities (banknotes and current accounts of the commercial banks) no longer match for each individual NCB. Hence, in the balance sheet, the resulting gap between total assets and liabilities is registered as claims or liabilities within the Eurosystem.

In the case of Spain, this item includes those claims related to the allocation of banknotes within the Eurosystem (26,453) since the amount of banknotes issued by the Banco de España was lower than the liabilities charged by the Eurosystem. The other two components are those assets which result from the transfer of foreign reserves to the ECB (4,783), and balances that arise as a result of the transactions carried out within the European System of Central Banks (ESCB), which are the TARGET2 balances. Since Spain is a deficit country, this item will appear as a liability.

**Banknotes in Circulation:** As Jobst et al (2012) clearly explain, banknotes issued by a NCB are not registered on that NCB at the issuance value. Rather, the total sum of banknotes in circulation is allocated to the ECB and the NCBs according to a specific share. The current practice consists of allocating 8% of the total banknotes in circulation as a liability of the ECB, while the remaining NCBs have a specific share which is related to their contribution to the capital of the ECB. For instance, Germany’s share of overall Eurosystem banknotes is 24.9%, France’s is 18.7%, Spain’s is 11.1% and Greece’s is 2.6%. If there are differences between the amount of banknotes effectively issued and the amount assigned by the Eurosystem, the accounting mechanism described in the item "Intra-Eurosystem accounts" is applied. For instance, as of June 2011 France had issued €83.9 billion in banknotes, but the Eurosystem had allocated €158.3 billion. Thus, the
Banque de France was given an asset for €74.4 billion under the item of Intra-Eurosystem accounts.

**Liabilities to EZ credit institutions (€):** these euro-denominated liabilities arise as a result of monetary policy operations, which are basically given by the deposits of commercial banks at the central bank. The main items within this category are the current accounts, which include the minimum reserve requirements (14,561) and the deposit facility (33,335).

**Liabilities to other EZ residents (€):** this item comprises the euro-denominated deposits that are made by the different public administrations of Spain at the central bank.

**Intra-Eurosystem Accounts (liabilities):** this item is given by the negative TARGET2 balances held vis-à-vis the ECB as a result of real and financial transactions carried out within the ESCB.

**Revaluation Accounts:** these accounts represent revaluation balances arising from unrealised gains on assets, liabilities and off-balance-sheet instruments.

The comparison between the assets of the Banco de España and the Bundesbank clearly show that the former had to undertake several refinancing operations in order to provide with liquidity its financial sector, which was under stress. In Germany, on the other hand, these refinancing operations were not necessary. Moreover, the intra-Eurosystem accounts of the Bundesbank are much larger than those of the Banco de España since Germany is a surplus country, which implies that it holds a positive TARGET2 position (hence, registered in the asset side, unlike Spain) vis-à-vis the ECB.

The composition of the balance sheet of the ECB is slightly but significantly different from that of the NCBs. First of all, it should be noted that the items "lending to EZ credit institutions" and "liabilities to EZ credit institutions", which are categories directly linked to monetary policy operations, do not appear or if they do, they are not significant. This implies that monetary policy operations are transactions that concern the NCBs and the

<table>
<thead>
<tr>
<th>ASSETS</th>
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<tbody>
<tr>
<td>Gold</td>
<td>Banknotes in circulation</td>
</tr>
<tr>
<td>Total Claims in Foreign Currency</td>
<td>Liabilities to EZ credit institutions</td>
</tr>
<tr>
<td>Claims on Non-EZ Residents (€)</td>
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<td>Revaluation Accounts</td>
</tr>
<tr>
<td>Securities of EZ Residents (€)</td>
<td></td>
</tr>
</tbody>
</table>

Source: Bundesbank

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domestic commercial banks, but not the ECB. However, in case extraordinary measures of monetary policy need to be applied, such as the two Covered Bond Programmes and the Securities Markets Programme, the assets acquired by ECB, as it was done with the NCBs, are registered under the "securities of EZ residents (€)" item.

As regards the intra-Eurosystem accounts on the assets side, they are divided into two categories: claims related to the allocation of euro banknotes within the Eurosystem (71,090) and other claims within the Eurosystem (43,393). The former consists of the claims of the ECB vis-à-vis the euro area NCBs relating to the allocation of euro banknotes within the Eurosystem. Since in practice the ECB issues no banknotes but 8% of total banknotes in circulation are computed as a liability for it, a claim of equal size must be credited on it assets side. The latter is mainly composed by the net TARGET2 balances of the ECB vis-à-vis the national banks, which in 2011 was positive due to the increase in the outstanding amounts related to back-to-back swap transactions conducted with NCBs in connection with US dollar liquidity-providing operations. Regarding the €40,307 billion worth liability, it comprises the totality of foreign reserves that NCBs transferred the ECB.

Unlike national central banks, the ECB’s main liability is given by the "liabilities to Non-EZ residents (€)", which in 2011 consisted mainly of a liability amounting to €64.2 billion (in 2010 it was only €0.1 billion) arising from the temporary reciprocal currency arrangement with the Federal Reserve. Under this arrangement, US dollars were provided by the Federal Reserve to the ECB by means of a temporary swap line, with the aim of offering short-term US dollar funding to Eurosystem counterparties. The ECB simultaneously entered into back-to-back swap transactions with Eurozone’s national central banks, which used the resulting funds to conduct US dollar liquidity-providing operations with Eurosystem counterparties in the form of reverse transactions. The back-to-back swap transactions resulted in intra-Eurosystem balances between the ECB and the national central banks.
3 A SFC representation of the Eurozone

In the first section of this article we presented a very brief description of the current crisis that the Eurozone is going through. In the second one, we presented a general overview of the specific features of the Eurosystem, which was helpful to understand the way in which this particular economic system works. Now, it is time to put all this information together in a stock-flow consistent model in order to examine the economic performance that member states may show under the current institutional setting. Thus, the aim of this section is to build a model that is able to represent the events that took place in the Eurozone both before and after 2008, when the global crisis broke out. 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). In this section, we intend to build a four-country model with the following features:

- The countries are: the US, Germany, Spain and the rest of the world. Whereas Spain represents the Eurozone’s periphery, i.e., the countries that have been accumulating persistent current account and budget deficits since the introduction of the euro, Germany represents the surplus countries of the Eurozone.

- Spain and Germany are engaged in a super-fixed exchange rate arrangement, which is the euro itself. However, the euro floats against the dollar and the currency of the rest of the world.

- The rest of the world fixes its currency against the US dollar.

- Initially, in order to represent the period that ranges from 2002 to 2008, interest rates are assumed constant. When we simulate the impact of both the financial and the sovereign debt crisis the interest rate of Spain will be allowed to vary, such that the Spanish bond market is cleared.

- In order to take into account the specific features of the Eurosystem described in Section 2, two unusual financial assets are incorporated into the model. The following balance sheet is representative of its structure, since it includes all the assets that can be traded as a result of investment and monetary policy operations. Most of the financial assets are well-known in the SFC literature. However, we are now introducing the TARGET2 balances and the Intra-Eurosystem Adjustment Accounts that were described in Section 2. Recall that the latter arise as a result of the difference between the effective issuances of banknotes and the liabilities allocated by the Eurosystem under this item.

Figure 9 shows the balance sheet of Spain’s institutional sectors and the ECB. As it happens in every SFC model, every financial asset has its counterpart. Thus, the only genuine source of wealth is given by the stock of capital, which is owned by the firms. It is worth mentioning that whereas Germany’s balance sheet is identical to Spain’s, in
In order to show that this representation of the Eurosystem in including all the components of the real balance sheets shown in Section 2, which in turn are related to the monetary policy operations also described in the previous section, the exact meaning of each asset is explained in Figure 10.

<table>
<thead>
<tr>
<th>Label in the real balance sheet</th>
<th>Label in our model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banknotes in circulation</td>
<td>$H_S$</td>
</tr>
<tr>
<td>Liabilities to EZ credit institutions</td>
<td>$R$</td>
</tr>
<tr>
<td>Lending to EZ credit institutions</td>
<td>$A$</td>
</tr>
<tr>
<td>Securities of EZ residents</td>
<td>$B_d, c_b^{SP}$</td>
</tr>
<tr>
<td>Total Claims in foreign currency</td>
<td>$B_d, c_b^{US}$</td>
</tr>
<tr>
<td>Intra-Eurosystem Accounts</td>
<td>$IEA$</td>
</tr>
<tr>
<td>Intra-Eurosystem Accounts (TARGET2)</td>
<td>$TG_2$</td>
</tr>
<tr>
<td>Revaluation Accounts</td>
<td>Included in Pcb (see equations 189-190)</td>
</tr>
</tbody>
</table>
Since the bilateral exchange rates will be used right from the beginning of the model it is worth starting by defining the six bilateral exchange rates that are considered.

$$1\$ = E1E = E2E = E4\#$$

$$1E = E6\#$$

Note that both E1 and E2 are euro/dollar exchange rates (E1 for Germany and E2 for Spain). Although under the current setting of the Eurozone the distinction between E1 and E2 is unnecessary, we define separate variables since later on we will allow for a return to national currencies in Europe. In the remaining of this model, E1 will always be equal to E2, which is the same to say that there is a single euro/dollar nominal exchange rate in Europe. Thus, the interpretation regarding appreciation or depreciation movements is the traditional one:

- If E1 and E2 goes up the euro depreciates against the dollar
- If E4 goes up the currency of the rest of the world depreciates against the dollar
- If E6 goes up the currency of the rest of the world depreciates against the euro

The general features of our model have now been described. Let us now turn to the system of equations that conform the model. It is worth mentioning that this system is constituted by two kinds of equations. The first type are, strictly speaking, accounting identities that can be directly deduced from the SAM and the flow of funds that we present in the annex. The second type are behavioural equations, which are needed to make the model run. The behavioural equations that we use are the ones that are generally used in SFC models. In the remaining of this section, in order to prevent the reader from falling asleep, only the equations that are required to provide a general intuition of the structure of the model are presented. The complete system of equations can be found in the annex.

### 3.1 Good’s Market Equilibrium and International Trade

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

\[
Y_t^i = C_t^i + I_t^i + G_t^i + X_t^i - IM_t^i \quad \forall i = US, RW, SP, GE
\]
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. However, the current institutional setting of the Eurozone dictates that member countries cannot run deficits larger than 3% of GDP. Thus, government spending in Spain and Germany are only partially exogenous, depending on the fiscal stance of each government.

\[ G_i^t = G_0^t + (1 + g^t).G_{i-1}^t \quad \forall i = US, RW \quad (5-6) \]

\[ G_i^t = \begin{cases} 
G_0^t + (1 + g^t).G_{i-1}^t, & \text{if } \frac{G_{i-1}^t - T_{i-1}^t}{Y_{i-1}^t} < 0.03 \\
G_0^t + (1 - g^t).G_{i-1}^t, & \text{if } \frac{G_{i-1}^t - T_{i-1}^t}{Y_{i-1}^t} \geq 0.03 
\end{cases} \quad \forall i = SP, GE \quad (7-8) \]

Hence, government spending in each period, \( G_t \), is given by a constant term, \( G_0 \), plus an exogenous rate of growth, \( g \). The constant term is initially set equal to zero, but its presence will be useful later on when we introduce an exogenous shock on aggregate demand through government spending.

We now turn to the equations that describe international trade transactions. Since the four economies that we are considering embody the whole world economy, the sum of total exports (i.e., \( \sum X^i \forall i = US, RW, SP, GE \)) has to be equal to total imports (i.e., \( \sum IM^i \forall i = US, RW, SP, GE \)). Otherwise, there would be leaks and the model would turn out to be inconsistent. Thus, we can define only the equations corresponding to one of the two trade flows (either exports or imports) and, since one is the mirror of the other, we can obtain the value for the other flow implicitly. The equations describing international trade flows (9 - 20) are the ones usually used in the literature, which account for both income and price effects (the latter being both direct and indirect). In order to give the reader a general idea, we present the three import equations of the US (9 - 11) - the rest are to be found in the annex.

\[ \log(IM_{US}^{GE}) = \mu_0^{US} + \mu_1^{US} \cdot \log(Y_1^{US}) + \mu_2^{US} \cdot \log(E1_t) + \mu_3^{US} \cdot \log(1/E4_t) \quad (9) \]

\[ \log(IM_{US}^{SP}) = \mu_4^{US} + \mu_5^{US} \cdot \log(Y_1^{US}) + \mu_6^{US} \cdot \log(E2_t) + \mu_7^{US} \cdot \log(1/E4_t) \quad (10) \]

\[ \log(IM_{US}^{RW}) = \mu_8^{US} + \mu_9^{US} \cdot \log(Y_1^{US}) + \mu_{10}^{US} \cdot \log(E4_t) + \mu_{11}^{US} \cdot \log(1/E1_t) \quad (11) \]

It is worth mentioning that since this is a model where prices are fixed, the real exchange rate will be equal to the nominal exchange rate. Thus, introducing the exchange rate as a determinant of trade flows between Spain and Germany is meaningless, since the corresponding term will be null (recall that a logarithmic function is being applied to the exchange rate between Spain and Germany, which will obviously be equal to 1). However,
for completeness and the possibility of introducing flexible prices later on, the exchange rate has been explicitly written. Once all the bilateral trade flows have been defined it is possible to construct the variable that represents aggregate imports and that, in turn, will feed the equation of the equilibrium of the good’s market (1-4).

\[ IM_i^t = \sum IM_{-i}^t \quad \forall i = US, RW, GE, SP \] (21-24)

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

\[ X_{US}^{GE} = IM_{GE}^{US} \cdot (1/E_1^t) \] (25)
\[ X_{US}^{RW} = IM_{RW}^{US} \cdot (1/E_4^t) \] (26)
\[ X_{US}^{SP} = IM_{SP}^{US} \cdot (1/E_2^t) \] (27)

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

\[ X_i^t = \sum X_{-i}^t \quad \forall i = US, RW, GE, SP \] (37-40)

3.2 Household’s Income and Consumption

According to national accounting, total income, \( Y_t \) is distributed between firms and households in return for their participation in the production process. Households supply their labour and in exchange receive a wage, \( W_t \) - firms contribute to the production process with their capital goods, and they earn a profit, \( P_t \). Normally, the proportion of national income that is appropriated 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.
\[ W^i_t = \psi^i.Y^i_t \quad \forall i = US, RW, GE, SP \tag{41-44} \]

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

\[ Th^US_t = \theta^US_h.(W^US_t + rd^US_{t-1}.Md^US_{t-1}) \quad \forall i = US, RW, GE, SP \tag{45-48} \]

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

\[ YD^i_t = W^i_t + rd^i_{t-1}.Md^i_{t-1} - Th^i_t \quad \forall i = US, RW, GE, SP \tag{49-52} \]

The consumption function that is used in this model is a Modigliani type function that incorporates the propensity to consume and additional term to account for wealth effects. It is worth mentioning that the propensity to consume on disposable income is much bigger than that on past accumulated wealth \( \alpha_1 > \alpha_2 \).

\[ C^i_t = \alpha_1^i.YD^i_t + \alpha_2^i.Vh^i_{t-1} \quad \forall i = US, RW, GE, SP \tag{53-56} \]

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

\[ \Delta Vh^i_t = YD^i_t - C^i_t \quad \forall i = US, RW, GE, SP \tag{57-60} \]
Households can hold their wealth in two kinds of assets: bank deposits and cash, which were previously defined as $Md_t$ and $Hd_t$. We assume that households keep a constant share of their wealth, $\varphi$, 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.

$$Hd_t^i = \varphi_i^i.Vh_t^i \quad \forall i = US, RW, GE, SP$$  (61-64)

$$Md_t^i = Vh_t^i - Hd_t^i \quad \forall i = US, RW, GE, SP$$  (65-68)

### 3.3 Firm’s Investment and Credit Demand

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

$$P_t^i = Y_t^i - W_t^i \quad \forall i = US, RW, GE, SP$$  (69-72)

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

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

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

The investment decision of the firms will be assumed to take the form of a Kaleckian-type formula, which accounts for crucial features that determine the accumulation of the capital stock. Hence, the profit rate (given by the ratio of gross profits to the stock of capital), the structure of the debt of the firms (given by the loans that they demanded to finance past investment) and the utilization rate, $u_t$, are incorporated into the model. Each term of this function is accompanied by a constant, $z$, which measures the sensibility of investment to each of its components.
\[
\frac{I_i}{K_{t-1}} = z_i' + z_i', \frac{Pf_i}{K_{t-1}} - z_i', \frac{rL_{t-1} - L_{t-1}}{K_{t-1}} + z_i', u_{t-1}' \quad \forall i = US, RW, GE, SP \quad (81-84)
\]

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

\[
u_i = \frac{Y_i}{K_i} \quad \forall i = US, RW, GE, SP \quad (85-88)
\]

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

\[
K_i = (1 - \delta_i).K_{i-1} + I_i \quad \forall i = US, RW, GE, SP \quad (89-92)
\]

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

\[
\Delta L_i = I_i - Pf_i \quad \forall i = US, RW, GE, SP \quad (93-96)
\]

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

\[
V f_i = K_i - L_i \quad \forall i = US, RW, GE, SP \quad (97-100)
\]
3.4 The Government

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

\[ T_i^t = Th_i^t + Tf_i^t + Pb_i^t \quad \forall i = US, RW, GE, SP \] (101-104)

The government is assumed to finance its consumption not only via tax collection, but also through the profits that the central bank transfers yearly, which are result of the interest payments that the monetary authority earns on its bond holdings as well as on any valuation effect that could occur as a result of exchange rate movements. Moreover, there is an additional expenditure that the government needs to finance each year: the interest payments on its debt. Should the value of public spending be higher than the sum of tax collection and central bank profits, the government finances the gap through bond issuances. Hence, supply of government bonds can be defined as follows:

\[ \Delta Bs_i^t = G_i^t - T_i^t + rb_i^{t-1}.Bs_i^{t-1} - Pcb_i^{t-1} \forall i = US, RW \] (105-106)
\[ \Delta Bs_{SP}^t = G_{SP}^t - T_{SP}^t + rb_{SP}^{t-1}.Bs_{SP}^{t-1} - Pcb_{SP}^{t-1} - \alpha P_{ECB}^{t-1} \] (107)
\[ \Delta Bs_{GE}^t = G_{GE}^t - T_{GE}^t + rb_{GE}^{t-1}.Bs_{GE}^{t-1} - Pcb_{GE}^{t-1} - (1 - \alpha) P_{ECB}^{t-1} \] (108)
\[ \alpha = \frac{Y_{SP}}{Y_{SP} + Y_{GE}} \] (109)

Note that in the cases of Spain and Germany, there is an additional source of income for the government, given by the profits of the ECB, which we assume that are distributed among the member countries according to their size (ideally, the distribution criterion should be based on each NCB’s contribution to the capital of the ECB). Moreover, it is worth mentioning that each government is assumed to issue its debt in local currency, which in the case of Spain and Germany is the euro. This feature of the model will be useful when the Eurozone member countries are no longer considered to be countries with sovereign currencies, as reality has proven lately.
3.5 Commercial Banks

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

In the real world, however, commercial banks (which also include the so-called investment banks) play an active role giving rise to a process labelled as "financialisation". This process is very complex and involves securitization, which is basically creating financial assets out of other financial assets. In this simple model that is being presented, financialisation is not considered. A recent study of financialisation within a SFC framework can be found in Saadaoui (2012). Commercial banks will be assumed to buy government bonds (both, domestic and foreign) using the money they obtain from households when the latter demand deposits. Hence, commercial banks will acquire assets by using the funds provided by households. 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. These portfolio decision can thus be written using Tobin and Godley’s criteria, which are standard in the SFC literature. For the sake of simplicity, only the portfolio equations of the US, i.e., equations (110 - 113) are written in this section. The portfolio equations of the remaining three countries, i.e, equations (114 - 125), can be found in the annex.

\[ Bd, b_{US}^{GE} = (M_t^{US} - R_t^{US})(\gamma_{10}^{US} \cdot r_b^{US} + \gamma_{11}^{US} \cdot r_b^{GE} + \gamma_{12}^{US} \cdot r_b^{SP} + \gamma_{13}^{US} \cdot r_b^{RW}) \] (110)

\[ Bd, b_{US}^{SP} = (M_t^{US} - R_t^{US})(\gamma_{20}^{US} \cdot r_b^{US} + \gamma_{21}^{US} \cdot r_b^{GE} + \gamma_{22}^{US} \cdot r_b^{SP} + \gamma_{23}^{US} \cdot r_b^{RW}) \] (111)

\[ Bd, b_{US}^{RW} = (M_t^{US} - R_t^{US})(\gamma_{30}^{US} \cdot r_b^{US} + \gamma_{31}^{US} \cdot r_b^{GE} + \gamma_{32}^{US} \cdot r_b^{SP} + \gamma_{33}^{US} \cdot r_b^{RW}) \] (112)

\[ Bd, b_{US}^{US} = (M_t^{US} - R_t^{US}) - Bd, b_{US}^{GE} - Bd, b_{US}^{SP} - Bd, b_{US}^{RW} \] (113)

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 \( Bd, b_{US}^{GE} \) 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 fulfil Tobin-Godley criteria.

As it happened before with international trade of goods (exports and imports) it is necessary to define the supply side of the international trade of bonds. Based on bilateral
demands, supply can be obtained by transforming the former through the bilateral exchange rate. We do this for the case of the US, i.e., equations (126 - 128). The remaining equations, (129 - 137) are written in the annex.

\[
Bs, b^U_{GE} = Bd, b^U_{GE}/E_1 \tag{126}
\]
\[
Bs, b^U_{SP} = Bd, b^U_{SP}/E_2 \tag{127}
\]
\[
Bs, b^U_{RW} = Bd, b^U_{RW}/E_4 \tag{128}
\]

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.

\[
R^U_t = \rho^U M^U_t \quad \forall i = US, RW, GE, SP \tag{138-141}
\]

Having defined almost all the components of banks’ balance sheet (it only remains to describe how Advances from the central bank are determined, which will be a residual), we are ready to describe the origin of banks’ profits. These will be the result of two sources: interest earnings/payments and valuation effects due to exchange rate movements. We write the equation of US’ banks profits, equation (142), and the three remaining ones, i.e., equations (143 - 145) are written in the annex.

\[
P^U_t = r^U_{t-1} Bd, b^U_{US_{t-1}} + r^RW_{t-1} Bs, b^RW_{US_{t-1}}/E_4 + r^SP_{t-1} Bs, b^SP_{US_{t-1}}/E_2 +
+ r^GE_{t-1} Bs, b^GE_{US_{t-1}}/E_1 + Bs, b^GE_{US_{t-1}} \Delta(1/E_1) + Bs, b^GE_{US_{t-1}} \Delta(1/E_1) +
+ Bs, b^SP_{US_{t-1}} \Delta(1/E_2) + r^US_{t-1} L^US_{t-1} + r^US_{t-1} R^US_{t-1} - r^US_{t-1} M^US_{t-1} -
- r^US_{t-1} A^US_{t-1} \tag{142}
\]

Taking into account that the totality of banks’ profits are transferred to the government under the form of taxes, their net worth is null.
\[ \Delta Vb_i^{US} = 0 \quad \forall i = US, RW, GE, SP \] (146-149)

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

\[ A_i^i = L_i + R_i + B\overline{d},b_i + B\overline{d},b_i - M_i - Vb_i \quad \forall i = US, RW, GE, SP \] (150-153)

### 3.6 Central Banks and ECB

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. It should be noted that in the Eurozone, the current institutional setting dictates that only 8% of total household’s demand for euros constitutes a liability of the ECB. The remaining 92% is divided into the national central banks. In this model, since it is initially assumed that Germany and Spain are of equal size, 46% of total household’s demand for cash is supplied by the Banco de España and the remaining 46% is supplied by the Bundesbank. On the other hand, the short-term interest rate constitutes the policy tool that the central bank can use to achieve its objectives. In line with this theoretical approach to monetary policy, the following equations can be written.

\[ r_i = \overline{r}_i \quad \forall i = US, RW, GE, SP \] (154-157)

\[ Hs_{i}^{US} = Hd_{i}^{US} \] (158)
\[ Hs_{i}^{RW} = Hd_{i}^{RW} \] (159)
\[ Hs_{i}^{EZ} = Hd_{i}^{SP} + Hd_{i}^{GE} \] (160)
\[ Hs,cb_{i}^{SP} = 0.46 Hs_{i}^{EZ} \] (161)
\[ Hs,cb_{i}^{GE} = 0.46 Hs_{i}^{EZ} \] (162)
\[ Hs_{i}^{ECB} = 0.08 Hs_{i}^{EZ} \] (163)
As it was explained in Section 2, the differences between the stock of cash that is issued by each NCB and the effective amount that is allocated by the Eurosystem is adjusted via Intra-Eurosystem accounting adjustments. As a result, these accounts, which were already introduced in the balance sheet, are defined as follows. Note that the ECB will always show a positive IEA account since it does never issue banknotes.

\begin{align*}
IEA_t^{SP} &= Hs, cb_t^{SP} - Hd_t^{SP} \\
IEA_t^{GE} &= Hs, cb_t^{GE} - Hd_t^{GE} \\
IEA_t^{ECB} &= Hs, cb_t^{ECB}
\end{align*}

(164)

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 (like the ECB has attempted to do with the launch of the SMP and OMT programmes). In this model, it is assumed, for the sake of simplicity, that the long and the short-term interest rates are equal. Even if they were not equal between 2002 and 2008, both were rather stable. Thus, this assumption should not be problematic. In the following sections, when we analyse the turbulence in the Eurozone after 2008, both interest rates will be divorced in order to get a clearer representation of reality.

\[ rb_t^{US} = r_t^{US} \quad \forall i = US, RW, GE, SP \]

(167-170)

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

In this model the rest of the world has a fixed exchange rate vis-a-vis the US dollar, whereas Spain and Germany are engaged in a monetary agreement that states that there is a fixed exchange rate for bilateral transactions, but a flexible exchange rate for the Eurozone’s transactions vis-à-vis the US and the rest of the world. Such an agreement is the euro itself. This peculiar institutional arrangement whereby two countries have a
fixed exchange rate between them but a common flexible exchange rate vis-à-vis extra-zone countries requires an unusual closure of NCBs balance sheets.

First, it is necessary to define TARGET2 balances in a way that is consistent with the accounting framework presented in Section 2. Consequently, the Banco de España and the Bundesbank will accumulate net TARGET2 balances, which are considered assets (in case these balances constitute a liability will appear in the asset side of the balance sheet with a negative sign), upon all bilateral real and financial transactions. Those transactions that entail a capital inflow are recorded with a plus sign, whereas those transactions that entail an outflow are recorded with a negative sign.

\[
\Delta TG_{2t}^{SP} = X_{SP, t}^{GE} - IM_{SP, t}^{GE} + r_{t-1}^{GE}Bd, b_{SP_{t-1}}^{GE} - r_{t-1}^{SP}.Bd, b_{Ge_{t-1}}^{SP} \\
+ \Delta Bs, b_{SP_{t}}^{GE} - \Delta Bd, b_{SP_{t}}^{GE}
\]

(171)

\[
\Delta TG_{2t}^{GE} = X_{GE, t}^{SP} - IM_{GE, t}^{SP} + r_{t-1}^{SP}Bd, b_{Ge_{t-1}}^{SP} - r_{t-1}^{GE}.Bd, b_{SP_{t-1}}^{GE} \\
+ \Delta Bs, b_{Ge_{t}}^{SP} - \Delta Bd, b_{SP_{t}}^{GE}
\]

(172)

The only component of the balance sheet of the Banco de España and the Bundesbank that is left to be defined is the stock of domestic bonds. Thus, this variable can be used to close their balance sheet. The variations in the stocks of domestic bonds held by each NCB can be interpreted as the result of their fine-tuning operations, which are undertaken as another tool to manage liquidity in the interbank market. In the real balance sheet of NCB these holdings of domestic bonds appear under the item "Securities of EZ residents".

\[
\Delta Bd, cb_{SP_{t}}^{SP} = \Delta R_{t}^{SP} + \Delta Hs, cb_{t}^{SP} - \Delta A_{t}^{SP} - \Delta IEA_{t}^{SP} - \Delta TG_{2t}^{SP} \\
\Delta Bd, cb_{GE_{t}}^{GE} = \Delta R_{t}^{GE} + \Delta Hs, cb_{t}^{GE} - \Delta A_{t}^{GE} - \Delta IEA_{t}^{GE} - \Delta TG_{2t}^{GE}
\]

(173)

(174)

Since the euro/dollar exchange rate is flexible, the market of bonds denominated in euros is cleared via the movements in the exchange rate. Thus, we can define the euro/dollar exchange rate based on the supply and demand of bonds denominated in euros to the US. Note that, as we have been mentioning in the previous sections, \(E1 = E2\).
Recall that under the current configuration of the Eurosystem, national central banks hold accounts at the ECB. These accounts accumulate the net inflow of euros that countries receive as a result of both real and financial transactions. These accounts are usually gathered under the label of TARGET2. Since we have already introduced intra-Eurosystem adjustments and the stock of cash supplied by the ECB we are now able to define the equilibrium in its balance sheet. We assume that the ECB transfers its profits to the governments of Spain and Germany. Therefore, its net worth is constant over time. Since the euro floats against the US dollar, the ECB does not accumulate bonds issued by the American government. Moreover, following the standard rules of the Eurosystem, the ECB is not allowed to purchase bonds of member states in the primary market (although, as mentioned in Section 2, this rule has been relaxed in order to deal with the sovereign debt crisis).

As it was also explained in Section 2, the ECB also accumulates TARGET2 balances. These are determined as a residual, such that the equilibrium in the balance sheet of the ECB is fulfilled at every point of time. In this simple model, where only two countries conform the Eurozone and where the totality of real and financial transactions are assumed to be carried out through the SEPA, TARGET2 balances of the ECB will always be null since Germany’s external surplus vis-à-vis Spain equals to Spain’s external deficit vis-à-vis Germany. Hence the absolute values of TARGET2 balances of both countries will always be the same, thereby yielding a zero balance for the ECB. This will be consistent with equation (177), since the absolute values of $Hs^E_{ECB}$ and $IEA^E_{ECB}$ will also be the same.

\[
\Delta TG^E_{ECB} = \Delta Hs^E_{ECB} - \Delta IEA^E_{ECB} \tag{177}
\]

\[
P^E_{ECB} = r^G_{t-1}Bd^G_{ECB_{t-1}} + r^S_{t-1}Bd^S_{ECB_{t-1}} + r^G_{t-1}IEA^E_{ECB_{t-1}} + r^G_{t-1}TG^E_{ECB_{t-1}} \\
+ r^US_{t-1}Bd^US_{ECB_{t-1}}E1_t + Bd^US_{ECB_{t-1}}.\Delta E1_t \tag{178}
\]

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

\[ E_4(t) = \bar{E}_4 \]  
\[ Bd, cb_{RW}^U = BS_t^RW - BS_t^RW - BS_t^RW - BS_t^RW - BS_t^RW - BS_t^RW - BS_t^RW \]  

Since, as equation (179) 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, \( Bd, cb_{RW}^U \), what becomes endogenous. This demand is written in such a way that the equilibrium in the balance sheet of the rest of the world’s central bank is fulfilled.

\[ \Delta Bd, cb_{RW}^U = \Delta H_t^RW + \Delta R_t^RW - \Delta A_t^RW - \Delta Bd, cb_{RW}^U \]  

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

\[ E_5(t) = E_2(t)/E_4(t) \]  
\[ E_6(t) = E_4(t)/E_1(t) \]

Regarding the dollar-denominated bond market, it is worth mentioning that this asset plays a distinct role as a result of the configuration of the international monetary system after the breakup of the Bretton Woods agreements. Since the rest of the world has a fixed exchange rate regime, the equilibrium in is balance of payments is ensured through the change in the stock of foreign reserves. These reserves, as it happens in the real world, are mainly constituted of US bonds. However, there has been a recent trend to reserve diversification. A detailed study of this effect within a SFC framework can be found in Lavoie and Zaho (2010). In this model we assume that foreign reserves are kept only under the form of dollar-denominated bonds, which are only issued by the US. Given that there are multiple sources of supply and demand for these assets and that the rate of interest of the US is kept exogenous (for economic policy reasons), there must be a quantity adjustment that ensures that the market is cleared. Thus, the central bank of the US intervenes in the bond market as follows:
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.

\[
B_d, c_b^{US} = Bs_t^{US} - Bs_t^{US} - b_s^{US} - Bs_t^{SP} - Bs_t^{GE} - Bs_t^{RW} - Bs_t^{US} (184)
\]

\[
B_s, c_b^{RW} = Bd, c_b^{US}/E4 (185)
\]

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

\[
\Delta R_t^{US} + \Delta H_t^{US} - \Delta A_t^{US} - \Delta Bd, c_b^{US} = 0 (190)
\]

The model has now been completely specified in equations (1-189). We can now proceed to some simulations that attempt to represent the situation of the Eurozone before the breakout of the current crisis, in 2008.
4 Imbalances in the Euro Area

During the period between 2002 and 2008 the "periphery" of the Eurozone exhibited relatively high growth rates, mainly Spain, Ireland, Cyprus and Greece. This process was matched by current account and government or private deficits (depending on the country), which were mostly financed by capital inflows from the creditor countries. However, unlike many similar exchange rate arrangements of the past, like the currency board of Argentina in the 1990s, the sustainability of the system was never questioned even though from an accounting framework it was evident that sometime an adjustment would have to be made since the south was accumulating debt denominated in a currency that it did not issue (or could issue in limited amounts and for limited purposes). Nevertheless, few economists seemed to be worried about this fallacy of composition. A sign of this optimistic attitude of financial markets towards the evolution of southern economies can be found in the very small gap between the long-term interest rate of Spanish, Greek, Portuguese and Italian bonds with respect to the German bond (normally taken as the risk-free asset within the Eurozone).

Let us now use the model presented in the previous section to represent the emergence of internal imbalances within the Eurozone as a result of the introduction of the euro as medium of exchange in 2002. Following Lapavitsas (2012), we consider that the parities at which southern countries entered the Eurozone were unfavourable, thereby eroding their competitiveness. A quantification of the "implicit transfers" from southern to northern Eurozone member countries can be found in Duwicquet et al (2012). Thus, in order to represent this situation, it is assumed a loss of competitiveness of Spain against the remaining three regional blocks, which can be introduced by increasing the constant term of the of Spanish import equations, \( \mu_{0}^{SP} \), \( \mu_{4}^{SP} \) and \( \mu_{8}^{SP} \). In order to account for the larger impact of this shock in the bilateral relationship with Germany, the parameter \( \mu_{0}^{SP} \) is increased doubly. Similarly, Germany’s constant terms are proportionally reduced. Thus, the simulation of this shock requires us to change six parameters simultaneously.

It should be noted that the remaining features of the world economy in this period (persistent twin deficits in the US, deepening of export-led growth strategies by the rest of the world, growing liquidity in financial markets, etc.) that eventually contributed to the global financial crisis are kept constant. Thus, the results of the following simulations should be interpreted as the impact of the introduction of the euro in comparison to the preceding situation, i.e., the one where countries had national currencies that had some degree of flexibility to float. We proceed in this way since, for the time being, we do not intend to reproduce the whole macrodynamic behaviour of the world economy (for instance, the accumulation of global imbalances) but just to examine the internal dynamics to which the introduction of the euro gave rise. Scenarios that incorporate all the forces that were interacting in the world economy are left for a future publication.
Figure 11: Effects of increase in Spain’s propensity to import from Germany

Figure 12: Effects of increase in Spain’s propensity to import from Germany
Figures 11 and 12 show that the loss of competitiveness increases Spain’s imports, thereby reducing its GDP. Even though the increase in the level of activity in Germany implies a second-round benefit for the Spanish economy given by the Harrod foreign trade multiplier (since its northern neighbour will increase its imports) this effect is not enough to outweigh the intensity of the initial shock. The overall effect of the shock, i.e., the effect on global growth is null since this shock has no repercussions outside the Eurozone - what Spain loses is gained by Germany and the negative effect that the recession in Spain may have on the US and the rest of the world is fully compensated by the positive effects of the expansion in Germany. As it is shown in Figure 13, the euro stays constant since no changes occur in the aggregate trading of bonds between the US and the Eurozone.
Figure 13: Effects of increase in Spain’s propensity to import
In order to complete our description of the situation before 2008, it is necessary to show the evolution of budget and current account balances in the context of a loss of competitiveness of Spain. As it can be observed in Figures 14 and 15, Spain exhibits budget and current account deficits which are equal to Germany’s surpluses, which implies the aggregate current account of the Eurozone is unchanged. This is another way to explain why even in a context of flexible exchange rates, the euro does not fluctuate against the dollar.
Figure 14: Effects of increase in Spain’s propensity to import from Germany

Figure 15: Effects of increase in Spain’s propensity to import from Germany
As Ocampo (2012) suggests, small open economies tend to exhibit what he calls "balance of payments dominance", which implies that the economy is vulnerable to external shocks and that ultimately it is the result of the balance of payments which determines the remaining financial balances within the economy. In this case, the causality running from external to budget deficits is straightforward. If the private sector is to be maintained close to a balanced position, fiscal balances must be a mirror of external balances. Phrased differently, if as a result of a loss of competitiveness the economy starts to import more from abroad (thereby producing a current account deficit), some sector in the domestic economy should be consuming and paying for these goods. As it was already mentioned, the US and the rest of the world are unaffected by this shock. Thus, their current account and budget deficits remain unchanged.

Figures 16 and 17 show the evolution of the so-called financial balances in Spain and Germany. The behaviour of budget and external balances has already been explained. As regards the private sector, in the short run it goes into deficit since savings drop more strongly than investment (which in turn proves that investment need not be caused by savings, like it is usually stated). However, after fifteen simulation periods (not comparable to fifteen years in real-time) the Spanish private sector starts to run a surplus at the expense of the government, which deepens its deficit while the current account deficit remains constant over time. This is the result of the continuous deterioration of private wealth, which in turn decreases consumption and GDP. The reduction in the level of activity reduces tax collection, thereby worsening the fiscal balance of the government. As regards the private sector in Germany, the trajectory of its financial balance and the underlying reasons are exactly the opposite. Recall that the sum of the three financial balances must always add up to zero.

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Figure 16: Financial Balances of Spain

Figure 17: Financial Balances of Germany
Finally, we show that as a result of the shock there is a deterioration on Spain’s net international investment position. Basically, the current account deficit in the context of a fixed exchange rate implies a reduction in the TARGET2 balances, which are considered an asset for the Banco de España. Moreover, the increase in the budget deficit implies the issue of bonds, which constitutes a foreign liability for the Spanish economy. The inverse rationale has to be followed to explain the trajectory of Germany’s net international investment position. It should be noted that in the short run the effects are inverted because we are computing the ratio of net foreign assets to GDP and in the period when the shock takes place GDP varies by a larger amount with respect to net foreign assets (for instance, even though net foreign assets in Spain go down, the drop of Spain’s GDP is such that the ratio goes up).
Figure 18: Effect of increase in Spain’s Imports

Figure 19: Effect of increase in Spain’s Imports
The conclusion that can be drawn from this section is that the institutional setting of the Eurozone did not (and seemingly still does not) consider the structural differences of member countries. Before the introduction of the euro, national exchange rates could adjust to help each economy to reach both and external and internal equilibria. The establishment of the monetary union eliminated this possibility and made significantly different economies compete as if they were identical. The internal imbalances which by now are well-known and that our model has reproduced were hidden until 2008 under the veil of capital movements, that financed the persistent deficits of southern countries.

However, the breakout of the global financial crisis in 2008 changed completely the scenario in which European imbalances were developing, i.e., a context of "euphoria" in financial markets or at least one in which international investors seemed eager to finance the deficits of countries with limited capacity to pay. This state of affairs was exhibited in the stable yields of the Eurozone’s periphery. As it was shown in Figure 1, after the fall of Lehman Brothers in September 2008, nothing would ever be like before in the Eurozone.

5 Conclusion

Based on the limited availability of theoretical models that correctly account for the specific features of the Eurozone as SFC model that incorporates these specificities was built. As a first experiment aimed at understanding the results that such a model can produce we decided to reproduce the immediate effect of the introduction of the euro, which in turn generated the conditions that led to the macroeconomic fragility in which the "periphery" of the Eurozone is immersed. When Spain loses competitiveness due to the unfavourable exchange rate parity with which it entered the Eurozone, the economy enters in a dynamic of persistent current account deficits, which must be matched with deficits in either the public or the private sector, or both at the same time. In a context of monetary sovereignty, like the case of the US, such a situation can persist over time. However, if a country is indebted in a currency which does not issue (or it issues in limited amounts), the continuity of these financial imbalances is determined by the willingness of international investors to keep on financing the deficit country. As many events in economic history have shown, fictitious growth processes do not last too much.

It could be argued that the simulations of our model do not describe all the events that have been occurring in the Eurozone since the fall of Lehman Brothers or that, if they do, a more chaotic panorama should be derived from the second set of simulations. These are our future lines of research, which can be undertaken with relative ease now that a detailed model of the Eurosystem has been constructed. In particular, we are using this model (with the necessary modifications) to study the introduction of a European government that sends transfers and carries out investment projects in deficit countries, the effect of the introduction of Eurobonds, a shift to a multi-speed Europe (for instance, the breakup of the euro into a northern and a southern, more depreciated, euro), the impact of the bankruptcy of the banking sector of a certain country, etc. Additionally, we are trying different alternatives to incorporate expectations into the portfolio equations, which could in turn produce endogenous speculative attacks. These are some of the lines
of research that we are pursuing, which we intend to be able to present in the near future.

References


6 Annex

6.1 The Social Accounting Matrices and the Flow of Funds
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Table 1: Matrix of Flows
United States

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<td><strong>Taxes</strong></td>
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**Total**

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Note: Continues on next page.
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<td>$-I^t_{SP}$</td>
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Table 1: Matrix of Flows

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Profits

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$Z = P_{cb}^{GE} + (1 - \alpha)P_{cb}^{ECB} + P_{f}^{GE}$
6.2 The System of Equations of the Model

\[ Y_{tUS} = C_{tUS} + I_{tUS} + G_{tUS} + X_{tUS} - IM_{tUS} \]  
(1)

\[ Y_{tRW} = C_{tRW} + I_{tRW} + G_{tRW} + X_{tRW} - IM_{tRW} \]  
(2)

\[ Y_{tSP} = C_{tSP} + I_{tSP} + G_{tSP} + X_{tSP} - IM_{tSP} \]  
(3)

\[ Y_{tGE} = C_{tGE} + I_{tGE} + G_{tGE} + X_{tGE} - IM_{tGE} \]  
(4)

\[ G_{tUS} = G_{0tUS} + (1 + g_{US}).G_{t-1} \]  
(5)

\[ G_{tRW} = G_{0tRW} + (1 + g_{RW}).G_{t-1} \]  
(6)

\[ G_{tSP} = \begin{cases} 
G_{0tSP} + (1 + g_{SP}).G_{tSP}, & \text{if } \frac{G_{tSP} - T_{tSP}}{Y_{tSP}} < 0.03 \\
G_{0tSP} + (1 - g_{SP}).G_{tSP}, & \text{if } \frac{G_{tSP} - T_{tSP}}{Y_{tSP}} \geq 0.03 
\end{cases} \]  
(7)

\[ G_{tGE} = \begin{cases} 
G_{0tGE} + (1 + g_{GE}).G_{tGE}, & \text{if } \frac{G_{tGE} - T_{tGE}}{Y_{tGE}} < 0.03 \\
G_{0tGE} + (1 - g_{GE}).G_{tGE}, & \text{if } \frac{G_{tGE} - T_{tGE}}{Y_{tGE}} \geq 0.03 
\end{cases} \]  
(8)

\[ \log(IM_{US}) = \mu_{0US} + \mu_{1US} \log(Y_{tUS}) + \mu_{2US} \log(E1_t) + \mu_{3US} \log(1/E4_t) \]  
(9)

\[ \log(IM_{SP}) = \mu_{4US} + \mu_{5US} \log(Y_{tUS}) + \mu_{6US} \log(E2_t) + \mu_{7US} \log(1/E4_t) \]  
(10)

\[ \log(IM_{RW}) = \mu_{8US} + \mu_{9US} \log(Y_{tUS}) + \mu_{10US} \log(E4_t) + \mu_{11US} \log(1/E4_t) \]  
(11)

\[ \log(IM_{GE}) = \mu_{0RW} + \mu_{1RW} \log(Y_{tRW}) + \mu_{2RW} \log(1/E6_t) + \mu_{3RW} \log(E4_t) \]  
(12)

\[ \log(IM_{US}) = \mu_{0SP} + \mu_{1SP} \log(Y_{tSP}) + \mu_{2SP} \log(1/E3_t) + \mu_{3SP} \log(E2_t.E5_t) \]  
(13)

\[ \log(IM_{SP}) = \mu_{0SP} + \mu_{1SP} \log(Y_{tSP}) + \mu_{2SP} \log(1/E3_t) + \mu_{3SP} \log(E2_t.E5_t) \]  
(14)

\[ \log(IM_{GW}) = \mu_{0GE} + \mu_{1GE} \log(Y_{tGE}) + \mu_{2GE} \log(E1_t) + \mu_{3GE} \log(1/E6_t) \]  
(15)

\[ \log(IM_{SP}) = \mu_{8SP} + \mu_{9SP} \log(Y_{tSP}) + \mu_{10SP} \log(1/E3_t) + \mu_{11SP} \log(E2_t) \]  
(16)

\[ \log(IM_{GE}) = \mu_{0GE} + \mu_{1GE} \log(Y_{tGE}) + \mu_{2GE} \log(1/E1_t) + \mu_{3GE} \log(1/E6_t) \]  
(17)

\[ \log(IM_{GW}) = \mu_{8GE} + \mu_{9GE} \log(Y_{tGE}) + \mu_{10GE} \log(E3_t) + \mu_{11GE} \log(E1_t) \]  
(18)

\[ \log(IM_{US}) = \mu_{0RW} + \mu_{1RW} \log(Y_{tUS}) + \mu_{2RW} \log(E1_t) + \mu_{3RW} \log(1/E6_t) \]  
(19)

\[ \log(IM_{SP}) = \mu_{8SP} + \mu_{9SP} \log(Y_{tSP}) + \mu_{10SP} \log(E3_t) + \mu_{11SP} \log(E1_t) \]  
(20)

\[ IM_{US} = IM_{US_u} + IM_{US_y} + IM_{US_t} \]  
(21)

\[ IM_{RW} = IM_{RW_u} + IM_{RW_y} + IM_{RW_t} \]  
(22)
\[ IM_t^{SP} = IM_t^{RW} + IM_t^{US} + IM_t^{GE} \]  
(23)

\[ IM_t^{GE} = IM_t^{RW} + IM_t^{SP} + IM_t^{US} \]  
(24)

\[ X_{US_t}^{GE} = IM_t^{US}_{GE_t} \cdot (1/E1_t) \]  
(25)

\[ X_{RW_t}^{US} = IM_t^{US}_{RW_t} \cdot (1/E4_t) \]  
(26)

\[ X_{US_t}^{SP} = IM_t^{US}_{SP_t} \cdot (1/E2_t) \]  
(27)

\[ X_{US_t}^{RW} = IM_t^{RW}_{US_t} \cdot (E4_t) \]  
(28)

\[ X_{RW_t}^{GE} = IM_t^{RW}_{GE_t} \cdot (E6_t) \]  
(29)

\[ X_{SP_t}^{RW} = IM_t^{RW}_{SP_t} \cdot (1/E5_t) \]  
(30)

\[ X_{US_t}^{SP} = IM_t^{SP}_{US_t} \cdot (E2_t) \]  
(31)

\[ X_{SP_t}^{GE} = IM_t^{GE}_{SP_t} \]  
(32)

\[ X_{RW_t}^{SP} = IM_t^{SP}_{RW_t} \cdot (E5_t) \]  
(33)

\[ X_{US_t}^{GE} = IM_t^{GE}_{US_t} \cdot (E1_t) \]  
(34)

\[ X_{SP_t}^{GE} = IM_t^{GE}_{SP_t} \]  
(35)

\[ X_{RW_t}^{GE} = IM_t^{GE}_{RW_t} \cdot (1/E6_t) \]  
(36)

\[ X_t^{US} = X_{US_t}^{GE} + X_{US_t}^{SP} + X_{US_t}^{RW} \]  
(37)

\[ X_t^{RW} = X_{RW_t}^{GE} + X_{RW_t}^{SP} + X_{RW_t}^{US} \]  
(38)

\[ X_t^{SP} = X_{SP_t}^{GE} + X_{SP_t}^{RW} + X_{SP_t}^{US} \]  
(39)

\[ X_t^{GE} = X_{GE_t}^{US} + X_{GE_t}^{SP} + X_{GE_t}^{RW} \]  
(40)

\[ W_t^{US} = \psi_t^{US} \cdot Y_t^{US} \]  
(41)

\[ W_t^{RW} = \psi_t^{RW} \cdot Y_t^{RW} \]  
(42)

\[ W_t^{SP} = \psi_t^{SP} \cdot Y_t^{SP} \]  
(43)

\[ W_t^{GE} = \psi_t^{GE} \cdot Y_t^{GE} \]  
(44)

\[ Th_t^{US} = \theta_t^{US} \cdot (W_t^{US} + rd_t^{US} \cdot M_{t-1}^{US}) \]  
(45)

\[ Th_t^{RW} = \theta_t^{RW} \cdot (W_t^{RW} + rd_t^{RW} \cdot M_{t-1}^{RW}) \]  
(46)

\[ Th_t^{SP} = \theta_t^{SP} \cdot (W_t^{SP} + rd_t^{SP} \cdot M_{t-1}^{SP}) \]  
(47)

\[ Th_t^{GE} = \theta_t^{GE} \cdot (W_t^{GE} + rd_t^{GE} \cdot M_{t-1}^{GE}) \]  
(48)
\[
\begin{align*}
YD_t^{US} &= W_t^{US} + rd_t^{US} \cdot M_{t-1}^{US} - Th_t^{US} \\
YD_t^{RW} &= W_t^{RW} + rd_t^{RW} \cdot M_{t-1}^{RW} - Th_t^{RW} \\
YD_t^{SP} &= W_t^{SP} + rd_t^{SP} \cdot M_{t-1}^{SP} - Th_t^{SP} \\
YD_t^{GE} &= W_t^{GE} + rd_t^{GE} \cdot M_{t-1}^{GE} - Th_t^{GE} \\
C_t^{US} &= \alpha_1^{US} YD_t^{US} + \alpha_2^{US} Vh_t^{US} \\
C_t^{RW} &= \alpha_1^{RW} YD_t^{RW} + \alpha_2^{RW} Vh_t^{RW} \\
C_t^{SP} &= \alpha_1^{SP} YD_t^{SP} + \alpha_2^{SP} Vh_t^{SP} \\
C_t^{GE} &= \alpha_1^{GE} YD_t^{GE} + \alpha_2^{GE} Vh_t^{GE} \\
\Delta Vh_t^{US} &= YD_t^{US} - C_t^{US} \\
\Delta Vh_t^{RW} &= YD_t^{RW} - C_t^{RW} \\
\Delta Vh_t^{SP} &= YD_t^{SP} - C_t^{SP} \\
\Delta Vh_t^{GE} &= YD_t^{GE} - C_t^{GE} \\
Hd_t^{US} &= \varphi_t^{US} Vh_t^{US} \\
Hd_t^{RW} &= \varphi_t^{RW} Vh_t^{RW} \\
Hd_t^{SP} &= \varphi_t^{SP} Vh_t^{SP} \\
Hd_t^{GE} &= \varphi_t^{GE} Vh_t^{GE} \\
Md_t^{US} &= Vh_t^{US} - Hd_t^{US} \\
Md_t^{RW} &= Vh_t^{RW} - Hd_t^{RW} \\
Md_t^{SP} &= Vh_t^{SP} - Hd_t^{SP} \\
Md_t^{GE} &= Vh_t^{GE} - Hd_t^{GE} \\
P_t^{US} &= Y_t^{US} - W_t^{US} \\
P_t^{RW} &= Y_t^{RW} - W_t^{RW} \\
P_t^{SP} &= Y_t^{SP} - W_t^{SP} \\
P_t^{GE} &= Y_t^{GE} - W_t^{GE} \\
Pf_t^{US} &= P_t^{US} - rl_t^{US} \cdot L_{t-1}^{US} - Tf_t^{US} \\
Pf_t^{RW} &= P_t^{RW} - rl_t^{RW} \cdot L_{t-1}^{RW} - Tf_t^{RW}
\end{align*}
\]
\[ P_{f_t}^{SP} = P_t^{SP} - r_t^{SP}L_t^{SP} - T_{f_t}^{SP} \]  \tag{75}

\[ P_{f_t}^{GE} = P_t^{GE} - r_t^{GE}L_t^{GE} - T_{f_t}^{GE} \]  \tag{76}

\[ T_{f_t}^{US} = \theta_f^{US}(P_t^{US} - r_t^{US}L_t^{US}) \]  \tag{77}

\[ T_{f_t}^{RW} = \theta_f^{RW}(P_t^{RW} - r_t^{RW}L_t^{RW}) \]  \tag{78}

\[ T_{f_t}^{SP} = \theta_f^{SP}(P_t^{SP} - r_t^{SP}L_t^{SP}) \]  \tag{79}

\[ T_{f_t}^{GE} = \theta_f^{GE}(P_t^{GE} - r_t^{GE}L_t^{GE}) \]  \tag{80}

\[ \frac{I_t^{US}}{K_t^{US}} = \delta_0^{US} + \delta_1^{US} \frac{P_{f_t}^{US}}{K_t^{US}} - \delta_2^{US} \frac{r_t^{US}L_t^{US}}{K_t^{US}} + \delta_3^{US}u_t^{US} \]  \tag{81}

\[ \frac{I_t^{RW}}{K_t^{RW}} = \delta_0^{RW} + \delta_1^{RW} \frac{P_{f_t}^{RW}}{K_t^{RW}} - \delta_2^{RW} \frac{r_t^{RW}L_t^{RW}}{K_t^{RW}} + \delta_3^{RW}u_t^{RW} \]  \tag{82}

\[ \frac{I_t^{SP}}{K_t^{SP}} = \delta_0^{SP} + \delta_1^{SP} \frac{P_{f_t}^{SP}}{K_t^{SP}} - \delta_2^{SP} \frac{r_t^{SP}L_t^{SP}}{K_t^{SP}} + \delta_3^{SP}u_t^{SP} \]  \tag{83}

\[ \frac{I_t^{GE}}{K_t^{GE}} = \delta_0^{GE} + \delta_1^{GE} \frac{P_{f_t}^{GE}}{K_t^{GE}} - \delta_2^{GE} \frac{r_t^{GE}L_t^{GE}}{K_t^{GE}} + \delta_3^{GE}u_t^{GE} \]  \tag{84}

\[ u_t^{US} = \frac{Y_{t}^{US}}{K_t^{US}} \]  \tag{85}

\[ u_t^{RW} = \frac{Y_{t}^{RW}}{K_t^{RW}} \]  \tag{86}

\[ u_t^{SP} = \frac{Y_{t}^{SP}}{K_t^{SP}} \]  \tag{87}

\[ u_t^{GE} = \frac{Y_{t}^{GE}}{K_t^{GE}} \]  \tag{88}

\[ K_t^{US} = (1 - \delta^{US})K_{t-1}^{US} + I_t^{US} \]  \tag{89}

\[ K_t^{RW} = (1 - \delta^{RW})K_{t-1}^{RW} + I_t^{RW} \]  \tag{90}

\[ K_t^{SP} = (1 - \delta^{SP})K_{t-1}^{SP} + I_t^{SP} \]  \tag{91}

\[ K_t^{GE} = (1 - \delta^{GE})K_{t-1}^{GE} + I_t^{GE} \]  \tag{92}

\[ \Delta L_t^{US} = I_t^{US} - P_{f_t}^{US} \]  \tag{93}

\[ \Delta L_t^{RW} = I_t^{RW} - P_{f_t}^{RW} \]  \tag{94}

\[ \Delta L_t^{SP} = I_t^{SP} - P_{f_t}^{SP} \]  \tag{95}

\[ \Delta L_t^{GE} = I_t^{GE} - P_{f_t}^{GE} \]  \tag{96}
\[VF^{US}_t = K^{US}_t - L^{US}_t\]  \hspace{1cm} (97)
\[VF^{RW}_t = K^{RW}_t - L^{RW}_t\]  \hspace{1cm} (98)
\[VF^{SP}_t = K^{SP}_t - L^{SP}_t\]  \hspace{1cm} (99)
\[VF^{GE}_t = K^{GE}_t - L^{GE}_t\]  \hspace{1cm} (100)
\[T^{US}_t = Th^{US}_t + T^{US}_t + Pb^{US}_t\]  \hspace{1cm} (101)
\[T^{RW}_t = Th^{RW}_t + T^{RW}_t + Pb^{RW}_t\]  \hspace{1cm} (102)
\[T^{SP}_t = Th^{SP}_t + T^{SP}_t + Pb^{SP}_t\]  \hspace{1cm} (103)
\[T^{GE}_t = Th^{GE}_t + T^{GE}_t + Pb^{GE}_t\]  \hspace{1cm} (104)
\[\Delta B^{US}_t = G^{US}_t - T^{US}_t + r b^{US}_t, B s^{US}_t - P c b^{US}_t\]  \hspace{1cm} (105)
\[\Delta B^{RW}_t = G^{RW}_t - T^{RW}_t + r b^{RW}_t, B s^{RW}_t - P c b^{RW}_t\]  \hspace{1cm} (106)
\[\Delta B^{SP}_t = G^{SP}_t - T^{SP}_t + r b^{SP}_t, B s^{SP}_t - P c b^{SP}_t - \alpha P^{ECB}_t\]  \hspace{1cm} (107)
\[\Delta B^{GE}_t = G^{GE}_t - T^{GE}_t + r b^{GE}_t, B s^{GE}_t - P c b^{GE}_t - (1 - \alpha) P^{ECB}_t\]  \hspace{1cm} (108)
\[\alpha = \frac{Y^{SP}}{Y^{SP} + Y^{GE}}\]  \hspace{1cm} (109)
\[B d, b^{GE}_{US, t} = (M^{US}_t - R^{US}_t), (\gamma^{US}_{10} + \gamma^{US}_{11} r b^{US}_t + \gamma^{US}_{12} r r^{GE}_t + \gamma^{US}_{13} r b^{SP}_t + \gamma^{US}_{14} r b^{RW}_t)\]  \hspace{1cm} (110)
\[B d, b^{GE}_{US, t} = (M^{US}_t - R^{US}_t), (\gamma^{US}_{20} + \gamma^{US}_{21} r b^{US}_t + \gamma^{US}_{22} r r^{GE}_t + \gamma^{US}_{23} r b^{SP}_t + \gamma^{US}_{24} r b^{RW}_t)\]  \hspace{1cm} (111)
\[B d, b^{GE}_{US, t} = (M^{US}_t - R^{US}_t), (\gamma^{US}_{30} + \gamma^{US}_{31} r b^{US}_t + \gamma^{US}_{32} r r^{GE}_t + \gamma^{US}_{33} r b^{SP}_t + \gamma^{US}_{34} r b^{RW}_t)\]  \hspace{1cm} (112)
\[B d, b^{GE}_{US, t} = (M^{US}_t - R^{US}_t) - B d, b^{GE}_{US, t} - B d, b^{GE}_{US, t} - B d, b^{GE}_{US, t}\]  \hspace{1cm} (113)
\[B d, b^{GE}_{RW, t} = (M^{RW}_t - R^{RW}_t), (\gamma^{RW}_{10} + \gamma^{RW}_{11} r b^{US}_t + \gamma^{RW}_{12} r r^{GE}_t + \gamma^{RW}_{13} r b^{SP}_t + \gamma^{RW}_{14} r b^{RW}_t)\]  \hspace{1cm} (114)
\[B d, b^{GE}_{RW, t} = (M^{RW}_t - R^{RW}_t), (\gamma^{RW}_{20} + \gamma^{RW}_{21} r b^{US}_t + \gamma^{RW}_{22} r r^{GE}_t + \gamma^{RW}_{23} r b^{SP}_t + \gamma^{RW}_{24} r b^{RW}_t)\]  \hspace{1cm} (115)
\[B d, b^{GE}_{RW, t} = (M^{RW}_t - R^{RW}_t), (\gamma^{RW}_{30} + \gamma^{RW}_{31} r b^{US}_t + \gamma^{RW}_{32} r r^{GE}_t + \gamma^{RW}_{33} r b^{SP}_t + \gamma^{RW}_{34} r b^{RW}_t)\]  \hspace{1cm} (116)
\[B d, b^{GE}_{RW, t} = (M^{RW}_t - R^{RW}_t) - B d, b^{GE}_{RW, t} - B d, b^{GE}_{RW, t} - B d, b^{GE}_{RW, t}\]  \hspace{1cm} (117)

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\[ Bd, b_{SPa}^{US} = (M_t^{SP} - R_t^{SP}).(\gamma_{10}^{SP} + \gamma_{11}^{SP} \cdot r_t^{US} + \gamma_{12}^{SP} \cdot r_t^{GE} + \gamma_{13}^{SP} \cdot r_t^{SP} + \gamma_{14}^{SP} \cdot r_t^{RW}) \] (118)

\[ Bd, b_{SPa}^{GE} = (M_t^{SP} - R_t^{SP}).(\gamma_{20}^{GE} + \gamma_{21}^{GE} \cdot r_t^{US} + \gamma_{22}^{GE} \cdot r_t^{GE} + \gamma_{23}^{GE} \cdot r_t^{SP} + \gamma_{24}^{GE} \cdot r_t^{RW}) \] (119)

\[ Bd, b_{SPa}^{RW} = (M_t^{SP} - R_t^{SP}).(\gamma_{30}^{SP} + \gamma_{31}^{SP} \cdot r_t^{US} + \gamma_{32}^{SP} \cdot r_t^{GE} + \gamma_{33}^{SP} \cdot r_t^{SP} + \gamma_{34}^{SP} \cdot r_t^{RW}) \] (120)

\[ Bd, b_{SPa}^{US} = (M_t^{SP} - R_t^{SP}) - Bd, b_{SPa}^{GE} - Bd, b_{SPa}^{RW} - Bd, b_{SPa}^{US} \] (121)

\[ Bd, b_{GEt}^{US} = (M_t^{GE} - R_t^{GE}).(\gamma_{10}^{GE} + \gamma_{11}^{GE} \cdot r_t^{US} + \gamma_{12}^{GE} \cdot r_t^{GE} + \gamma_{13}^{GE} \cdot r_t^{SP} + \gamma_{14}^{GE} \cdot r_t^{RW}) \] (122)

\[ Bd, b_{GEt}^{GE} = (M_t^{GE} - R_t^{GE}).(\gamma_{20}^{GE} + \gamma_{21}^{GE} \cdot r_t^{US} + \gamma_{22}^{GE} \cdot r_t^{GE} + \gamma_{23}^{GE} \cdot r_t^{SP} + \gamma_{24}^{GE} \cdot r_t^{RW}) \] (123)

\[ Bd, b_{GEt}^{RW} = (M_t^{GE} - R_t^{GE}).(\gamma_{30}^{GE} + \gamma_{31}^{GE} \cdot r_t^{US} + \gamma_{32}^{GE} \cdot r_t^{GE} + \gamma_{33}^{GE} \cdot r_t^{SP} + \gamma_{34}^{GE} \cdot r_t^{RW}) \] (124)

\[ Bd, b_{GEt}^{US} = (M_t^{GE} - R_t^{GE}) - Bd, b_{GEt}^{SP} - Bd, b_{GEt}^{RW} - Bd, b_{GEt}^{US} \] (125)

\[ Bs, b_{GEt}^{US} = Bd, b_{GEt}^{US}/E1_t \] (126)

\[ Bs, b_{GEt}^{GE} = Bd, b_{GEt}^{GE}/E2_t \] (127)

\[ Bs, b_{GEt}^{US} = Bd, b_{GEt}^{US}/E4_t \] (128)

\[ Bs, b_{GEt}^{GE} = Bd, b_{GEt}^{GE}/E5_t \] (129)

\[ Bs, b_{GEt}^{SP} = Bd, b_{GEt}^{SP}/E6_t \] (130)

\[ Bs, b_{GEt}^{GE} = Bd, b_{GEt}^{GE}/E3_t \] (131)

\[ Bs, b_{GEt}^{US} = Bd, b_{GEt}^{US}/E2_t \] (132)

\[ Bs, b_{GEt}^{GE} = Bd, b_{GEt}^{GE}/E1_t \] (133)

\[ Bs, b_{GEt}^{SP} = Bd, b_{GEt}^{SP}/E5_t \] (134)

\[ Bs, b_{GEt}^{GE} = Bd, b_{GEt}^{GE}/E1_t \] (135)

\[ Bs, b_{GEt}^{SP} = Bd, b_{GEt}^{GE}/E6_t \] (136)

\[ R_t^{US} = \rho_{US} \cdot M_t^{US} \] (138)

\[ R_t^{GE} = \rho_{GE} \cdot M_t^{GE} \] (141)
\[ P_{l,t}^{US} = \text{rb}_{l-1}^{US} \cdot \text{Bs}, b_{US_l-1}^{US} / E_4_t + \text{rb}_{l-1}^{SP} \cdot \text{Bs}, b_{US_l-1}^{SP} / E_2_t \]
\[ + \text{rb}_{l-1}^{GE} \cdot \text{Bs}, b_{US_l-1}^{GE} / E_1_t + \text{Bs}, b_{US_l-1}^{RW} \cdot \Delta(1/E_4_t) + \text{Bs}, b_{US_l-1}^{GE} \cdot \Delta(1/E_1_t) \]
\[ + \text{Bs}, b_{US_l-1}^{SP} \cdot \Delta(1/E_2_t) + \text{rt}_{l-1}^{US} \cdot L_{l-1}^{US} + \text{rs}_{l-1}^{US} \cdot R_{l-1}^{US} - \text{rd}_{l-1}^{US} \cdot M_{l-1}^{US} \]
\[ - \text{rt}_{l-1}^{US} \cdot A_{l-1}^{US} \tag{142} \]

\[ P_{l,t}^{RW} = \text{rb}_{l-1}^{RW} \cdot \text{Bs}, b_{RW_l-1}^{RW} + \text{rb}_{l-1}^{US} \cdot \text{Bs}, b_{US_l-1}^{US} \cdot E_4_t + \text{rb}_{l-1}^{SP} \cdot \text{Bs}, b_{RW_l-1}^{SP} / E_5_t \]
\[ + \text{rb}_{l-1}^{GE} \cdot \text{Bs}, b_{RW_l-1}^{GE} \cdot E_6_t + \text{Bs}, b_{US_l-1}^{US} \cdot \Delta(E_4_t) + \text{Bs}, b_{RGB_l-1}^{GE} \cdot \Delta(E_6_t) \]
\[ + \text{Bs}, b_{RW_l-1}^{SP} \cdot \Delta(1/E_5_t) + \text{rt}_{l-1}^{RW} \cdot L_{l-1}^{RW} + \text{rs}_{l-1}^{RW} \cdot R_{l-1}^{RW} - \text{rd}_{l-1}^{RW} \cdot M_{l-1}^{RW} \]
\[ - \text{rt}_{l-1}^{RW} \cdot A_{l-1}^{RW} \tag{143} \]

\[ P_{l,t}^{SP} = \text{rb}_{l-1}^{SP} \cdot \text{Bs}, b_{SP_l-1}^{SP} + \text{rb}_{l-1}^{US} \cdot \text{Bs}, b_{SP_l-1}^{US} \cdot E_2_t + \text{rb}_{l-1}^{RW} \cdot \text{Bs}, b_{SP_l-1}^{RW} \cdot E_5_t \]
\[ + \text{rb}_{l-1}^{GE} \cdot \text{Bs}, b_{SP_l-1}^{GE} + \text{Bs}, b_{US_l-1}^{US} \cdot \Delta(E_2_t) + \text{Bs}, b_{SP_l-1}^{SP} \cdot \Delta(E_5_t) \]
\[ + \text{rt}_{l-1}^{SP} \cdot L_{l-1}^{SP} + \text{rs}_{l-1}^{SP} \cdot R_{l-1}^{SP} - \text{rd}_{l-1}^{SP} \cdot M_{l-1}^{SP} + \text{rs}_{l-1}^{SP} \cdot A_{l-1}^{SP} \tag{144} \]

\[ P_{l,t}^{GE} = \text{rb}_{l-1}^{GE} \cdot \text{Bs}, b_{GE_l-1}^{GE} + \text{rb}_{l-1}^{US} \cdot \text{Bs}, b_{GE_l-1}^{US} \cdot E_1_t + \text{rb}_{l-1}^{RW} \cdot \text{Bs}, b_{GE_l-1}^{RW} / E_6_t \]
\[ + \text{rb}_{l-1}^{SP} \cdot \text{Bs}, b_{GE_l-1}^{SP} + \text{Bs}, b_{US_l-1}^{US} \cdot \Delta(E_1_t) + \text{Bs}, b_{GE_l-1}^{GE} \cdot \Delta(1/E_6_t) \]
\[ + \text{rt}_{l-1}^{GE} \cdot L_{l-1}^{GE} + \text{rs}_{l-1}^{GE} \cdot R_{l-1}^{GE} - \text{rd}_{l-1}^{GE} \cdot M_{l-1}^{GE} + \text{rs}_{l-1}^{GE} \cdot A_{l-1}^{GE} \tag{145} \]

\[ \Delta V_{l,t}^{US} = 0 \tag{146} \]

\[ \Delta V_{l,t}^{RW} = 0 \tag{147} \]

\[ \Delta V_{l,t}^{SP} = 0 \tag{148} \]

\[ \Delta V_{l,t}^{GE} = 0 \tag{149} \]

\[ A_{t}^{US} = L_{t}^{US} + R_{t}^{US} + \text{Bs}, b_{US_t}^{US} + \text{Bs}, b_{US_t}^{US} + \text{Bs}, b_{US_t}^{GE} \]
\[ - M_{t}^{US} - Vb_{t}^{US} \tag{150} \]

\[ A_{t}^{RW} = L_{t}^{RW} + R_{t}^{RW} + \text{Bs}, b_{RW_t}^{RW} + \text{Bs}, b_{RW_t}^{US} + \text{Bs}, b_{RW_t}^{SP} + \text{Bs}, b_{RW_t}^{GE} \]
\[ - M_{t}^{RW} - Vb_{t}^{RW} \tag{151} \]

\[ A_{t}^{SP} = L_{t}^{SP} + R_{t}^{SP} + \text{Bs}, b_{SP_t}^{SP} + \text{Bs}, b_{SP_t}^{SP} + \text{Bs}, b_{SP_t}^{GE} \]
\[ - M_{t}^{SP} - Vb_{t}^{SP} \tag{152} \]

\[ A_{t}^{GE} = L_{t}^{GE} + R_{t}^{GE} + \text{Bs}, b_{GE_t}^{GE} + \text{Bs}, b_{GE_t}^{GE} + \text{Bs}, b_{GE_t}^{SP} + \text{Bs}, b_{GE_t}^{US} \]
\[ - M_{t}^{GE} - Vb_{t}^{GE} \tag{153} \]
\[ r_t^{US} = r_t^{\bar{U}S} \]  \hspace{1cm} (154)
\[ r_t^{RW} = r_t^{\bar{R}W} \]  \hspace{1cm} (155)
\[ r_t^{SP} = r_t^{SP} \]  \hspace{1cm} (156)
\[ r_t^{GE} = r_t^{GE} \]  \hspace{1cm} (157)
\[ H_{s_t}^{US} = H_{d_t}^{US} \]  \hspace{1cm} (158)
\[ H_{s_t}^{RW} = H_{d_t}^{RW} \]  \hspace{1cm} (159)
\[ H_{s_t}^{EZ} = H_{d_t}^{SP} + H_{d_t}^{GE} \]  \hspace{1cm} (160)
\[ H_{s_t} = 0.46 H_{s_t}^{EZ} \]  \hspace{1cm} (161)
\[ H_{s_t}^{GE} = 0.46 H_{s_t}^{EZ} \]  \hspace{1cm} (162)
\[ H_{s_t}^{ECB} = 0.08 H_{s_t}^{EZ} \]  \hspace{1cm} (163)
\[ IEA_{t}^{SP} = H_{s_t}^{SP} - H_{d_t}^{SP} \]  \hspace{1cm} (164)
\[ IEA_{t}^{GE} = H_{s_t}^{GE} - H_{d_t}^{GE} \]  \hspace{1cm} (165)
\[ IEA_{t}^{ECB} = H_{s_t}^{ECB} \]  \hspace{1cm} (166)
\[ r_{b_t}^{US} = r_{\bar{U}S}^{b} \]  \hspace{1cm} (167)
\[ r_{b_t}^{RW} = r_{\bar{R}W}^{b} \]  \hspace{1cm} (168)
\[ r_{b_t}^{SP} = r_{SP}^{b} \]  \hspace{1cm} (169)
\[ r_{b_t}^{GE} = r_{GE}^{b} \]  \hspace{1cm} (170)
\[ \Delta TG_{2t}^{SP} = X_{SP_t}^{GE} - IM_{SP_t}^{GE} + rb_{t-1}^{GE} \cdot Bd_t^{GE} - rb_{t-1}^{SP} \cdot Bd_{t-1}^{SP} \]  \hspace{1cm} (171)
\[ + \Delta Bs_t^{GE} - \Delta Bd_t^{SP} \]
\[ \Delta TG_{2t}^{GE} = X_{GE_t}^{SP} - IM_{GE_t}^{SP} + rb_{t-1}^{SP} \cdot Bd_{t-1}^{SP} - rb_{t-1}^{GE} \cdot Bd_{t-1}^{GE} \]  \hspace{1cm} (172)
\[ + \Delta Bs_t^{SP} - \Delta Bd_t^{GE} \]
\[ \Delta Bd_t, cb_{SP_t} = \Delta R_{SP_t} + \Delta H_{s_t}^{SP} - \Delta A_{SP_t}^{SP} - \Delta IEA_{t}^{SP} - \Delta TG_{2t}^{SP} \]  \hspace{1cm} (173)
\[ \Delta Bd_t, cb_{GE_t} = \Delta R_{GE_t} + \Delta H_{s_t}^{GE} - \Delta A_{GE_t}^{GE} - \Delta IEA_{t}^{GE} - \Delta TG_{2t}^{GE} \]  \hspace{1cm} (174)
\[ E_1_t = \frac{B_s^{GE} + B_s^{SP} - B_s, b_{SPt}^{SP} - B_s, b_{GE}^{GE} - B_s, b_{SPt}^{SP} - B_s, b_{RW}, B_s, b_{RWt}^{GE} - B_s, b_{RW}^{GE}}{B_d, b_{US}^{SP} + B_d, b_{US}^{GE}} \]

(175)

\[ E_2_t = \frac{B_s^{GE} + B_s^{SP} - B_s, b_{SPt}^{SP} - B_s, b_{GE}^{GE} - B_s, b_{SPt}^{SP} - B_s, b_{RW}, B_s, b_{RWt}^{GE} - B_s, b_{RW}^{GE}}{B_d, b_{US}^{SP} + B_d, b_{US}^{GE}} \]

(176)

\[ \Delta T G_2^{ECB} = \Delta H_t^{ECB} - \Delta I E A_t^{ECB} \]

(177)

\[ P_t^{ECB} = r_{t-1}^{GE} B_d_{ECB_{t-1}}^{GE} + r_{t-1}^{SP} B_d_{ECB_{t-1}}^{SP} + r_{t-1}^{GE} I E A_{t-1}^{ECB} + r_{t-1}^{GE} T G_2^{ECB} \]

(178)

\[ E_4_t = \bar{E}_4 \]

(179)

\[ B_d, c_{RWt} = B_s^{RW} - B_s, b_{US}^{RW} - B_s, b_{SPt}^{SP} - B_s, b_{GE}^{GE} - B_s, b_{RW}^{SP} - B_s, b_{RW}^{GE} \]

(180)

\[ \Delta B_d, c_{RWt} = \Delta H_t^{RW} + \Delta I_t^{RW} - \Delta A_{t-1}^{RW} - \Delta B_d, c_{RWt} \]

(181)

\[ E_5_t = E_2_t / E_4_t \]

(182)

\[ E_6_t = E_4_t / E_1_t \]

(183)

\[ B_d, c_{US}^{US} = B_s^{US} - B_s, b_{US}^{US} - B_s, b_{SPt}^{SP} - B_s, b_{GE}^{US} - B_s, b_{RW}^{US} - B_s, b_{RW}^{US} \]

(184)

\[ B_s, c_{RW}^{US} = B_d, c_{RW}^{US} / E_4 \]

(185)

\[ P_c_{t-1} = r_{t-1}^{US} B_d, c_{US}^{US} + r_{t-1}^{US} A_{t-1}^{US} - r_{t-1}^{US} R_{t-1}^{US} \]

(186)

\[ P_c_{RW} = r_{t-1}^{US} B_d, c_{RW}^{US} + r_{t-1}^{US} A_{t-1}^{RW} - r_{t-1}^{US} R_{t-1}^{RW} + r_{t-1}^{US} B_s, c_{RW}^{US} \]

(187)

\[ P_{c_{t-1}}^{SP} = r_{t-1}^{GE} T G_{t-1}^{SP} - r_{t-1}^{SP} R_{t-1}^{SP} + r_{t-1}^{SP} B_d, c_{SPt-1}^{SP} + r_{t-1}^{US} B_s, c_{US}^{SP} \]

(188)

\[ P_{c_{t-1}}^{GE} = r_{t-1}^{GE} T G_{t-1}^{GE} - r_{t-1}^{GE} R_{t-1}^{GE} + r_{t-1}^{GE} B_d, c_{GE}^{GE} + r_{t-1}^{US} B_s, c_{US}^{GE} \]

(189)

\[ \Delta H_t^{US} + \Delta I_t^{US} - \Delta A_{t-1}^{US} - \Delta B_d, c_{US}^{US} = 0 \]

(190)