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Topics on Open Economy Macroeconomics: A stock-flow consistent approach

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Acknowledgements

The tour that now finds me presenting this thesis began in 2009, when having recently finished my undergraduate studies I entered the Ministry of Economic Affairs of Argentina for an internship. The task that I was given was to write weekly reports on the evolution of the global financial crisis, which was going through its darker phase. Since my academic formation was mainly neoclassical, I was unable to understand the causes of the crisis and the possible ways out of it. Fortunately, Emmanuel Alvarez Agis and Fernando Toledo were then working in the same department. Sharing the same working environment with them was crucial to my future academic career, since they were the first approach that I had to heterodox economics. In particular, it was Fernando Toledo who strongly recommended me the reading of Godley and Lavoie's manual on stock-flow consistent models. During the year I spent at the Ministry I also benefited from the exchanges with Isidoro Sorokin, Luis Trajtemberg and Fabio Klitenik.

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Table of contents

1. Introduction…… 1
1.1 Historical background and motivation…… 1
1.2 Epistemology……4
1.3 The standard New Keynesian model versus stock-flow consistent models..13

2. Reforming the international monetary system…….. 39
2.1 Introduction……..39
2.2 The current international monetary (non)system……43
2.3 Keynes' proposal……..48
2.4 A four country stock-flow consistent model……55
2.5 Reforming the international monetary system……..78
2.6 Assessment of different monetary regimes……..95
2.7 Conclusions…… 111
2.8 Annex…… 111

3. Alternative monetary regimes for the euro area…….. 113
3.1 Introduction…… …… 113
3.2 Historical background…… ……114
3.3 The working of the Eurosystem – General features…… ……..117
3.4 A stock-flow consistent model for the Eurozone…… ……129
3.5 Evaluation of the model…… ……155
3.6 Ways-out of the crisis: alternative monetary arrangements……173
3.7 A more constructive solution: the European Clearing Union……..188

4. Economic structure and external vulnerability…….. 213
4.1 Introduction…… ……213
4.2 Theoretical background…… ……214
4.3 The structuralist stock-flow consistent model…… ……217
4.4 Economic structure and external vulnerability…… ……261
4.5 Conclusions…… ……286

5. Conclusions…….. 289

References…… 291

List of Figures

1.1 The New Keynesian model……28
1.2 The New Keynesian model……30
2.1 Current account balances as percentage of US GDP…… ……40
2.2 Features of alternative international monetary systems……54
2.3 Restrictive fiscal policy in the US – Dollar model……98
2.4 Restrictive fiscal policy in the US – Dollar model……98
2.5 Restrictive fiscal policy in the US – Dollar model……99
2.6 Restrictive fiscal policy in the Eurozone – Dollar model……99
2.7 Restrictive fiscal policy in the Eurozone – Dollar model……100
2.8 Restrictive fiscal policy in the Eurozone – Dollar model……100
2.9 Restrictive fiscal policy in the US – SDR model ……102
2.10 Restrictive fiscal policy in the US – SDR model ……103
2.11 Restrictive fiscal policy in the US – Bancor model ……105
2.12 Restrictive fiscal policy in the US – Bancor model ……105
2.13 Restrictive fiscal policy in the US – Bancor model ……106
2.14 Restrictive fiscal policy in the US – Bancor model ……106
2.15 Restrictive fiscal policy in the US – Bancor model with adjustable XR……108
2.16 Restrictive fiscal policy in the US – Bancor model with adjustable XR……108
2.17 Restrictive fiscal policy in the US – Bancor model with adjustable XR……109
2.18 Restrictive fiscal policy in the US – Bancor model with adjustable XR……109
2.19 Restrictive fiscal policy in the US – Fully floating model……110
3.1 Timeline of the crisis in the Eurozone…… 114
3.2 Eurozone's key interest rates……119
3.3 Liquidity management in the Eurosystem……121
3.4 TARGET2 balances…… 125
3.5 Effect of the introduction of the euro…… 156
3.6 Effect of the introduction of the euro…… 157
3.7 Effect of the introduction of the euro…… …158
3.8 Effect of the introduction of the euro…… 159
3.9 Effect of the introduction of the euro…… 160
3.10 Effect of the introduction of the euro…… 161
3.11 Effect of the introduction of the euro…… 162
3.12 Effect of the introduction of the euro…… 163
3.13 Effect of the introduction of the euro with financial panic …… 167

3.14 Effect of the introduction of the euro with financial panic …… 167
3.15 Effect of the introduction of the euro with financial panic …… 168
3.16 Effect of the introduction of the euro with financial panic ……170
3.17 Effect of the introduction of the euro with financial panic ……170
3.18 Effect of the introduction of the euro with financial panic ……171
3.19 Effect of the introduction of the euro with financial panic ……172
3.20 Effect of loss of competitiveness on Spain's trade balance ……..181
3.21 Effect of loss of competitiveness on the Spanish euro…….. ……181
3.22 Effect of loss of competitiveness on the German euro…….. ……182
3.23 Effect of loss of competitiveness on Spain's GDP…… ……. ……..182
3.24 Effect of loss of competitiveness on Germany's GDP…….. ……183
3.25 Spain's current account with respect to Germany……200
3.26 Spain's currency versus the US dollar ……202
3.27 Spain's GDP……203
3.28 Current account of Spain with respect to Germany……..205
3.29 Spain's currency versus the US dollar……208
3.30 Spain's GDP……209
3.31 Current account of the US……..210
4.1 Impact of a fall in the price of "A" on the current account……263
4.2 Impact of a fall in the price of "A" on the nominal exchange rate……..264
4.3 Impact of a fall in the price of "A" on local price……265
4.4 Impact of a fall in the price of "A" on functional distribution of income……267
4.5 Impact of a fall in the price of "A" on output……..268
4.6 Impact of a fall in the price of "Q" on the current account……271
4.7 Impact of a fall in the price of "Q" on the exchange rate……273
4.8 Impact of a fall in the price of "Q" on foreign direct investment……273
4.9 Impact of a fall in the price of "Q" on local prices……275
4.10 Impact of a fall in the price of "Q" on functional distribution of income……275
4.11 Impact of a fall in the price of "Q" on output……277
4.12 Impact of an increase in international interest rate on the financial account..278
4.13 Impact of an increase in international interest rate on the exchange rate…...280
4.14 Impact of an increase in international interest rate on prices……..281
4.15 Impact of an increase in international interest rate on distribution of income.283
4.16 Impact of an increase in international interest rate on output……284

List of Tables

1.1 Matrix of transactions of a stock-flow consistent model……19
2.1 Major holders of Treasury securities……41
2.2 Matrices of transactions……57-61
2.3 Table 2.3: Matrix of stocks of the US……62
2.4 Summary of alternative closures……78
2.5 Summary of alternative closures……82
2.6 Matrices of transactions……84-88
2.7 Summary of alternative closures……92
3.1 Bail-outs to member States……122
3.2 Balance sheet of Spain…… 131
3.3 Identification of real-world assets in the model…… 132
3.4 Matrix of transactions…… ..133-136
3.5 Alternative closures of the model……180
3.6 Balance sheet……191
3.7 Matrices of transactions……192-195
3.8 Alternative closures of the Euro-bancor model……204
4.1 Matrix of transactions……216
4.2 Input-output matrix……219
4.3 Calibration of each economic structure……261

Summary

This thesis presents a series of theoretical studies sharing a common methodology: the use of stock-flow consistent models. Based on the failure of the *state of the art* analytical tool of the mainstream, the so-called DSGE models, I attempt to show what are the main drawbacks of these models, which include both methodological problems and the omission of some aspects of reality that are crucial (e.g., the role of money and financial markets). In the first chapter of this thesis I show why stock-flow consistent models offer a more accurate vehicle to the understanding of modern economies. These reasons, which are connected to a higher concern with realism, accounting accuracy and the interaction between the different economic agents and social institutions, explain why stock-flow consistent models have been successful in detecting the instabilities that were accumulating in the years before the outbreak of the global financial crisis.

After explaining the motivation for studying macroeconomic dynamics through stock-flow consistent models I present three chapters in which these models are adapted to the study of some specific problems of the real world, which have been and still are relevant and have a privileged place in the political agenda. In the second chapter I study some of the different alternatives for the reform of the international monetary system that have been proposed since the end of the Second World War. Starting from a model that describes the current state of affairs, it is shown how this model can be modified in order to examine how each of the alternative solutions could work. These solutions include some options that have been widely debated for decades, such as the introduction of the SDR (the currency issued by the IMF) and the bancor (the international currency that Keynes proposed together with the establishment of an international clearing union). After building the models some simulation experiments are undertaken. These experiments show in what way each solution could offer a better global environment for the development of international economic relations. In particular, it is found that the establishment of a clearing union along Keynes' lines would not only tend to reduce global imbalances but also produce higher level of effective demand in a global scale.

The goal of the third chapter is similar to the one of the second, with the difference that the concern is the crisis in the Eurozone. The chapter begins with a thorough description of the way in which the Eurosystem works. Then, a specific model is built to represent the economic dynamics that took place both before and after the crisis. The chapter continues with some proposals for reform, including a multi-speed Europe, the return to a system along the lines of the old EMS, the exit of the surplus countries from the Eurozone and the establishment of a European Clearing Union, with close ties to Keynes' proposal for the international monetary system. Each of these proposals is accompanied by a model that aims to comprehensively explain how the system would work. Not surprisingly, many of these proposals could yield more stable economic dynamics. However, their implementation seems difficult from a political point of view.

The forth chapter of this thesis entails a real challenge, since it attempts to develop the supply side of the economy, which in most stock-flow consistent models is not modelled in detail. Even though supply side issues may not be of great relevance in advanced economies (since bottlenecks

are not a usual phenomenon) they are of paramount importance in developing countries. In the case of Latin American economies, the existence of the so-called unbalanced productive structures and enclave economies requires that the economic analysis is made from a different perspective. In particular, the structuralist school of thought seems to have provided the most interesting theoretical contributions to the understanding of these types of economies. Hence, this chapter attempts to integrate some of the main features of Latin American countries into the watertight structure provided by stock-flow consistent models. Since there is a large heterogeneity within Latin American countries, four types of economies are identified: agro-industrial, oil-based, mining-based and maquila-based economies. After a model is built for each case, I examine the reaction of each economy to three exogenous shocks of great importance that are expected to happen in the near future.

It is expected that this thesis, whose chapters will be published separately in different journals, contributes to the diffusion of stock-flow consistent models as a useful tool both for academic and policy-making issues. There are in principle three features that should help in the promotion of these models as a superior alternative to DSGE models. First, their much more realistic description of reality (based on the higher *realisticness* of the assumptions, the adoption of a holistic approach and the concern with accounting accuracy). Second, their success at explaining and predicting recent economic events, to a larger extent than DSGE models (which actually did not predict any of the most serious recent events and were also unable to provide reasonable explanations for what was going on). Third, their flexibility to being adapted to the study of different and diverse economic problems. If more researchers start undertaking their studies using stock-flow consistent models or, at least, appealing to their underlying logic, macroeconomics will surely become a more reliable discipline and, therefore, it could be able to make a contribution to the wellbeing of the society. This is an outstanding debt - at least since the end of the Keynesian era in the late 1970s, macroeconomic policies have brought more harm than relief to the people who are supposed to benefit from them.

Résumé

Cette thèse présente une série d'études théoriques partageant une méthodologie commune: l'utilisation des modèles stock-flux cohérents. Sur la base de l'échec de l'outil d'analyse économique traditionnel, les modèles DSGE, je tente de montrer quels sont les principaux inconvénients de ces modèles, qui comprennent à la fois des problèmes méthodologiques et l'omission de certains aspects de la réalité qui sont cruciales (par exemple, le rôle de la monnaie et des marchés financiers). Dans le premier chapitre de cette thèse je montre pourquoi les modèles stock-flux cohérents offrent un véhicule plus précis à la compréhension des économies modernes. Ces raisons, qui sont reliés à une préoccupation plus élevé avec le réalisme, la précision comptable et l'interaction entre les différents agents économiques et des institutions sociales, expliquent pourquoi les modèles stock-flux cohérents ont réussi à détecter les instabilités qui se accumulaient dans les années avant l'éclatement de la crise financière mondiale.

Après avoir expliqué la motivation pour étudier la dynamique macroéconomique par des modèles stock-flux cohérents je présente trois chapitres dans lesquels ces modèles sont adaptés à l'étude de certains problémes spécifiques du monde réel, qui ont été et sont toujours pertinents et ont une place privilégié dans l'agenda politique. Dans le deuxième chapitre, j'étudie certaines des différentes alternatives pour la réforme du système monétaire international qui ont été proposées depuis la fin de la Seconde Guerre mondiale. A partir d'un modèle qui décrit l'état actuel des choses, il est montré comment ce modèle peut être modifié afin d'examiner comment chacune des solutions alternatives pourraient fonctionner. Ces solutions comprennent des options qui ont été largement débattues depuis des décennies, comme l'introduction du DTS (la monnaie émise par le FMI) et le bancor (la monnaie internationale que Keynes a proposé, avec la création d'une chambre de compensation internationale). Après avoir construit les modèles, des exercices de simulation sont menés. Ces expériences montrent de quelle façon chaque solution pourrait offrir un meilleur environnement mondial pour le développement des relations économiques internationales. En particulier, il est constaté que la mise en place d'une chambre de compensation comme Keynes l'a propose, ne serait pas seulement avantageuse pour réduire les déséquilibres mondiaux, mais elle pourrait aussi produire un haut niveau de demande effective à l'échelle mondiale.

L'objectif du troisième chapitre est semblable à celui du second, à la différence que la préoccupation est la crise dans la zone euro. Le chapitre commence par une description détaillée de la manière dont fonctionne l'Eurosystème. Ensuite, un modèle spécifique est construit pour représenter les dynamiques économiques qui ont eu lieu avant et après la crise. Le chapitre se poursuit avec quelques propositions de réforme, y compris une Europe à plusieurs vitesses, le retour à un système similaire à l'ancien SME, la sortie des pays excédentaires de la zone euro et la création d'une chambre européenne de compensation, avec des liens étroits à la proposition de Keynes pour le système monétaire international. Chacune de ces propositions est accompagnée d'un modèle qui vise à expliquer en détail comment le système pourrait fonctionner. Sans

surprise, la plupart de ces propositions pourraient donner des dynamiques économiques plus stables. Cependant, leur mise en œuvre semble difficile d'un point de vue politique.

Le quatrième chapitre de cette thèse implique un véritable défi, car il tente de développer le côté de l'offre de l'économie, ce qui dans la plupart des modèles stock-flux n'est pas modélisé de manière détaillée. Même si les questions de l'offre peuvent ne pas être d'une grande importance dans les économies avancées (les goulets d'étranglement ne sont pas un phénomène habituel), ils sont d'une importance primordiale dans les pays en développement. Dans le cas des économies latino-américaines, l'existence des structures productives asymétriques et les économies enclavées nécessite que l'analyse économique soit faite à partir d'une perspective différente. En particulier, l'école structuraliste de la pensée semble avoir apporté des contributions théoriques les plus intéressantes à la compréhension de ces types d'économies. Par conséquent, ce chapitre tente d'intégrer certaines des principales caractéristiques de pays d'Amérique latine dans la structure comptable des modèles stock-flux cohérents. Comme il existe une grande hétérogénéité au sein des pays d'Amérique latine, quatre types d'économies sont identifiées: agro-industrielle, pétroleière, miniér et des économies fondées sur la maquila. Après un modèle a été construit pour chaque cas, je examine la réaction de chaque économie à trois chocs exogènes de grande importance qui pourrait se produire dans un avenir proche.

Il est prévu que cette thèse, dont les chapitres seront publiés séparément dans différentes revues, contribue à la diffusion des modèles stock-flux cohérents comme un outil utile à la fois pour des questions académiques et politiques. Il y a, en principe, trois caractéristiques qui devraient aider à la promotion de ces modèles comme une alternative supérieure aux modèles DSGE. Tout d'abord, leur description beaucoup plus réaliste de la réalité (sur la base du réalisme supérieur des hypothèses, l'adoption d'une approche holistique et le souci de la précision de la comptabilité). Deuxièmement, leur succès à expliquer et prédire des événements économiques récents (au contraire de l'échec des modèles DSGE). Troisièmement, leur flexibilité à être adapté à l'étude des problèmes économiques différents et variés. Si plus de chercheurs commencent entreprendre leurs études utilisant des modèles stock-flux cohérents ou, au moins, faire appel à leur logique sous-jacente, la macroéconomie va sûrement devenir une discipline plus fiable et, par conséquent, il pourrait être en mesure d'apporter une contribution au bien-être de la société. Depuis la fin de l'ère keynésienne à la fin des années 1970, les politiques macroéconomiques ont apporté plus de mal que de soulagement pour les gens qui sont censés en bénéficier.

1. Introduction

1.1 Historical background and motivation

The forty years that followed the publication of Keynes' *General Theory* were characterized by the dominance of the Keynesian paradigm. This was particularly true in the field of economic policy, but was also observed (to a lesser extent) in the academic world. By the early 1970s it was possible to read the contributions of non-neoclassical economists in the most prestigious journals, which seemed to have an open-minded stance. A proof of this relative pluralism in the profession are the so-called "Cambridge Controversies", an exchange of ideas on the theories of production and distribution that showed many weaknesses of the neoclassical paradigm, which took place in the most well known journals. However, this apparent pluralism disappeared in the 1980s, when most developed countries suffered from "high" levels of inflation and unemployment at the same time, something that the Keynesian paradigm was said to be unable to explain[1].

There are, however, many reasons to think that the stagflation of the 1970s was explained by the supply-side shock that followed the oil shocks rather than by an excessive intervention of the States (Mitchell and Muysken, 2008). Nevertheless, this anomaly laid the grounds for a wider promotion of some ideas that until then had been only debated in the academic world – the notion of a natural rate of unemployment to which the economic system tended to lie in the long run. According to the ideas developed by Friedman (1968) and Phelps (1967, 1970) given the adaptive nature of expectations governments could exploit the trade-off between inflation and unemployment through demand management policies only in the short run. A few years later, with the advent of the rational expectations hypothesis of the New Classical branch of the neoclassical paradigm, money was considered neutral even in the short run and fiscal policy an obstacle to full employment and price stability. These extraneous ideas, closer to a fiction than to a description of the real world, quickly spread to the field of economic policy. In the 1980s many of the features of the welfare state had already dissapeared[2].

[1] In this regard, Lucas (1981), one of the most influential economists of the neoclassical paradigm and founder of the New Classical branch of the mainstream said that "Keynesian orthodoxy or the Neoclassical synthesis *is* in deep trouble, the deepest trouble in which an applied body of theory can find itself: It appears to be giving seriously wrong answers to the most basic questions of macroeconomic policy".

[2] The shift from a demand oriented policy scheme to a supply side framework can be interpreted from the following statement from Layard (1998), an influential Labor Party adviser in the UK and one of the authors the OECD *Jobs Study*, the document where the main pillars of modern economic policy concerning

The political defeat of Keynesianism also implied the shift in the world of economic policy. Its main objective tuned to keeping inflation low. This was to be achieved through a very low degree of intervention and, in case there were temporary supply shocks, monetary policy could help. Volcker's success at reducing inflation (with an important increase in the rate of unemployment as a by-product) was the beginning of an era of very passive fiscal policy and a design of monetary policy with the sole aim of keeping inflation low. In the early 1990s this approach was labeled "Inflation Targeting" and became the standard approach to economic policy making. The higher unemployment rates that were brought about by this paradigm change were supposed to be dealt with supply side policies that, as the quote from Layard presented above makes clear, considered the problem of unemployment not as a demand insufficiency phenomenon but as a problem of lack of attractiveness of the workers. Mitchell and Muysken (2008) present a detailed description of this radical change in the role of the State, in what they call the shift from the "Full Employment" to the "Full Employability" framework.

The succession of 25 years without major economic crises was claimed as a success of the economic policies that emanated from the New Neoclassical Synthesis, which gathered the main contributions of both the New Classical and the New Keynesian approaches (which means that its spirit was still neoclassical). Bernanke (2004) has dubbed this period the "Great Moderation" and affirmed that "there is evidence for the view that improved control of inflation has contributed in important measure to this welcome change in the economy". Thus, in 2007 nobody in the academic world and the political sphere seemed worried about the unsustainable growth path that the global economy was embarked in. When in 2008 Lehman Brothers went bankrupt and the worse financial and economic crisis in 80 years broke out the majority of economists found themselves in turmoil, incapable of explaining what was going on. What was actually happening in the real world was supposed to be impossible to occur. As a result, there was no recipe to end the crisis. Interestingly, Keynesian policies, which were not supposed to work, did the job and helped to undermine the damage.

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employment are laid down. Layard stated that "In the very bad old days, people thought unemployment could be permanently reduced by stimulating aggregate demand in the economy… But [this] did not address the fundamental problem; to ensure that inflationary pressures do not develop while there are still massive pockets of unemployed people. The only way to address this problem is to make all the unemployed more attractive to employers – through help with motivation and job finding, through skill formation, and through a flexible system of wage differentials. Nothing else will do the trick".

However, it is not fully correct to say that no one saw the crisis coming. After a thorough revision of the literature Bezemer (2009) found that twelve economists had foreseen the upcoming events, provided some timing and made these predictions public[3]. Comparing their studies, Bezemer found four common aspects in theirs analyzes. First, the recognition of financial assets as different and autonomous from real-sector assets. Second, an analysis of the credit flows that finances both forms of wealth. Third, a worry about the growth of debt accompanying the growth in financial wealth. Fourth, an emphasis on the accounting relation between the financial and the real economy. Even if these concerns seem reasonable and even trivial, they were excluded from the models of the mainstream. Thus, it is no surprise that *no one (within the mainstream) has seen this coming* if *this* was not something that, according to the theory, could actually happen.

When analyzing the model used to produce the OECD Economic Outlook forecasts, Bezemer notes that "there are no credit flows, asset prices or increasing net worth driving a borrowing boom, nor interest payment indicating growing debt burdens, and no balance sheet stock and flow variables that would reflect all this". Keen (2011) attempts to explain the underlying rationale in the mainstream model to explain such a serious omission, by saying that "neoclassical economic theory assumes that the financial system is rather like lubricating oil in an engine – it enables the engine to work smoothly, but has no driving effect. Neoclassical economists therefore believe that that they can ignore the financial system in economic analysis, and focus on the `real exchanges going on behind the `veil of money'".

Based on the failure of neoclassical economics to explain and predict economic phenomena with great impact it is necessary to explore alternative approaches. The systemic or integrated approach followed by the economists that could *see it coming* has been inspiring to me in the context of the crisis, when as a last-year Bachelor student I was founding serious difficulties in understanding the events by means of the (neoclassical) tools acquired in my years of formation. The work of Godley has been particularly enlightening to me and his joint work with Marc Lavoie in the development of stock-flow consistent models has given me the opportunity to undertake dynamic analyses in the lines of those who were able to understand that something was wrong with the growth process of the 2000s and that it would eventually come to an abrupt end.

[3] These economists are Dean Baker (2006), Wynne Godley (2006, 2007), Fred Harrison (2005), Michael Hudson (2006), Eric Janszen (2006, 2007), Steve Keen (2006), Jakob Brochner Madsen and Jens Kjaer Sorensen (2005, 2006), Kurt Richebächer (2006), Nouriel Roubini (2006), Peter Schiff (2006, 2007), and Robert Shiller (2006).

This thesis gathers the main works that I have done in the last three years. The common aspect of these works is the methodological approach: the use of stock-flow consistent models. Based on the contributions of Godley and Lavoie (2007) I have tried to extend and modify the models in order to adapt them to the study of some specific problems of open economies. In the remaining of this introductory chapter the main differences of the stock-flow consistent modeling approach with the standard New Keynesian framework (also known as Dynamic Stochastic General Equilibrium) are laid down. It is expected that after the presentation of these differences it is evident why the stock-flow consistent approach is to be considered a better methodological tool and, therefore, why in the subsequent chapters each topic is addressed from this perspective.

1.2 Epistemology

Broadly speaking, there are two big research programs in economics: the mainstream (also known as Neoclassical economics or Marginalism) and Heterodox economics. Even though the latter gathers a wide variety of heterogeneous approaches, they all share two features that seem sufficient to label them under the same category. First, they are explicitly against the mainstream, they object to the theories of the mainstream and do not aspire to be part of it. Instead, they consider that their theories offer a superior vehicle to the understanding of the economic phenomena that economics as a science attempts to study. Second, and more importantly, as Lawson (2009) argues, the different heterodox schools of thought share a common conception of social phenomena. Thus, if heterodox economists are against the mainstream it is not simply because they disagree on how a certain model should be closed or what policy should be recommended in a certain situation, but because they feel that orthodox economics excludes from the analysis some features that, for a heterodox economist, are crucial. In other words, orthodox and heterodox economics do not share the same "ontology" (Lawson, 2006).

In order to compare the standard model of the mainstream with a standard stock-flow consistent model, and to understand why the former failed to predict the unsustainable growth regime of the 2000s and explain the events that took place since the bankruptcy of Lehman Brothers, it is useful to examine the main pillars of the ontology of each research program. This requires study of what Lavoie (2014) call the "essentials" or what Leijonhufvud (1976) refers to as the "presuppositions" or "cosmological beliefs". In terms of Lavoie, these are "a set of commonly metaphysical beliefs, which cannot be put in a formal form, and which are anterior to the constitution of the assumptions that rule

specific models". These "beliefs", which are strongly related to ideology and the worldview of each individual, are commonly referred to as "cosmological" or "metaphysical" because, as Leijonhufvud has stated, "no one has come up with the empirical tools sharp enough to discriminate convincingly between contending hypotheses". However, given that what these beliefs are describing is crucial to the object of study, they cannot (or should not) be neglected.

Lavoie (2014) identifies five pairs of presuppositions that distinguish the mainstream from heterodox economics. These presuppositions are not only related to the worldview of each research program, but also concern methodological issues. In the remaining of this section we provide a brief summary of Lavoie's presentation of these presuppositions, which will be helpful to distinguish the mainstream approach to economics from the heterodox paradigm[4]. When we present in the next section the standard model of the mainstream (also known as the New Keynesian model) and a standard stock-flow consistent model, we will try to identify each of these "cosmological beliefs" as well as the methodological approaches underlying the model of each research program.

Ontology

The first dimension over which there are strong differences between the mainstream and the heterodox paradigm is the one concerning the nature and existence of the phenomena that economics attempts to study. Since, in principle, economics deal with real world problems such as inflation, unemployment and poverty, the theoretical description of the phenomena under consideration should resemble to a certain extent the real phenomena. For instance, if we are attempting to model aggregate private consumption it might be closer to reality to assume heterogeneous agents subject to fundamental uncertainty and bounded rationality than a single representative agent with full rationality and perfect foresight. However, the complexity of social sciences added to the fact that their object of study is subject to continuous changes make it difficult to reach a level realism that keeps the theories and models tractable. In other words, it might be hard to reach a full and permanent understanding of the true structures and

[4] Although Lavoie presents five pairs of presuppositions, we only deal with the first four, leaving aside the one related to the "political core". This omission does not imply that the political core is irrelevant. On the contrary, it seems that the need to prove scientifically that unregulated capitalism is the best of possible economic systems is the reason why neoclassical economics is still the dominant paradigm. However, when we compare the standard model of the mainstream with a standard stock-flow consistent model we focus on methodological and ontological aspects.

casual mechanisms that explain the facts that we observe in the real world. There are, thus, two ways to deal with this problem.

The first alternative is to aim at developing theories that exhibit what Mäki (1989) has denominated "realisticness", being "unrealisticness…not about reality or observables, being about inessentials, being false, disconfirmed in tests, idealizing, exaggerating, oversimplified, implausible, practically irrelevant". In order for a theory to be realistic, it must be grounded on realistic assumptions. This means that the description of the context in which the theory is framed is plausible. Even though simplifications are always necessary, it is important that they do not decontextualize the phenomena under consideration. Otherwise, there are no reasons to expect the results of our theories to have any explanatory power. According to Caldwell (1989), the importance given to explanation rather than prediction is a feature of Post-Keynesians (an important branch of heterodox economics), and this may explain why the heterodox schools of thought tend to be very careful in giving the assumptions and theories that they develop a high level of realisticness.

The other option is to follow an instrumentalist approach, as suggested by Friedman (1953). In this case, the value of truth of a theoretical statement is not important. Comprehensiveness in the explanations of social phenomena are neither relevant. What really matters is the predictive power of the theory in question. Thus, if theories are judged on their ability to predict future events (something in what mainstream theories do not seem to have succeeded) economists do not need to invest time and neurons in building complex theories and models that sometimes become too hard to be fully understood. It is better, instead, to keep things as simple as possible and, providing that predictions match the facts, we should not worry about the *realisticness* of our theories. Lucas (1981b) has taken this argument farther claiming that "insistence on realism of an economic model subverts its potential usefulness in thinking about reality" and that good models have to "necessarily be artificial, abstract, patently unreal".

Foley (2004) warns how the excessive instrumentalism has taken economic theory too far from the real world. "For one thing, the Rational Consumer integrates the roles of the Classical Worker, Capitalist, and Landowner. Everyone is, after all, to some extent a worker supplying labor-power, a capitalist who owns at least some dividend or interest yielding assets, and a landowner. The marginalist revolution obliterates the vigorous class distinction of Classical political economy to create a Representative Economic Agent who is a scale model of the whole society. The link between this representative agent and the concrete individuals who actually make up capitalist society (and who remained just as

driven by class distinctions as ever) is simply quantitative: some real individuals have larger relative endowment of capital, or labor-power, or land (or, indeed, larger or smaller absolute endowments), and thus make a correspondingly skewed contribution to the behavior the aggregate Representative Agent". The excessive reductionism for the sake of simplicity decontextualizes the theory to an extent that it makes it useless to understand the real world. Reductionism in economics has also, as Foley's quote makes clear, excluded social interactions from the core of economic phenomena.

Hence, the first difference between the mainstream and heterodox economics concerns ontology. Whereas the former focus on prediction, the latter put the emphasis on explanation. If the most important feature of a theory is its predictive power, then it might be unnecessary to "get lost" in the description of the complexities that entail the real world (as long as the theory succeeds in predicting real events). However, it seems reasonable to think whether a theory that provides a fictitious description of phenomena can succeed in its predictive goal and, if it does, to what extent this can be attributed to its appropriateness or, more likely, to chance. On the other hand, if a theory is expected to provide a comprehensive explanation of social phenomena, to give us a better understanding of the problems under consideration, then *realisticness* becomes a necessary condition. Sacrificing *realisticness* automatically implies the failure of the explanatory goal of the theory.

Rationality

The second dimension where the discrepancies between the mainstream and the heterodox research programs appear is the one concerning the behavior of the economic agents involved in the theories. This behavior is often connected to the type of rationality that agents are assumed to have. In other words, when in economics we talk about rationality we are referring to the way in which human beings behave, the way in which me make our decisions. Since behavior plays a key role in the determination of the facts that economics studies (for instance, portfolio choice, investment and consumption decisions, economic policy decisions, etc.) the way in which economics agents are assumed to behave is crucial for the conclusions that a theory will produce.

In line with its instrumentalist approach to economic theorizing, the mainstream assumes what Lavoie calls "model-consistent rationality" or "unbounded rationality". This implies that economic agents not only know all the possible states of nature but also, and more importantly, they are assumed to know how the economic system works. Despite the fact

that social scientists have been arguing for long about the way in which the world operates and that there is not a conclusive and widely accepted definition on the issue, the economic agents described in the models of the mainstream are aliens to these debates. They just know all the possible contingencies, each of them associated to a probability distribution function and they just make an optimal decision based on their perfect and complete knowledge about the working of the system. As Mirowski (2011) has illustrated, "orthodox macroeconomists came to conflate "being rational" with thinking like an orthodox economist. What this implied was that agents knew the one and only "true model" of the economy (which conveniently was stipulated as identical with neoclassical microeconomics)".

On the other side, heterodox economics do not adhere to the use of model-consistent rationality in their models. This is reasonable considering that they feel more confortable with a realistic rather than an instrumentalist approach to economic theorizing. However, this does not imply that human behavior is ignored and excluded from the analysis. The different strands of the heterodox paradigm prefer to work with the hypothesis of bounded rationality, which means that given that economic agents are faced with a very large (and thus intractable) amount of information, some of which might be relevant and some of which might not, they must develop some decision rules that allow them to make choices without wasting too much time and resources. As Lavoie explains, "agents attempt to achieve these norms and will modify their short-run behavior when these norms are not satisfied, thus reacting to what they perceive as disequilibria". Unlike the concept of rationality embedded in mainstream theories, the heterodox paradigm recognizes the inability of individuals to make optimal decisions, although this does not imply that the actions pursued by economic agents go against their own interest. What is clear is that whereas for the mainstream economic agents are rationally optimizing at every point of time, in the heterodox paradigm individuals try to make the best possible decision given the seemingly unlimited amount of available information (with different degrees of accuracy and reliability) and limited amount of time to process it.

Methodology

Another dimension in which the mainstream and the heterodox schools of thought differ substantially is the one concerning methodology, i.e., the principles underlying economic reasoning that determine how we acquire our knowledge. In the models of the mainstream economic agents are assumed to be independent and isolated "atoms" whose optimizing behavior, in the absence of frictions or rigidities, produce a result that is

socially optimal. This individual behavior is generalized to the totality of economic agents in the society to yield the aggregates that are usually analyzed in macroeconomics. This approach, where there is not a social and institutional structure that conditions human behavior and where there are no interdependencies between the different members of the society does not allow for the emergence of properties that cannot be obtained as the simple sum of the different behaviors. In other words, there is no room for non-linearities and the results that they produce, some of which are of great importance in macroeconomics (for instance, the paradox of thrift (Keynes, 1936), the paradox of costs (Kalecki 1969, Rowthorn, 1981) and the paradox of tranquility (Minsky, 1975)).

Most of the theories and models developed in economics have followed the instrumentalist approach, in accordance with the methodological individualism. Kincaid (1998) argues that the foundations of methodological individualism can be summarized in the following three theses. First, society is constituted by and does not exist beyond individual human beings. Second, social processes are completely determined by actions that involve human beings. Third, all economic and socially relevant properties of human beings are independent of other's human beings behavior and of social groups and institutions. Thus, for methodological individualism human behavior, from which the aggregate variables are derived, has no relation with the social structure in which the economic phenomena that the theory tries to explain takes place. According to Boland (1982) methodological individualism is "the view that allows only individuals to be decision-makers in any explanation of social phenomena. Thus, explanations involving non-individualistic decision-makers, such as institutions, weather or even historical destiny, are nor allowed".

On the contrary, for heterodox economists human behavior is conditioned by historical and institutional factors. Thus, economic theories and models must be framed in an appropriate social context and human being cannot be treated as isolated atoms independent of that context. This leads to a more holistic approach. According to Viskovatoff (1998) "holism is any set of visions according to, the parts that constitute the whole, cannot be understood adequately or described individually if it is not by considering their relationship with the whole". That is why heterodox economics usually distinguish between the different types of economic agents that constitute the social structure. There is not a single representative agent that represents all individuals but there are different, heterogeneous agents (workers, capitalists, landowners, bankers, etc.) that interact and may have conflicting claims. But these conflicts of interests are not the only outcome of social interactions. It can also happen that coexistence within the same

social environment gives rise to the so-called emulation effects, through which some individuals imitate the behavior of other individuals. A good example from the real world that highlights the importance of these effects and therefore the need to analyze economic dynamics following a holistic method is provided by Zezza (2008) and Barba and Pivetti (2009), who claim that the attempt of low and middle-income US households during the 2000s to catch-up with the consumption pattern of high-income households laid the foundations for the financial fragility that ended up in the subprime crisis.

However, the distinction between the atomistic approach adopted by the mainstream and the holistic method of heterodox economics must be nuanced. Even though the description of the two preceding paragraphs apply to the majority of the theories of the research programs under consideration, it is fair to say that in recent decades (probably because they felt that their models were unbearably unrealistic) some mainstream economists have introduced some of the features of the social structure in which the theories are supposed to be framed. Without adopting a fully holistic approach, some models have incorporated the idea of conflicting claims, for instance when explaining the determination of the rate of inflation (underlying the concept of the NAIRU there is a theory of wage negotiations between unions and capitalists) or the real wage (all the models framed within the principal-agent framework give account of the fact that every exchange relationship entails two parts whose interests may at some point become incompatible). Nevertheless, the fact that there are some realistic features in the current models of the mainstream does imply that its core has abandoned the instrumentalist and atomistic approach, thereby placing it too distantly from the real world.

Economic core

Thus far we have focused our analysis of the presuppositions of the mainstream and heterodox paradigms on ontological and methodological issues. There is, however, a more specific feature, directly connected to economic phenomena, where both research programs differ radically. This feature is so crucial that it determines the very definition of economics as a science. The most widely known definition, proposed by Robbins (1932), defines economics as “a science which studies human behavior as a relationship between ends and scarce means which have alternative uses”. The key assumption of this definition, upon which all the building blocks of the mainstream are underpinned, is that of scarcity. In other words, economics comes to provide us with mechanisms that allow us to find the best allocation of scarce resources to attain an unlimited amount of needs. As was described above, following the instrumentalist approach, the techniques of

constrained optimization in a context of perfect rationality are the ones that best fit this definition of economics.

In a world of scarcity the traditional supply and demand apparatus becomes an appropriate tool to the understanding of economic phenomena, since in the absence of imperfections prices are the most efficient signal that allow economic agents to make their optimal decisions. Think, for instance, of the supply curve of a certain commodity. In the orthodox analysis this curve is upward sloping meaning that the production of the commodity exhibits diminishing returns to scale. This statement is valid under the assumption that at least one factor of production is fixed. If we take this assumption as valid, then it might be true that in the absence of imperfections prices are a measure of scarcity that induce economic agents to make optimal decisions. But, are resources actually scarce? In other words, do firms and the economy as a whole operate in a permanent situation of full employment?

In an important work on this topic Sraffa (1926) showed the invalidity of traditional supply and demand analysis. He argued that either resources are not scarce (in which case prices are not a signal of scarcity and thus a vehicle for making optimal decisions) or, if they are, the supply and demand curves are not independent, in which case every point of the supply curve would be associated to a different demand curve. Even if Sraffa's analysis is focused on the microeconomic level, the fact that the mainstream derives aggregate variables from the sum of disaggregated ones without taking into consideration the possibility of non-linearities and emerging properties implies that his conclusions also apply to aggregate supply and demand analysis.

Following Keen's (2011) interpretation of Sraffa, if we take the broadest possible definition of industry (for instance, agriculture) it is valid to treat some production factors as fixed (for instance, land). If there is an attempt to increase agricultural output, then it is likely that the price of the fixed factor increases. This, in turn, changes income distribution and affects the demand for the product itself (as well as the demand for all the remaining commodities). Hence, if resources are scarce supply and demand cannot be analyzed independently. If, on the other hand, we work with a more narrow definition of industry (for instance, wheat) then it is more difficult to assume that a certain factor is fixed since if producers wanted to increase production of the commodity in question they can easily reduce the production of other good (for instance, corn). This possibility is harder if we work with the broad definition of industry, since using more land for agriculture would imply less land for, say, manufacturing or tourism. Such a change in the allocation of resources is not immediate and easy to undertake. The broadest definition of industry

could eventually be expanded to represent the whole economy, where the same conclusion would hold. To conclude, Sraffa explains that either resources are not scarce or, if they are, the supply and demand apparatus used by the mainstream and the role that prices are given becomes invalid.

Even if Sraffa's critique is interesting (mainly because it is framed within the neoclassical analysis, showing that it is not necessary to make critiques from the outside in order to prove the inconsistencies of the mainstream) it is still worth asking if resources are actually scarce. In this regard, Kornai (1979), who was trying to determine why socialist economies tended to stagnate while Western capitalist countries exhibited persistent growth rates, found that a key feature of socialist systems was shortage. In his analysis of social systems and the constraints that could hinder economic growth he identified three types of constraints: resource constraints, demand constraints and budget constraints. In a later work Kornai (1990) concludes that while "with the classical capitalist firm it is usually the demand constraint that is binding, with the traditional socialist firm it is the resource constraint". Kornai's conclusions about the abundance of resources in the capitalist world seem undeniable, since there is an observable excess supply of labor and it is well known that firms tend to operate with excess capacity.

Adopting a more realistic rather than instrumentalist approach, the heterodox paradigm leaves aside the notion of scarcity and focus on the demand constraints. If capitalist economies find constraints on growth it is not because resources have been depleted and there are no more inputs to be put in the aggregate production function, but because there are some problems that prevent resources to be fully utilized. Arestis (1996) is clear on this when he says that "effective demand in the post-Keynesian analysis implies that it is scarcity of demand rather than scarcity of resources that is to be confronted in modern economies, so that output is ordinarily limited by effective demand…". If resources are abundant prices no longer are an index of scarcity. As explained by Pasinetti (1981) this possibility of always increasing production commonly assumed by heterodox economists is very close to the tradition of the classical economists. In both cases, prices are not a signal of scarcity but a reflection of the production costs underlying each commodity. Taking into account the substantial differences in the economic core it is also necessary to redefine economics as a science. Weeks (2012) proposes an alternative to the traditional definition, one that accounts for the main features of the economic core of the heterodox paradigms: "economics is the study of the process by which society brings its available resources into production, and the distribution of that production among its members".

Thus far we have presented the main differences regarding the epistemology of the mainstream and heterodox economics. In the next section we describe the main features of the standard New Keynesian model in order to identify the aforementioned ontological and methodological features. At the same time, we present the structure of a standard stock-flow consistent model, one of the main modeling tools of the Post-Keynesian research program. From the comparison of these two modeling approaches the advantages of the latter should emerge.

1.3 The standard New Keynesian model versus a standard Stock-Flow consistent model

Before presenting the main features of the standard New Keynesian model and comparing it with a standard stock flow consistent model, it is important to make a distinction that so far we had not made. That is the one that concerns theories and models. According to Boumans (2005), "to understand their specific function in economic research, models should be distinguished from economic theories. As will be shown, they are not theories about the world but instruments through which we can see the world and so gain some understanding of it. As mathematical representations, models should also be distinguished from pure formal objects. They should be seen as 'lanterns', as devices that help us to see the phenomena more clearly. Models are the economist's instruments of investigation, just as the microscope and the telescope are tools of the biologist and the astronomer". Thus, our critique of the mainstream is not on the use of models but on its theories. Since the models inherit the ontology and methodology of the theories, there are no reasons to think that the New Keynesian model can provide any interesting conclusion about the real world.

General structure and households' behavior

In the standard New Keynesian model, as presented in Galí (2008), the description of the economy starts with the behavior of households. Without any reference to the role that households play in the economy and their relationship with the rest of the economic agents that are part of the system, the analysis begins like this: "The representative infinitely-lived household seeks to maximize the objective function

$$E_0 \sum_{t=0}^{\infty} \beta^t U(C_t, N_t)$$

where C_t is a consumption index given by

$$C_t \equiv \left(\int_0^1 C_t(i)^{1-\frac{1}{\varepsilon}} \, di \right)^{\frac{\varepsilon}{\varepsilon-1}}$$

with $C_t(i)$ representing the quantity of good i consumed by the household in period t." It is assumed the existence of a continuum of goods represented by the interval [0,1]. The variable N_t in the utility function denotes hours of work or employment. The period utility $U(C_t, N_t)$ is assumed to be continuous and twice differentiable, with $U_{c,t} \equiv \frac{\partial U(C_t,N_t)}{\partial C_t} > 0$, $U_{cc,t} \equiv \frac{\partial U(C_t,N_t)}{\partial C_t^2} \leq 0$, $U_{n,t} \equiv \frac{\partial U(C_t,N_t)}{\partial N_t} \leq 0$, and $U_{nn,t} \equiv \frac{\partial U(C_t,N_t)}{\partial N_t^2} \leq 0$.

The model goes on to define the constraint that households face at every point of time.

$$\int_0^1 P_t(i) C_t(i) \, di + Q_t B_t \leq B_{t-1} + W_t N_t - T_t$$

Where $P_t(i)$ is the price of good i, W_t denotes the nominal wage, B_t represents the quantity of one-period, nominally riskless discount bonds purchased in period t and maturing in period t+1. Each bond pays one unit of money at maturity and its price is Q_t. As regards tax payments, T_t represents lump-sum subtractions to period income.

The model assumes that together with the decision concerning labor supply and consumption the representative household must choose an optimal combination of the available goods in the economy. This requires the consumption index to be maximized for any given level of expenditures $\int_0^1 P_t(i) C_t(i) \, di$. The solution to this problem yields the set of demand equations

$$C_t(i) = \left(\frac{P_t(i)}{P_t} \right)^{-\varepsilon} C_t$$

where $P_t \equiv \left[\int_0^1 P_t(i)^{1-\varepsilon} \, di \right]^{\frac{1}{1-\varepsilon}}$ is an aggregate price index. Since the representative household behaves optimally, $\int_0^1 P_t(i) C_t(i) \, di = P_t C_t$. Thus, the budget constraint can be rewritten as

$$P_t C_t + Q_t B_t \leq B_{t-1} + W_t N_t - T_t$$

This constraint can be plugged into the utility function (meaning that the representative consumer maximizes its utility subject to the budget constraint). Taking the derivatives of the utility function with respect to each of its arguments yields the following optimality conditions.

$$-\frac{U_{n,t}}{U_{c,t}} = \frac{W_t}{P_t}$$

$$Q_t = \beta E_t \left\{ \frac{U_{c,t+1}}{U_{c,t}} \frac{P_t}{P_{t+1}} \right\}$$

In the standard New Keynesian model the utility function is assumed to take the form $U(C_t, N_t) = \frac{C_t^{1-\sigma}}{1-\sigma} - \frac{N_t^{1+\varphi}}{1+\varphi}$. Thus, the optimality conditions become:

$$\frac{W_t}{P_t} = C_t^{\sigma} N_t^{\varphi}$$

$$Q_t = \beta E_t \left\{ \left(\frac{C_{t+1}}{C_t} \right)^{-\sigma} \frac{P_t}{P_{t+1}} \right\}$$

If we solve the first optimality condition for N_t we get the labor supply, since the amount of labor is expressed as a function of the real wage. It is also possible to solve the second optimality condition for C_t, which yields the households' demand for the consumption good.

$$c_t = E_t\{c_{t+1}\} - \frac{1}{\sigma}(i_t - E_t\{\pi_{t+1}\} - \rho)$$

where $i_t \equiv -logQ_t$is the short-term interest rate and $\rho \equiv -log\beta$ is the discount rate and lowercase letters are used to denote logs of the original variables. This is the so-called Euler equation, which states that households tend to smooth consumption over time. This result is closely related to the permanent income hypothesis developed by Friedman (1957) and the life-cycle hypothesis proposed by Modigliani and Brumberg (1954), according to which consumption is a function not of actual income (as in the traditional Keynesian model) but on average or expected income or of the value of lifetime resources. This implies that the consumer evens out the fluctuations in actual income by saving or dissaving, in such a way that a smoother consumption pattern is obtained.

Another implication of this result is the unresponsiveness of the flow of consumption to income changes that are perceived to be transitory. As it is argued below, this description of the behavior of the representative agents requires it to have a level of knowledge and rationality that are not often observed in the real world.

As it can be easily noted, the description that the New Keynesian model makes of households is one that privileges mathematical convenience or parsimony rather than the difficulties that entail understanding households' behavior as a complex social phenomenon. Both the choice of the utility function and its specific features are such that the analysis is made in a context that favors the underlying theory. Thus, the preference of an instrumentalist rather than a realistic approach is reflected right from the outset. The fact that there is one representative consumer that condenses all the features of the wide variety of consumers who constitute the real-world economy neglects heterogeneity and the possibility of having non-linearities that might bring about emerging properties. The decision to take reductionism to such a large extent reflects the adoption of a methodological individualism approach to the detriment of a more holistic framework. The combination of both a methodological individualism with an instrumentalist approach is sufficient to create an unrealistic representation of reality.

As if all this was not enough, this consumer is assumed to be rational in the sense that is always able to choose the optimal combination of consumption and leisure, given an ad-hoc intertemporal budget constraint. This implies that the individual must gather all the available information on all possible actions and states of nature and, consequently, on all possible outcomes (in the orthodox jargon the preferences are said to be *complete*). After processing all the relevant information and discarding all the useless data, the individual is assumed to order the different outcomes according to a certain degree of utility that each of them yields (this is the *transitivity* property of preferences). Once all is done, the consumer is able to make the decision that produces the highest attainable outcome, given the intertemporal budget constraint.

Moreover, the representative consumer is assumed to live in a context of risk, which means when making decisions that concern the present time and the future she knows all the possible states of the world and she builds a probability distribution function that allows her to make the optimal choice. From this perspective, there is very little room for the occurrence of unexpected events (that in the real world seem to be the rule rather than the exception), which enter under the form of a stochastic shock, which follows a normal distribution with zero mean. These descriptions of human behavior (unbounded

rationality) and the context in which decision are made (risk) are consistent with the methodological individualism and instrumentalist approaches, that tended to simplify the explanation to such an extent that the theory ends up describing a world that bears no relationship with the world in which the alleged object of study is actually framed.

From this simple optimization problem two important processes of the economy are derived: the supply of labor and the demand for goods. Since both result from the decision of the same agent they are interdependent. If, for any reason, the representative consumer wanted to enjoy more leisure that will necessarily imply a lower level of consumption as a result of a lower labor income. Although this may be true for the individual consumer, it might not be the case for the economy as a whole. If a certain worker decides to reduce its supply of labor that would not prevent another worker in the economy, providing that there exists a permanent excess supply of labor (there does not seem to be reasons to assume otherwise), from taking the job and generating the same flow of income. In the world described in the New Keynesian model more leisure reduces labor supply and, given a certain level of labor demand, pushes up the real wage, which is completely endogenous. In the real world, however, it seems that there is a permanent excess supply of labor that allows firms to always be able to hire workers at the prevailing wage, which is determined by historical and institutional factors that might be partially influenced by the business cycle.

The stock-flow consistent approach, for its part, presents a description of household behavior (and the whole economy) that privileges *realisticness* and holism. These models are built upon three matrices and two types of equations, which represent the relations embedded in the matrices. The first matrix is the social accounting matrix, which represents all the current transactions that take place in the economy within a certain period. This representation not only identifies the different components of the socio-economic structure, but also specifies how they relate with each other. The second matrix is the balance sheet, which enumerates all the real and financial assets in the economy, making clear for what sector they constitute an asset and for which they are a liability. The third matrix is the flow of funds, which show how the balance sheet of each institutional agent changes as a result of the surplus or deficit that results from the economic activity. Regarding the equations, some of them are behavioral (they explain how each institutional agent makes its decisions) and most of them are simply the accounting identities through which the elements in the different matrices are linked. This comprehensive and coherent accounting framework ensures that all the relevant processes in the economy are correctly defined, leaving no “black holes” (i.e., variables

representing processes that no agent undertakes, assets that no one holds, income the comes from nowhere, etc.).

Taking model *SIM* as an example (the most basic model developed by Godley and Lavoie (2007)) the differences with respect to the New Keynesian model appear right from the outset. Instead of assuming an isolated household that bears no relationship with the rest of the components of the social structure, every stock flow consistent model starts by defining the institutional agents that constitute the economy and comprehensively describing the multiple relations through which they interact. These relations are the current transactions that take place every period and that, added up, produce the aggregate variables that are usually analyzed in macroeconomics. Thus, household's behavior (as well as the behavior of all the remaining institutional agents) is defined in a holistic way, where the decisions made by each agent is conditioned by the decisions of the others and by the institutional arrangements that the history of the economy in question has produced.

All this information is usually presented under the form of a matrix of transactions, which includes the social accounting matrix (where all current transactions are registered) and a flow of funds matrix (where all the changes in the stock of wealth are recorded). This is a very important feature of the stock-flow consistent approach since it ensures that every flow goes from somewhere to elsewhere without nothing being lost along the way. More importantly, it shows how the outcomes of economic dynamics (be them surpluses or deficits) are transformed into an increase or a decrease in the net worth of each institutional agent participating in the economy. This crucial characteristic that may seem trivial is excluded from the analysis of the New Keynesian model. Therefore, it is no surprise that the financial fragility derived from a debt-led growth regime like the one that took place in the 2000s in the US has nor been foreseen by the standard models of the mainstream.

In order to illustrate the holistic framework that stock-flow consistent models adopt we present the matrix of transactions of model *SIM*. As Table 1.1 shows, before any description of the behavior of each institutional agent the social structure is defined. From this social structure specific relations between each member of society are established. The fact that all lines must add up to zero implies that for every transaction both the emitter and receiver are explicitly defined. This also implies that ex post every market is in equilibrium (as it is explained below, the way in which this is achieved depends on the underlying theory), without necessarily implying market clearing. As regards the columns

of the matrix of transactions, they represent the budget constraint of each institutional agent. The fact that ex post every column adds up to zero implies that the model is correctly specifying the way in which each agent is either financing its deficits or accumulating the wealth that results from its surpluses. Another important aspect that ensures consistency in the flows included in the model is that fact that gross domestic product, Y, must be equal when computed as the sum of total expenditures (in the very simple matrix presented in Table 1.1 these are given by C_s and G_s) and as the sum of total income (in this case income is totally given by wages).

Table 1.1 Matrix of transactions of a stock-flow consistent model

	Households	Production	Government	$\sum$
Consumption	$-C_d$	$+C_s$		0
Gov. Expend.		$+G_s$	$-G_d$	0
[Output]		$[Y]$		$[Y]$
Wages	$+W.N_s$	$-W.N_d$		0
Taxes	$-T_s$		$+T_d$	0
Δ Money	$-\Delta H_h$		$+\Delta H_s$	0
$\sum$	0	0	0	0

Once the main features of the social structure of the corresponding economy had been laid down it is possible to proceed to the description of household behavior. Unlike the New Keynesian model where a single representative household is described and then generalized to define aggregate consumption and labor supply, stock-flow consistent models borrow the structure of National Accounts and analyze households as a whole. Although this may seem not too different from the analysis of the mainstream (in the end, in both cases there is only one *entity* representing households) it must be noted that if households are defined as an institutional agent in the way that stock-flow model do it this implies that their behavior is described as the weighted average of all the households in the economy. Although heterogeneity is not explicitly included into the model, it can be reflected in the parameters of the equations that describe household behavior. Nothing prevents, however, from adding more columns into the matrix in order to explicitly account for heterogeneity within the households.

The specification of the model can be derived directly from the matrix of transactions. Households provide labor to firms, in exchange for which they earn a wage (given by the product of the nominal wage *W* and the amount of labor supplied N_s). Part of this wage

must be paid to the government under the form of taxes, T_s. The difference between total income and taxes gives disposable income, YD. Private consumption is financed both from (expected) labor income and wealth. The parameters α_1 and α_2 of the consumption function reflect the propensity to consume out of expected labor income and wealth, respectively. Finally, households see their stock of wealth increased or decreased according to the difference between consumption and disposable income.

$$YD = W.N_s - T_s$$

$$T_s = T_d = \theta.W.N_s \quad \theta < 1$$

$$C_d = \alpha_1.YD^e + \alpha_2.H_{h-1}$$

$$\Delta H_h = YD - C_d$$

As can be seen, the consumption equation of the stock-flow consistent model is different from the Euler equation of the New Keynesian model. First, the decision on how much to consume is not a forward-looking optimization problem whose result is the smoothening of the intertemporal flow of consumption. Instead, consumption is a flow that not only satisfies the needs of households but also adjusts in order to meet a certain target of wealth. This target results from historical processes that determine the stock of wealth that households consider adequate. It is a sort of attracting point below which households feel poorer than they should be, thereby inducing them to increase saving. On the contrary, if the actual stock of wealth is above the target households may feel that they are refraining to consume in accordance to their status, so they reduce the flow of saving. This can be observed more clearly if the equation defining the change of wealth is rearranged in order to express it with consumption on the left-hand side.

$$C_d = YD - \Delta H_h = \alpha_1.YD^e + \alpha_2.H_{h-1}$$

$$\Delta H_h = (1 - \alpha_1).YD^e - \alpha_2.H_{h-1}$$

$$\Delta H_h = \alpha_2.(\alpha_3.YD^e - H_{h-1})$$

Where $\alpha_3 = (1 - \alpha_1)/\alpha_2$. The last equation is a partial adjustment function, which states that wealth is being accumulated at a rate α_2, towards some desired proportion α_3 of disposable income. Each period households start with a given level of wealth, H_{h-1}

(which is not exogenous but determined in the previous period), and given the expected disposable income they target a certain target of wealth, given by $\alpha_3.YD^e$. Godley and Lavoie call α_3 the *stock-flow norm* of households which, according to the derivation presented above, is embedded in the consumption equation. Whenever the target level of wealth is higher than the realized level households save, in an attempt to reach their target. Hence, the stock-flow norm allows households to correct the disequilibria of the past by modifying their present behavior.

However, unlike the households of the New Keynesian model, these households are assumed to live in a context of fundamental uncertainty. This implies that they can make mistakes on their expectations on the flow of disposable income, in which case their ability to correct the mistakes of the past will be undermined. If households decide ex ante how much to consume based on an expectation on how high disposable income will be, if there are mistakes there must be something that cushions the effects of these errors. In other words, there must be a buffer that increases when disposable income is underestimated and decreases when it is overestimated. In this simple model the change in the stock of money held by households, ΔH_h, plays this role. This can be seen starting from the consumption equation and making some rearrangements.

$$C_d = \alpha_1.YD^e + \alpha_2.H_{h-1}$$

$$\Delta H_d = H_d - H_{h-1} = YD^e - C_d$$

$$H_h - H_d = YD - YD^e$$

At the beginning of every period households form an expectation on disposable income. This expectation is used, as shown above, to decide on the flow of consumption, but also to estimate a certain amount of wealth that they desire to hold, H_d. If households' expectations are not verified, they will not be able to hold the desired amount of wealth. This is because this variable is the buffer that adjusts for the mistakes in the expectations. The gap between actual and desired wealth will be equal to the size of mistake of the expectations on disposable income. For instance, if actual disposable income turns out to be higher than expected, households would find that after having realized the flow of consumption they would hold excess cash balances, which will necessarily be saved.

From the description of both the general structure in which a stock-flow consistent model is framed and the behavior of households it is possible to conclude that the analysis is

closer to reality due to the following reasons. First, households are not isolated atoms but a component of a social structure with multiple dependencies with the rest of the society. Second, they are not assumed to know all the states of nature, their probability distribution functions and, more importantly, the *true* way in which the system works. Instead, they are assumed to live in an environment of fundamental uncertainty that leads them to make continuous mistakes. Hence, instead of being rational agents that continuously optimize a certain objective function, they are assumed to follow certain *rules of thumb* that allow them to correct past disequilibria and partially reach a target position. Third, there is an explicit description of the impact of their mistakes on their balance sheets, which eventually may condition their behavior (this feature is absent in the New Keynesian model). Finally, both the mathematics and their underlying rationale seem more familiar to the everyday behavior of households.

Production, inflation and equilibrium in the New Keynesian model

The description of production of the New Keynesian model is also abstracted from the complexities that the real world entails. Galí (2008) invites us to "assume a continuum of firms indexed by $i \in [0,1]$. Each firm produces a differentiated good, but they all use an identical technology, represented by the production function

$$Y_t(i) = A_t N_t(i)^{1-\alpha}$$

where A_t represents the level of technology, assumed to be common to all firms and to evolve exogenously over time according to some stochastic process."

It is further assumed that all firms face an identical isoelastic demand schedule given by $C_t(i) = \left(\frac{P_t(i)}{P_t}\right)^{-\varepsilon} C_t$, and take the aggregate price level P_t and aggregate consumption index C_t as given. Unlike the traditional monetarist models where prices where fully flexible, the New Keynesian model follows Calvo (1983) and states that each firm may reset its price with probability $1-\theta$ in any period. Hence, each period a proportion $1-\theta$ of firms reset their prices and the remaining θ producers keep their prices unchanged. Therefore, θ becomes a measure of price stickiness. Assuming that the $1-\theta$ firms that can reset their prices choose a new price P_t^* (which is the same for all, since they face the same demand schedule). Thus, in the New Keynesian model not all firms are able to reset their prices in every period, leading to a situation where not all disequilibria can be adjusted through price movements.

Following Calvo's description, the rate of inflation can be defined as follows:

$$\Pi_t^{1-\varepsilon} = \theta + (1-\theta)\left(\frac{P_t^*}{P_{t-1}}\right)^{1-\varepsilon}$$

where $\Pi_t \equiv \frac{P_t}{P_{t-1}}$ is the "gross inflation rate" between t-1 and t. The definition of the rate of inflation makes clear that the key determinant of the change in prices is given by an optimal decision made by firms, which reset their prices (as long as they are able to do so) when their desired price differs from the actual price observed in the previous period. Thus, in order to determine the fundamental causes of inflation it is necessary to describe explicitly the optimization problem that firms solve at every point of time.

According to Galí (2008), "a firm reoptimizing in period t will choose the price P_t^* that maximizes the current market value of the profits generated while that price remains effective". This implies that the producer solves the problem

$$\underset{P_t^*}{max} \sum_{k=0}^{\infty} \theta^k E_t\{Q_{t,t+k}(P_t^* Y_{t+k|t} - \Psi_{t+k}(Y_{t+k|t}))\}$$

subject to the sequence of demand constraints

$$Y_{t+k|t} = \left(\frac{P_t^*}{P_{t+k}}\right)^{-\varepsilon} C_{t+k}$$

where $Q_{t,t+k}$ is the stochastic discount factor for nominal payoffs, $\Psi_t(.)$ is the cost function and $Y_{t+k|t}$ denotes output in period t+k for a firm that last reset its price in period t. The first order condition associated to the problem above takes the form

$$\sum_{k=0}^{\infty} \theta^k E_t \left\{ Q_{t,t+k} Y_{t+k|t} \left(\frac{P_t^*}{P_{t-1}} - \mathcal{M} MC_{t+k|t} \pi_{t-1|t+k} \right) \right\} = 0$$

where $MC_{t+k|t} \equiv \frac{\Psi'_{t+k}(Y_{t+k|t})}{P_{t+k}}$ denotes the real marginal cost in period t+k for a firm which last rest its price in period t and $\mathcal{M} \equiv \frac{\varepsilon}{\varepsilon-1}$, which is the desired mark-up. In the zero inflation steady state, $\frac{P_t^*}{P_{t-1}} = 1$ and $\pi_{t-1|t+k} = 1$. The fact that the price level is constant

implies that in that steady state $P_t^* = P_{t+k}$, from which it follows that $Y_{t+k|t} = Y$ and $MC_{t+k|t} = MC$, because all firms will be producing the same quantity of output. Furthermore, it must be the case that in the steady state the condition $Q_{t,t+k} = \beta^k$ is met. Accordingly, $MC = \frac{1}{\mathcal{M}}$. If we take a first order Taylor approximation of the first order condition around the zero inflation steady state we get

$$p_t^* - p_{t-1} = (1-\beta\theta)\sum_{k=0}^{\infty}(\beta\theta)^k E_t\{\widehat{mc}_{t+k|t} + (p_{t+k} - p_{t-1})\}$$

where $\widehat{mc}_{t+k|t} \equiv mc_{t+k|t} - mc$ denotes the log deviation of marginal costs from its steady state value $mc = -\mu$, and where $\mu = log\mathcal{M}$ is the log of the desired markup. According to this definition of the optimal price level set by firms inflation is determined by the deviations of the real marginal costs of firms from their steady state value, which in turn is proportional to the deviation of the actual level of output from its natural level. Thus, those firms that expect their markups to be below their desired (steady state) level will increase their prices (as long as they can do it) in order to bring the markup up, back to the desired level.

After several manipulations (that can be found in Galí (2008, p. 47-49)) the following expression for the rate of inflation is derived.

$$\pi_t = \beta . E_t\{\pi_{t+1}\} + \kappa . \tilde{y}_t$$

where $\kappa \equiv \frac{(1-\theta)(1-\beta\theta)}{\theta}\frac{1-\alpha}{1-\alpha+\alpha\varepsilon}\left(\sigma + \frac{\varphi+\alpha}{1-\alpha}\right)$ and σ represents the relative risk aversion coefficient (all the remaining parameters have already been defined). This equation is often referred to as the *New Keynesian Phillips Curve* (NKPC) and constitutes the main theoretical devise to explain price dynamics in modern economies. According to this relation, current inflation is determined by the deviation of actual output from potential output, i.e., the output gap, $\tilde{y}_t$. If the central bank is independent and credible economic agents will expect inflation to be constant and equal to the target announced by the monetary authority. Thus, the output gap becomes the only determinant of the fluctuations of the rate of inflation around the target. The price stickiness reflected by θ tends to dampen the effect of the output gap on the rate of inflation.

If the rate of inflation is mainly determined by the output gap it is necessary to define how the deviation of actual output from potential output can arise. The way the standard New Keynesian model has been presented implies that equilibrium in the goods market results from a series of optimization problems. On one side the representative households maximizes its utility function, which depends on consumption and leisure. In turn, the representative household maximizes the consumption index subject to a certain level of expenditures. The result of this maximization yields the individual demand for each of the available goods in the economy. On the other side, firms produce these commodities and set their prices by setting a markup on marginal costs. Market clearing requires that

$$Y_t(i) = C_t(i)$$

for all $i \in [0,1]$ and all t. Letting aggregate output be defined as $Y_t \equiv \left(\int_0^1 Y_t(i)^{1-\frac{1}{\varepsilon}} di\right)^{\frac{\varepsilon}{\varepsilon-1}}$ it follows that

$$Y_t = C_t$$

must hold for all t. Combining this market clearing condition with the Euler equation yields the following equilibrium condition, which we express in logarithms. As usual, this expression shows a negative relation between the rate of interest and the level of output (in this case, where investment is omitted, this is explained by the intertemporal substitution effect). Also, if the level of income is expected to grow, current output will tend to be higher (in line with the permanent income hypothesis).

$$y_t = E_t\{y_{t+1}\} - \frac{1}{\sigma}(i_t - E_t\{\pi_{t+1}\} - \rho)$$

This same equation can be rewritten in terms of the output gap as:

$$\tilde{y_t} = E_t\{\tilde{y}_{t+1}\} - \frac{1}{\sigma}(i_t - E_t\{\pi_{t+1}\} - r_t^n)$$

where r_t^n is the *natural rate of interest*, given by $r_t^n \equiv \rho + \sigma E_t\{\Delta y_{t+1}^n\}$. Galí calls this equation the *dynamic IS equation* and states that under the assumption that the effects of nominal rigidities tend to vanish asymptotically the output gap can be rewritten as:

$$\widetilde{y_t} = -\frac{1}{\sigma}\sum_{k=0}^{\infty}(r_{t+k} - r_{t+k}^{n})$$

where $r_t \equiv i_t - E_t\{\pi_{t+1}\}$ is the real rate of interest. This expression shows that the output gap is proportional to the sum of current and anticipated deviations of the real rate of interest with respect to its natural level. In the case that the sum of the deviations is equal to zero the output gap will also be zero and the economy will rest at the natural level of output. Thus far, there is nothing in the model that can take the economy away from its long-run equilibrium, i.e., the point where the output gap is zero, inflation is on its target and the rate of interest is at its natural level (the one that ensures equilibrium in the goods market).

The New Keynesian model is closed with the introduction of a monetary policy rule that describes the behavior of the central bank. One important feature of this model in terms of *realisticness* is the fact that, unlike the older versions of the neoclassical macroeconomics, money is considered endogenous. This means that the central bank has no control over the quantity of money that circulates in the economy. Instead, it chooses a certain target for the short-term interest rate and provides the market with all the demand for money that arises given that level of the rate of interest. If the monetary authority did not behave this way, i.e., if the demand for money was not fulfilled, it would not hit its interest rate target. The monetary rule followed by the central bank is derived from an optimization problem carried out by the monetary authority, whose main goal is to minimize a loss function that depends on the deviation of the rate of inflation from its target and, eventually, on the output gap. The result of this optimization problem yields a reaction function that defines the behavior of the central bank. Assuming a zero inflation steady state this monetary policy rule takes the form of:

$$i_t = \rho + \phi_\pi . \pi_t + \phi_y . \widetilde{y_t} + \upsilon_t$$

Should the inflation target be different from zero the term including inflation would be replaced by the deviation of actual inflation from the target. The parameters ϕ_π and ϕ_y are non-negative coefficients chosen by the central bank according to the weigh of each disequilibria on its loss function. Regarding υ_t, it is an exogenous stochastic component of monetary policy. This simple policy rule shows the power of monetary policy to correct any disequilibrium in the real economy. In order to describe the stabilizing nature of monetary policy in the framework of the New Keynesian model let us look analyze

together the monetary rule with the NKPC and the dynamic IS equation. These three equations constitute the core of the New Keynesian model (also know as the three equations model or the New Consensus model). Note that in what follows we add a stochastic shock to the NKPC and the IS equations. We also add an inertial term in the NKPC, thereby transforming it in what can be called a hybrid NKPC, since it makes use of the traditional lagged component that was present since the early days of this relation. This is representation can be found in Galí and Gertler (1999) and, according to Hornstein (2008), it follows from the fact that inflation shows high levels of persistence that, if not taken into account, it makes hard for the model to fit the data.

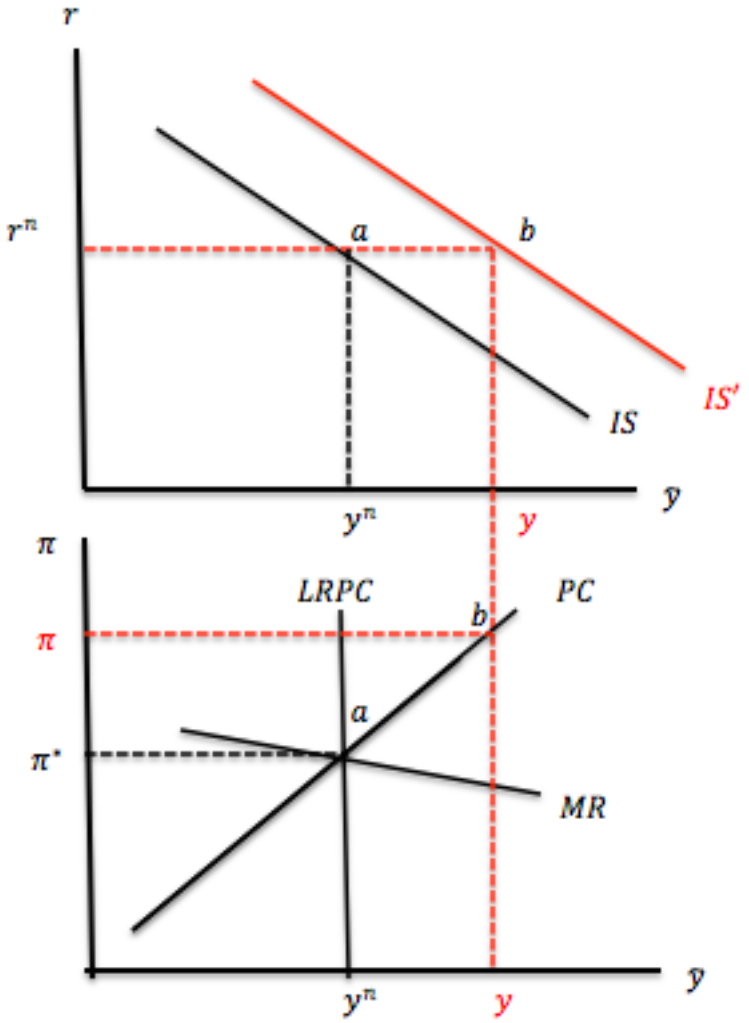
$$i_t = \rho + \phi_\pi . \pi_t + \phi_y . \tilde{y}_t + \upsilon_t$$

$$\pi_t = \tau . \pi_{t-1} + \beta . E_t\{\pi_{t+1}\} + \kappa . \tilde{y}_t + \nu_t$$

$$\tilde{y}_t = -\frac{1}{\sigma}\sum_{k=0}^{\infty}(r_{t+k} - r^n_{t+k}) + \eta_t$$

These three equations can be represented in a graph in the following way (Carlin and Soskice, 2006).

Figure 1.1: The New Keynesian model

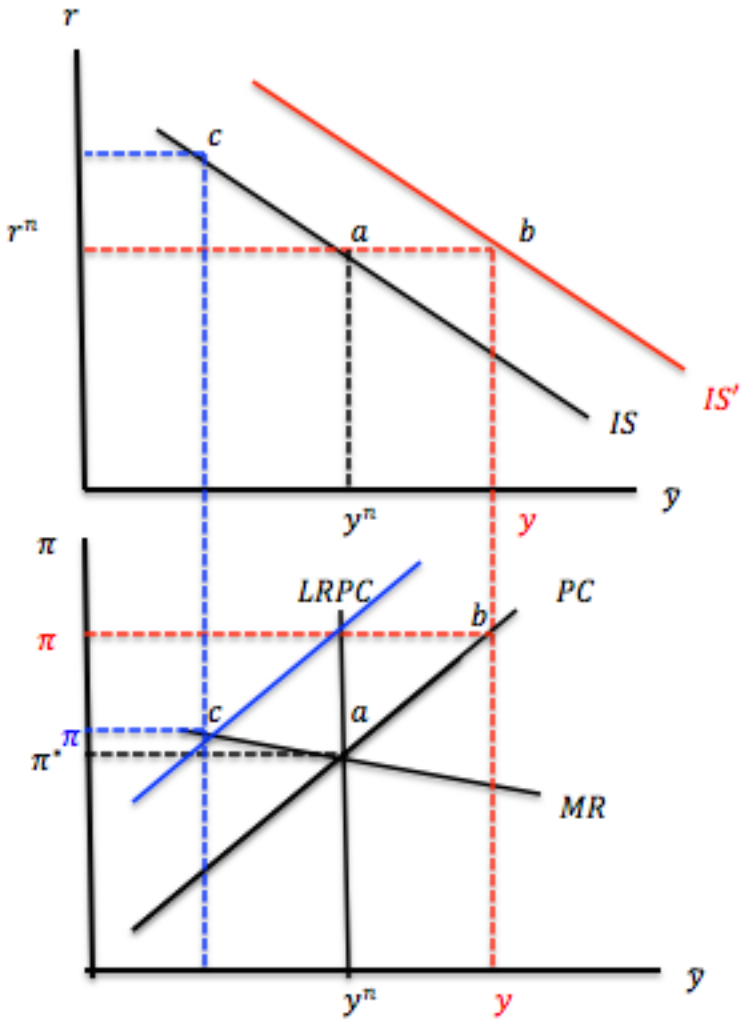


As mentioned before, in the absence of perturbations the economy can rest indefinitely at the long-run equilibrium, a. Let us assume an expansionary shock introduced by the government (for instance, an increase in government expenditures). Since the government has not been explicitly defined in the model (maybe because for the New Keynesian paradigm the smaller the size of the government the better the economic performance) the only way to simulate a shock of this nature is through the stochastic shock of the dynamic IS equation, η_t. This would shift the economy out of its long-run equilibrium, thereby producing a positive output gap, $y > y^n$. As a result, inflation will rise above the target set by the central bank, $\pi > \pi^*$. The economy will find itself at point b, which is a short-run equilibrium.

The central bank, which so far had been passive, finds that given the actual level of output and inflation its loss function is not being minimized. Assuming that the fiscal policy shock will be zero in the next period (which implies that the IS curve will return to its original level) and taking into account the effects of inertia on the evolution of prices, it makes an expectation on the next period rate of inflation (which is represented by the shift of the Phillips curve in Figure 1.2). The intersection between the monetary policy rule and the new Phillips curve gives the central bank the optimal level of the interest rate, which is higher than the natural level. This higher rate of interest is supposed to reduce the level of activity (as shown in the IS equation), bringing it to a point that is below the natural level. This negative output gap that will take place in the next period will help reduce the rate of inflation, which will still be above the target but below the level observed immediately after the shock. The economy will find itself at point *c*. Eventually, provided that the economy is not subjected to further perturbations, the central bank will be able to start reducing the rate of interest. As the output gap (still negative) is gradually reduced, inflation will converge to the target. Finally, the economy will arrive at point *a*, the long-run equilibrium.

According to the New Keynesian model there is a long-run equilibrium, entirely determined by supply side factors, to which the economy inevitably converges. Demand management policies have no effects in the long run, but may shift the economy away from the long-run equilibrium for short periods of time. Although inflation can arise from both supply and demand factors (the stochastic factors are broad enough to include a wide variety of shocks), there is a strong case against fiscal expansions due to their inflationary impact and null real impact in the long run. Monetary policy has a stabilizing effect, as long as the central bank is “well-behaved”. There is also a clear distinction between the short and the long run, which neglects the possibility that short-term fluctuations of the business cycle affect the dynamics of the economy in the future.

Figure 1.2: The New Keynesian model



As regards the labor market, several attempts have been made to introduce rigidities that prevent the equilibrium from being consistent with full employment. Some of these attempts are the so-called insider-outsider models (Oswald, 1993) and the efficiency wages models (Shapiro and Stiglitz, 1984). In the first type of models, unions are assumed to be concerned only about of the wages of the currently employed workers, thereby preventing the real wage from declining in such a way that firms are willing to hire more workers (outsiders), which would help reduce the rate of involuntary unemployment. In the second type of models, firms are concerned about the fact that workers do not maximize their effort. In order to induce them to behave in a way that is consistent with profit maximization, they must pay an "efficiency wage", that is higher than the market-clearing wage. As in the previous case, these real rigidities lead to the existence of a pool

of involuntarily unemployed workers. Thus, unemployment is explained not as a consequence of demand insufficiency but as a pure supply-side problem.

In the previous pages we have presented the supply side of the New Keynesian model, the underlying theory of inflation, the process through which markets are assumed to clear and the notion of long-run equilibrium. Making use of the epistemological framework presented in the previous section, we conclude that even if the current baseline theory of the mainstream is more realistic than its predecessor (imperfections in real markets are introduced under the form of imperfect competition and sticky prices, money is endogenous and there is a quite realistic description of the way central banks operate) there is still a dominance of instrumentalism over realism. The fact that agents are still know-it-all forward-looking isolated units is particularly weak, too far from reality. The analysis is also still undertaken following a methodological individualism approach, leaving no room for interactions within economic agents and with the superstructure in which they are framed. The notion that the economy always tends to a long-run equilibrium entirely determined by supply-side factors is also very distant from the real world, where there is large evidence suggesting the existence of hysteresis (Stanley, 2004; Mitchell and Muysken, 2008).

Production, inflation and equilibrium in stock-flow consistent models

According to the economic core of heterodox economics described in the previous section, abundance and not scarcity is the main feature of the economic environment. Given the stock of capital, it is assumed that firms can always increase production by hiring more workers without incurring in decreasing marginal returns. As suggested by Robinson (1964), there is a "utilization function" that relates output to employment. Unlike the neoclassical theory of production, inputs are not substitutes, implying that technical coefficients are fixed (for a detailed explanation of the Post-Keynesian theory of production it is recommended to read Lavoie (2014, ch. 3)). The possibility of increasing production by means of a higher labor demand is valid up to the point were full capacity utilization is reached. This point, however, is hard to reach since as demand and production grow investment will also tend to increase, in line with the so-called accelerator effect. Thus, under normal conditions (abundance of labor and machinery) production is assumed to be demand-led, which implies that real markets tend to be cleared through quantity adjustments.

As Godley and Lavoie (2007) clearly explain, there are four ways in which a market can be cleared. First, we have the case where the prices are perfectly flexible and therefore they moves upwards or downwards in order to correct any disequilibria between supply and demand. This closure is the most common in financial markets but has been traditionally used by the mainstream theories that were framed within the context of perfect competition. Second, there could be a case where there are quantity constraints (for instance, there is a shortage of a certain good) and therefore the quantities of the ex post equilibrium are given by the constrained flow (in our example, the supply of the good). In this case, if prices are flexible, market clearing is also attained through a price adjustment but in the so-called "short side" of the market. Then we have the cases where prices do not adjust and the market is cleared through quantity adjustments. These can happen either by the accumulation or depletion of inventories (in the cases where production takes time) or by adjusting supply to demand at every point of time (this is more common in the services sector, where production is instantaneous once the production structure has been established).

In general stock-flow consistent models assume a single good whose production is entirely demand-led and whose market is closed through quantity adjustments (either through an automatic adjustment of production or by inventory accumulation or depletion). This is why most stock-flow consistent models begin with the accounting identity that states that aggregate production is equal to the sum of all the components of aggregate demand. This identity represents the equilibrium in the goods market and is fulfilled instantaneously (bottlenecks in the supply side are neglected, since they are not compatible with the principle of abundance). Taking model *SIM* as an example,

$$Y = C_s + G_s$$

$$C_s = C_d$$

$$G_s = G_d$$

Recall that the demand for consumption was an endogenous variable that depended on labor income, which in turn was a function of the level of activity, *Y*. Given the level of output (which in this simple model is given by the exogenous level of government expenditures, G_d) the utilization function gives a number of workers that must be hired. Thus, the level of employment is determined in the goods market. In the following

equations the parameter *z* represents the technical coefficient of labor, which says how many units of labor are required to produce one unit of output.

$$N_d = \frac{Y}{z}$$

$$N_s = N_d$$

This way of representing the "labor market" is consistent with the Post-Keynesian proposition that the labor market does not really exist. This is due to the fact that there are not labor supply and demand functions, as described by mainstream economics. In the real world there seems to be an infinite pool of unemployed workers that are willing to take jobs at the prevailing wage. Thus, labor is an abundant "factor" that firms can always increase when the demand is such that output needs to be raised. As shown above, the demand for labor is proportional to the level of output and there are no decreasing marginal returns, which means that unlike the mainstream theory of the labor market, the fact that more workers are hired does not imply that their productivity decreases.

Now, if in a stock-flow consistent model the goods market is closed through quantity adjustments and the equilibrium level of employment is given by the equilibrium in the goods market, prices and wages can be determined outside these markets. As a matter of fact, for heterodox economics prices and wages are variables whose determination derives from historical and institutional factors. Although the business cycle can have an effect on the actual level of both wages and prices, these are mostly a reflection of more complex issues such as power relations and the social and economic structure of the society in question. Thus, in every period wages and prices are mostly predetermined and, consequently, do not ensure the clearing of any market. However, as explained above, since in both the goods and the labor market there is a perfectly elastic supply (meaning that given the wage/price and a certain demand suppliers provide the market with as many labor/goods as are demanded) the fact that prices are given does not prevent the market from reaching equilibrium.

For most heterodox theories, inflation arises as a consequence of confliction claims between firms and workers. Based on the works of Cripps and Godley (1976) and Rowthorn (1977), among others, Godley and Lavoie (2007, ch.9) describe wages and prices according to the following rationale. First, it is assumed that workers and their unions target a real wage, ω^T, which depends on both labor productivity and the level of

activity (approximated by the difference between the actual level of employment and the level of full employment). It is also assumed that the rate of growth of the nominal wage, W, is a function of the difference between the target real wage and the observed real wage in the previous period.

$$\omega^T = \left(\frac{W}{p}\right)^T = \Omega_0 + \Omega_1 . z + \Omega_2 . \left(\frac{N_s}{N_{fe}}\right)$$

$$W = W_{-1} . \left(1 + \Omega_3 \left(\omega_{-1}^T - \frac{W_{-1}}{p_{-1}}\right)\right)$$

Firms are assumed to set their prices following a simple mark-up on unit variable costs rule (although there are different ways to describe the pricing rule in the heterodox literature, all of them based on the idea that prices are a reflect of production costs, here we present the simplest pricing equation).

$$p = (1 + \varphi) . \frac{W}{z}$$

Under this formulation of the conflicting claims theory of inflation it is assumed that at the beginning of every period workers negotiate a certain nominal wage and that then firms set a price that allow them to achieve a desired mark-up. Therefore, real wages are a residual, meaning that workers will not necessarily get the desired real wage. This will only happen if there is compatibility between the claims of both workers and firms. In chapter 4 of this thesis we present this phenomena in a more complex way, where the bargaining power of workers and firms is not constant, but it depends on the evolution of the business cycle.

No matter how simple the description of production, market clearing and inflation in a basic stock-flow consistent model are, when compared to those of the New Keynesian model the epistemological differences appear once again. The higher *realisticness* of the heterodox approach seems to be closely connected to the economic core. The fact that the New Keynesian model is framed in a world of scarcity (something that is not observed in the real world, at least in capitalist economies) inevitably leads it to draw conclusions that are hard to believe. Involuntary unemployment does not arise as a consequence of demand deficiency, but due to supply-side frictions that prevent prices (in this case, the wage rate) from offering the signal that induce economic agents to behave in the most

efficient way. Also, firms are not assumed to be fully rational units but agents that have to make decisions in a context of fundamental uncertainty. As it happened with the consumers, when firms make mistakes in their previsions there is always a buffer through which these errors are adjusted (for instance, inventories). This description of the context in which economic agents interact and they way they deal with it seems more plausible, closer to reality, a hence more prone to offer better explanations about the working of the real world.

Another important difference between the New Keynesian model and stock-flow consistent models concerns the notion of long-run equilibrium. As was previously described, in the framework of the New Keynesian model the long-run equilibrium is a predetermined situation, given entirely by supply-side factors, where in the absence of perturbations the economy would settle indefinitely. Even if there were short-run movements away from this equilibrium, either due to exogenous shocks or to economic policy decisions, as time passes by the economy would converge to its long-run equilibrium. It is under this vision of the working of the system that, in line with the Monetarist and New Classical Phillips curves, it is often recommended that governments refrain from trying to exploit the trade-off between inflation and unemployment. However, in the stock-flow consistent literature there is nothing like a predetermined equilibrium to which the economy tends. The long run is seen as a sequence of short-term equilibria that continuously change the path that the economy follows and force institutional agents to change their behavior. Hysteresis and persistence are the rule.

The role of money and financial markets

One last point that is worth making when comparing the New Keynesian model to stock-flow consistent models is the one related to the role of money and financial markets. Even though, as already mentioned, the current version of the mainstream accepts the fact that money is endogenous, the role that it plays in the economic system is substantially different. This obeys to the conception that each paradigm has over the nature of the economy. Whereas for mainstream economists the economies where we live are pure exchange economies, for the heterodox research program modern economies are *monetary production economies*. In a pure exchange economy, money is just a medium that facilitates trade. It is purely passive, i.e., it has no real implications. In a monetary production economy money is of fundamental importance because it allows the system of social production and circulation to work. In this context investment is not constrained by

saving, as in mainstream theories, but by the availability of finance from the financial sector (that does not require a prior act of saving by the private sector).

As a result of economic dynamics, the different institutional agents end up with monetary assets and liabilities in their balance sheets. These are due at some point in the future and also entail interest payments that must be paid. Also, wealth effects can arise as a result of the holding of these assets. All these profits or losses can have direct impacts on the real economy, since they can condition firms' or households' ability to spend. The omission of balance sheet analysis that appears in the New Keynesian model makes it impossible to explain and predict the financial crises that characterize modern economies. This is an aspect where stock-flow consistent models are clearly superior, since the whole analysis is based on the dynamic link between the real and financial spheres. The very simple matrix of transactions presented above, where spending decisions (real) are conditioned on the fulfillment of stock-flow norms (financial) and, a it is shown in the remaining of this thesis, on the availability of financing exhibits the way in which stock-flow models define the interdependencies of the real and financial side of the economy.

The role of money and financial markets is also different in the two paradigms since the knowledge of individuals about the environment in which they make their decisions differs substantially. As mentioned above, in the New Keynesian model agents are rational and make decisions in a context of risk. Thus, their saving decisions are just an optimal choice between present and future consumption. In the heterodox paradigm agents are assumed to live in a context of fundamental uncertainty. Thus, money and other financial assets become stores of value that can be used to hedge against unexpected events. The possibility of saving under the form of a monetary asset (like it happens in most cases, with some exceptions like gold) implies a reduction in the demand for goods. Hence, unlike the mainstream theory where every act of saving entails an equivalent flow of investment, for heterodox economics an excess of saving can bring about a recession (paradox of thrift). In order for a model to be capable of describing these real world events it is necessary that it be framed in a context of uncertainty where money is not just a veil, but a complex and crucial phenomenon that can govern many of the economic processes that characterize modern economies.

So what?

The comparison made in the previous pages between stock-flow consistent models and DSGE models would only be a matter of intellectual confrontation if it were not for the

impact that economic theory has had in the world of policy making during the Great Moderation. A couple of years after the "significant improvements in economic growth and productivity" and "also a marked reduction in economic volatility" (Bernanke, 2004) were attributed to the better management of both fiscal and monetary policies, which bases were built upon the foundations of the New Keynesian model, another prestigious economist contributed to the promotion of the idea that economic theory had reached a degree an acceptable capacity to explain real-world facts. Just a couple of months before the fall of Lehman Brothers, Blanchard (2008) was saying that "over time however, largely because facts have a way of not going away, a largely shared vision both of fluctuations and of methodology has emerged. Not everything is fine. Like all revolutions, this one has come with the destruction of some knowledge, and suffers from extremism, herding, and fashion. But none of this is deadly. The state of macro is good". A year before, Jean-Philippe Cotis, chief economist of the OECD, was optimistic about the prospects of the global economy when he affirmed that "the current economic situation is in many ways better than what we have experienced in years. Our central forecast remains indeed quite benign: a soft landing in the United States, a strong and sustained recovery in Europe, a solid trajectory in Japan and a buoyant activity in China and India" (Cotis, 2007).

The abrupt end of the Great Moderation brought about by the outbreak of the global financial crisis did not leave the mainstream theory unharmed. The fact that during the worst months of the crisis the policy makers of developed countries had completely abandoned the recommendations provided by the New Keynesian model (which, as shown above, was unable to explain what was going on) and instead applied the remedies embedded in heterodox theories implied a hard blow for the mainstream. Also, mainstream economists were questioned by the political authorities (and the whole society) for not having been able to see the upcoming crisis. Some members of the mainstream recognized that the descriptions of the New Keynesian model were excessively simplistic and not representative of the way in which the real world worked. For example, Blanchard (2009) admitted that "we thought of monetary policy as having one target, inflation, and one instrument, the policy rate. So long as inflation was stable, the output gap was likely to be small and stable and monetary policy did its job. We thought of fiscal policy as playing a secondary role, with political constraints sharply limiting its de facto usefulness. And we thought of financial regulation as mostly outside the macroeconomic policy framework".

Even though the mainstream has acknowledged its massive failure at explaining and predicting economic phenomena and some amendments have been made to the standard

New Keynesian model, its core has not been changed. This is why the deepening of the study of alternative approaches to macroeconomic modeling is still necessary. In this chapter we have presented the motivation for deepening the study of stock-flow consistent models as an alternative to the widely used DSGE models of the mainstream. This motivation is not only historical (i.e., the failure of DSGE to predict and explain the most relevant economic events) but also epistemological. As shown in the previous pages, the New Keynesian model is full of drawbacks that do not allow it to produce interesting analyzes of real-world phenomena. On the contrary, the stock-flow consistent approach, an incipient though quite old line of research (for a detailed survey on the evolution of this methodology, it is recommended to read Caverzasi and Godin (2015)), seems to solve many of the disadvantages of DSGE, thereby offering a more interesting vehicle to the understanding of modern economies.

In the next three chapters it is shown how stock-flow consistent models can be adapted to the study of different economic problems that are of great importance nowadays. In the second chapter of this thesis a four-country model is built to study some of the different alternatives that have been proposed for the reform of the international monetary system. In chapter three a similar task is undertaken, but with the aim of assessing the possible performance of alternative ways out of the current crisis in the Eurozone. Both the models and the simulations presented in these chapters provide a good example of the flexibility of stock-flow consistent models and their ability to give an accurate description of economic dynamics. Finally, chapter four faces the challenge of explicitly incorporating supply-side dynamics in a multi-sector model. As will be shown, both the description and the results seem reasonable and do not need *ad hoc* hypotheses to protect a *hard core* that, opposite to what it should be, in the case of the New Keynesian model has a very low explanatory power over everyday economic issues.

2. Reforming the international monetary system

2.1. Introduction

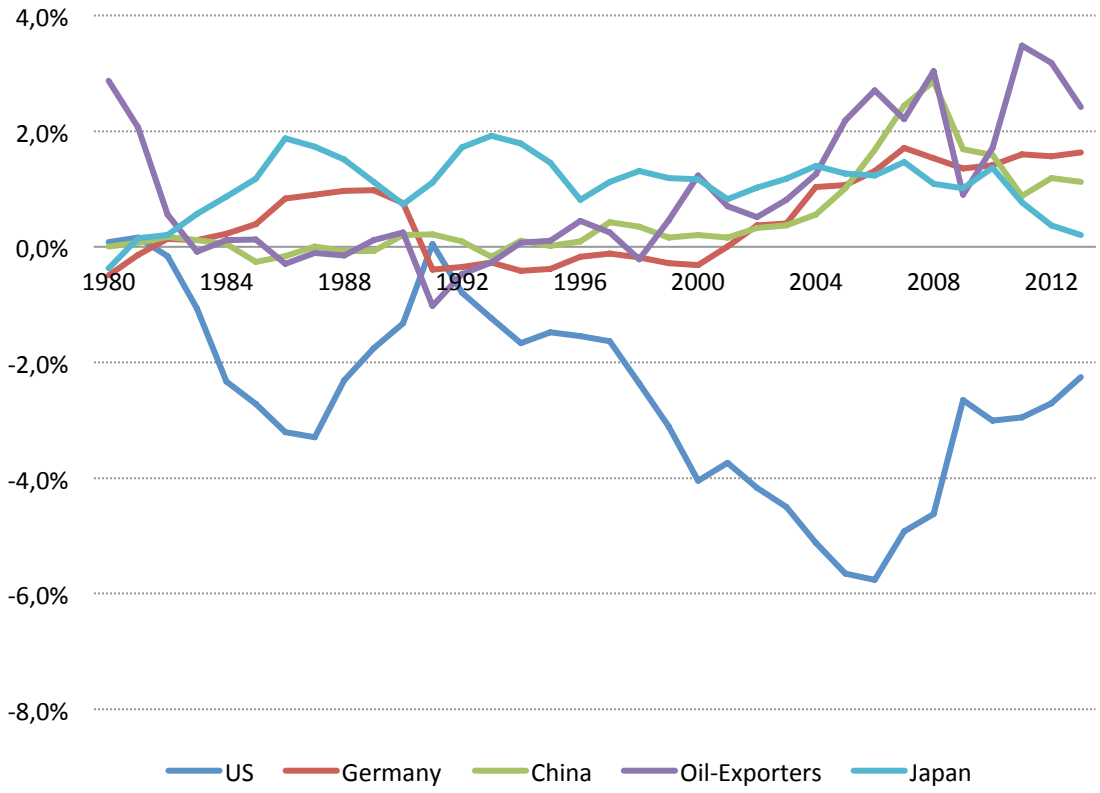
The debate on the urgency of reforms in the current International Monetary System (IMS) has revamped immediately before the Great Recession which started in 2007, due to the growing and persisting disequilibria in the current account balances of some major economies, notably the U.S. as a deficit country, and Germany, China and the oil exporters as surplus countries. The debate was further stimulated by an influential intervention by the governor of the People's Bank of China[5] (Zhou, 2009) but after an international agreement for an extraordinary allocation of reserves in Special Drawing Rights (SDRs) in 2009[6], the debate has faded away, while more urgent problems – such as the high and persistent levels of unemployment first, and the sovereign debt crisis in Europe later - were brought to the forefront of the agenda. We aim to show that the current international monetary "non-system", as it has been defined by Triffin (1960), still plays a relevant role in current macroeconomic problems, and a reform of the IMS is necessary to achieve more balanced growth at the world level.

The current state of global imbalances is depicted in Figure 2.1, obtained from the April 2012 IMF World Economic Outlook database, which includes predictions up to 2017. Current account balances of key countries have been scaled by US' GDP, in order to make them directly comparable. Since the 1980s, the U.S. have experienced external deficits, which started to increase in magnitude from the mid 1990s. The mirror image of the U.S. deficit is the surplus of oil and gas exporters - OPEC and Russia - and of China, while Japan slightly reduced its weight among export-led-growth countries. Germany increased its surplus with the start of the euro era, from 1999.

[5] Zhou (2009): "The crisis again calls for creative reform of the existing international monetary system towards an international reserve currency with a stable value, rule-based issuance and manageable supply, so as to achieve the objective of safeguarding global economic and financial stability".

[6] In August 2009 the IMF approved an extraordinary issuance of SDRs equivalent to USD 250 billion. The allocation of these SDRs was made in proportion to the existing quotas in the Fund, which are based broadly on the relative size of each country in the global economy.

Figure 2.1: Current account balances as percentage of US GDP



Source: IMF

Since the end of the Bretton Woods system in 1971, exchange rates have been floating, although some countries – notably in Europe – chose to enter into a managed floating system first, and adopted a common currency later. In a pure floating regime, we would expect the currencies of deficit countries to depreciate against the currency of surplus countries. However, since the demand for U.S. dollar arises not just from the U.S. current external account, but also from its financial account since foreign investors demand dollar denominated financial assets, the large and growing U.S. current account deficit has not been followed by a comparable depreciation of the dollar that induces a reversal in the sign of the current account. On the contrary, the U.S. dollar appreciated in real terms up to 2002, and some countries running a growing surplus against the U.S. - notably China – managed to peg their currency up to 2007.

In order to keep their currency from appreciating, many US trading partners compensated the net demand for their currency stemming from their current account surpluses with an equivalent net supply, used to purchase US safe financial assets. The value of US securities held by China in October 2014 had grown to 1.25 trillion dollars, with Japan holding a

slightly smaller amount at 1.22 trillion dollars. Oil exporters hold a much smaller amount – given the size of their trade surplus. In Table 2.1 we report the holdings of US long-term Treasury securities, which form the largest share of US debt (other than equity) held abroad. The large share held in financial centers may be due – at least in part – to indirect holding of US assets from surplus countries.

Table 2.1: Major foreign holders of Treasury securities (October 2014)

Country	Holdings (in trillions of dollars)
China	1.25
Japan	1.22
Belgium	0.34
Caribbean Banking Centers	0.32
Oil Exporters	0.28
Brazil	0.26
Switzerland	0.18
Taiwan	0.17
United Kingdom	0.17

Source: US Treasury

It has been suggested that US financial assets are demanded by emerging economies as an insurance against possible capital flights (Ocampo, 2007/08). In this regard, there have been several attempts to build measures of "optimal" reserve holdings that prevent emerging countries from suffering the devastating effects of sudden stops (Jeanne and Rancière (2006), Gonçalves (2007) and Calvo et al (2013)). Interestingly, Calvo et al (2013) find that in most countries the level of reserves held before the subprime crisis were not very far from the "optimal" level, although the reasons that explain the strategy of reserve accumulation would not only be related to the self-insurance motive, but also to some intertemporal sustainability (for instance, it is argued that oil-producing countries need to hoard larger stocks of reserves in order to sustain growth once oil reserves are depleted). Whatever the reason for reserve accumulation, a growth strategy based on the accumulation of foreign debt is fragile and doomed to generate crises, which will be the more severe the higher the level of foreign debt.

The country issuing the international currency, the United States at present, will not have an external constraint, as long as her creditors are willing to accept dollar-denominated assets in exchange for exports to the US. However, the accumulation of US financial assets in foreign countries will lead to capital losses, should the US dollar devalue. And should

foreign investors decide abruptly to stop rolling over their credit towards the US, financial turmoil may arise, unless the Federal Reserve is willing to fill any gap between supply and demand for US financial assets. The current system has therefore been described as a "balance of financial terror" (Summers, 2008). This is a slightly different way to put the so-called "Triffin dilemma": Triffin (1960) noted that when the international currency is issued by a single country – as it is the case with the US dollar – the international demand for that currency may not be compatible with the domestic targets for monetary policy in the issuing country. This implies that either the global issuer of reserve currency has to sacrifice some domestic economic policy goals (such as balanced trade or full employment) or, if it does not, the global system will not have the required amount of liquidity to work properly. The result of the last scenario could be a global recession or situation of very mild growth, implying unacceptable levels of unemployment[7].

In a different perspective, again, if the world uses a single currency – the US dollar – the hoarding of that currency for precautionary reasons (or for whatever other reasons) puts a deflationary bias on the system as a whole, as Keynes noted. "A country finding itself in a creditor position against the rest of the world as a whole should enter into an obligation to dispose of this credit balance and not to allow it meanwhile to exercise a contractionist pressure against the world economy and, by repercussion, against the economy of the creditor country itself" (Keynes, 1943). According to Amato and Fantacci's (2011) interpretation of Keynes' plan for the monetary system of the post-war, the fact that creditor countries had to spend the proceeds of their surpluses was not a matter of appealing to the goodness or philanthropy of these countries, but a matter of

[7] Triffin (1960): "Two problems are inescapable. The first is that the elimination of our overall balance of payments deficits would, by definition, put an end to the constant deterioration of our monetary reserves and deprive thereby the rest of the world of the major source by far from which the international liquidity requirements of an expanding world economy have been met in recent years, in the face of a total inadequate supply of monetary gold. The second is that the huge legacy of short term foreign indebtedness already inherited by us from the past is likely to place a heavy handicap on sound policies for economic growth and stability in this country. Refugee capital has flown here in large amounts after the Second World War, as it had flown to London after the First World War. Some of It may return home, as currency conditions become definitely stabilized in Europe, just as it left London in the late 1920s. Our huge gold losses of last year were due in part to such a repatriation of foreign capital at a time when interest rates had fallen here well below the rates available in Europe. They have been slowed down this year by an extremely sharp rise of interest rates in this country, prompted by our domestic concern about creeping inflation. In this case, external and internal interest rate policy happily coincided, but may diverge tomorrow. If and when we feel reassured about our internal price and costs trends we may wish to ease credit and lower interest rates in order to spur our lagged rate of economic growth in comparison not only to Russia, but with Europe as well. We may then be caught, however, exactly as the British were in the 1920s, between these legitimate and essential policy objectives and the need to retain short term funds here in order to avoid excessive gold losses".

guaranteeing the soundness of the monetary system, which should benefit the world economy as a whole and, consequently, each country at the individual level. "To achieve this the system was to be constructed in such a way that creditor countries would not expect to be thanked for lending, but rather would have a concrete interest in doing so" (Amato and Fantacci, 2011).

As it is well known, in the early 1940s, after a couple of years of debates on how to build a new monetary order for the post-war period, Keynes' plan was abandoned in favor of White's plan, which was amended at the last minute to have a gold-backed US dollar as the only international currency, with a new international reserve asset created in 1969– labeled Special Drawing Rights – based on a basket of currencies that could be allocated to participating countries. The institutions which were set up to supervise international payments and provide liquidity to deficit countries which were running out of reserves – the World Bank and the IMF – were organized so that a country requiring external liquidity was forced to adopt restrictive policies, and the recessionary trait which Keynes wanted to avoid was instead embedded into the system.

After this introduction we present a very brief description of the main features and drawbacks of the current international monetary (non)system. Then we explain how a monetary order that follows Keynes' ideas could be implemented. In section 4 we develop a four-country stock-flow consistent model to examine the economic dynamics that such a system could bring about. Finally, we draw the main conclusions of our study.

2.2. The current international monetary (non)system

After the collapse of the Bretton Woods agreements in 1971 exchange rates acquired a larger degree of flexibility and were mostly determined by market forces[8]. However, the lack of an international set of rules regarding the coordination of exchange rate policies allowed countries to manage their exchange rates through interventions and other types of regulation. As a result, while Europe chose a floating regime vis-à-vis the US dollar (although currencies within the region were pegged in the framework of the European Monetary System), Asian countries opted for an administrated regime that tended to keep

[8] Even if the Bretton Woods agreements finished in August 1971 when the US suspended the convertibility of the US dollar to gold, currencies started to float in 1973. In December 1971 the Smithsonian Institution Agreement was signed by the G-10, whereby the US committed to peg the dollar against gold at $38 (instead of $35) with 2,25% trading bands. Since the dollar price in the gold market continued to cause pressure on the official dollar rate, a devaluation of 10% was announced in February 1973. Soon after, Japan and European economies decided to let their currencies float.

the exchange rate relatively stable. As Padoa-Schioppa (2010) has stated: “Such an exchange rate configuration was not introduced by design, it was not based on a body of economic research comparable to that underpinning domestic monetary policies, nor was it stipulated by international agreement. It was largely adopted by default and can in no way be defined as a system, or a regime, or an order”.

There were, however, some attempts to build a more coordinated set of rules that govern international monetary relationships. In 1972-74 the Committee on Reform of the International Monetary System and Related Issues (also know as the Committee of Twenty), established within the IMF, started studying the possible implementation of a substitution account. The plan would allow official reserve holders (creditor countries) to replace a portion of their foreign exchange reserves with SDRs issued by a special account overseen by the IMF. This would imply a substitution of the debtor – instead of owing liabilities (under the form of Treasury bills) to creditor countries the US would owe its debt to the IMF which, in turn, would issue the SDR balances under which creditor countries would hold their reserves. It was not clear, however, what would be the cost that the US would have to face under this alternative regime in comparison to the prevailing situation, where it had to pay the interest rate on the Treasury bills. Thus, the US preferred to keep an open mind to the need of transforming reserves while an emphasis was put on the necessity to introduce mechanisms that promoted symmetric adjustments of current account imbalances. As a result of the lack of agreement on the interests payable on assets and liabilities under this alternative framework combined with the need to focus on more urgent problems (mainly the oil crisis and the context of stagflation) the proposal of the Committee of Twenty was dismissed (McCauley and Schenk, 2014).

The second attempt to rule the working of the international monetary system took place in 1978-1980, when two new projects for a substitution account were proposed (by two different managing directors of the IMF). These projects suggested that developed countries (including the United States) deposit an amount of dollars equivalent to the amount of SDRs they were allocated into a substitution account in order to increase the proportion of global reserves denominated in SDRs. The IMF would then invest the proceeds in long-term US Treasury securities. According to McCauley and Schenk (2014) these attempts failed for several reasons. First, the reluctance of the US government to creating a rival to the dollar as the reserve currency. Second, the lack of agreement regarding the return on SDR assets in the substitution account. Third, the need for the United States to take on a major burden of any of the proposed schemes. Last, the desire of European that the United States amortize its obligations. Kenen (2010) seems to share

this view when he states that “the proposal was widely discussed at the time but was not adopted for two reasons: the strengthening of the dollar in foreign-exchange markets at the start of the 1980s and, more importantly, the refusal of the United States to take sole responsibility for maintaining the dollar value of the SDR-denominated claims on the proposed account”.

The third attempt to coordinate monetary and exchange rate policies at the international level took place in the second half of the 1980s, with the signing of the Plaza and Louvre Accords in 1985 and 1987, respectively. The strong appreciation that the US dollar registered between 1980 and 1985 against the currencies of Japan, Germany, France and the United Kingdom widened current account imbalances. This implied that creditor countries were hoarding massive stocks of American debt. Moreover, the United States was stuck in a recession and the lack of competitiveness of its manufacturing sector (explained in part by the appreciation of the dollar) was laying the foundations for protectionist laws. In order to prevent potential problems in the domain of international trade the government started negotiations with the remaining big countries to let the dollar depreciate. After the Plaza Accord, signed in 1985, the dollar exhibited a large depreciation but this proved insufficient to reverse the American trade deficit. The depreciation of the dollar was possible because central banks coordinated their interventions in a way that was predictable to the market. A study of Catte et al (1992) based on the analysis of the daily operations in the foreign exchange market has found that central bank interventions during the period 1985 and 1991 were rare and concentrated in time, consistent with one another and very similar in their timing.

As a result of the sharp depreciation of the dollar in 1987 the Louvre Accord was signed. This agreement not only entailed the coordination of exchange rate policies, but also attempted to coordinate domestic fiscal and monetary policies in such a way that imbalances were reduced. By the end of 1987, the fears of inflation in Germany led the Bundesbank to raise the short-term rate of interest, which was followed by the monetary authorities of the remaining countries. The inability to commit to the rules of the agreement put an end to the Louvre Accord and, with it, to the last attempt to build an international monetary order.

As a result of these failed attempts to build a universally accepted monetary arrangement the global economy was left without any monetary order at all. As Padoa-Schioppa (2010) has concluded, “in this vacuum, money’s basic functions (its role as a *numèraire*, medium of exchange and store of value) were performed by a random combination of local

arrangements and tools, market mechanisms and initiatives, loose cooperation between national authorities, occasionally by coordinated action, and by the disorderly interplay of national policies". However, as Kenen (1983) and Krugman (1984) have pointed out, after the abandonment of Bretton Woods the dollar was performing *de facto* six functions (the three roles of money both for private and official purposes). What is clear is that regardless each one's subjective perception regarding the higher or lower degree of *order* that characterized international monetary relationships, there was not a true monetary *order,* and it would be debatable whether there was a monetary system[9]. Although, as McKinnon (1993) has gathered in his "rule boxes", there were some common policies pursued by the main countries, there were no written set of rules that coordinated international monetary relations. As a result, there was a high space for discretion in the management of national economic policies, which eventually led to global financial instability.

In light of the absence of a system that is able to "provide a framework that facilitates the exchange of goods, services, and capital among countries, and that sustains sound economic growth" (Article IV of the IMF) there has been a renewed interest in the alternative proposals for the reform of the international monetary (non)system. Between 2010 and 2011 the *Palais Royal Initiative* gathered former managing directors of the IMF, former governors of national central banks and academic economists to debate on the alternative ways which in a new international monetary system and/or order could be built. In their final report (Boorman and Icard, 2011) they identify the following weaknesses of the current (non)system to which we add some others that have been largely emphasized from Keynes (1930) to more contemporary economists such as Kregel (2009) and Davidson (1992).

1) Ineffective global adjustment process:
    a. There are no either self-correcting or imposed mechanisms that tend to

[9] Mundell (1972) defines a system as "an aggregation of diverse entities united by regular interaction according to some form of control. When we speak of the international monetary system we are concerned with the mechanisms governing the interaction between trading nations, and in particular between the money and credit instruments of national communities in foreign exchange, capital, and commodity markets. The control is exerted through policies at the national level interacting with one another in that loose form of supervision that we call co-operation. An order, as distinct from a system, represents the framework and setting in which the system operates. It is a framework of laws, conventions, regulations, and mores that establish the setting of the system and the understanding of the environment by the participants in it. A monetary order is to a monetary system somewhat like a constitution is to a political or electoral system. We can think of the monetary system as the *modus operandi* of the monetary order."

reduce current account imbalances.

b. The IMF surveillance of domestic policies, which could serve as a way of facilitating international coordination, is ineffective (mainly in the cases of countries that do not need to borrow from the IMF).
c. When imbalances turn out to be unsustainable, only deficit countries are forced to pursue "structural adjustment policies" or "structural reforms". Phrased differently, the burden of the adjustment is born only by the debtors.

2) Financial excesses and destabilizing capital flows:
    a. In the years before the subprime crisis there was an unsustainable expansion of global credit that, combined with the lack of supervision, brought about very high levels of financial vulnerability. This was possible, in part, because there are no commonly agreed definitions and measures of global liquidity.
    b. Large swings of capital flows can undermine counties' ability to meet their domestic targets regarding macroeconomic and financial stability.
    c. There is no international lender of last resort, which means that countries' may be constrained in their capacity to deal with situations of liquidity crises.

3) Excessive exchange rate fluctuations and deviations from fundamentals[10]:
    a. Exchange rates, mainly driven by portfolio behavior of financial speculators, have deviated from fundamentals and therefore been unable to reduce global imbalances.

4) Excessive expansion of international reserves:
    a. Many countries (mainly emerging markets) have accumulated an unprecedented stock of foreign reserves, either as a goal in itself or as a result of other policies (domestic or external).
    b. Easy availability of financing has contributed to financial imbalances that postponed the adjustment of unsustainable growth regimes.

Once advanced economies had resumed economic growth in the beginning of the 2010s the main lessons that economists and politicians seemed to have learned was that

[10] Following Williamson (1994), we consider that the exchange rate is misalligned if it is different from that one that brings the economy to both internal and external equilibrium.

excessive deregulation of financial markets was not desirable. In other words, banking should be made more boring (Krugman, 2009)[11]. As a corollary, the Basel III Accord was agreed in 2010-2011 (although there were some modifications in 2013), aiming at strengthening banks' capital and liquidity requirements and reducing leverage ratios. However, no steps were taken to improve the deficiencies of the international monetary (non)system. The most eloquent proof of this is the fact that the United States has been conducting its monetary policy (launching three quantitative easing programs) according to its own needs regardless the effect that the flood of dollars in the global economy could have. Similarly, it is expected that the rate of interest raises in 2015, which would have damaging effects for emerging markets. For these reasons we advocate for the establishment of a supranational institution that coordinates international financial relations. We believe that Keynes' proposal of an international clearing union, back in the early 1940s, has many virtues and deserves consideration.

2.3 Keynes' Proposal

The period that goes from 1914 to 1945 was one of great financial turmoil. In terms of McKinnon (1992) there were no "rules of the game" at all. In the context of the First World War countries suspended their convertibility to gold and, once the war was over, the attempts to reestablish convertibility had drastic effects. First, when the United Kingdom reestablished its prewar parity to gold in 1924 it produced an automatic overvaluation of the pound sterling. The tight monetary policy that followed the reestablishment of the gold standard had devastating effects for its economy. When in 1931 the authorities decided to devalue the currency the pressure was transferred to the other countries that were still pegged to gold (mainly the United States and France), who eventually had to devalue their currencies as well. All these devaluations (that received the label of beggar-thy-neighbor policies) were preceded by painful deflationary and protectionist measures. Added to these recessionary policies, the long-lasting effects of the Great Depression drove the world economy to a major collapse.

One of the main conclusions drawn from the experience of the 1930s was that countries needed more room for domestic policies than the one that provided a rigid system like Gold Standard. This called for exchange rate flexibility. However, the negative effects of the beggar-thy-neighbor policies called for some form of coordination regarding exchange

[11] Krugman draws this conclusion based on a study of Philippon and Reshef (2009), who find that wages in the American financial sector tended to be higher before the 1930s and after the 1980s, where there was little regulation on this activity.

rate policy. In response to the need for an international monetary system that fulfilled these requirements Keynes (1942) came up with a proposal that could simultaneously reduce global imbalances without the deflationary bias implicit in the Gold Standard (and also in the Bretton Woods system, which was finally implemented instead of Keynes' plan).

The main reason for a new currency – the bancor – and a new international institution – the International Clearing Union (ICU) - is to avoid the recessionary impacts which are implicit in any system where the medium of exchange is provided in insufficient quantities, or – which amounts to the same thing – is hoarded either because it is perceived as a safe store of value or for insurance reasons. Therefore, the bancor should be only a unit of account that the ICU uses to settle international transactions. It follows that, at least in principle, other existing currencies – including the US dollar – would be used only domestically, and that there will be no need for international reserves. Countries could either exchange their stock of gold for an equivalent credit in bancors at their account at the ICU or keep the precious metal in their vaults. There would be no compulsory action in this regard. However, in case they choose to exchange their gold for bancor balances this would be a one-way convertibility (i.e., countries would not be allowed to get their gold back in exchange for a reduction in their bancor balances), since bancor balances would only be usable for real transactions between countries. This rule would not prevent, however, countries from exchanging gold between them as long as they do it at the par value[12].

Keynes proposed "to establish a Currency Union, here designated an *International Clearing Union,* based on international bank-money, called (let us say) *bancor,* fixed (but not unalterably) in terms of gold and accepted as the equivalent of gold by the British Commonwealth and the United States and all the other members of the Union for the purpose of settling international balances. The Central Banks of all member States (and also of non-members) would keep accounts with the International Clearing Union through which they would be entitled to settle their exchange balances with one another at their par value as defined in terms of bancor. Countries having a favorable balance of payments

[12] "The international bank-money which we have designated *bancor* is defined in terms of a weight of gold. Since the national currencies of the member States are given a defined exchange value in terms of bancor, it follows that they would each have a defined gold content which would be their official buying price for gold, above which they must not pay" (Keynes, 1943).

with the rest of the world as a whole would find themselves in possession of a credit account with the Clearing Union, and those having an unfavorable balance would have a debit account. Measures would be necessary (see below) to prevent the piling up of credit and debit balances without limit, and the system would have failed in the long run if it did not possess sufficient capacity for self-equilibrium to secure this" (Keynes, 1943).

Regarding the working of the ICU, Keynes attempted to "generalize the essential principle of banking as it is exhibited within any closed system[13]. This principle is the necessary equality of credits and debits. If no credits can be removed outside the clearing system, but only transferred within it, the Union can never be in any difficulty as regards the honoring of cheques drawn upon it" (Keynes, 1943). Any transaction between two countries through the ICU – say exports of goods from country A to country B – would generate an increase in the Bancor balance for country A, and a corresponding decrease in the balance for country B. Bancors are thus created without any need for collateral (although in some cases, when countries persistently surpass the predetermined threshold that limits the size of trade deficits, the ICU may ask them to deposit a "suitable collateral", which could take the form of gold).

Each country would have to pay the ICU an annual interest (in Keynes' plan it was set at a rate of 1%) on the net bancor balance in excess of a quarter of its quota[14], regardless this balance is positive or negative. A further charge of 1% would have to be paid for those balances that surpass half of the quota of the country. Thus, only countries that find themselves in a situation that is close to external balance would be exempted from these interest payments. Although Keynes noted that these adjustment mechanisms would not tend to balance external positions completely, he believed that these charges "would be

[13] Keynes (1943) noted that within the domestic banking system "no depositor in a local bank suffers because the balances, which he leaves idle, are employed to finance the business of someone else. Just as the development of national banking systems served to offset a deflationary pressure which would have prevented otherwise the development of modern industry, so by extending the same principle into the international field we may hope to offset the contractionist pressure which might other- wise overwhelm in social disorder and disappointment the good hopes of our modern world".

[14] "Each member State shall have assigned to it a *quota,* which shall determine the measure of its responsibility in the management of the Union and of its right to enjoy the credit facilities provided by the Union. The initial quotas might be fixed by reference to the sum of each country's exports and imports on the average of (say) the three pre-war years, and might be (say) 75% of this amount, a special assessment being substituted in cases (of which there might be several) where this formula would be, for any reason, inappropriate. Subsequently, after the elapse of the transitional period, the quotas should be revised annually in accordance with the running average of each country's actual volume of trade in the three preceding years, rising to a five-year average when figures for five post-war years are available" (Keynes, 1943).

valuable and important inducements towards keeping a level balance, and a significant indication that the system looks on excessive credit balances with as critical an eye as on excessive debit balances" (Keynes, 1943).

As we show in the next section, this process of symmetric interest payments could be operationalized as follows: interest would be paid in bancors, which means that the creditor country will see its balance with the ICU reduced when interests are paid, while debtor countries will see their balance increase. It follows that – for the amount of interest paid on creditor positions – a country with a surplus would be giving part of its exports "for free" by an amount given by interest payments. Interest payments will generate a "profit" for the ICU, which can – and should – be used to sustain less developed countries. Since these countries usually lack technology and/or capital which must be imported, crediting the bancor position of these countries would provide the necessary purchasing power.

Each country would have a fixed – but adjustable – exchange rate between its own currency and the bancor: there would be a threshold on each country's bancor balance – given by its quota – which implies an automatic readjustment of the parity. In the original plan this devaluation could not be larger than 5%. If after this adjustment deficits are still large and persistent, further measures could be taken (including the possibility of not allowing the country to draw anymore on its account until the external situation is resolved). Similarly, if country A is running a sufficiently large and persistent current account surplus (i.e., surpluses that exceed the quota) the ICU could require that some measures are taken to reduce the external surplus. These measures would include the expansion of domestic credit and demand and/or the appreciation of its currency against the bancor. A bancor-based system would therefore have the usual advantages of a managed exchange rate system, with a reduced volatility with respect to a floating rates regime.

A final point that has to be made regarding the features of this bancor-based system is the one concerning international capital movements. Keynes seemed to be in favor of reducing these to a large extent due to their destabilizing effects[15]. The fact that capital movements played a very limited role under the Bretton Woods system that was

[15] "There is no country which can, in future, safely allow the flight of funds for political reasons or to evade domestic taxation or in anticipation of the owner turning refugee. Equally, there is no country that can safely receive fugitive funds, which constitute an unwanted import of capital, yet cannot safely be used for fixed investment" (Keynes, 1943).

established after the war shows that the majority of the politicians of the time shared Keynes' view. However, "the universal establishment of a control of capital movements cannot be regarded as essential to the operation of the Clearing Union" (Keynes, 1943). What Keynes proposed was the establishment of a series of mechanisms that were able to distinguish "long-term loans by creditor countries, which help to maintain equilibrium and develop the world's resources, from movements of funds out of debtor countries which lack the means to finance them" (Keynes, 1943) and control "short-term speculative movements or flights of currency whether out of debtor countries or from one creditor country to another" (Keynes, 1943). Taking into account the disruptive effects that financial capital has had on the stability of the world economy we take Keynes' recommendation of introducing strict controls on capital movements – therefore in our model we will not allow for portfolio investment flows.

Recent Developments

An early advocate of a reform of the International Monetary System (IMS) along Keynes' lines was Davidson (1992-93)[16]. In his (2004) contribution, he reminds that, since the world economy is a closed system, Keynesian results of the recessionary effects of a propensity to over-save are relevant, irrespective of the exchange rate being fixed or flexible. He advocates a new system where countries running an external surplus have to share the cost of realignments by either (a) increasing their imports; (b) increasing foreign investment in deficit countries; or (c) increasing foreign aid. A similar position, stressing the need for coordinated solutions, can be found more recently in Kregel (2010).

The more recent debate has seen a growing number of contributions with slightly different approaches. Rossi (2009) stresses the relevance of Keynes' "banking principle", according to which final payment must take place in the currency of the vendor, rather than leaving the vendor with a claim on deposits in a different country and currency, as it is today. He suggests the creation of a Clearing Union (CU), which should issue a supranational currency backed by assets (securities). He notes that, under the Clearing Union, each country running a trade deficit will be supplying securities for an equivalent amount to the CU. On the other hand, the CU will be selling securities to surplus countries. No imbalance will occur. This last point, however, is problematic in our view, as it assumes that surplus countries are willing to accept CU securities (or debtor countries' securities). Imbalances will not disappear because of the adoption of a consistent system for clearing

[16] See also Davidson (1999); (2004).

international transactions. Rather, by establishing mechanisms for automatic adjustment of trade (or capital movements) imbalances.

Alessandrini and Fratianni (2009a; 2009b) propose to establish a CU starting from an agreement between the US and the ECB. They make it clear that a CU does not imply a unique monetary policy: 'A single monetary policy applied to vastly heterogeneous countries amplifies divergences between countries with different levels of development' (2009a) which is also quite appropriate for the euro area. The supranational currency they advocate would not replace domestic currencies: rather, establishing a CU should let countries acquire a degree of freedom in running monetary policy on domestic targets.

In our view, the contributions of Bibow (2009) and Costabile (2009) share some common features and provide more detail. In their proposals, the CU would imply a semi-automatic mechanism for exchange rate realignments, whenever a country's balance with the CU exceeds a given limit. Creation of supranational money would be endogenous. The new "currency" would be overdraft money generated automatically by countries external deficits with the CU, up to a given quota. Interest rates would be applied to both deficit and surplus countries balances with the CU. Proceeds from interest payments would be used by the CU to support developing countries, thus ensuring that the coordinated realignment process advocated by Keynes and Davidson is in place. Finally, in this proposal no country should keep additional reserves, other than as their CU position.

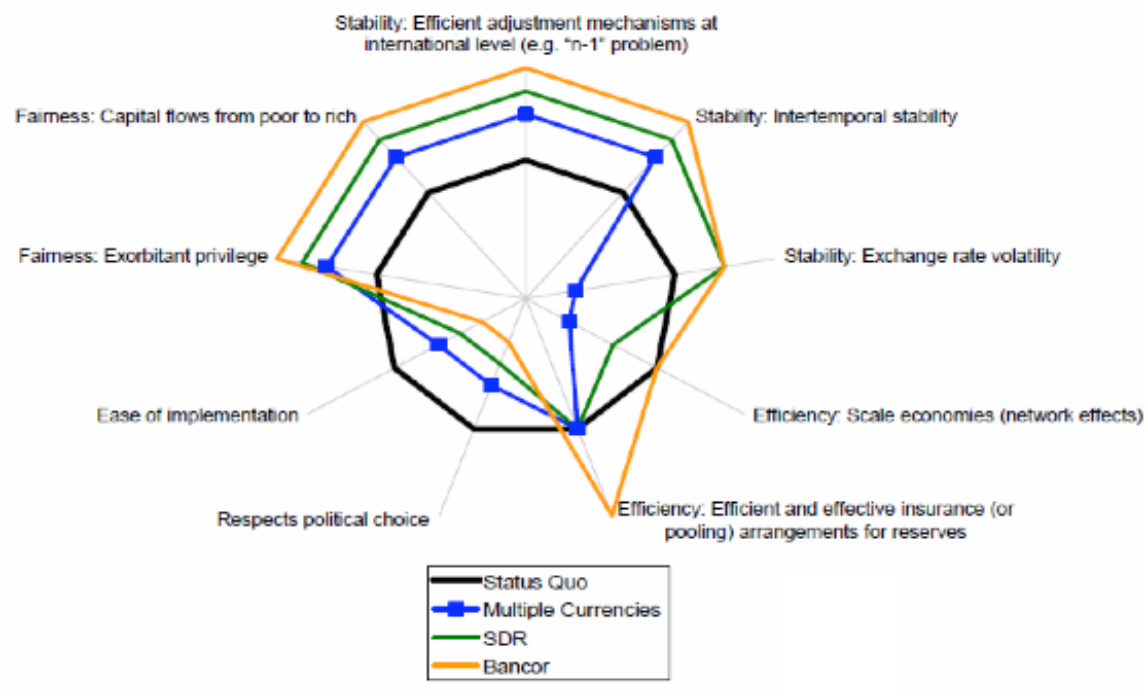
Recently, there have also been developments on the ideas aimed at enhancing the role of the SDR as a reserve currency[17]. Kenen (2011) proposes a system where countries deposit their reserves at the IMF in exchange for SDRs. They could then transfer these SDRs to other countries in exchange for their currencies either to intervene in the foreign exchange markets whenever it is needed, to make debt payments or for other purposes. The IMF would make regular emissions of SDRs to provide the world with the required amount of liquidity. Icard (2011) and Ocampo (2010) have also come up with different proposals aiming at enhancing the role of the SDR as a reserve asset but neither of these proposals provides the self-correcting mechanisms that Keynes' plan incorporated. Hu (2011) goes farther to propose the creation of an international currency unit on the basis of the SDR. This would imply, among other uses of enhanced SDR, the usage of this currency as a transaction, payment and settlement currency. In order for the SDR to acquire a relevant role at a global scale it would be necessary to create an official SDR

[17] Kenen (2010) argues that a distinction should be made between the concept of a reserve asset (which the SDR already is) and reserve currency (which the SDR has never been).

market where the IMF and countries interact. The IMF would be given the role of the market maker. Cate (2011) also advocates the development of private SDR markets. However, as it happens with the SDR-based proposals, it is not clear how the system would tend to correct global imbalances.

Mateos y Lago et al. (2009) stress the need to reduce the demand for international reserves for insurance purposes (the over saving in Davidson's words) and explore different alternatives. Their results are summarized in a chart reproduced as Figure 2.2.

Figure 2.2: Features of alternative International Monetary Systems



The figure shows how alternative settings in the IMS would compare relative to the current situation. Their analysis suggests that a system along the lines of Keynes' bancor would perform best with respect to:

- ✓ eliminating the "exorbitant privilege" given to a single country issuing a reserve currency;

- ✓ eliminating global imbalances which imply that rich country have a current account deficit which implies in turn a transfer of financial capital from developing countries;

- ✓ reducing the instability of the adjustment mechanisms in exchange rates;

- ✓ improve the inter-temporal stability of currency values, and reduce exchange rate volatility;

- ✓ providing better insurance by eliminating the need to accumulate reserves.

However, they admit that the complex coordination problems required to establish the ICU and a bancor are very relevant.

2.4 A four-country stock-flow consistent model

Our model is in the tradition of open economy, stock-flow-consistent models pioneered by Godley (1999) and Godley - Lavoie (2003). The main feature of these models is the complete integration of the real sectors of the economy with the financial sector, so that the linkages between money and credit on one side, and investment and growth on the other, are clearly set out. Besides, in these models saving for all sectors accumulate into wealth (or debt for negative saving). This allows an appropriate formalization of future income payments arising from dividends, interest payments etc., and in addition it is assumed that the existing stocks of wealth and debt are relevant for future expenditure and saving decisions. The result is a class of models which describe the evolution of an economy through time, with no necessary distinction between a "short period" and a "long period", since the latter is implied by a sequence of (out of equilibrium) short term adjustments.

While many of the features of stock-flow models relate to accounting identities, and should therefore be common to any proper macro model, in our approach based on Godley – Lavoie (2007a), it is assumed, in the Keynesian tradition, that production is demand-led, and that discrepancies between expected values of, say, disposable income, and the realized value will not be cleared instantaneously by some price adjustment, but will result in an unexpected level of one (or more) stock of assets, and this deviation from "equilibrium" will be taken into account for future decisions, so that the economy is path dependent.

The path-breaking work of Godley (1999) and Godley – Lavoie (2003) showed how to model a watertight system with a complete, although simple, representation of both the current external balances and of the financial balances of two countries, and used the

model to show that external imbalances for the country issuing an international currency can persist possibly without limits. They also showed that some results of the Mundell-Fleming textbook model do not hold, and offered insights on how to model alternative institutional or policy settings, such as fixed versus flexible exchange rates, and exogenous versus endogenous interest rates.

Later work include Izurieta (2003), who developed a model of dollarization; chapter 6 of Godley – Lavoie (2007b); Lavoie and Zhao (2010) who move to a three country model of China, Europe and the US where the exchange rate between the US dollar and the euro is floating, while the Chinese renminbi is pegged to the US dollar; Lavoie and Daigle (2011) who model exchange rate expectations; Mazier and Tiou-Tagba Aliti (2012) who expand Lavoie and Zhao (2010) to include four countries in order to study global imbalances under the present system. More recently, Bortz (2014) has shown how to incorporate foreign debt issues in the context of open economies in order to analyze the dynamic impacts that these flows can have on the exchange rate.

The current model expands on this literature – which shares a common modeling setting – to include an additional region and an international monetary institution, so that our model aims at describing the US - which is the only country issuing a reserve currency in our baseline scenario, Europe – or better the Euro zone – who has a floating exchange rate vis-à-vis the other currencies, China, who pegs its exchange rate to the US dollar, and the "Rest of the world", who also pegs to the U.S. dollar. The purpose of adding a fourth region, as Mazier and Tiou-Tagba Aliti (2012) argue, is to allow for more flexibility and realism, as well as being able to eventually tackle the "n-th country problem"[18].

Before moving to the description of the model we can briefly describe the main intuitions embedded in it, as well as some of the assumptions upon which the model is based. We assume that production is demand determined, and therefore we do not have an explicit representation of (the change in the stock of) inventories. The functional distribution of income is the wage bill, which together with interest and dividends paid by banks, determines household income, which is taxed by the government. Households spend out of disposable income and wealth and the residual saving determines the end-of-period stock of household wealth, which can be held under the form of money or bank deposits.

[18] Mundell (1968): "Only n-1 independent balance of payments instruments are needed in an n-country world because equilibrium in the balances of n-1 countries implies equilibrium in the balance of the n-th country. The *redundancy problem* is the problem of deciding how to utilize this extra degree of freedom"

Non-financial firms do not distribute dividends, and have to pay taxes and interest on the existing stock of loans. Retained earnings are available for investment, which is determined by the profit rate, the cost of servicing the debt and an accelerator term. The demand for loans is given by the desired investment that cannot be financed by retained earnings. These loans are provided on demand, with no credit rationing[19]. We assume that banks distribute all of their profits—obtained from net interest payments from financial assets which are purchased according to a portfolio choice equation—to households, although we keep the possibility of changing these assumptions in different versions by computing net bank profits and net wealth. Additionally, banks are required to hold reserves as a share of deposits, and ask for advances from the Central bank whenever the amount of liquidity from deposits—or eventually own capital—is insufficient to provide loans plus satisfying their demand for domestic and foreign bills.

The Central bank is assumed to transfer its 'profits' to the government and to provide advances to commercial banks on demand with no restriction on credit. The government deficit is obtained as the difference between expenditure on goods and services, which grow at a constant, exogenous rate plus interest payments and tax receipts. Any deficit is financed by issuances of new bills. Imports are determined on a bilateral basis from GDP and the exchange rate, since we assume fixed prices in this preliminary version of the model.

After this general description of the model we present the system of equations that specifies it in full. Table 2.2 presents the matrices of transactions, which embody both the social accounting matrices and the flows of funds of all the country blocs of the model. These matrices will be useful when specifying the model, since they will help us to ensure that every flow has a defined point of departure and arrival, and that all markets are cleared ex-post. For completeness, Table 2.3 presents the matrix of stocks, where all the assets and liabilities of the model are defined. We present this matrix for the US, but it should be born in mind that there is an equivalent matrix for the three remaining country blocks.

Table 2.2: Matrices of transactions

[19] Even if credit rationing constitutes an issue of major importance in modern economies, in order to keep the model as simple as possible it is assumed that firms can get all the credit that they require to finance their investment projects. A detailed treatment of credit rationing within a stock-flow consistent framework can be found in the works of Le Hèron and Mouakil (2008) and Le Hèron (2011).

	United States								
	Households	Firms		Com. Banks		Government	Central Bank		
		Current	Capital	Current	Capital		Current	Capital	
Consumption	$-C_t^{US}$	C_t^{US}							
Investment		I_t^{US}	$-I_t^{US}$						
Gov.Spending		G_t^{US}				$-G_t^{US}$			
Net Exports		NX_t^{US}							
Wages	W_t^{US}	$-W_t^{US}$							
Taxes	$-Th_t^{US}$	$-Tf_t^{US}$				T_t^{US}			
Int.Deposits	$rd_{t-1}^{US}.Md_{t-1}^{US}$			$-rd_{t-1}^{US}.Md_{t-1}^{US}$					
Int.Loans		$-rl_{t-1}^{US}.Ld_{t-1}^{US}$		$rl_{t-1}^{US}.Ld_{t-1}^{US}$					
Int.Reserves				$rs_{t-1}^{US}.R_{t-1}^{US}$			$-rs_{t-1}^{US}.R_{t-1}^{US}$		
Int.Advances				$-r_{t-1}^{US}.A_{t-1}^{US}$			$r_{t-1}^{US}.A_{t-1}^{US}$		
$Int.Bonds^{US}$				$r_{t-1}^{US}.Bd, b_{US_{t-1}}^{US}$		$-r_{t-1}^{US}.Bs_{t-1}^{US}$	$r_{t-1}^{US}.Bd, cb_{US_{t-1}}^{US}$		
$Int.Bonds^{RW}$				$r_{t-1}^{RW}.Bd, b_{US_{t-1}}^{RW}$					
$Int.Bonds^{CH}$				$r_{t-1}^{CH}.Bd, b_{US_{t-1}}^{CH}$					
$Int.Bonds^{EZ}$				$r_{t-1}^{EZ}.Bd, b_{US_{t-1}}^{EZ}$					
Profits	Pb^{US}	$-Pf^{US}$	Pf^{US}	$-Pb^{US}$		Pcb^{US}	$-Pcb^{US}$		
$\Delta Cash$	$-\Delta Hd^{US}$							ΔHs^{US}	
$\Delta Deposits$	$-\Delta Md^{US}$				ΔMd^{US}				
$\Delta Loans$			ΔL^{US}		$-\Delta L^{US}$				
$\Delta Reserves$					$-\Delta R^{US}$			ΔR^{US}	
$\Delta Advances$					ΔA^{US}			$-\Delta A^{US}$	
$\Delta Bonds^{US}$					$-\Delta Bd, b_{US}^{US}$	ΔBs^{US}		$-\Delta Bd, cb_{US}^{US}$	
$\Delta Bonds^{RW}$					$-\Delta Bd, b_{US}^{RW}$				
$\Delta Bonds^{CH}$					$-\Delta Bd, b_{US}^{CH}$				
$\Delta Bonds^{EZ}$					$-\Delta Bd, b_{US}^{EZ}$				
Total	0	0	0	0	0	0	0	0	

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	Rest of the World								
	Households	Firms		Com. Banks		Government	Central Bank		
		Current	Capital	Current	Capital		Current	Capital	
Consumption	$-C_t^{RW}$	C_t^{RW}							
Investment		I_t^{RW}	$-I_t^{RW}$						
Gov.Spending		G_t^{RW}				$-G_t^{RW}$			
Net Exports		NX_t^{RW}							
Wages	W_t^{RW}	$-W_t^{RW}$							
Taxes	$-Th_t^{RW}$	$-Tf_t^{RW}$				T_t^{RW}			
Int.Deposits	$rd_{t-1}^{RW}.Md_{t-1}^{RW}$			$-rd_{t-1}^{RW}.Md_{t-1}^{RW}$					
Int.Loans		$-rl_{t-1}^{RW}.Ld_{t-1}^{RW}$		$rl_{t-1}^{RW}.Ld_{t-1}^{RW}$					
Int.Reserves				$rs_{t-1}^{RW}.R_{t-1}^{RW}$			$-rs_{t-1}^{RW}.R_{t-1}^{RW}$		
Int.Advances				$-r_{t-1}^{RW}.A_{t-1}^{RW}$			$r_{t-1}^{RW}.A_{t-1}^{RW}$		
$Int.Bonds^{US}$				$r_{t-1}^{US}.Bd, b_{RW_{t-1}}^{US}$			$r_{t-1}^{US}.Bd, cb_{RW_{t-1}}^{US}$		
$Int.Bonds^{RW}$				$r_{t-1}^{RW}.Bd, b_{RW_{t-1}}^{RW}$		$-r_{t-1}^{RW}.Bs_{t-1}^{RW}$	$r_{t-1}^{RW}.Bd, cb_{RW_{t-1}}^{RW}$		
$Int.Bonds^{CH}$				$r_{t-1}^{CH}.Bd, b_{RW_{t-1}}^{CH}$					
$Int.Bonds^{EZ}$				$r_{t-1}^{EZ}.Bd, b_{RW_{t-1}}^{EZ}$					
Profits	Pb^{RW}	$-Pf^{RW}$	Pf^{RW}	$-Pb^{RW}$		Pcb^{RW}	$-Pcb^{RW}$		
$\Delta Cash$	$-\Delta Hd^{RW}$							ΔHs^{RW}	
$\Delta Deposits$	$-\Delta Md^{RW}$				ΔMd^{RW}				
$\Delta Loans$			ΔL^{RW}		$-\Delta L^{RW}$				
$\Delta Reserves$					$-\Delta R^{RW}$			ΔR^{RW}	
$\Delta Advances$					ΔA^{RW}			$-\Delta A^{RW}$	
$\Delta Bonds^{US}$					$-\Delta Bd, b_{RW}^{US}$			$-\Delta Bd, cb_{RW}^{US}$	
$\Delta Bonds^{RW}$					$-\Delta Bd, b_{RW}^{RW}$	ΔBs^{RW}		$-\Delta Bd, cb_{RW}^{RW}$	
$\Delta Bonds^{CH}$					$-\Delta Bd, b_{RW}^{CH}$				
$\Delta Bonds^{EZ}$					$-\Delta Bd, b_{RW}^{EZ}$				
Total	0	0	0	0	0	0	0	0	

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	China								
	Households	Firms		Com.Banks		Government	Central Bank		
		Current	Capital	Current	Capital		Current	Capital	
Consumption	$-C_t^{CH}$	C_t^{CH}							
Investment		I_t^{CH}	$-I_t^{CH}$						
Gov.Spending		G_t^{CH}				$-G_t^{CH}$			
Net Exports		NX_t^{CH}							
Wages	W_t^{CH}	$-W_t^{CH}$							
Taxes	$-Th_t^{CH}$	$-Tf_t^{CH}$				T_t^{CH}			
Int.Deposits	$rd_{t-1}^{CH}.Md_{t-1}^{CH}$			$-rd_{t-1}^{CH}.Md_{t-1}^{CH}$					
Int.Loans		$-rl_{t-1}^{CH}.Ld_{t-1}^{CH}$		$rl_{t-1}^{CH}.Ld_{t-1}^{CH}$					
Int.Reserves				$rs_{t-1}^{CH}.R_{t-1}^{CH}$			$-rs_{t-1}^{CH}.R_{t-1}^{CH}$		
Int.Advances				$-r_{t-1}^{CH}.A_{t-1}^{CH}$			$r_{t-1}^{CH}.A_{t-1}^{CH}$		
$Int.Bonds^{US}$				$r_{t-1}^{US}.Bd, b_{CH_{t-1}}^{US}$			$r_{t-1}^{US}.Bd, cb_{CH_{t-1}}^{US}$		
$Int.Bonds^{RW}$				$r_{t-1}^{RW}.Bd, b_{CH_{t-1}}^{RW}$					
$Int.Bonds^{CH}$				$r_{t-1}^{CH}.Bd, b_{CH_{t-1}}^{CH}$		$-r_{t-1}^{CH}.Bs_{t-1}^{CH}$	$r_{t-1}^{CH}.Bd, cb_{CH_{t-1}}^{CH}$		
$Int.Bonds^{EZ}$				$r_{t-1}^{EZ}.Bd, b_{CH_{t-1}}^{EZ}$					
Dividends									
Profits	Pb^{CH}	$-Pf^{CH}$	Pf^{CH}	$-Pb^{CH}$		Pcb^{CH}	$-Pcb^{CH}$		
$\Delta Cash$	$-\Delta Hd^{CH}$							ΔHs^{CH}	
$\Delta Deposits$	$-\Delta Md^{CH}$				ΔMd^{CH}				
$\Delta Loans$			ΔL^{CH}		$-\Delta L^{CH}$				
$\Delta Reserves$					$-\Delta R^{CH}$			ΔR^{CH}	
$\Delta Advances$					ΔA^{CH}			$-\Delta A^{CH}$	
$\Delta Bonds^{US}$					$-\Delta Bd, b_{CH}^{US}$			$-\Delta Bd, cb_{CH}^{US}$	
$\Delta Bonds^{RW}$					$-\Delta Bd, b_{CH}^{RW}$				
$\Delta Bonds^{CH}$					$-\Delta Bd, b_{RW}^{CH}$	ΔBs^{CH}		$-\Delta Bd, cb_{CH}^{CH}$	
$\Delta Bonds^{EZ}$					$-\Delta Bd, b_{CH}^{EZ}$				
Total	0	0	0	0	0	0	0	0	

Continues on next page

	Eurozone								
	Households	Firms		Com.Banks		Government	Central Bank		
		Current	Capital	Current	Capital		Current	Capital	
Consumption	$-C_t^{EZ}$	C_t^{EZ}							0
Investment		I_t^{EZ}	$-I_t^{EZ}$						0
Gov.Spending		G_t^{EZ}				$-G_t^{EZ}$			0
Net Exports		NX_t^{EZ}							0
Wages	W_t^{EZ}	$-W_t^{EZ}$							0
Taxes	$-Th_t^{EZ}$	$-Tf_t^{EZ}$				T_t^{EZ}			0
Int.Deposits	$rd_{t-1}^{EZ}.Md_{t-1}^{EZ}$			$-rd_{t-1}^{EZ}.Md_{t-1}^{EZ}$					0
Int.Loans		$-rl_{t-1}^{EZ}.Ld_{t-1}^{EZ}$		$rl_{t-1}^{EZ}.Ld_{t-1}^{EZ}$					0
Int.Reserves				$rs_{t-1}^{EZ}.R_{t-1}^{EZ}$			$-rs_{t-1}^{EZ}.R_{t-1}^{EZ}$		0
Int.Advances				$-r_{t-1}^{EZ}.A_{t-1}^{EZ}$			$r_{t-1}^{EZ}.A_{t-1}^{EZ}$		0
$Int.Bonds^{US}$				$r_{t-1}^{US}.Bd, b_{EZ_{t-1}}^{US}$			$r_{t-1}^{US}.Bd, cb_{EZ_{t-1}}^{US}$		0
$Int.Bonds^{RW}$				$r_{t-1}^{RW}.Bd, b_{EZ_{t-1}}^{RW}$					0
$Int.Bonds^{CH}$				$r_{t-1}^{CH}.Bd, b_{EZ_{t-1}}^{CH}$					0
$Int.Bonds^{EZ}$				$r_{t-1}^{EZ}.Bd, b_{CH_{t-1}}^{EZ}$		$-r_{t-1}^{CH}.Bs_{t-1}^{EZ}$	$r_{t-1}^{EZ}.Bd, cb_{EZ_{t-1}}^{EZ}$		0
Profits	Pb^{EZ}	$-Pf^{EZ}$	Pf^{EZ}	$-Pb^{EZ}$		Pcb^{EZ}	$-Pcb^{EZ}$		0
$\Delta Cash$	$-\Delta Hd^{EZ}$							ΔHs^{EZ}	0
$\Delta Deposits$	$-\Delta Md^{EZ}$				ΔMd^{EZ}				0
$\Delta Loans$			ΔL^{EZ}		$-\Delta L^{EZ}$				0
$\Delta Reserves$					$-\Delta R^{EZ}$			ΔR^{EZ}	0
$\Delta Advances$					ΔA^{EZ}			$-\Delta A^{EZ}$	0
$\Delta Bonds^{US}$					$-\Delta Bd, b_{EZ}^{US}$			$-\Delta Bd, cb_{EZ}^{US}$	0
$\Delta Bonds^{RW}$					$-\Delta Bd, b_{EZ}^{RW}$				0
$\Delta Bonds^{CH}$					$-\Delta Bd, b_{EZ}^{CH}$				0
$\Delta Bonds^{EZ}$					$-\Delta Bd, b_{CH}^{EZ}$	ΔBs^{EZ}		$-\Delta Bd, cb_{EZ}^{EZ}$	0
Total	0	0	0	0	0	0	0	0	0

Table 2.3: Matrix of stocks of the US

	Households	Firms	Com. Banks	Government	Central Bank
Capital		K^{US}			
Cash	H^{US}				$-H^{US}$
Deposits	M^{US}		$-M^{US}$		
Loans		$-L^{US}$	L^{US}		
Reserves			R^{US}		$-R^{US}$
Advances			$-A^{US}$		A^{US}
Bonds US			Bd, b_{US}^{US}	$-Bs_{US}^{US}$	Bd, cb_{US}^{US}
Bonds EZ			Bd, b_{US}^{EZ}		
Bonds China			Bd, b_{US}^{CH}		
Bonds RoW			Bd, b_{US}^{RW}		

Exchange Rates Definition

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

1 $ = E1 € = E2 ¥ = E4 #

1 € = E6 # = E3 ¥

1 # = E5 ¥

Thus, the interpretation regarding appreciation or depreciation movements is the traditional one:

If E1 goes up the euro depreciates against the dollar

If E2 goes up the renminbi depreciates against the dollar

If E3 goes up the renminbi depreciates against the euro

If E4 goes up the currency of the rest of the world depreciates against the dollar

If E5 goes up the renminbi depreciates against the currency of the rest of the world

If E6 goes up the currency of the rest of the world depreciates against the euro

Good's Market Equilibrium

The equilibrium in the good's market is given by the equation 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)).

$$Y_t^i = C_t^i + I_t^i + G_t^i + X_t^i - IM_t^i \qquad \forall\, i = US, EZ, CH, RW \qquad (2.1 - 2.4)$$

All the components of aggregate demand are considered endogenous, except for government spending, which is given by the following expression:

$$G_t^i = Go_t^i + \left(1 + w^i\right).G_{t-1}^i \qquad \forall\, i = US, EZ, CH, RW \qquad (2.5 - 2.8)$$

Hence, government spending in each period (G_t) is given by a constant term (Go_t) plus an exogenous rate of growth (w^i). The constant term (Go_t) 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.

International Trade

Since the four economies that we are considering embody the whole world economy, the sum of total exports (i.e., $\sum X^i$ ∀ i = US, EZ, CH, RW) has to be equal to total imports (i.e., $\sum IM^i$ ∀ i = US, EZ, CH, RW). 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 imports equation is normally defined as follows:

$$IM = \mu 0\ .\ Y^{\mu 1}\ .\ E^{\mu 2}$$

where $\mu 0$ is a constant term, E is the real exchange rate (since in this model prices are fixed, the real exchange rate will be equal to the nominal exchange rate), $\mu 1$ is the income

elasticity of imports and $\mu 2$ is the price elasticity of imports. If we log-linearize the imports equation, it becomes:

$$\log(IM) = \log \mu 0 + \mu 1 \,.\, \log(Y) + \mu 2 \,.\log(E)$$

This version of the import equation is the one that we are going to use in the model to describe the behavior of trade flows. The advantage of the utilization of a logarithmic function is that it prevents trade flows and their generating variables from being negative. An equation of this nature is also the one that is usually estimated to obtain the values of the μ parameters. It is worth mentioning that an additional term is included to each import function written below, in order to account for the fact that the movements of the other currencies also have an impact on imports (for instance, when the Eurozone decides how many imports to purchase from the US not only the dollar plays an important role regarding the final amount of imports but also the renminbi and the currency of the rest of the world do). Hence, bilateral trade flows can be defined as follows (recall that the superscript refers to the country to which the trade flow belongs, whereas the subscript refers to the partner country from which the trade flow is coming – thus, IM_{EZ}^{US} stands for "imports of the US from the Eurozone"):

$$\log\left(IM_{EZ\,t}^{US}\right) = \mu 0^{US} + \mu 1^{US} \,.\log(Y_t^{US}) + \mu 2^{US} \,.\log(E1_t) + \mu 3^{US} \,.\log((1/E2_t)\,.\,(\tfrac{1}{E4_t})) \quad (2.9)$$

$$\log\left(IM_{CH\,t}^{US}\right) = \mu 4^{US} + \mu 5^{US} \,.\log(Y_t^{US}) + \mu 6^{US} \,.\log(E2_t) + \mu 7^{US} \,.\log((1/E4_t)\,.\,(\tfrac{1}{E1_t})) \quad (2.10)$$

$$\log\left(IM_{RW\,t}^{US}\right) = \mu 8^{US} + \mu 9^{US} \,.\log(Y_t^{US}) + \mu 10^{US} \,.\log(E4_t) + \mu 11^{US} \,.\log((1/E2_t)\,.\,(\tfrac{1}{E1_t})) \quad (2.11)$$

$$\log\left(IM_{US\,t}^{EZ}\right) = \mu 0^{EZ} + \mu 1^{EZ} \,.\log(Y_t^{EZ}) + \mu 2^{EZ} \,.\log\left(\tfrac{1}{E1_t}\right) + \mu 3^{EZ} \,.\log((1/E3_t)\,.\,(\tfrac{1}{E6_t})) \quad (2.12)$$

$$\log\left(IM_{CH\,t}^{EZ}\right) = \mu 4^{EZ} + \mu 5^{EZ} \,.\log(Y_t^{EZ}) + \mu 6^{EZ} \,.\log(E3_t) + \mu 7^{US} \,.\log((E1)\,.\,(\tfrac{1}{E6_t})) \quad (2.13)$$

$$\log\left(IM_{RW\,t}^{EZ}\right) = \mu 8^{EZ} + \mu 9^{EZ} \,.\log(Y_t^{EZ}) + \mu 10^{EZ} \,.\log(E6_t) + \mu 11^{US} \,.\log((E1_t)\,.\,(\tfrac{1}{E3_t})) \quad (2.14)$$

$$\log\left(IM_{EZ\,t}^{CH}\right) = \mu 0^{CH} + \mu 1^{CH} \,.\log(Y_t^{CH}) + \mu 2^{CH} \,.\log(\tfrac{1}{E3_t}) + \mu 3^{CH} \,.\log((E2_t)\,.(E5)) \quad (2.15)$$

$$\log\left(IM_{US\,t}^{CH}\right) = \mu 4^{CH} + \mu 5^{CH} \,.\log(Y_t^{CH}) + \mu 6^{CH} \,.\log(\tfrac{1}{E2_t}) + \mu 7^{CH} \,.\log((E3_t)\,.(E5)) \quad (2.16)$$

$$\log\left(IM_{RW\,t}^{CH}\right) = \mu 8^{CH} + \mu 9^{CH} \,.\log(Y_t^{CH}) + \mu 10^{CH} \,.\log(\tfrac{1}{E5_t}) + \mu 11^{CH} \,.\log((E2_t)\,.(E3)) \quad (2.17)$$

$$\log\left(IM_{EZ\,t}^{RW}\right) = \mu 0^{RW} + \mu 1^{RW} \,.\log(Y_t^{RW}) + \mu 2^{RW} \,.\log(\tfrac{1}{E6_t}) + \mu 3^{RW} \,.\log((E4_t)\,.(1/E5)) \quad (2.18)$$

$$\log\left(IM_{US\,t}^{RW}\right) = \mu 4^{RW} + \mu 5^{RW} \,.\log(Y_t^{RW}) + \mu 6^{RW} \,.\log(\tfrac{1}{E4_t}) + \mu 7^{RW} \,.\log((E6_t)\,.(1/E5)) \quad (2.19)$$

$$\log\left(IM_{CH\,t}^{RW}\right) = \mu 8^{RW} + \mu 9^{RW} \,.\log(Y_t^{RW}) + \mu 10^{RW} \,.\log(E5_t) + \mu 11^{RW} \,.\log((E4_t)\,.(E6)) \quad (2.20)$$

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 (2.1 – 2.4).

$$IM_t^{US} = IM_{EZ}^{US}{}_t + IM_{CH}^{US}{}_t + IM_{RW}^{US}{}_t \quad (2.21)$$

$$IM_t^{EZ} = IM_{US}^{EZ}{}_t + IM_{CH}^{EZ}{}_t + IM_{RW}^{EZ}{}_t \quad (2.22)$$

$$IM_t^{CH} = IM_{US}^{CH}{}_t + IM_{EZ}^{CH}{}_t + IM_{RW}^{CH}{}_t \quad (2.23)$$

$$IM_t^{RW} = IM_{US}^{RW}{}_t + IM_{EZ}^{RW}{}_t + IM_{CH}^{RW}{}_t \quad (2.24)$$

As it was mentioned before, a trade flow is the mirror of the other. Thus, IM_{EZ}^{US} has to be equal to X_{US}^{EZ}. Since it is required that every trade flow is expressed in the domestic currency of the corresponding country, the following transformation is applied:

$$X_{EZ}^{US}{}_t = IM_{US}^{EZ}{}_t \cdot \left(\frac{1}{E1_t}\right) \quad (2.25)$$

$$X_{CH}^{US}{}_t = IM_{US}^{CH}{}_t \cdot \left(\frac{1}{E2_t}\right) \quad (2.26)$$

$$X_{RW}^{US}{}_t = IM_{US}^{RW}{}_t \cdot \left(\frac{1}{E4_t}\right) \quad (2.27)$$

$$X_{US}^{EZ}{}_t = IM_{EZ}^{US}{}_t \cdot (E1_t) \quad (2.28)$$

$$X_{CH}^{EZ}{}_t = IM_{EZ}^{CH}{}_t \cdot \left(\frac{1}{E3_t}\right) \quad (2.29)$$

$$X_{RW}^{EZ}{}_t = IM_{EZ}^{RW}{}_t \cdot \left(\frac{1}{E6_t}\right) \quad (2.30)$$

$$X_{US}^{CH}{}_t = IM_{CH}^{US}{}_t \cdot (E2_t) \quad (2.31)$$

$$X_{EZ}^{CH}{}_t = IM_{CH}^{EZ}{}_t \cdot (E3_t) \quad (2.32)$$

$$X_{RW}^{CH}{}_t = IM_{CH}^{RW}{}_t \cdot (E5_t) \quad (2.33)$$

$$X_{US}^{RW}{}_t = IM_{RW}^{US}{}_t \cdot (E4_t) \quad (2.34)$$

$$X_{EZ}^{RW}{}_t = IM_{RW}^{EZ}{}_t \cdot (E6_t) \quad (2.35)$$

$$X_{CH}^{RW}{}_t = IM_{RW}^{CH}{}_t \cdot \left(\frac{1}{E5_t}\right) \quad (2.36)$$

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

$$X_t^{US} = X_{EZ\,t}^{US} + X_{CH\,t}^{US} + X_{RW\,t}^{US} \quad (2.37)$$

$$X_t^{EZ} = X_{US\,t}^{EZ} + X_{CH\,t}^{EZ} + X_{RW\,t}^{EZ} \quad (2.38)$$

$$X_t^{CH} = X_{US\,t}^{CH} + X_{EZ\,t}^{CH} + X_{RW\,t}^{CH} \quad (2.39)$$

$$X_t^{RW} = X_{US\,t}^{RW} + X_{EZ\,t}^{RW} + X_{CH\,t}^{RW} \quad (2.40)$$

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 labor 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 ψ^i, which represents the share of wages out of total income.

$$W_t^i = \psi^i \,.\, Y_t^i \qquad \forall\, i = US, EZ, CH, RW \quad (2.41 – 2.44)$$

Although labor income may constitute the main source of income that finances households' consumption, there are other processes that need to be taken into account. On the one hand, firms may earn income out of other activities. In this model, households are assumed to hold two types of assets: the first one is cash (H), which yields no interest – the second ones are the short-term deposits (M), which earn a yield rd_t^i. Moreover, households earn an additional income which is derived from commercial banks' profits (PNb_t^i), since banks are owned by people that use the proceeds of their activity to consume. On the other hand, households have to pay taxes out of their income. In this model, it is assumed that a fraction θh^i of total income is levied, leading to the total amount of taxes that households pay (Th_t^i).

$$Th_t^i = \theta h^i \,.\, (W_t^i + rd_{t-1}^i \,.\, M_{t-1}^i + Pb_t^i) \qquad \forall\, i = US, EZ, CH, RW \quad (2.45 – 2.48)$$

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

$$Yd_t^i = W_t^i + rd_{t-1}^i . M_{t-1}^i + Pb_t^i - Th_t^i \qquad \forall\, i = US, EZ, CH, RW \qquad (2.49 - 2.52)$$

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 the propensity to consume out of wealth ($\alpha 1 > \alpha 2$).

$$C_t^i = \alpha 1^i . Yd_t^i + \alpha 2^i . Vh_{t-1}^i \qquad \forall\, i = US, EZ, CH, RW \qquad (2.53 - 2.56)$$

The part of disposable income that is not used to finance consumption is saved (being $(1 - \alpha 1^i)$ the propensity to save). Hence, the change in household's wealth is given by the flow of saving, which in turn is given by the difference between disposable income and consumption.

$$\Delta Vh_t^i = Yd_t^i - C_t^i \qquad \forall\, i = US, EZ, CH, RW \qquad (2.57 - 2.60)$$

Households can hold their wealth in two kinds of assets: short-term deposits issued by the local banks, which were previously defined as M_t^i, and high-powered money, H_t^i, which is issued by the central bank. The decision on what proportion of their wealth is held under each of these types of assets is a portfolio decision, mainly driven by the liquidity preference (the model could be easily extended to incorporate the rate of interest as an additional variable that influences households' choice). Thus, it is assumed that households decide to hold a certain proportion of consumption expenditure under the form of high-powered money (notes and coins). Therefore:

$$H_t^i = \lambda_t^i . C_t^i \qquad \forall\, i = US, EZ, CH, RW \qquad (2.61 - 2.64)$$

where $0 < \lambda_t^i < 1$. The remaining part of household's wealth is held as bank deposits.

$$M_t^i = Vh_t^i - H_t^i \qquad \forall\, i = US, EZ, CH, RW \qquad (2.65 - 2.68)$$

Firm's Profits and Investment

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

$$P_t^i = Y_t^i - W_t^i \qquad \forall\, i = US, EZ, CH, RW \qquad (2.69 – 2.72)$$

However, P_t^i are nothing but gross profits. Firms also have to pay interests on the credits taken in the past.

$$Int_t^i = rl_{t-1}^i \,.\, L_{t-1}^i \qquad \forall\, i = US, EZ, CH, RW \qquad (2.73 – 2.76)$$

Subsequently, firms have to pay taxes on their total profits (including those arising from their productive activity and those that result from the holding of financial assets and liabilities), which are given by:

$$Tf_t^i = \theta f^i \,.\, (P_t^i - Int_t^i) \qquad \forall\, i = US, EZ, CH, RW \qquad (2.77 – 2.80)$$

Therefore, net profits can be written as follows:

$$Pf_t^i = (P_t^i - Intf_t^i) \,.\, (1 - \theta f^i) \qquad \forall\, i = US, EZ, CH, RW \qquad (2.81 – 2.84)$$

The investment decision of the firms will be assumed to take the form of a Kaleckian-type formula, which accounts for some crucial features that determine the evolution of the stock of capital. Hence, the rate of profit (given by the ratio of net profits to the stock of capital), the debt structure of the firms (given by the credit that they demanded to finance past investment), the rate of capacity utilization (u_t). Each term of this function is accompanied by a constant (z^i) which measures the sensibility of investment to each of its components.

$$\frac{I_t^i}{K_{t-1}^i} = z0^i + z1^i \,.\, \frac{PD_t^i}{K_{t-1}^i} - z2^i \,.\, \frac{rl_{t-1}^i \,.\, L_{t-1}^i}{K_{t-1}^i} + z3^i \,.\, u_{t-1}^i \qquad \forall\, i = US, EZ, CH, RW \quad (2.85 – 2.88)$$

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

$$u_t^i = \left(\frac{Y_t^i}{K_t^i}\right) \,.\, v^i \qquad \forall\, i = US, EZ, CH, RW \quad (2.89 – 2.92)$$

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

$$K_t^i = \left(1 - \delta^i\right).K_{t-1}^i + I_t^i \qquad \forall\, i = US, EZ, CH, RW \quad (2.93 – 2.96)$$

Finally, firms finance their investment spending through net profits. If the latter are not sufficient to cover the whole value of the current investment flow, firms obtain the lacking funds in the credit market thereby acquiring a liability (it is assumed that there is no credit rationing).

$$\Delta L_t^i = I_t^i - PD_t^i \qquad \forall\, i = US, EZ, CH, RW \quad (2.97 – 2.100)$$

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

$$Vf_t^i = K_t^i - Ld_t^i \qquad \forall\, i = US, EZ, CH, RW \quad (2.101 – 2.104)$$

Government

Many features of the behavior of the government have already been introduced. Government spending was considered to be exogenous, as defined by equations (2.5 – 2.8) and taxes on households and firms have been defined in equations (2.45 – 2.48) and (2.81 – 2.84), respectively. Thus, total tax income by the government is given by the sum of taxes on households and firms.

$$T_t^i = Th_t^i + Tf_t^i \qquad \forall\, i = US, EZ, CH, RW \quad (2.105 – 2.108)$$

Government's revenues are given by two different sources: tax collection and 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 payment 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, the supply of government bonds can be defined as follows:

$$\Delta Bs_t^i = G_t^i - T_t^i + r_{t-1}^i.Bs_{t-1}^i - Pcb_t^i \qquad \forall\, i = US, EZ, CH, RW \quad (2.109 – 2.112)$$

Commercial Banks

Thus far, commercial banks have been introduced implicitly and in a passive manner. It was showed that households could hold their wealth under different types of assets, both issued by commercial banks. Moreover, firms demanded credit 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 and bills to households is totally demand-led, i.e., banks supply as much credit, deposits and bills as are demanded. Although this way of describing the role of commercial banks may seem reasonable for the case of their relationship with households, some readers may disagree with the fact that credit is a demand driven phenomenon. In this regard, it is important to mention that in order to be consistent with Post-Keynesian theory it is being assumed that all credit worthy firms are granted credits and those are the firms that in the end can undertake the investment flow described by equations (2.85 – 2.88).

In the real world, however, the financial sector, than not only includes commercial banks but also investment banks, hedge funds, etc. play an active role, giving rise to a process labeled 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 we do not deal with financialisation (some interesting attempts to describe this phenomenon in the framework of stock-flow models can be found in Caverzasi & Godin (2014) and van Treeck (2009)). Instead, we simply assume that commercial banks 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 their extremely liquid liabilities, i.e., the money that belongs to households. The decision about how many bonds they buy from each government is a portfolio decision mainly driven by the return of each type of bond, given by the interest rate. Following Tobin (1969) and Godley (1996) criteria (described in detail in the Annex) we write equations (2.113 – 2.128):

$$Bd, b_{EZ_t}^{US} = [(1 - \xi^{EZ}).M_t^{EZ}] . (\gamma 10^{EZ} + \gamma 11^{EZ} . r^{US} + \gamma 12^{EZ} . r^{EZ} + \gamma 13^{EZ} . r^{CH} + \gamma 14^{EZ} . r^{RW}) \quad (2.113)$$

$$Bd, b_{EZ_t}^{CH} = [(1 - \xi^{EZ}).\ M_t^{EZ}] . (\gamma 20^{EZ} + \gamma 21^{EZ} . r^{US} + \gamma 22^{EZ} . r^{EZ} + \gamma 23^{EZ} . r^{CH} + \gamma 24^{EZ} . r^{RW}) \quad (2.114)$$

$$Bd, b_{EZ_t}^{RW} = [(1 - \xi^{EZ}).\ M_t^{EZ}] . (\gamma 30^{EZ} + \gamma 31^{EZ} . r^{US} + \gamma 32^{EZ} . r^{EZ} + \gamma 33^{EZ} . r^{CH} + \gamma 34^{EZ} . r^{RW}) \quad (2.115)$$

$$Bd, b_{EZ_t}^{EZ} = [(1 - \xi^{EZ}).\ M_t^{EZ}] - Bd, b_{EZ_t}^{US} - Bd, b_{EZ_t}^{CH} - Bd, b_{EZ_t}^{RW} \quad (2.116)$$

$$Bd, b_{US_t}^{EZ} = [(1 - \xi^{US}).\ M_t^{US}] \,.\, (\gamma 10^{US} + \gamma 11^{US} \,.\, r^{US} + \gamma 12^{US} \,.\, r^{EZ} + \gamma 13^{US} \,.\, r^{CH} + \gamma 14^{US} \,.\, r^{RW}) \quad (2.117)$$

$$Bd, b_{US_t}^{CH} = [(1 - \xi^{US}).\ M_t^{US}] \,.\, (\gamma 20^{US} + \gamma 21^{US} \,.\, r^{US} + \gamma 22^{US} \,.\, r^{EZ} + \gamma 23^{US} \,.\, r^{CH} + \gamma 24^{US} \,.\, r^{RW}) \quad (2.118)$$

$$Bd, b_{US_t}^{RW} = [(1 - \xi^{US}).M_t^{US}] \,.\, (\gamma 30^{US} + \gamma 31^{US} \,.\, r^{US} + \gamma 32^{US} \,.\, r^{EZ} + \gamma 33^{US} \,.\, r^{CH} + \gamma 34^{US} \,.\, r^{RW}) \quad (2.119)$$

$$Bd, b_{US_t}^{US} = [(1 - \xi^{US}).\ M_t^{US}\ ] - Bd, b_{US_t}^{EZ} - Bd, b_{US_t}^{CH} - Bd, b_{US_t}^{RW} \quad (2.120)$$

$$Bd, b_{CH_t}^{EZ} = [(1 - \xi^{CH}).\ M_t^{CH}]. (\gamma 10^{CH} + \gamma 11^{CH} \,.\, r^{US} + \gamma 12^{CH} \,.\, r^{EZ} + \gamma 13^{CH} \,.\, r^{CH} + \gamma 14^{CH} \,.\, r^{RW}) \quad (2.121)$$

$$Bd, b_{CH_t}^{US} = [(1 - \xi^{CH}).\ M_t^{CH}]. (\gamma 20^{CH} + \gamma 21^{CH} \,.\, r^{US} + \gamma 22^{CH} \,.\, r^{EZ} + \gamma 23^{CH} \,.\, r^{CH} + \gamma 24^{CH} \,.\, r^{RW}) \quad (2.122)$$

$$Bd, b_{CH_t}^{RW} = [(1 - \xi^{CH}).M_t^{CH}]. (\gamma 30^{CH} + \gamma 31^{CH} \,.\, r^{US} + \gamma 32^{CH} \,.\, r^{EZ} + \gamma 33^{CH} \,.\, r^{CH} + \gamma 34^{CH} \,.\, r^{RW}) \quad (2.123)$$

$$Bd, b_{CH_t}^{CH} = [(1 - \xi^{CH}).\ M_t^{CH}] - Bd, b_{CH_t}^{EZ} - Bd, b_{CH_t}^{US} - Bd, b_{CH_t}^{RW} \quad (2.124)$$

$$Bd, b_{RW_t}^{EZ} = [(1 - \xi^{RW}).\ M_t^{RW}].(\gamma 10^{RW} + \gamma 11^{RW} . r^{US} + \gamma 12^{RW} \,.\, r^{EZ} + \gamma 13^{RW} \,.\, r^{CH} + \gamma 14^{RW} \,.\, r^{RW}) \quad (2.125)$$

$$Bd, b_{RW_t}^{US} = [(1 - \xi^{RW}).M_t^{RW}] .(\gamma 20^{RW} + \gamma 21^{RW} . r^{US} + \gamma 22^{RW} \,.\, r^{EZ} + \gamma 23^{RW} \,.\, r^{CH} + \gamma 24^{RW} \,.\, r^{RW}) \quad (2.126)$$

$$Bd, b_{RW_t}^{CH} = [(1 - \xi^{RW}).M_t^{RW}].(\gamma 30^{RW} + \gamma 31^{RW} . r^{US} + \gamma 32^{RW} \,.\, r^{EZ} + \gamma 33^{RW} \,.\, r^{CH} + \gamma 34^{RW} \,.\, r^{RW}) \quad (2.127)$$

$$Bd, b_{RW_t}^{RW} = [(1 - \xi^{RW}).M_t^{RW}] - Bd, b_{RW_t}^{EZ} - Bd, b_{RW_t}^{US} - Bd, b_{RW_t}^{CH} \quad (2.128)$$

In order to facilitate the understanding of the notation used above, let us take equation (2.113) as an example. This equation states that the demand for bonds of Eurozone's commercial banks denominated in US dollars ($Bd, b_{EZ_t}^{US}$) is financed by the part of household's money deposited at commercial banks which is kept within commercial banks, $(1 - \xi^{EZ})M_t^{EZ}$, being ξ^{EZ} the share of deposits that banks are obliged to constitute at the central bank as reserves). The parameters γ^i represent the sensibility of the demand of each type of bond to changes on the relative returns that these assets yield.

As it happened before with the international trade of goods (exports and imports) it is necessary to define the supply side of the international trade market of bonds. Since the demand was just defined above, the supply can be obtained by transforming the bilateral demand of bonds by the banks through the bilateral exchange rate.

$$Bs, b_{EZ_t}^{EZ} = Bd, b_{EZ_t}^{EZ} \quad (2.129)$$

$$Bs, b_{EZ_t}^{US} = \frac{Bd, b_{EZ_t}^{US}}{E1_t} \quad (2.130)$$

$$Bs, b_{EZ_t}^{CH} = Bd, b_{EZ_t}^{CH} \,.\, E3_t \quad (2.131)$$

$$Bs, b_{EZ_t}^{RW} = Bd, b_{EZ_t}^{RW} \,.\, E6_t \quad (2.132)$$

$$Bs, b_{US_t}^{US} = Bd, b_{US_t}^{US} \quad (2.133)$$

$$Bs, b_{US_t}^{EZ} = Bd, b_{US_t}^{EZ} . E1_t \quad (2.134)$$

$$Bs, b_{US_t}^{CH} = Bd, b_{US_t}^{CH} . E2_t \quad (2.135)$$

$$Bs, b_{US_t}^{RW} = Bd, b_{US_t}^{RW} . E4_t \quad (2.136)$$

$$Bs, b_{CH_t}^{CH} = Bd, b_{CH_t}^{CH} \quad (2.137)$$

$$Bs, b_{CH_t}^{EZ} = \frac{Bd, b_{CH_t}^{EZ}}{E3_t} \quad (2.138)$$

$$Bs, b_{CH_t}^{US} = \frac{Bd, b_{CH_t}^{US}}{E2_t} \quad (2.139)$$

$$Bs, b_{CH_t}^{RW} = \frac{Bd, b_{CH_t}^{RW}}{E5_t} \quad (2.140)$$

$$Bs, b_{RW_t}^{RW} = Bd, b_{RW_t}^{RW} \quad (2.141)$$

$$Bs, b_{RW_t}^{EZ} = \frac{Bd, b_{RW_t}^{EZ}}{E6_t} \quad (2.142)$$

$$Bs, b_{RW_t}^{US} = \frac{Bd, b_{RW_t}^{US}}{E4_t} \quad (2.143)$$

$$Bs, b_{RW_t}^{CH} = Bd, b_{RW_t}^{CH} . E5_t \quad (2.144)$$

As a result of their holdings of different assets and liabilities commercial banks make profits. These profits are higher as the rate of interest on bonds purchased from governments, credit granted to firms and the stock of reserves being held at the central bank (which are given by the variable Rd_t^i that is going to be defined shortly when the central bank is introduced) is higher. On the other hand, as the rate of interest on deposits and advances increases, profits would tend to be lower. Moreover, commercial banks can make extra profits as a result of valuation effects (either positive or negative) on their holdings of foreign bonds. Thus, equations (2.145 – 2.148) can be written as follows:

$$Pb_t^{US} = r_{t-1}^{US}. Bd, b_{US_{t-1}}^{US} + r_{t-1}^{EZ}. Bd, b_{US_{t-1}}^{EZ} + r_{t-1}^{CH}. Bd, b_{US_{t-1}}^{CH} + r_{t-1}^{RW}. Bd, b_{US_{t-1}}^{RW} + Bs, b_{US_{t-1}}^{EZ}. \Delta\left(\frac{1}{E1}\right) + Bs, b_{US_{t-1}}^{CH}. \Delta\left(\frac{1}{E2}\right) + Bs, b_{US_{t-1}}^{RW}. \Delta\left(\frac{1}{E4}\right) + rs_{t-1}^{US}. R_{t-1}^{US} + rl_{t-1}^{US}. L_{t-1}^{US} - rd_{t-1}^{US}. M_{t-1}^{US} - r_{t-1}^{US}. A_{t-1}^{US} \quad (2.145)$$

$$Pb_t^{EZ} = r_{t-1}^{EZ}. Bd, b_{EZ_{t-1}}^{EZ} + r_{t-1}^{US}. Bd, b_{EZ_{t-1}}^{US} + r_{t-1}^{CH}. Bd, b_{EZ_{t-1}}^{CH} + r_{t-1}^{RW}. Bd, b_{EZ_{t-1}}^{RW} + Bs, b_{EZ_{t-1}}^{US}. \Delta(E1) + Bs, b_{EZ_{t-1}}^{CH}. \Delta\left(\frac{1}{E3}\right) + Bs, b_{EZ_{t-1}}^{RW}. \Delta\left(\frac{1}{E6}\right) + rs_{t-1}^{EZ}. R_{t-1}^{EZ} + rl_{t-1}^{EZ}. L_{t-1}^{EZ} - rd_{t-1}^{EZ}. M_{t-1}^{EZ} - r_{t-1}^{EZ}. A_{t-1}^{EZ} \quad (2.146)$$

$$Pb_t^{CH} = r_{t-1}^{CH}. Bd, b_{CH_{t-1}}^{CH} + r_{t-1}^{EZ}. Bd, b_{CH_{t-1}}^{EZ} + r_{t-1}^{US}. Bd, b_{CH_{t-1}}^{US} + r_{t-1}^{RW}. Bd, b_{CH_{t-1}}^{RW} + Bs, b_{CH_{t-1}}^{EZ}. \Delta(E3) + Bs, b_{CH_{t-1}}^{US}. \Delta(E2) + Bs, b_{CH_{t-1}}^{RW}. \Delta(E5) + rs_{t-1}^{CH}. R_{t-1}^{CH} + rl_{t-1}^{CH}. L_{t-1}^{CH} - rd_{t-1}^{CH}. M_{t-1}^{CH} - r_{t-1}^{CH}. A_{t-1}^{CH} \quad (2.147)$$

$$Pb_t^{RW} = r_{t-1}^{RW}. Bd, b_{RW_{t-1}}^{RW} + r_{t-1}^{EZ}. Bd, b_{RW_{t-1}}^{EZ} + r_{t-1}^{CH}. Bd, b_{RW_{t-1}}^{CH} + r_{t-1}^{US}. Bd, b_{RW_{t-1}}^{US} + Bs, b_{RW_{t-1}}^{EZ}. \Delta(E6) + Bs, b_{RW_{t-1}}^{CH}. \Delta\left(\frac{1}{E5}\right) + Bs, b_{RW_{t-1}}^{US}. \Delta(E4) + rs_{t-1}^{RW}. R_{t-1}^{RW} + rl_{t-1}^{RW}. L_{t-1}^{RW} - rd_{t-1}^{RW}. M_{t-1}^{RW} - r_{t-1}^{RW}. A_{t-1}^{RW} \quad (2.148)$$

Finally, it is important to describe how the banking system of these economies operates. In this model, it is assumed that the four economies are overdraft economies, which implies that commercial banks can obtain all the financing needs from the central bank. These are equal to the difference between their assets and the liabilities. Therefore, we denote the advances made to commercial banks by the central banks by (A_t^i), which are an asset for the central banks and a liability for the commercial banks (2.149 – 2.152).

$$A_t^{EZ} = Bd, b_{EZ_t}^{EZ} + Bd, b_{EZ_t}^{US} + Bd, b_{EZ_t}^{CH} + Bd, b_{EZ_t}^{RW} + L_t^{EZ} + R_t^{EZ} - M_t^{EZ} - Vb_t^{EZ} \quad (2.149)$$

$$A_t^{US} = Bd, b_{US_t}^{US} + Bd, b_{US_t}^{EZ} + Bd, b_{US_t}^{CH} + Bd, b_{US_t}^{RW} + L_t^{US} + R_t^{US} - M_t^{US} - Vb_t^{US} \quad (2.150)$$

$$A_t^{CH} = Bd, b_{CH_t}^{CH} + Bd, b_{CH_t}^{EZ} + Bd, b_{CH_t}^{US} + Bd, b_{CH_t}^{RW} + L_t^{CH} + R_t^{CH} - M_t^{CH} - Vb_t^{CH} \quad (2.151)$$

$$A_t^{RW} = Bd, b_{RW_t}^{RW} + Bd, b_{RW_t}^{EZ} + Bd, b_{RW_t}^{US} + Bd, b_{RW_t}^{CH} + L_t^{RW} + R_t^{RW} - M_t^{RW} - Vb_t^{RW} \quad (2.152)$$

Finally, the change on commercial banks' wealth is equal to zero since banks' profits are entirely transferred to households.

$$\Delta Vb_t^i = 0 \qquad \forall\, i = US, EZ, CH, RW \qquad (2.153 – 2.156)$$

Thus far all the sectors of our four economies have been defined, except for the central bank. The behavior of the monetary authority depends on the exchange rate regime. Since we are aiming at comparing the performance of several institutional settings of the international monetary system, we define a baseline scenario and then we show how this can be changed to represent the other cases that we want to examine. Our baseline scenario consists of a situation where both China and the rest of the world have currency pegs vis-à-vis the US dollar, whereas the euro floats freely.

Central Bank with fixed exchange rates

It is worth starting this section by making clear which are the variables that are left to be defined and what accounting processes need to be "closed". The variables that we have not defined yet are the demand of each central bank for domestic bonds, the profits of the central banks, the exchange rates and the demand for foreign reserves by the central banks of China and the rest of the world, whose currencies are pegged to the dollar.

Since central banks transfer the totality of their profits to the government, their wealth must be constant over time (as it will be shown shortly, we assume that total profits include capital gains). Therefore, if an asset of the central bank is increasing (for instance,

foreign bonds due to the accumulation of reserves) either a liability must be increasing by the same amount, an asset has to be exhibiting an equal decrease, or a combination of both. The equations that ensure the fulfillment of this condition can be derived from matrix of transactions.

$$\Delta Bd, cb_{US_t}^{US} = \Delta H_t^{US} + \Delta R_t^{US} - \Delta A_t^{US} \quad (2.157)$$

$$\Delta Bd, cb_{EZ_t}^{EZ} = \Delta H_t^{EZ} + \Delta H_t^{EZ} - \Delta A_t^{EZ} \quad (2.158)$$

$$\Delta Bs, cb_{CH_t}^{US} = \frac{\left(\Delta H_t^{CH} + \Delta R_t^{CH} - \Delta A_t^{CH} - \Delta Bd, cb_{CH_t}^{CH}\right)}{E2_t} \quad (2.159)$$

$$\Delta Bs, cb_{RW_t}^{US} = \frac{\left(\Delta H_t^{RW} + \Delta R_t^{RW} - \Delta A_t^{RW} - \Delta Bd, cb_{RW_t}^{RW}\right)}{E4_t} \quad (2.160)$$

$$Bs, cb_{US_t}^{US} = Bd, cb_{US_t}^{US} \quad (2.161)$$

$$Bs, cb_{EZ_t}^{EZ} = Bd, cb_{EZ_t}^{EZ} \quad (2.162)$$

$$\Delta Bd, cb_{CH_t}^{US} = Bs, cb_{CH_{t-1}}^{US} \Delta E2_t + \Delta Bs, cb_{CH_t}^{US} E2_t \quad (2.163)$$

$$\Delta Bd, cb_{RW_t}^{US} = Bs, cb_{RW_{t-1}}^{US} \Delta E4_t + \Delta Bs, cb_{RW_t}^{US} E4_t \quad (2.164)$$

Equations 2.157-2.158 state that the central bank's demand for domestic bonds in the US and in the Eurozone adjusts to ensure that the net worth of each monetary authority remains constant. As regards the balance sheet identity of the central banks of China and the rest of the world, since they are engaged in a fixed exchange rate arrangement the monetary authority has to accumulate (liquidate) reserves every time the country runs a balance of payments surplus (deficit), in such a way that the net inflow (outflow) of foreign exchange does not modify the nominal exchange rate. Thus, equations 2.159-2.160 state that the change in the stock of foreign reserves is such that the balance sheet identity of the central banks of China and the rest of the world is always fulfilled. We make the assumption that the totality of foreign reserves is kept under the form of US bonds[20]. Equations 2.161-2.162 simply state that the demand for bonds by the central banks of the US and the Eurozone is always met. Equations 2.163-2.164 describe the change in the stock of reserves of China and the rest of the world expressed in domestic currency, taking into account that this stock may change not only due to balance of payments surpluses or deficits, but also as a result of variations of the exchange rate. As long as the exchange rate is kept fix permanently, these valuation effects will be null.

[20] For a study of reserve diversification in the framework of stock-flow consistent models see Lavoie and Zhao (2010)

Let us now introduce the exchange rates and the foreign reserves, which in turn will be useful to continue "closing" these accounting processes. The exchange rate E1 will be written in such a way that the euro-denominated bonds market is cleared. Since supply and demand for these assets are originated through different processes there is no guarantee that supply will be equal to demand ex ante. Therefore, it is the nominal exchange rate E1 which will make the adjustment that will guarantee the equilibrium in this market.

$$E1_t = \frac{Bs_t^{EZ} - Bs,b_{EZ_t}^{EZ} - Bs,cb_{EZ_t}^{EZ} - Bs,b_{CH_t}^{EZ} - Bs,b_{RW_t}^{EZ}}{Bd,b_{US_t}^{EZ}} \quad (2.165)$$

The renminbi is fixed to the dollar, which implies that the exchange rate is exogenous. Hence, unlike the Eurozone, where the exchange rate clears the domestic bond market, in China there should be another variable playing this role. Equation 2.167 states that it is the central bank of China that will absorb as many bonds remain to be purchased in the market. Equation 2.168 simply describes the supply of domestic bonds to the national central bank as an endogenous process.

$$E2_t = \overline{E2} \quad (2.166)$$

$$Bd, cb_{CH_t}^{CH} = Bs_t^{CH} - Bs, b_{CH_t}^{CH} - Bs, b_{EZ_t}^{CH} - Bs, b_{US_t}^{CH} - Bs, b_{RW_t}^{CH} \quad (2.167)$$

$$Bs, cb_{CH_t}^{CH} = Bd, cb_{CH_t}^{CH} \quad (2.168)$$

Finally, together with the exogenous exchange rate of the rest of the world with respect to the dollar, the demand of the central bank of the rest of the world for bonds denominated in its own currency is written in such a way that the bond market of the rest of the world is in equilibrium.

$$E4_t = \overline{E4} \quad (2.169)$$

$$Bd, cb_{RW_t}^{RW} = Bs_t^{RW} - Bs, b_{RW_t}^{RW} - Bs, b_{EZ_t}^{RW} - Bs, b_{CH_t}^{RW} - Bs, b_{US_t}^{RW} \quad (2.170)$$

$$Bs, cb_{RW_t}^{RW} = Bd, cb_{RW_t}^{RW} \quad (2.171)$$

We have already defined the equilibrium in the balance sheets of the four central banks and also how the equilibrium in the bill markets of the Eurozone, China and the rest of the world are cleared. It remains to be described how the dollar-denominated bond market is

equilibrated. In order to meet its interest rate target, the FED must purchase the excess supply of bills (equation 2.172). The reader that has followed the whole description of the model with the matrix of transactions on hand should have realized that the demand for US bills by the FED has been defined twice (in equations 2.157 and 2.172). This is a key feature of stock flow consistent models. The idea is that if the model is consistent there would be no need to write one of these equations explicitly, since it should be derived from all the other equations of the model. That is why one of these equations is generally referred to as the "missing equation" or "redundant equation", which is not written in the model and, instead, used only to verify the consistency of the system. Let us take equation 2.157 as the redundant equation.

$$Bd, cb_{US_t}^{US} = Bs_t^{US} - Bs, b_{US_t}^{US} - Bs, b_{EZ_t}^{US} - Bs, b_{CH_t}^{US} - Bs, b_{RW_t}^{US} - Reserves_t \quad (2.172)$$

$$Reserves_t = Bs, cb_{EZ_t}^{US} + Bs, cb_{CH_t}^{US} + Bs, cb_{RW_t}^{US}$$

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

$$E3_t = \frac{E2_t}{E1_t} \quad (2.173)$$

$$E5_t = \frac{E2_t}{E4_t} \quad (2.174)$$

$$E6_t = \frac{E4_t}{E1_t} \quad (2.175)$$

As it was mentioned before, in most 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 bank's demand for reserves are given by a proportion ζ of household's deposits M_t. These reserves constitute an asset in the balance sheet of commercial banks and a liability on the balance sheet of the central bank. Thus,

$$R_t^i = \xi^i . M_t^i \qquad \forall\, i = US, EZ, CH, RW \quad (2.176 – 2.179)$$

Given that the central bank also hold assets and liabilities (the former embody the stock of government bonds plus the advances made to commercial banks and the latter the reserves made by commercial banks), it also makes profits. As it was already mentioned, these profits are transferred each period to the government as an additional source of financing. Moreover, central bank's profits must include the adjustment for valuation

effects due to the variation of the exchange rate. Hence, equations (2.180 – 2.183) can be written:

$$Pcb_t^{US} = r_{t-1}^{US}.Bd, cb_{US_{t-1}}^{US} - rs_{t-1}^{US}.Rd_{t-1}^{US} + r_{t-1}^{US}.A_{t-1}^{US} \quad (2.180)$$

$$Pcb_t^{EZ} = r_{t-1}^{EZ}.Bd, cb_{EZ_{t-1}}^{EZ} + r_{t-1}^{US}.Bd, cb_{EZ_{t-1}}^{US} + Bs, cb_{EZ_{t-1}}^{US}.\Delta(E1) - rs_{t-1}^{EZ}.R_{t-1}^{EZ} + r_{t-1}^{EZ}.A_{t-1}^{EZ} \quad (2.181)$$

$$Pcb_t^{CH} = r_{t-1}^{CH}.Bd, cb_{CH_{t-1}}^{CH} + r_{t-1}^{US}.Bd, cb_{CH_{t-1}}^{US} + Bs, cb_{CH_{t-1}}^{US}.\Delta(E2) - rs_{t-1}^{CH}.R_{t-1}^{CH} + r_{t-1}^{CH}.A_{t-1}^{CH} \quad (2.182)$$

$$Pcb_t^{RW} = r_{t-1}^{RW}.Bd, cb_{RW_{t-1}}^{RW} + r_{t-1}^{US}.Bd, cb_{RW_{t-1}}^{US} + Bs, cb_{RW_{t-1}}^{US}.\Delta(E4) - rs_{t-1}^{RW}.R_{t-1}^{RW} + r_{t-1}^{RW}.A_{t-1}^{RW} \quad (2.183)$$

Regarding interest rates, in this model many of them have been introduced (interest rates earned on credits, deposits, bills, bonds, reserves). All of them are assumed to be determined exogenously and following the decision of the central bank.

$$rl_t^i = rd_t^i = rq_t^i = rs_t^i = r_t^i \qquad \forall\, i = US, EZ, CH, RW \qquad (2.184 – 2.199)$$

Central Bank with flexible exchange rates

When exchange rates are allowed to float freely the closure of the model needs to be slightly modified. The equilibrium in the euro-denominated bond market does not change since E1 is flexible in both closures. However, the equilibrium in the remaining bond markets is defined differently. Let us start by writing the endogenous exchange rates E2 and E4.

$$E2_t = \frac{Bs_t^{CH} - Bs, b_{CH_t}^{CH} - Bs, cb_{CH_t}^{CH} - Bs, b_{EZ_t}^{CH} - Bs, b_{RW_t}^{CH}}{Bd, b_{US_t}^{CH}} \quad (2.166a)$$

$$E4_t = \frac{Bs_t^{RW} - Bs, b_{RW_t}^{RW} - Bs, cb_{RW_t}^{RW} - Bs, b_{EZ_t}^{RW} - Bs, b_{CH_t}^{RW}}{Bd, b_{US_t}^{EZ}} \quad (2.169a)$$

Equations 2.166a and 2.169a imply that the bond markets of China and the rest of the world are being cleared via the exchange rate, as it happens with E1 and the euro-denominated bond market. As a consequence, the balance sheet identity of the central banks of China and the rest of the world need to be changed, since the is no more reserve accumulation.

$$Bs, cb_{CH_t}^{US} = \overline{Bs, cb_{CH}^{US}} \quad (2.159a)$$

$$Bs, cb_{RW_t}^{US} = \overline{Bs, cb_{RW}^{US}} \quad (2.160a)$$

$$\Delta Bd, cb_{CH_t}^{CH} = \Delta Hd, h_{CH_t}^{CH} + \Delta Rd, h_{CH_t}^{CH} - \Delta Ad_t^{CH} \quad (2.167a)$$

$$\Delta Bd, cb_{RW_t}^{RW} = \Delta Hd, h_{RW_t}^{RW} + \Delta Rd, h_{RW_t}^{RW} - \Delta Ad_t^{RW} \quad (2.170a)$$

These are the specific changes of the flexible exchange rates closure. The rest of the model is exactly the same to the fixed exchange rates closure. In order to summarize the way our model is closed we present a table that indicates which endogenous variable ensures both the clearing of the bond market of each country and the fulfillment of the balance sheet identity of each central bank.

Table 2.4: Summary of alternative closures

	Peg model	Fully floating model
B^{US}	Bd, cb_{US}^{US}	Bd, cb_{US}^{US}
B^{EZ}	$E1$	$E1$
B^{CH}	Bd, cb_{CH}^{CH}	$E2$
B^{RW}	Bd, cb_{RW}^{RW}	$E4$
CB^{US}	Missing equation	Missing equation
CB^{EZ}	Bd, cb_{EZ}^{EZ}	Bd, cb_{EZ}^{EZ}
CB^{CH}	Bd, cb_{CH}^{US}	Bd, cb_{CH}^{CH}
CB^{RW}	Bd, cb_{RW}^{US}	Bd, cb_{RW}^{RW}

2.5 Reforming the IMS: alternative closures

The baseline four-country model presented in the previous section intends to represent the current state of affairs (being the true state of affairs somewhere in between our two extreme closures). It does so in the sense that the international monetary system is ruled by the same principles that are found in the real world, i.e., the supremacy of the US dollar over the rest of the currency, being the only key currency. In this section we describe how some of the alternatives for reform, described in section 2.3, could be implemented. The task of building a model that is consistent with the accounting will help us to find the advantages and disadvantages of each proposal, as well as the difficulties that might be found if any of these possibilities was implemented.

The SDR model

This alternative entails the substitution of the US dollar as the reserve currency of the international monetary system for a currency that is issued by a supranational institution (say, the IMF). In theory, this would eliminate the problems associated with Triffin's dilemma, since the issuer of the key currency would no longer need to simultaneously pursue other economic policies that could eventually turn out to be incompatible with its role of supplier of global liquidity. Phrased differently, unlike the US that as a country has domestic goals such as full employment of low inflation, the IMF does not pursue economic policies in a specific country.

The SDR model attempts to represent one of the various alternatives that have been proposed during the last years based on a stronger role played by the SDR within the international monetary system. This proposal consists of taking up the idea of the substitution account, originally designed in the late 1970s. Under such a situation, governments and central banks would deposit dollar reserves in the IMF in exchange for claims denominated in SDR. Therefore, in a context where China and the Rest of the World accumulate foreign reserves, they would no longer be doing this under the form of US Treasury bills but under the form of SDRs. Phrased differently, China and the Rest of the World would still be creditor countries but their credits would no longer be against the US, but the IMF. The IMF, once it receives the dollars from China and the Rest of the World, could either keep them or exchange them for US Treasury bills. In essence the system would not work very differently to how it works today since in the end the US would be bearing from the costs of an ever-increasing demand for global liquidity (i.e., if China and the Rest of the World keep on accumulating reserves, now under the form of SDRs, the US would still be increasing its liabilities – the only change would be who its creditor would be).

Since the system would be working quite similarly, the closure of this model is rather similar to the one of the dollar model. Let us discuss it in detail. As regards the Eurozone, the only change that should be noted is that the (non-operative) foreign reserves are constituted in SDRs and not in US Treasury bills. However, since the euro is flexible these reserves are constant. We can assume that the euro, being one of the currencies that compose the SDR (which, as we will explain soon, is a basket-currency), has a positive stock of SDRs which has been allocated exogenously.

The cases of China and the Rest of the World are also similar to the dollar model. Since

their exchange rates are fixed, the equilibrium in the bond market is ensured by the domestic central bank's purchases/sales of domestic bonds. However, reserve accumulation is no longer materialized in US Treasury bills, but in SDRs. Thus, we can observe that there will be an endogenous demand for SDRs in every period, given by the current account surplus/deficits of China and the Rest of the World. Based on the idea of the substitution account, each issuance of SDR by the IMF is backed up by an equal purchase of US Treasury bills by the IMF. Since the IMF pays no interests on SDR issuances but earns a positive interest on its holdings of Treasuries, it can make a profit, and therefore will accumulate wealth over time. Since the growing wealth of the IMF has to be kept in some kind of asset, we assume that this asset is also the US Treasury bills.

$$\Delta SDR, d_t^{CH} = \Delta H_t^{CH} + \Delta R_t^{CH} - \Delta A_t^{CH} - \Delta Bd, cb_{CH_t}^{CH} \quad (2.159b)$$

$$\Delta SDR, d_t^{RW} = \Delta H_t^{RW} + \Delta R_t^{RW} - \Delta A_t^{RW} - \Delta Bd, cb_{RW_t}^{RW} \quad (2.160b)$$

$$SDR, s_t^{CH} = \frac{SDR, d_t^{CH}}{E9_t} \quad (2.163b)$$

$$SDR, s_t^{RW} = \frac{SDR, d_t^{RW}}{E10_t} \quad (2.164b)$$

Regarding the US, the situation is exactly the same one that we presented in the dollar model, with the slight difference that the composition of the demand for US Treasury bills has now changed due to the introduction of the substitution account. But in essence, the idea remains the same: the FED ensures the equilibrium in the Treasury bills market and these interventions are such that its balance sheet is always in equilibrium.

$$Bd, cb_{US_t}^{US} = Bs_t^{US} - Bs, b_{US_t}^{US} - Bs, b_{EZ_t}^{US} - Bs, b_{CH_t}^{US} - Bs, b_{RW_t}^{US} - Reserves_t - Bs_{IMF_t}^{US} \quad (2.172b)$$

We now turn to the explanation of how is the SDR constituted and how the exchange rates of each of the four national currencies with respect to the SDR are determined. First of all, it should be noted that in this model, the SDR is not playing the role of an international medium of exchange (the dollar is keeping its role in this regard) and not necessarily the role of an international unit of account. The sole change that the idea of the substitution account proposes is to modify the international store of value, but the underlying problems of the international monetary system would still be there. That is why we consider that a further move onwards, a move that takes us closer to Keynes' idea of an international clearing union, should be taken. However, in terms of Amato and Fantacci (2011) this would imply the substitution of the principle of clearing for the actual

principle of liquidity, which is not an easy decision to make (no matter how beneficial would be in economic terms).

Now that it is clear what the SDR is in our model, we can explain how it is constituted. We define the SDR with respect to the dollar as a basket currency given in equal terms by the dollar and the euro, i.e., the strong currencies (equation 2.200b). Appropriate equations determine the exchange rates of the euro, the renminbi and the currency of the Rest of the World with respect to the SDR, respectively. These conversion rates are then applied in all the equations that embody some kind of relationship between the national currencies and the SDR (for instance, central bank's profits equations).

$$\frac{1}{E7_t} = 0.5\ \frac{1}{E1_t} + 0.5 \quad (2.200b)$$

$$E8_t = \frac{E1_t}{E7_t} \quad (2.201b)$$

$$E9_t = \frac{E2_t}{E7_t} \quad (2.202b)$$

$$E10_t = \frac{E4_t}{E7_t} \quad (2.203b)$$

Since the financial asset used as reserve has changed the equation that describes the profits of the central banks must be changed accordingly.

$$Pcb_t^{US} = r_{t-1}^{US}.Bd, cb_{US_{t-1}}^{US} - rs_{t-1}^{US}.R_{t-1}^{US} + r_{t-1}^{US}.A_{t-1}^{US} + r_{t-1}^{SDR}.SDR_{t-1}^{US} + SDR_{t-1}^{US}.\Delta\left(\frac{1}{E7_t}\right) \quad (2.180b)$$

$$Pcb_t^{EZ} = r_{t-1}^{EZ}.Bd, cb_{EZ_{t-1}}^{EZ} - rs_{t-1}^{EZ}.R_{t-1}^{EZ} + r_{t-1}^{EZ}.A_{t-1}^{EZ} + r_{t-1}^{SDR}.SDR_{t-1}^{EZ} + SDR_{t-1}^{EZ}.\Delta E8_t \quad (2.181b)$$

$$Pcb_t^{CH} = r_{t-1}^{CH}.Bd, cb_{CH_{t-1}}^{CH} - rs_{t-1}^{CH}.R_{t-1}^{CH} + r_{t-1}^{CH}.A_{t-1}^{CH} + r_{t-1}^{SDR}.SDR_{t-1}^{CH} + SDR_{t-1}^{CH}.\Delta E9_t \quad (2.182b)$$

$$Pcb_t^{RW} = r_{t-1}^{RW}.Bd, cb_{RW_{t-1}}^{RW} - rs_{t-1}^{RW}.R_{t-1}^{RW} + r_{t-1}^{RW}.A_{t-1}^{RW} + r_{t-1}^{SDR}.SDR_{t-1}^{RW} + SDR_{t-1}^{RW}.\Delta E10_t \quad (2.183b)$$

We know have to define the equations that describe the behavior of the IMF. So far, we have said that whereas the US and the Eurozone hold an exogenous stock of SDRs (since their exchange rates are fully floating), the central banks of China and the rest of the world accumulate their reserves under the form of SDRs. This process of reserve accumulation has already been defined in equations 2.159b and 2.160b. The sum of all the SDRs demanded by the different central banks yields the total supply of SDRs, which in fully endogenous (since the US and the Eurozone have a flexible exchange rate regime, their holdings of SDRs is constant).

$$SDR, s_t = SDR, s_t^{US} + SDR, s_t^{EZ} + SDR, s_t^{CH} + SDR, s_t^{RW} \quad (2.204b)$$

The IMF earns profits on the net gain of its holdings of US Treasury bills and issuances of SDRs. These profits determine the change in the net worth of the IMF, which is materialized under the form of US Treasury bills. Recall that the IMF also backs up every SDR issued with a Treasury bill of equal value.

$$P_t^{IMF} = r_{t-1}^{US}.Bd_{IMF_{t-1}}^{US} - r_{t-1}^{SDR}.SDR,s_t + Bs_{IMF_t}^{US}.\Delta E7_t \quad (2.205b)$$

$$\Delta V_t^{IMF} = P_t^{IMF} \quad (2.206b)$$

$$Bd_{IMF_t}^{US} = SDR,s_t + V_t^{IMF} \quad (2.207b)$$

$$Bs_{IMF_t}^{US} = \frac{Bd_{IMF_t}^{US}}{E7_t} \quad (2.208b)$$

With these equations we have concluded the description of the model in which the US dollar is substituted for the SDR in its role of reserve currency. However, it would still be keeping its role of international medium of exchange and unit of account. This model has been specified only for the case where some countries have non-flexible exchange rates (in our case China and the rest of the world) because in a context where all the currencies float there would be no reserve accumulation at all. In such a scenario, the study of the impact of changing only the reserve currency would not be interesting as it could be if we also changed the medium of exchange and unit of account (see below). Table 2.4 summarizes the main features of these closures and compares them with those of the baseline model described in the previous section.

Table 2.5: Summary of alternative closures

	Dollar-based model	Dollar-based model (fully floating)	SDR model (substitution account)
B^{US}	Bd, cb_{US}^{US}	Bd, cb_{US}^{US}	Bd, cb_{US}^{US}
B^{EZ}	$E1$	$E1$	$E1$
B^{CH}	Bd, cb_{CH}^{CH}	$E2$	Bd, cb_{CH}^{CH}
B^{RW}	Bd, cb_{RW}^{RW}	$E4$	Bd, cb_{RW}^{RW}
CB^{US}	Missing equation	Missing equation	Missing equation
CB^{EZ}	Bd, cb_{EZ}^{EZ}	Bd, cb_{EZ}^{EZ}	Bd, cb_{EZ}^{EZ}
CB^{CH}	Bd, cb_{CH}^{US}	Bd, cb_{CH}^{CH}	SDR^{CH}
CB^{RW}	Bd, cb_{RW}^{US}	Bd, cb_{RW}^{RW}	SDR^{RW}
IMF	-	-	Bd_{IMF}^{US}

The Bancor model

We now explore the implications of the introduction of an International Clearing Union (ICU), roughly along the lines discussed in section 2.3 above. Recall that this proposal implies the elimination of the US dollar or any other financial asset as the international money and its substitution for an international unit of account, the bancor, that would be used as a tool for settling international payments.

The introduction of a ICU, as was suggested by Keynes, requires the compromise and coordination of all member countries. This institutional setting would tend to reduce global imbalances through three different mechanisms:

1. The elimination of the dollar (or any other financial asset) as the international medium of exchange would automatically deprive it from its role of international store of value. Countries would no longer be able to hoard dollars since the latter would no longer circulate internationally. Instead, surplus countries would accumulate bancors in their accounts at the ICU. The impossibility to hoard international reserves, regardless of the performance of the current account, would be a first disincentive to run persistent surpluses.

2. Unlike the case of a national clearing union (for instance, the banking system) where deposits are considered interest-bearing assets for the private sector, in the case of the international clearing union both credits and debits would be subject to interest payments. In other words, even though a country could be in a surplus situation, it could be argued that the positive stock of bancors has been lent by the clearing union (in the end, the surplus of the country is not against the clearing union, but against the rest of the world). Thus, both debtor and creditor countries would pay interests on their bancor balances (whether they are positive or negative). The fact that interest must be paid on these balances would encourage countries to keep them the closest to zero as it is possible. In order to do so, surplus countries could pursue more expansionary fiscal policies.

3. If the two aforementioned mechanisms were not sufficient to reduce the size of global imbalances, countries would be allowed to devalue their currencies in such a way that the external adjustment is made through the price mechanism.

In order to ease the understanding of how the system would work we modify the matrices of transactions to incorporate the ICU as an additional institutional agent. This implies that the related transactions are also incorporated into these matrices. As it can be observed in Table 2.5, there are two additional lines: one for the interest payments on bancor balances and another one for the change in the stock of bancor balances. It should also be noted that the profits of the ICU are fully distributed among the member countries under the form of aid. It should also be born in mind that portfolio investment flows have been eliminated.

Table 2.6: Matrices of transactions

	United States								
	Households	Firms		Com.Banks		Government	Central Bank		
		Current	Capital	Current	Capital		Current	Capital	
Consumption	$-C_t^{US}$	C_t^{US}							
Investment		I_t^{US}	$-I_t^{US}$						
Gov.Spending		G_t^{US}				$-G_t^{US}$			
Net Exports		NX_t^{US}							
Wages	W_t^{US}	$-W_t^{US}$							
Taxes	$-Th_t^{US}$	$-Tf_t^{US}$				T_t^{US}			
Int.Deposits	$rd_{t-1}^{US}.Md_{t-1}^{US}$			$-rd_{t-1}^{US}.Md_{t-1}^{US}$					
Int.Loans		$-rl_{t-1}^{US}.Ld_{t-1}^{US}$		$rl_{t-1}^{US}.Ld_{t-1}^{US}$					
Int.Reserves				$rs_{t-1}^{US}.R_{t-1}^{US}$			$-rs_{t-1}^{US}.R_{t-1}^{US}$		
Int.Advances				$-r_{t-1}^{US}.A_{t-1}^{US}$			$r_{t-1}^{US}.A_{t-1}^{US}$		
$Int.Bonds^{US}$				$r_{t-1}^{US}.Bd, b_{US_{t-1}}^{US}$		$-r_{t-1}^{US}.Bs_{t-1}^{US}$	$r_{t-1}^{US}.Bd, cb_{US_{t-1}}^{US}$		
$Int.Bonds^{RW}$									
$Int.Bonds^{CH}$									
$Int.Bonds^{EZ}$									
rb. Bancor							$-rb_{t-1}.Bancor_{t-1}^{US}.E7$		
Profits	Pb^{US}	$-Pf^{US}$	Pf^{US}	$-Pb^{US}$		Pcb^{US}	$-Pcb^{US}$		
$\Delta Cash$	$-\Delta Hd^{US}$							ΔHs^{US}	
$\Delta Deposits$	$-\Delta Md^{US}$				ΔMd^{US}				
$\Delta Loans$			ΔL^{US}		$-\Delta L^{US}$				
$\Delta Reserves$					$-\Delta R^{US}$			ΔR^{US}	
$\Delta Advances$					ΔA^{US}			$-\Delta A^{US}$	
$\Delta Bonds^{US}$					$-\Delta Bd, b_{US}^{US}$	ΔBs^{US}		$-\Delta Bd, cb_{US}^{US}$	
$\Delta Bonds^{RW}$									
$\Delta Bonds^{CH}$									
$\Delta Bonds^{EZ}$									
$\Delta Bancor$								$-\Delta Bancor^{US}$	
Total	0	0	0	0	0	0	0	0	

Continues on next page

	Rest of the World								
	Households	Firms		Com.Banks		Government	Central Bank		
		Current	Capital	Current	Capital		Current	Capital	
Consumption	$-C_t^{RW}$	C_t^{RW}							
Investment		I_t^{RW}	$-I_t^{RW}$						
Gov.Spending		G_t^{RW}				$-G_t^{RW}$			
Net Exports		NX_t^{RW}							
Wages	W_t^{RW}	$-W_t^{RW}$							
Taxes	$-Th_t^{RW}$	$-Tf_t^{RW}$				T_t^{RW}			
Int.Deposits	$rd_{t-1}^{RW}.Md_{t-1}^{RW}$			$-rd_{t-1}^{RW}.Md_{t-1}^{RW}$					
Int.Loans		$-rl_{t-1}^{RW}.Ld_{t-1}^{RW}$		$rl_{t-1}^{RW}.Ld_{t-1}^{RW}$					
Int.Reserves				$rs_{t-1}^{RW}.R_{t-1}^{RW}$			$-rs_{t-1}^{RW}.R_{t-1}^{RW}$		
Int.Advances				$-r_{t-1}^{RW}.A_{t-1}^{RW}$			$r_{t-1}^{RW}.A_{t-1}^{RW}$		
$Int.Bonds^{US}$									
$Int.Bonds^{RW}$				$r_{t-1}^{RW}.Bd, b_{RW_{t-1}}^{RW}$		$-r_{t-1}^{RW}.Bs_{t-1}^{RW}$	$r_{t-1}^{RW}.Bd, cb_{RW_{t-1}}^{RW}$		
$Int.Bonds^{CH}$									
$Int.Bonds^{EZ}$									
rb. Bancor							$-rb_{t-1}.Bancor_{t-1}^{RW}.E10$		
Profits	Pb^{RW}	$-Pf^{RW}$	Pf^{RW}	$-Pb^{RW}$		Pcb^{RW}	$-Pcb^{RW}$		
$\Delta Cash$	$-\Delta Hd^{RW}$							ΔHs^{RW}	
$\Delta Deposits$	$-\Delta Md^{RW}$				ΔMd^{RW}				
$\Delta Loans$			ΔL^{RW}		$-\Delta L^{RW}$				
$\Delta Reserves$					$-\Delta R^{RW}$			ΔR^{RW}	
$\Delta Advances$					ΔA^{RW}			$-\Delta A^{RW}$	
$\Delta Bonds^{US}$									
$\Delta Bonds^{RW}$					$-\Delta Bd, b_{RW}^{RW}$	ΔBs^{RW}		$-\Delta Bd, cb_{RW}^{RW}$	
$\Delta Bonds^{CH}$									
$\Delta Bonds^{EZ}$									
$\Delta Bancor$								$-\Delta Bancor^{RW}$	
Total	0	0	0	0	0	0	0	0	

Continues on next page

	China								
	Households	Firms		Com.Banks		Government	Central Bank		
		Current	Capital	Current	Capital		Current	Capital	
Consumption	$-C_t^{CH}$	C_t^{CH}							
Investment		I_t^{CH}	$-I_t^{CH}$						
Gov.Spending		G_t^{CH}				$-G_t^{CH}$			
Net Exports		NX_t^{CH}							
Wages	W_t^{CH}	$-W_t^{CH}$							
Taxes	$-Th_t^{CH}$	$-Tf_t^{CH}$				T_t^{CH}			
Int.Deposits	$rd_{t-1}^{CH}.Md_{t-1}^{CH}$			$-rd_{t-1}^{CH}.Md_{t-1}^{CH}$					
Int.Loans		$-rl_{t-1}^{CH}.Ld_{t-1}^{CH}$		$rl_{t-1}^{CH}.Ld_{t-1}^{CH}$					
Int.Reserves				$rs_{t-1}^{CH}.R_{t-1}^{CH}$			$-rs_{t-1}^{CH}.R_{t-1}^{CH}$		
Int.Advances				$-r_{t-1}^{CH}.A_{t-1}^{CH}$			$r_{t-1}^{CH}.A_{t-1}^{CH}$		
$Int.Bonds^{US}$									
$Int.Bonds^{RW}$									
$Int.Bonds^{CH}$				$r_{t-1}^{CH}.Bd, b_{CH_{t-1}}^{CH}$		$-r_{t-1}^{CH}.Bs_{t-1}^{CH}$	$r_{t-1}^{CH}.Bd, cb_{CH_{t-1}}^{CH}$		
$Int.Bonds^{EZ}$									
rb. Bancor							$-rb_{t-1}.Bancor_{t-1}^{CH}.E9$		
Profits	Pb^{CH}	$-Pf^{CH}$	Pf^{CH}	$-Pb^{CH}$		Pcb^{CH}	$-Pcb^{CH}$		
$\Delta Cash$	$-\Delta Hd^{CH}$							ΔHs^{CH}	
$\Delta Deposits$	$-\Delta Md^{CH}$				ΔMd^{CH}				
$\Delta Loans$			ΔL^{CH}		$-\Delta L^{CH}$				
$\Delta Reserves$					$-\Delta R^{CH}$			ΔR^{CH}	
$\Delta Advances$					ΔA^{CH}			$-\Delta A^{CH}$	
$\Delta Bonds^{US}$									
$\Delta Bonds^{RW}$									
$\Delta Bonds^{CH}$					$-\Delta Bd, b_{RW}^{CH}$	ΔBs^{CH}		$-\Delta Bd, cb_{CH}^{CH}$	
$\Delta Bonds^{EZ}$									
$\Delta Bancor$								$-\Delta Bancor^{CH}$	
Total	0	0	0	0	0	0	0	0	

Continues on next page

	Eurozone and ICU										
	Households	Firms		Com.Banks		Government	Central Bank		ICU		
		Current	Capital	Current	Capital		Current	Capital	Current	Capital	
Consumption	$-C_t^{EZ}$	C_t^{EZ}									0
Investment		I_t^{EZ}	$-I_t^{EZ}$								0
Gov.Spending		G_t^{EZ}				$-G_t^{EZ}$					0
Net Exports		NX_t^{EZ}									0
Wages	W_t^{EZ}	$-W_t^{EZ}$									0
Taxes	$-Th_t^{EZ}$	$-Tf_t^{EZ}$				T_t^{EZ}					0
Int.Deposits	$rd_{t-1}^{EZ}.Md_{t-1}^{EZ}$			$-rd_{t-1}^{EZ}.Md_{t-1}^{EZ}$							0
Int.Loans		$-rl_{t-1}^{EZ}.Ld_{t-1}^{EZ}$		$rl_{t-1}^{EZ}.Ld_{t-1}^{EZ}$							0
Int.Reserves				$rs_{t-1}^{EZ}.R_{t-1}^{EZ}$			$-rs_{t-1}^{EZ}.R_{t-1}^{EZ}$				0
Int.Advances				$-r_{t-1}^{EZ}.A_{t-1}^{EZ}$			$r_{t-1}^{EZ}.A_{t-1}^{EZ}$				0
$Int.Bonds^{US}$											0
$Int.Bonds^{RW}$											0
$Int.Bonds^{CH}$											0
$Int.Bonds^{EZ}$				$r_{t-1}^{EZ}.Bd, b_{CH_{t-1}}^{EZ}$		$-r_{t-1}^{CH}.Bs_{t-1}^{EZ}$	$r_{t-1}^{EZ}.Bd, cb_{EZ_{t-1}}^{EZ}$				0
rb. Bancor							$-rb_{t-1}.Bancor_{t-1}^{EZ}.E8$		$rb_{t-1}.Bancor_{t-1}^{ICU}$		0
Profits	Pb^{EZ}	$-Pf^{EZ}$	Pf^{EZ}	$-Pb^{EZ}$		Pcb^{EZ}	$-Pcb^{EZ}$				0
$\Delta Cash$	$-\Delta Hd^{EZ}$							ΔHs^{EZ}			0
$\Delta Deposits$	$-\Delta Md^{EZ}$				ΔMd^{EZ}						0
$\Delta Loans$			ΔL^{EZ}		$-\Delta L^{EZ}$						0
$\Delta Reserves$					$-\Delta R^{EZ}$			ΔR^{EZ}			0
$\Delta Advances$					ΔA^{EZ}			$-\Delta A^{EZ}$			0
$\Delta Bonds^{US}$											0
$\Delta Bonds^{RW}$											0
$\Delta Bonds^{CH}$											0
$\Delta Bonds^{EZ}$					$-\Delta Bd, b_{CH}^{EZ}$	ΔBs^{EZ}		$-\Delta Bd, cb_{EZ}^{EZ}$			0
$\Delta Bancor$								$-\Delta Bancor^{EZ}$		0	0
Total	0	0	0	0	0	0	0	0	0	0	0

To begin with, we introduce the international clearing union as the supranational institution where countries surpluses and deficits are registered under the form of bancor balances. These balances would be positive (negative) if the sum of the past stream of current account balances is positive (negative). Recall that in our standard model countries accumulated foreign reserves under the form of US Treasury bills. Moreover, note that if the exchange rate was fixed the change in the stock of foreign reserves was written as the difference between the change in all the remaining components of the balance sheet of each national central bank, assuming that the change in the central bank's wealth was always zero (since it transferred all its profits to the government). It is important to remember this closure of the model because here lays the main modification that we introduce when modeling the international clearing union.

Let us begin with the modifications that we have to introduce to the baseline model in order to represent how the international monetary system would work in the context of a ICU. First, all exchange rates would be pegged against the bancor. Hence, each currency would automatically be pegged against the rest. Equations 2.200c-2.203c represent the exchange rates of the US dollar, the euro, the renminbi and the rest of the world against the bancor. The rest of the equations describe the new way in which the original six exchange rates of our model are now determined. Note that in all cases they are derived from the parities of each currency against the bancor, thereby implying that they are all fixed.

$$E7_t = \overline{E7} \quad (2.200c)$$

$$E8_t = \overline{E8} \quad (2.201c)$$

$$E9_t = \overline{E9} \quad (2.202c)$$

$$E10_t = \overline{E10} \quad (2.203c)$$

$$E1_t = \frac{E8_t}{E7_t} \quad (2.165c)$$

$$E2_t = \frac{E9_t}{E7_t} \quad (2.166c)$$

$$E3_t = \frac{E9_t}{E8_t} \quad (2.173c)$$

$$E4_t = \frac{E10_t}{E7_t} \quad (2.169c)$$

$$E5_t = \frac{E10_t}{E9_t} \quad (2.174c)$$

$$E6_t = \frac{E10_t}{E8_t} \quad (2.175c)$$

Now, if all exchange rates are fixed this implies that, at least from the traditional perspective of open economy stock-flow consistent models, the balance sheet identity of all central banks must be equilibrated through changes in the stock of reserves. Even though in the present setting there would no longer be reserves as we know them today, it would still be true that there would be a change in an asset of the balance sheet of the monetary authority. This asset would be the bancors, which would be at the same time a liability for the ICU. Thus, every time a country registers a current account surplus this would be reflected by an increase in its stock of bancors. However, this should not imply an increase in the net worth of the central bank, since it would not have pursued any specific activity that increases its wealth – in other words, in the present setting the central bank is just a mere intermediary between the domestic economy and the rest of the world. Thus, in order to keep the wealth of the central bank constant (recall that it transfers its profits to the government) either another asset should decrease by the same amount or a liability should increase proportionally. If the model is consistent this will happen automatically since as a result of the current account surplus a new income flow is created, which is materialized under different forms of wealth (money, deposits, bonds, etc.) that in the end appear, directly or indirectly, as a change in the components of the balance sheet of the central bank. Hence, the balance sheet identity of central bank is expressed as follows (equations 2.204c-2.207c). Equations 2.208c-2.211c express the stock of bancors held by each central bank in domestic currency.

$$\Delta Bancor, s_t^{US} = \frac{\left(\Delta H_t^{US} + \Delta R_t^{US} - \Delta A_t^{US} - \Delta Bd, cb_{US_t}^{US}\right)}{E7_t} \quad (2.204c)$$

$$\Delta Bancor, s_t^{EZ} = \frac{\left(\Delta H_t^{EZ} + \Delta R_t^{EZ} - \Delta A_t^{EZ} - \Delta Bd, cb_{EZ_t}^{EZ}\right)}{E8_t} \quad (2.205c)$$

$$\Delta Bancor, s_t^{CH} = \frac{\left(\Delta H_t^{CH} + \Delta R_t^{CH} - \Delta A_t^{CH} - \Delta Bd, cb_{CH_t}^{CH}\right)}{E9_t} \quad (2.206c)$$

$$\Delta Bancor, s_t^{RW} = \frac{\left(\Delta H_t^{RW} + \Delta R_t^{RW} - \Delta A_t^{RW} - \Delta Bd, cb_{RW_t}^{RW}\right)}{E10_t} \quad (2.207c)$$

$$\Delta Bancor, d_t^{US} = Bancor, s_{t-1}^{US}.\Delta E7_t + \Delta Bancor, s_t^{US}.E7_t \quad (2.208c)$$

$$\Delta Bancor, d_t^{EZ} = Bancor, s_{t-1}^{EZ}.\Delta E8_t + \Delta Bancor, s_t^{EZ}.E8_t \quad (2.209c)$$

$$\Delta Bancor, d_t^{CH} = Bancor, s_{t-1}^{CH}.\Delta E9_t + \Delta Bancor, s_t^{CH}.E9_t \quad (2.210c)$$

$$\Delta Bancor, d_t^{RW} = Bancor, s_{t-1}^{RW}.\Delta E10_t + \Delta Bancor, s_t^{RW}.E10_t \quad (2.211c)$$

Note that since China and the rest of the world no longer accumulate reserves under the

form of US Treasury bills, their stock of these type of assets must be set equal to zero.

$$Bs, cb_{CH_t}^{US} = 0 \quad (2.159c)$$

$$Bs, cb_{RW_t}^{US} = 0 \quad (2.160c)$$

Note that bancors are created automatically as a result of international trade transactions. Thus, the level of global liquidity is endogenous and there is no risk of a global deflation should the supplier of the key currency decide to reduce the stock of liquidity. However, since in the aggregate trade surpluses cancel out with trade deficits, the net wealth of the ICU will always be equal to zero (some countries would be creditors to the ICU and others would be debtors, but the total size of assets would equal the size of liabilities). For this condition to be met, it should happen that in every period the sum of the changes in the bancor balances of the central banks equals to zero. This will be our missing equation.

$$\Delta Bancor, s_t^{US} + \Delta Bancor, s_t^{EZ} + \Delta Bancor, s_t^{CH} + \Delta Bancor, s_t^{RW} = \Delta V_t^{ICU} = 0 \quad (2.212c)$$

Finally, the closure of the domestic bond market needs to be redefined. Since exchange rates are fixed they cannot adjust to ensure the equilibrium between supply and demand. Thus, following the traditional closure of a fixed exchange rate system, we assume that the domestic central bank of each country will purchase or sell the necessary amount of bonds that ensures market clearing.

$$Bd, cb_{US_t}^{US} = Bs_t^{US} - Bs, b_{US_t}^{US} - Bs, b_{EZ_t}^{US} - Bs, b_{CH_t}^{US} - Bs, b_{RW_t}^{US} \quad (2.172c)$$

$$Bd, cb_{EZ_t}^{EZ} = Bs_t^{EZ} - Bs, b_{EZ_t}^{EZ} - Bs, b_{US_t}^{EZ} - Bs, b_{CH_t}^{EZ} - Bs, b_{RW_t}^{EZ} \quad (2.158c)$$

$$Bd, cb_{CH_t}^{CH} = Bs_t^{CH} - Bs, b_{CH_t}^{CH} - Bs, b_{EZ_t}^{CH} - Bs, b_{US_t}^{CH} - Bs, b_{RW_t}^{CH} \quad (2.167c)$$

$$Bd, cb_{RW_t}^{RW} = Bs_t^{RW} - Bs, b_{RW_t}^{RW} - Bs, b_{EZ_t}^{RW} - Bs, b_{CH_t}^{RW} - Bs, b_{US_t}^{RW} \quad (2.170c)$$

With these equations we conclude the description of the model that replaces the dollar with the bancor and that introduces an ICU as a supranational institution governing international transactions following more fair “rules of the game”. Table 2.6 summarizes the closure of the bancor model and compares it with the previous models.

Table 2.7: Summary of alternative closures

	Dollar model (fixed)	Dollar model (floating)	SDR model (substitution account)	Bancor model
B^{US}	Bd, cb_{US}^{US}	Bd, cb_{US}^{US}	Bd, cb_{US}^{US}	Bd, cb_{US}^{US}
B^{EZ}	$E1$	$E1$	$E1$	Bd, cb_{EZ}^{EZ}
B^{CH}	Bd, cb_{CH}^{CH}	$E2$	Bd, cb_{CH}^{CH}	Bd, cb_{CH}^{CH}
B^{RW}	Bd, cb_{RW}^{RW}	$E4$	Bd, cb_{RW}^{RW}	Bd, cb_{RW}^{RW}
CB^{US}	Missing equation	Missing equation	Missing equation	$Bancor^{US}$
CB^{EZ}	Bd, cb_{EZ}^{EZ}	Bd, cb_{EZ}^{EZ}	Bd, cb_{EZ}^{EZ}	$Bancor^{EZ}$
CB^{CH}	Bd, cb_{CH}^{US}	Bd, cb_{CH}^{CH}	SDR^{CH}	$Bancor^{CH}$
CB^{RW}	Bd, cb_{RW}^{US}	Bd, cb_{RW}^{RW}	SDR^{RW}	$Bancor^{RW}$
IMF	-	-	Bd_{IMF}^{US}	-
ICU	-	-	-	Missing equation

Thus far, we have described the main changes that need to be made to the basic structure of the model in order to represent the substitution of the dollar for the bancor. Let us now analyze some of the different adjustment mechanisms that, combined with the existence of the ICU, could reduce global imbalances and produce higher levels of activity and employment in a global scale.

Interest payments, foreign aid and expansionary fiscal policies

Based on the fact that bancor balances held at the ICU (be they positive or negative) are subject to interest payments, the ICU collects interests paid on existing Bancor balances (since not all the stock of bancors is necessarily depleted through the international trade mechanism described above) and transfers them as foreign aid. This process is described in equations 2.213d-2.223d. Equation 2.213d simply defines the profits of the ICU as the sum of the interests paid by both debtor and creditor countries on their bancor balances. Equation 2.215d defines the flow of aid sent by the ICU to each recipient country as the ratio of profits to the number of countries eligible to receive aid, given by σ (which is in turn given by the number of countries whose GDP is below the world average). All recipient countries receive an equal flow of aid from the ICU, as equations 2.216d-2.219d show. Since these flows of aid are expressed in bancors, accounting consistency requires us to transform these flows into the currencies of each country (equations 2.220d-2.223d).

$$P_t^{ICU} = \left|r_{t-1}^b . Bancor, s_{t-1}^{US}\right| + \left|r_{t-1}^b . Bancor, s_{t-1}^{EZ}\right| + \left|r_{t-1}^b . Bancor, s_{t-1}^{CH}\right| + \left|r_{t-1}^b . Bancor, s_{t-1}^{RW}\right| \quad (2.213d)$$

$$Y_t^W = Y_t^{US} + \frac{Y_t^{EZ}}{E1_t} + \frac{Y_t^{CH}}{E2_t} + \frac{Y_t^{RW}}{E4_t} \quad (2.214d)$$

$$Aid, s_t^{ICU} = \frac{P_t^{ICU}}{\sigma} \quad (2.215d)$$

$$Aid, s_{ICU_t}^{US} = \begin{cases} Aid, s_t^{ICU} & if\ Y_t^{US} \leq \frac{Y_t^W}{4} \\ 0 & if\ Y_t^{US} > \frac{Y_t^W}{4} \end{cases} \quad (2.216d)$$

$$Aid, s_{ICU_t}^{EZ} = \begin{cases} Aid, s_t^{ICU} & if\ \frac{Y_t^{EZ}}{E1_t} \leq \frac{Y_t^W}{4} \\ 0 & if\ \frac{Y_t^{EZ}}{E1_t} > \frac{Y_t^W}{4} \end{cases} \quad (2.217d)$$

$$Aid, s_{ICU_t}^{CH} = \begin{cases} Aid, s_t^{ICU} & if\ \frac{Y_t^{CH}}{E2_t} \leq \frac{Y_t^W}{4} \\ 0 & if\ \frac{Y_t^{CH}}{E2_t} > \frac{Y_t^W}{4} \end{cases} \quad (2.218d)$$

$$Aid, s_{ICU_t}^{RW} = \begin{cases} Aid, s_t^{ICU} & if\ \frac{Y_t^{RW}}{E1_t} \leq \frac{Y_t^W}{4} \\ 0 & if\ \frac{Y_t^{RW}}{E4_t} > \frac{Y_t^W}{4} \end{cases} \quad (2.219d)$$

$$Aid, r_t^{US} = Aid, s_{ICU_t}^{US} . E7_t \quad (2.220d)$$

$$Aid, r_t^{EZ} = Aid, s_{ICU_t}^{EZ} . E8_t \quad (2.221d)$$

$$Aid, r_t^{CH} = Aid, s_{ICU_t}^{CH} . E9_t \quad (2.222d)$$

$$Aid, r_t^{RW} = Aid, s_{ICU_t}^{RW} . E10_t \quad (2.223d)$$

The interest payments paid and the foreign aid received by each country must be computed in such a way that, as Davidson (2004) proposed, the country's stock of bancors changes accordingly. For instance, if a country pays interests to the ICU its position must worsen (if the country was a creditor its credit should decrease, and if the country was a debtor its debt should increase). Since the change in the stock of bancors of each country is determined by the equilibrium of the balance sheet of the central bank, it is required that we incorporate the flows of interest payments and foreign aid into the balance sheet of the central bank. Hence, the equations describing the accumulation of bancor balances must be slightly modified.

$$\Delta Bancor, s_t^{US} = \frac{\left(\Delta H_t^{US} + \Delta R_t^{US} - \Delta A_t^{US} - \Delta Bd, cb_{US_t}^{US} - \left|r_{t-1}^b . Bancor, d_{t-1}^{US}\right| + Aid, r_t^{US}\right)}{E7_t} \quad (2.204d)$$

$$\Delta Bancor, s_t^{EZ} = \frac{\left(\Delta H_t^{EZ} + \Delta R_t^{EZ} - \Delta A_t^{EZ} - \Delta Bd, cb_{EZ_t}^{EZ} - |r_{t-1}^b . Bancor, d_{t-1}^{EZ}| + Aid, r_t^{EZ}\right)}{E8_t} \quad (2.205d)$$

$$\Delta Bancor, s_t^{CH} = \frac{\left(\Delta H_t^{CH} + \Delta R_t^{CH} - \Delta A_t^{CH} - \Delta Bd, cb_{CH_t}^{CH} - |r_{t-1}^b . Bancor, d_{t-1}^{CH}| + Aid, r_t^{CH}\right)}{E9_t} \quad (2.206d)$$

$$\Delta Bancor, s_t^{RW} = \frac{\left(\Delta H_t^{RW} + \Delta R_t^{RW} - \Delta A_t^{RW} - \Delta Bd, cb_{RW_t}^{RW} - |r_{t-1}^b . Bancor, d_{t-1}^{RW}| + Aid, r_t^{RW}\right)}{E10_t} \quad (2.207d)$$

The monetary arrangement embedded in the bancor-system, in which the accumulation of foreign reserves does no longer make any sense, entails that since surplus countries also have to pay interests on their bancor balances they would be encouraged to pursue more expansionary policies that eventually reduce their current account surpluses. This would eliminate the recession-bias that characterizes the current non-system. We can model this feature by incorporating an additional term to the public spending equation, which depends positively on the interest payments that (only) surplus countries pay on their bancor balances. Although deficit countries must also pay these interests, this would not encourage them to pursue more expansionary policies since that would tend to increase their deficits. However, this system would prevent them from having to undertake contractive policies in order to balance their economies.

$$G_t^i = Go_t^i + \left(1 + w^i\right). G_{t-1}^i + GG_t^i \qquad \forall\, i = US, EZ, CH, RW \qquad (2.5d - 2.8d)$$

$$GG_t^i = \begin{cases} \chi^i . rb_{t-1} . Bancor_{t-1}^i & if \quad Bancor, s_{t-1}^i > 0 \ \wedge \ \frac{CA_{t-1}^i}{Y_{t-1}^i} > 0 \\ 0 & if \quad Bancor, s_{t-1}^i \leq 0 \ \wedge \ \frac{CA_{t-1}^i}{Y_{t-1}^i} \leq 0 \end{cases} \qquad (2.224d\text{-}2.227d)$$

Note that even though we have made some adjustments to the baseline bancor model the closure has not changed. Basically, exchange rates remain fixed to the bancor, each national central bank clears the domestic bond market through purchases and sales of bonds and, simultaneously, ensures the equilibrium in its balance sheet by means of accumulation of bancor balances at the ICU.

Fixed but adjustable exchange rates

Although in this new setting of the international monetary system exchange rates would be fixed, there would be a possibility to adjust them every time a country finds itself in a

situation of persistent deficits associated to a problem of price competitiveness, i.e., a situation where if the exchange rate was adjusted the economy would start to reverse the sign of its current account. Thus, the specification of the bancor model could also allow for this possibility to take place. In order to do so, no major changes are needed (since exchange rates would still be fixed) just the description of the conditions under which a devaluation is triggered. Equations 2.200c-2.203c are modified accordingly.

$$E7_t = \begin{cases} E7_{t-1} & if \ \sum_{i=1}^{5} \frac{CA_{t-i}^{US}}{Y_{t-i}^{US}} \geq \lambda \\ E7_{t-1}.(1+\kappa) & if \ \sum_{i=1}^{5} \frac{CA_{t-i}^{US}}{Y_{t-i}^{US}} < \lambda \end{cases} \quad (2.200c)$$

$$E8_t = \begin{cases} E8_{t-1} & if \ \sum_{i=1}^{5} \frac{CA_{t-i}^{EZ}}{Y_{t-i}^{EZ}} \geq \lambda \\ E8_{t-1}.(1+\kappa) & if \ \sum_{i=1}^{5} \frac{CA_{t-i}^{EZ}}{Y_{t-i}^{EZ}} < \lambda \end{cases} \quad (2.201c)$$

$$E9_t = \begin{cases} E9_{t-1} & if \ \sum_{i=1}^{5} \frac{CA_{t-i}^{CH}}{Y_{t-i}^{CH}} \geq \lambda \\ E9_{t-1}.(1+\kappa) & if \ \sum_{i=1}^{5} \frac{CA_{t-i}^{CH}}{Y_{t-i}^{CH}} < \lambda \end{cases} \quad (2.202c)$$

$$E10_t = \begin{cases} E10_{t-1} & if \ \sum_{i=1}^{5} \frac{CA_{t-i}^{RW}}{Y_{t-i}^{RW}} \geq \lambda \\ E10_{t-1}.(1+\kappa) & if \ \sum_{i=1}^{5} \frac{CA_{t-i}^{RW}}{Y_{t-i}^{RW}} < \lambda \end{cases} \quad (2.203c)$$

2.6 Assessment of the different monetary regimes

The aim of section is to examine the reaction of the model to a situation where the global issuer of reserve currency implements a restrictive fiscal policy. In order to do so, we need to examine the impact of a situation in which the world's demand for the international currency (the dollar) increases while, at the same time, the issuer of that currency (the US) pursues a restrictive policy that attempts to improve its current account, thereby reducing the supply of global liquidity. Recall that the Triffin dilemma states that if a country is the global provider of the key currency (i.e., if the key currency is also a national currency) this implies that either that country has to sacrifice some domestic economic policy goals (such as balanced trade or full employment) or, if it does not, the global system will not have the required amount of liquidity to work properly. This is a situation that could possibly happen and in such an event the result that we can foresee *a priori* is one of a global recession. The reason for this outcome would be given by the fact that the lower fiscal impulse in the US would discourage investment and economic growth, thereby

improving the US' current account. However, such an improvement in the external position of the US is incompatible with a situation in which the overall global system requires a growing amount of international liquidity. This scenario represents, in turn, one of the key shortcomings of the current *non-system*. As it was pointed out by Keynes (1943) for the case of the period that ranged from the end of the Gold Standard (in 1914) and the beginning of the talks for the post-war monetary coordination[21], the present *non-system* implies an asymmetric adjustment process through which the whole burden falls over the debtor countries. In this case, in order to restore external equilibrium the US should reduce its level of activity.

We start with the "US dollar model" (the model that represents the current state of the international monetary system). In order to make the model close to reality the US is assumed to run a persistent current account deficit, whereas China and the Rest of the World run surpluses. The Eurozone, for its part, is in a balanced position. During the last decades the growing amount of liquidity in global markets has been possible since the US accumulated persistence current account deficits, which in turn was possible since global markets have not put into question the ability of the US government to pay its debts. Now, assume that at a certain point of time the US reduces the growth rate of public expenditures by one percentage point (for instance, to reduce the current account deficit). Under such a situation the negative income effect that results from the restrictive fiscal policy may end up in an overall decrease of imports from the remaining country blocks. Figure 2.3 shows the impact of this shock on the level of activity both at the domestic and global level.

As can be seen from Figure 2.3 a one-percentage point reduction in the rate of growth of public expenditures in the US leads to a global recession. The lower fiscal impulse reduces the level of activity and the rate of profit, thereby reducing investment through the accelerator effect. The lower demand that results from the decline of investment reduces

[21] Keynes (1943): "The proposal put forward below differs in one important respect from the pre-war system because it aims at putting some part of the responsibility for adjustment on the creditor country as well as on the debtor. This is an attempt to recover the advantages which were enjoyed in the nineteenth century when a favorable balance in favor of London and Paris, which were the main creditor centers, immediately produced an expansionist pressure in those markets, but which have been lost since New York succeeded to the position of main creditor, the effect of this change being aggravated by the breakdown of international borrowing credit and by the flight of loose funds from one depository to another. The object is that the creditor should not be allowed to remain entirely passive. For if he is, an intolerably heavy task may be laid on the debtor country, which is already for that very reason in the weaker position".

income, thereby affecting household's consumption (recall that in a stock-flow consistent model consumption does not depend of permanent income, as in mainstream models, but on real actual disposable income). Thus, the overall effect of this shock on households' capacity to consume is negative. Since part of the consumption of the US corresponds to imported goods, this negative shock has a contractionary impact on the three remaining country blocks through the channel of international trade.

However, in the case of the Eurozone there is something that works differently that end up increasing its exports, in such a way that the overall effect of the shock is null. Unlike the currencies of China and the rest of the world, the euro floats. Since the shock tends to improve the fiscal balance of the US (even though tax collection decreases as a result of the lower level of activity, the drop of expenditures is larger) the supply of bills by the American Treasury decreases. This produces an excess demand for dollar-denominated bills, which appreciates the US dollar and the currencies that are pegged to it. The mirror of this situation is a depreciation of the euro, which makes European exports become more competitive (Figure 2.5). Hence, the trade balance of the euro area improves, which has a positive effect on the level of activity, and explains why unlike the GDP of China and the rest of the world, in the Eurozone output stays almost constant. The overall effect of this shock on the World's GDP is negative.

Figure 2.4 plots the current account balances of the four country blocks. As can be guessed, the restrictive monetary policy pursued by the US improves its current account balance at the expense of that of China and the rest of the world, who find their trade balances deteriorated through the income effect (the lower level of activity in the US reduces its demand for Chinese and the rest of the world's exports). Since their currencies are tied to the dollar there is no mechanism that compensates this negative effect, as it happened with the Eurozone, whose currency depreciates to such an extent that the current account deteriorates but very slightly.

The result that we have presented so far could be interpreted as a general one, regardless of the country whose public expenditures are decreased. However, in line with the Triffin dilemma, we want to show that these effects are specific to the case in which the country that pursues a certain domestic economic policy goal is the global issuer of reserve currency. In order to prove this, we show the effect of the same shock but applied to the case of the Eurozone, i.e., we decrease the rate of growth of the Eurozone's public expenditures by one percentage point. The results are plotted in Figures 2.6, 2.7 and 2.8.

Figure 2.3: Restrictive fiscal policy in the US – Dollar model

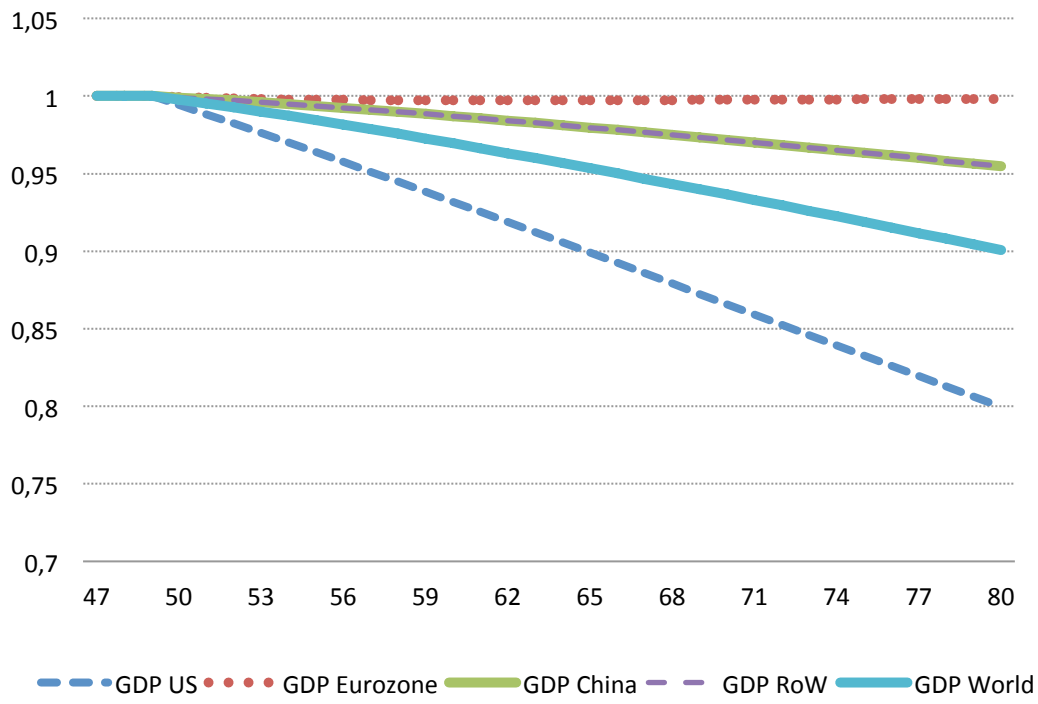


Figure 2.4: Restrictive fiscal policy in the US – Dollar model

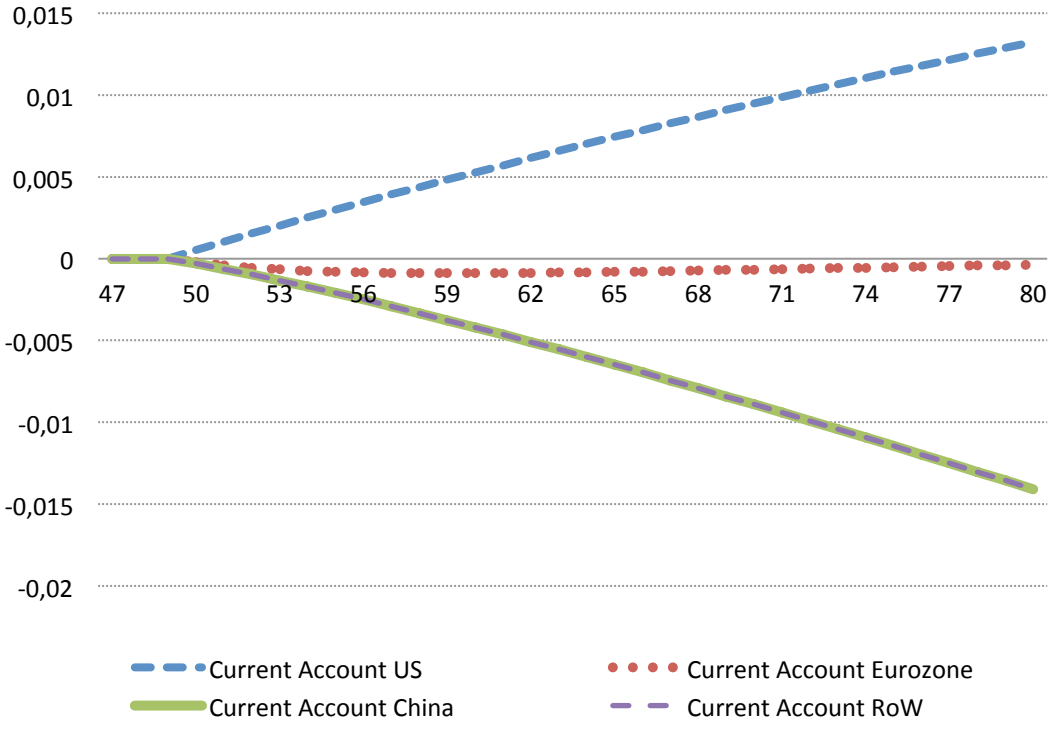


Figure 2.5: Restrictive fiscal policy in the US – Dollar model

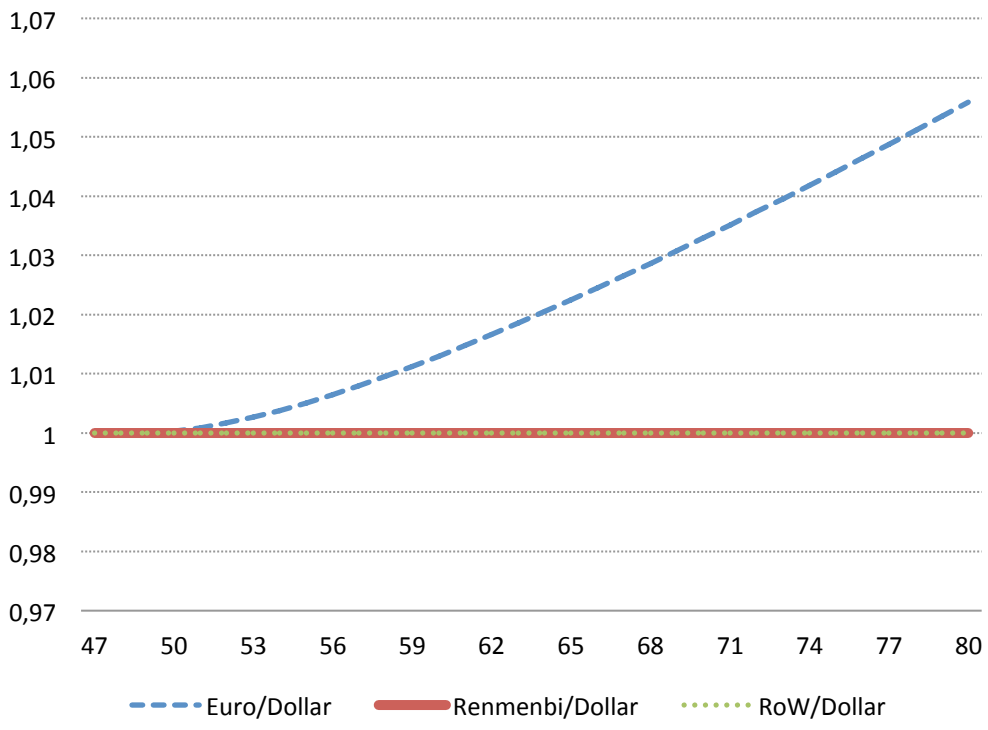


Figure 2.6: Restrictive fiscal policy in the Eurozone – Dollar model

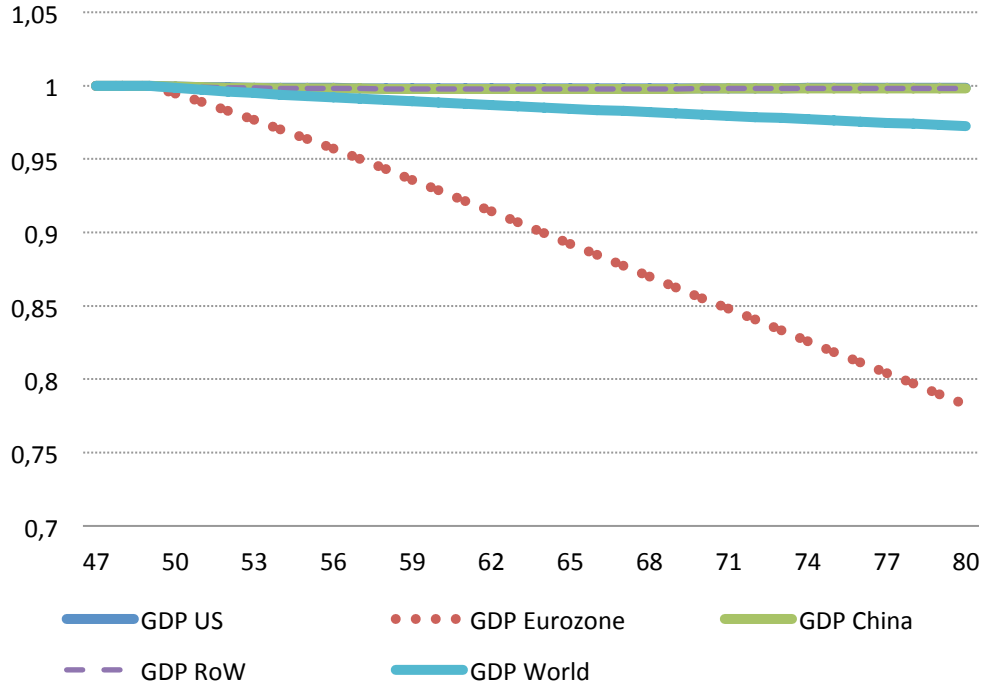


Figure 2.7: Restrictive fiscal policy in the Eurozone – Dollar model

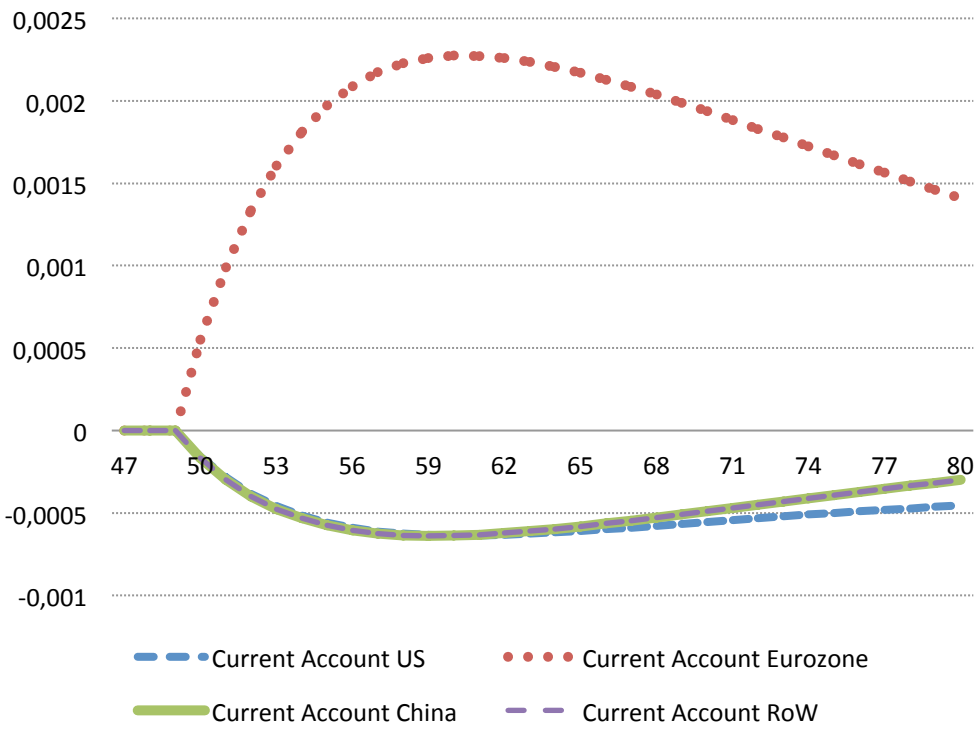
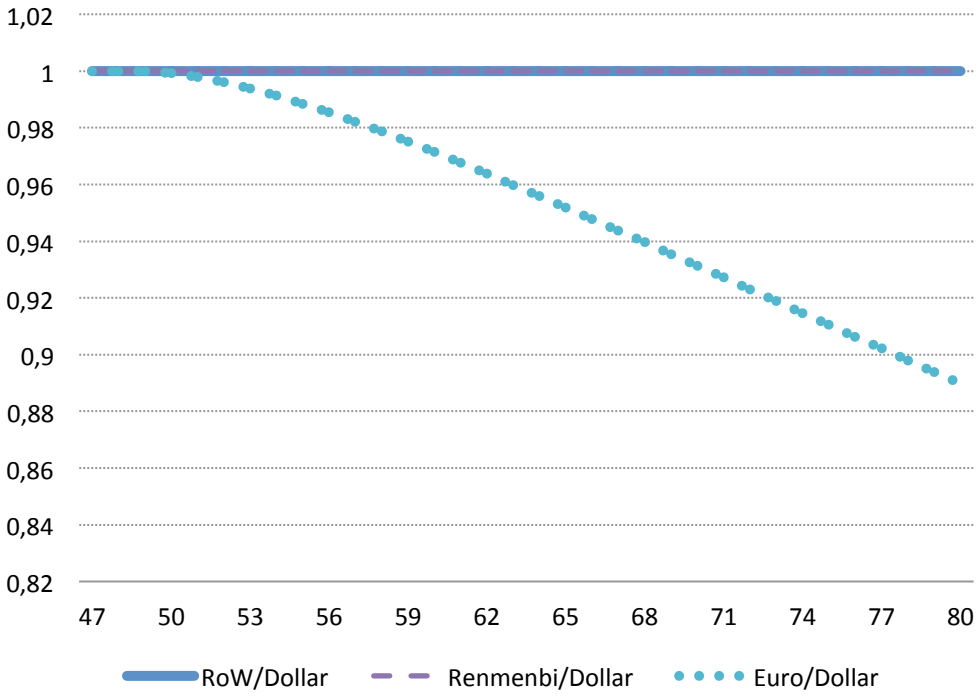


Figure 2.8: Restrictive fiscal policy in the Eurozone – Dollar model



As can be observed in the graphs, the negative impact on output on the country that restricts its fiscal impulse is equally negative, which is reasonable. What changes substantially, however, is the effect on the remaining country blocks. There are two reasons that explain this difference. First, as Figure 2.8 shows, the euro appreciates against the dollar and, consequently, against the currencies of China and the rest of the world. This obeys to the fact that the restrictive fiscal policy introduced by the Eurozone improves its fiscal balance, thereby reducing the financing needs of the government. As a result, there is an excess demand for euro-denominated bills that in a context of a flexible exchange rate regime produce an appreciation of the exchange rate. The stronger euro increases the competitiveness of the exports of the three remaining country blocks. This undermines the negative income effect that the lower level of activity in the Eurozone has on the exports of its three trade partners.

The second reason that explains why global growth, although lower than in the baseline scenario is higher in comparison to the scenario where it is the US that applies a restrictive fiscal policy, is connected to the fact that unlike the US, the Eurozone is not a global consumer of last resort. Given its role of provider of reserve currency, the US must run a current account deficit (i.e., it must consume foreign goods) to such an extent that the global demand for reserve currency is fulfilled. This puts it in a position of global consumer of last resort or global growth engine, upon which the export-led growth strategies of the countries that want to increase their holdings of dollar-denominated assets (or, more broadly, foreign reserves which may not necessarily be denominated in US dollars) are based. Thus, if it decides to implement a negative fiscal policy the effects on global growth may be devastating. This is not the case if the country that restricts its government expenditures is the Eurozone, whose role in the global economy is substantially different (as Figure 2.7 shows, the impact of this shock on the current account balances is much lower than in the case where the US is the country that restricts its fiscal policy).

We next present the results of the same shock, but applied to the SDR-based model. Recall that in this case we are substituting the role of the dollar as the international store of value, but we are not changing the essential features of the international monetary system. Thus, we expect to get very similar results to the ones obtained in the previous model, which in our view represents the current state of affairs regarding the working of the international monetary system. And, in fact, that is what can be deduced from Figure 2.9 and Figure 2.10, which look very similar to the previous ones. The small differences can be explained by the fact that some flows of interest payments experience slight changes. For instance, in the dollar-based model China earns interests on its foreign

reserves and in the SDR model reserves yield no interests at all. Thus, the worsening of the current account of China in the US dollar model not only implies a loss of foreign reserves with respect to the baseline scenario, but also a reduction in the income that results from the holding of foreign reserves. In the SDR model this last effect does not exist since in the baseline model foreign reserves yielded no interests at all. This explains why the current account of China is worse in the long run in the dollar-based model in comparison to the SDR model. But, in essence, it is clear that the working of the international monetary system will not change by the simple fact that the role of the dollar is being taken away its role as an international reserve currency. What should be done, if there is a real will to reduce global imbalances and the recession-biased adjustment mechanism implicit in the current *non-system*, is to give the SDR a function that is closer to the one that Keynes proposed for the bancor.

Figure 2.9: Restrictive fiscal policy in the US – SDR model

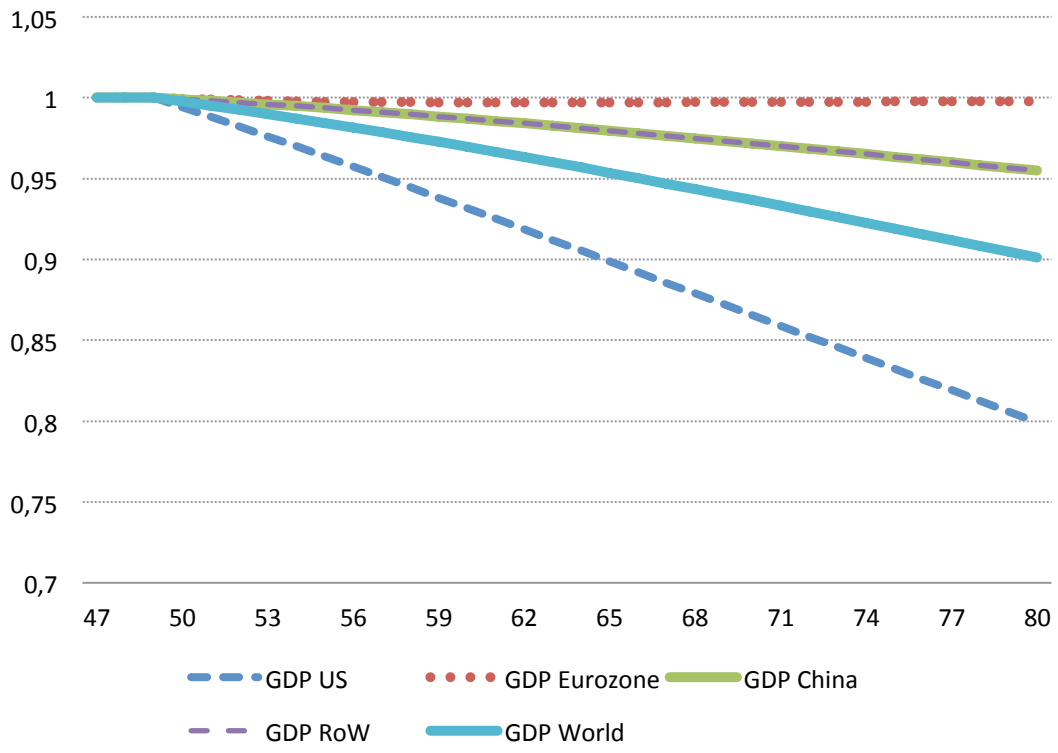
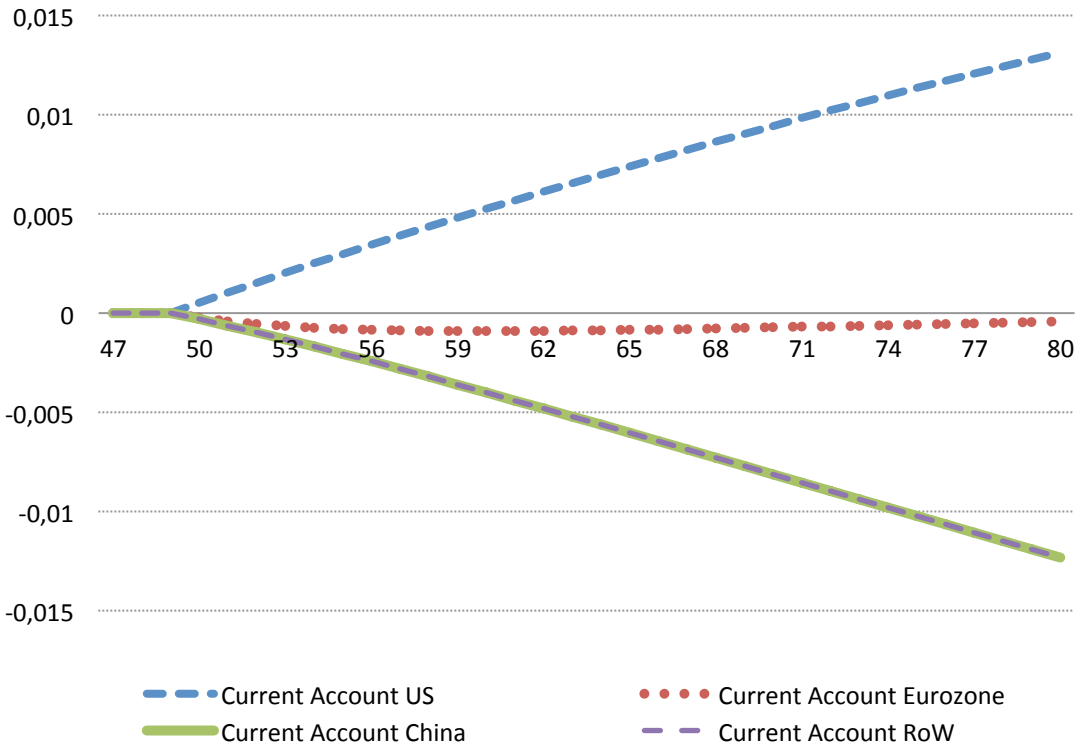


Figure 2.10: Restrictive fiscal policy in the US – SDR model



Finally, we present the simulations of the bancor-based model. Keynes' proposal for the introduction of a bancor-based system included, as mentioned above, many adjustment mechanisms. In this case we present the simulations of a model that incorporates all of them operating simultaneously. As described in section 2.3, these adjustments imply that:

- ✓ Both surplus and deficit countries have to pay interests on their bancor balances, whether positive or negative.

- ✓ The ICU collects these interest payments and distributes them to deficit countries. This can capture the idea of foreign aid to finance development.

- ✓ Surplus countries, finding it useless to accumulate reserves under the form of bancors, pursue more expansionary fiscal policies that tend to narrow down global imbalances.

- ✓ Each country's currency is fixed to the bancor. However, there is a possibility to introduce discrete devaluations if the bancor balance of the country in question surpasses a certain threshold. This mechanism is designed so as to allow for an

adjustment that favors deficit countries if the remaining mechanisms prove to be insufficient.

Finally, it should also be remembered that following Keynes' recommendations the introduction of the ICU and a bancor-based system could be accompanied by the abolishment of international capital movements. In what follows we present all the graphs that represent the simulation of this shock under the setting of the ICU and we will then explain the underlying processes.

Figure 2.11 shows that the impact of the same restrictive fiscal policy analyzed in both the US dollar model and the SDR model. The decrease in the rate of growth of US' public expenditures has an evident negative effect on global growth. This is seen in the drop of all GDPs immediately after the shock (the lines corresponding to the Eurozone, China and the rest of the world are overlapping). Therefore, the global economy suffers from the willingness of the US to run a current account surplus (Figure 2.12). However, unlike the last 30 years where there were no self-correcting mechanisms of these imbalances, these simulations show that under a bancor-based framework there would be a trend to balance the external position of all countries. Basically, the US starts importing more from the three deficit regions since it is starting to accumulate positive bancor balances at the ICU (see Figure 2.13, where the bancor balances of the Eurozone, China and the rest of the world are the three overlapping lines in the negative quadrant).

Figure 2.11: Restrictive fiscal policy in the US – Bancor model

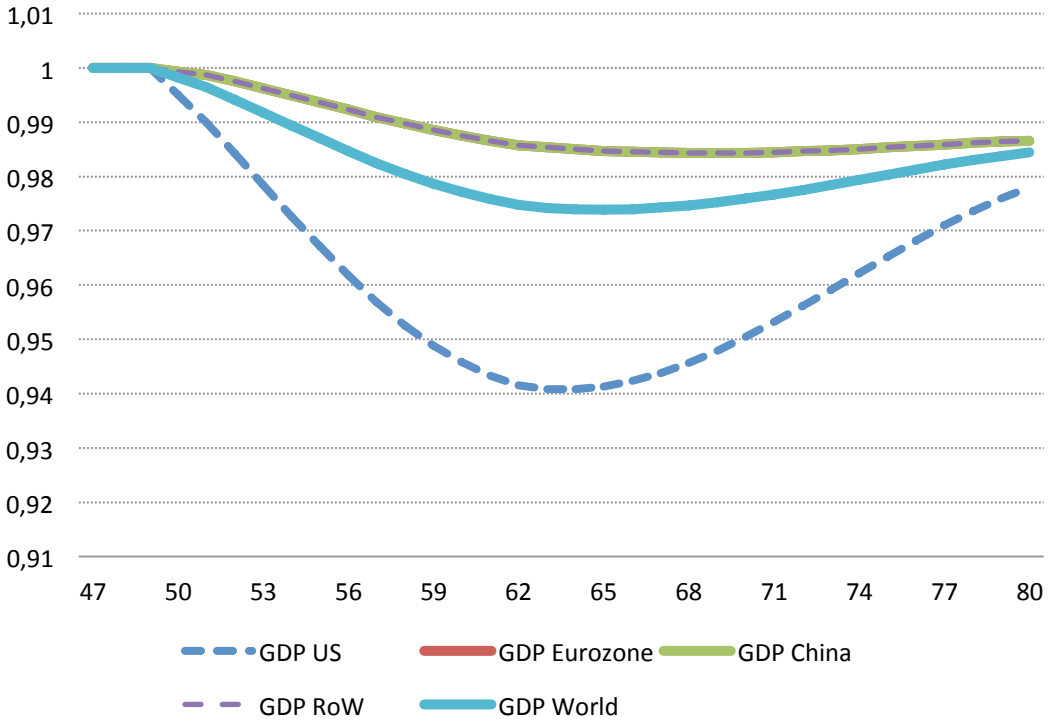


Figure 2.12: Restrictive fiscal policy in the US – Bancor model

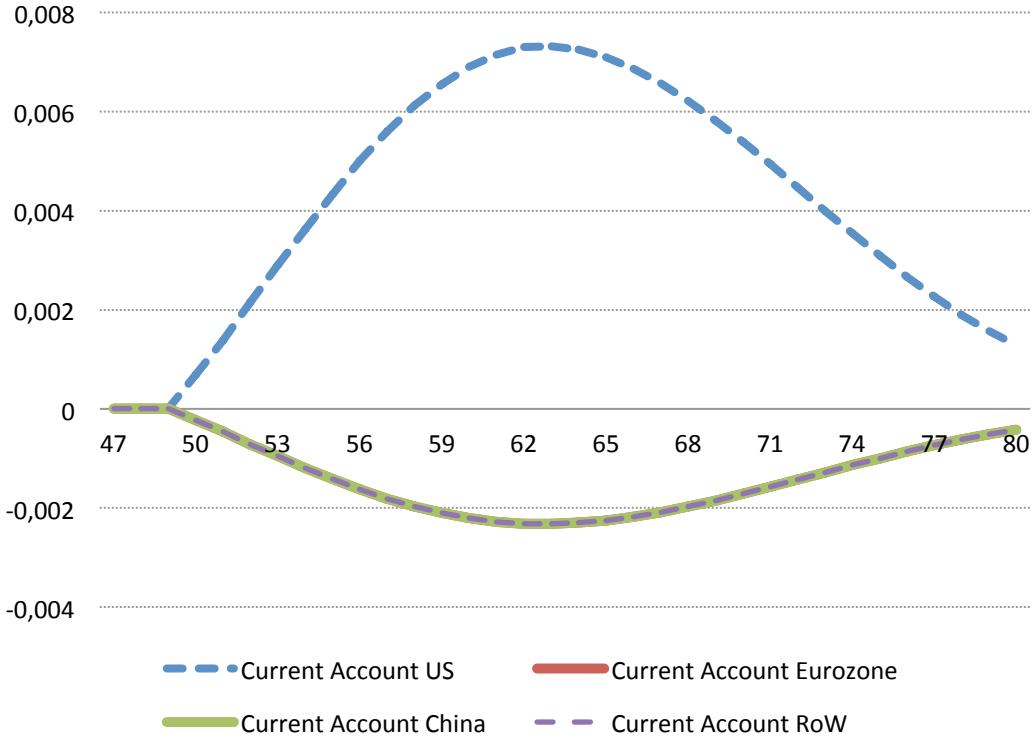


Figure 2.13: Restrictive fiscal policy in the US – Bancor model

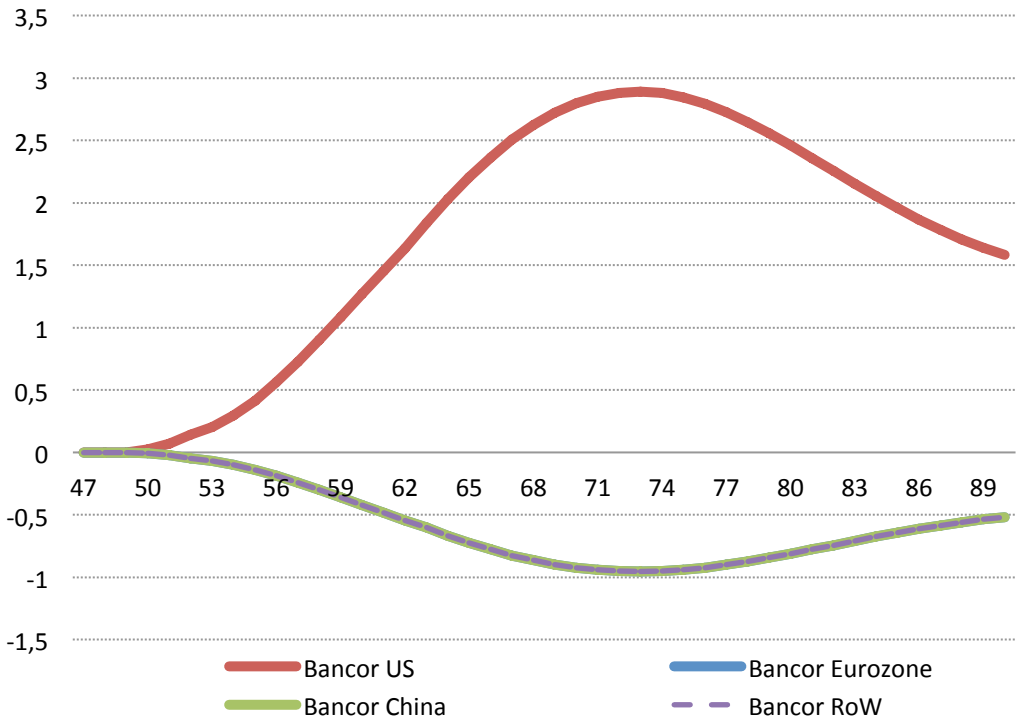
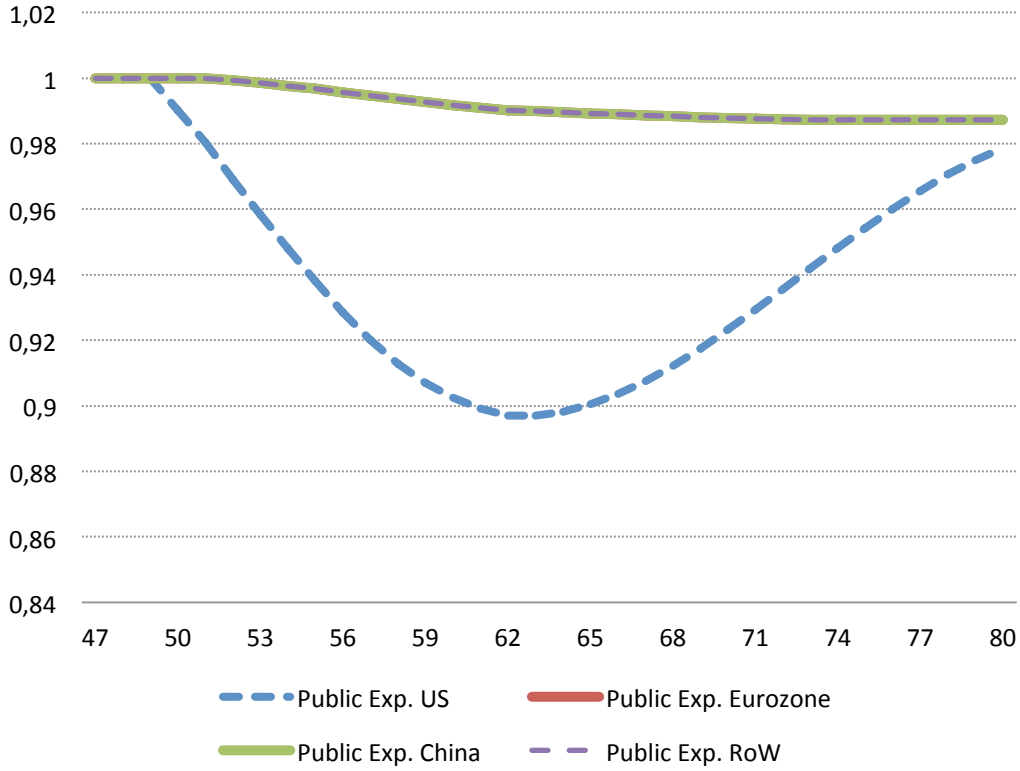


Figure 2.14: Restrictive fiscal policy in the US – Bancor model



As was mentioned before, this system discourages the accumulation of bancor balances since they bear an interest payment whether they are positive or negative. Thus, immediately after the shock the accumulation of bancor balances by surplus countries (in this case, only the US) lead to more expansionary fiscal policies that help rebalancing the world economy. This can be seen in Figure 2.14, where even though the exogenous component of fiscal policy is permanently reduced by one percentage point (in line with the shocks introduced in the other two models) there is an endogenous component that encourages the government to increase its expenditures. Otherwise, it would still lose an equivalent amount of funds under the form of interest payments to the ICU, for which it would receive no goods at all. The advantage of this way of solving global imbalances, as Keynes noted, is that no country needs to go through a process of internal devaluation that would likely entail a recession.

Another alternative to reduce imbalances within the bancor system would imply the addition to the precedent adjustment mechanisms the possibility of adjusting the exchange rate when current account deficits are persistent. Suppose that if a country that accumulates five consecutive periods of current account deficits that are below a certain predetermined threshold (which has to be decided with the agreement of all countries participating in this monetary regime) is allowed to adjust the exchange rate parity. Thus, if the US pursues the same contractionary fiscal policy analyzed above the immediate effect would be a decrease in its GDP as well as on the GDP of the three remaining country blocks (Figure 2.15) and an improvement in its current account accompanied with a deterioration of the current account of the remaining countries (Figure 2.16).

Although the adjustment mechanisms described above would be set into motion, they might not be strong enough to reduce imbalances to a desired level or in a certain period of time. To make this possible, an exchange rate adjustment would be helpful (Figure 2.18). As it is observed in Figure 2.16, after the exchange rate has been adjusted, the current account surplus of the US is being reduced at a faster pace with respect to the scenario where exchange rates are constant. This also implies that the balancing of bancor balances of all countries also becomes faster (Figure 2.17). The alternative adjustment mechanisms embedded in the bancor model show how if countries reach an agreement on the establishment of an ICU in the spirit of Keynes there would be automatic incentives to pursue policies that would tend to take the global economy to more stable growth path in term of external balances. Also, the global level of activity would also tend to be higher, which would entail a higher number of people participating in the labor market Hence, the model makes a case for a reconsideration of Keynes' bancor proposal.

Figure 2.15: Restrictive fiscal policy in the US – Bancor model with adjustable XR

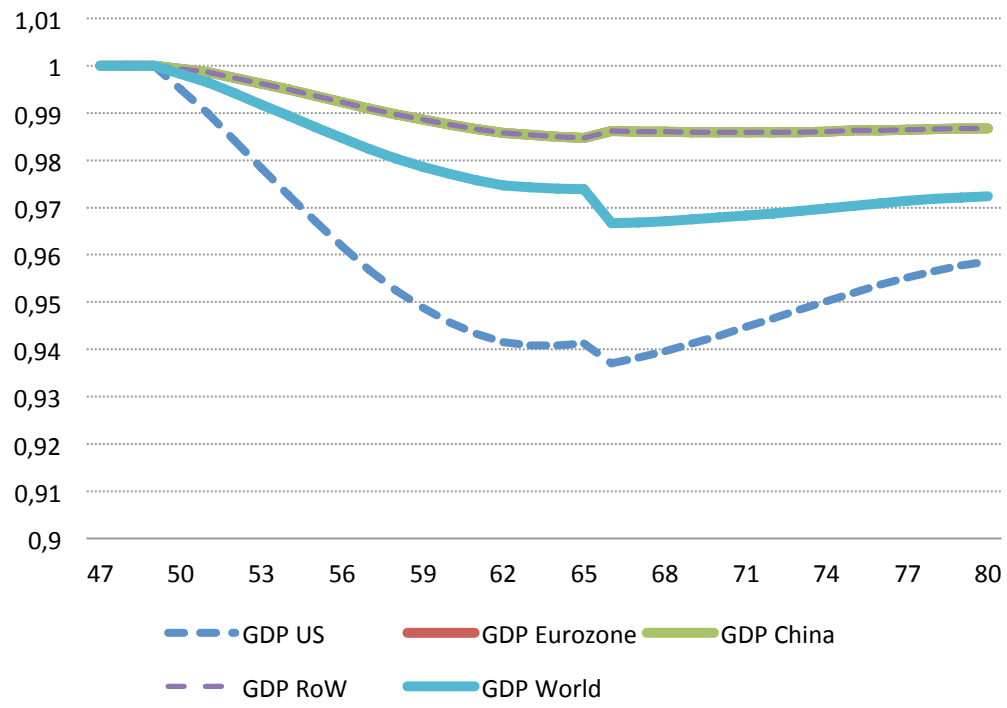


Figure 2.16: Restrictive fiscal policy in the US – Bancor model with adjustable XR

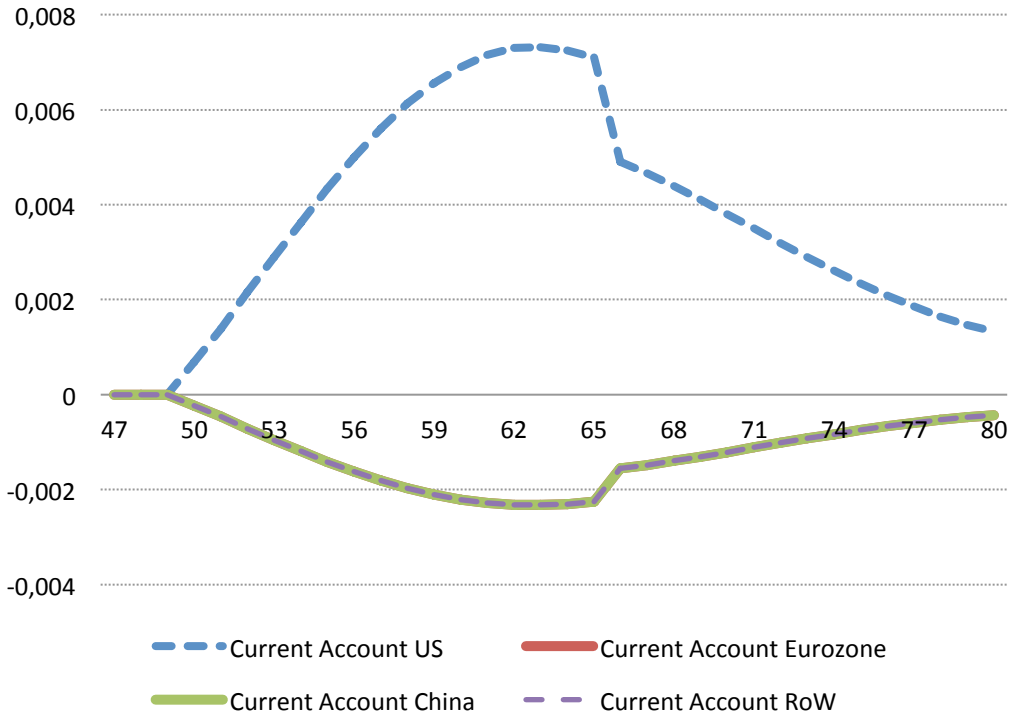


Figure 2.17: Restrictive fiscal policy in the US – Bancor model with adjustable XR

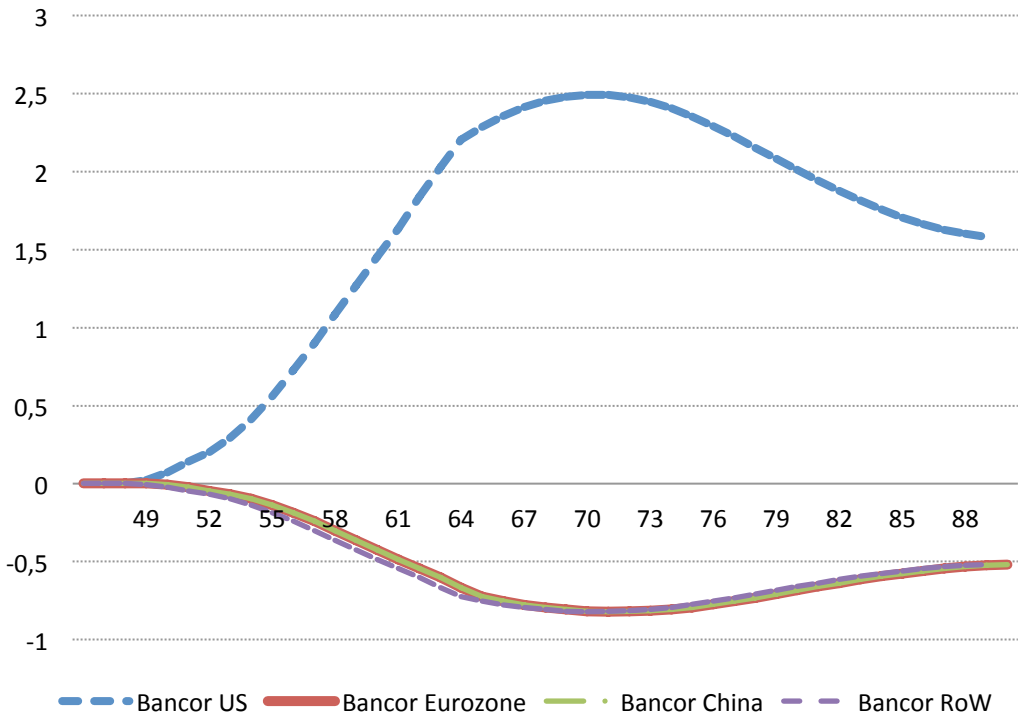
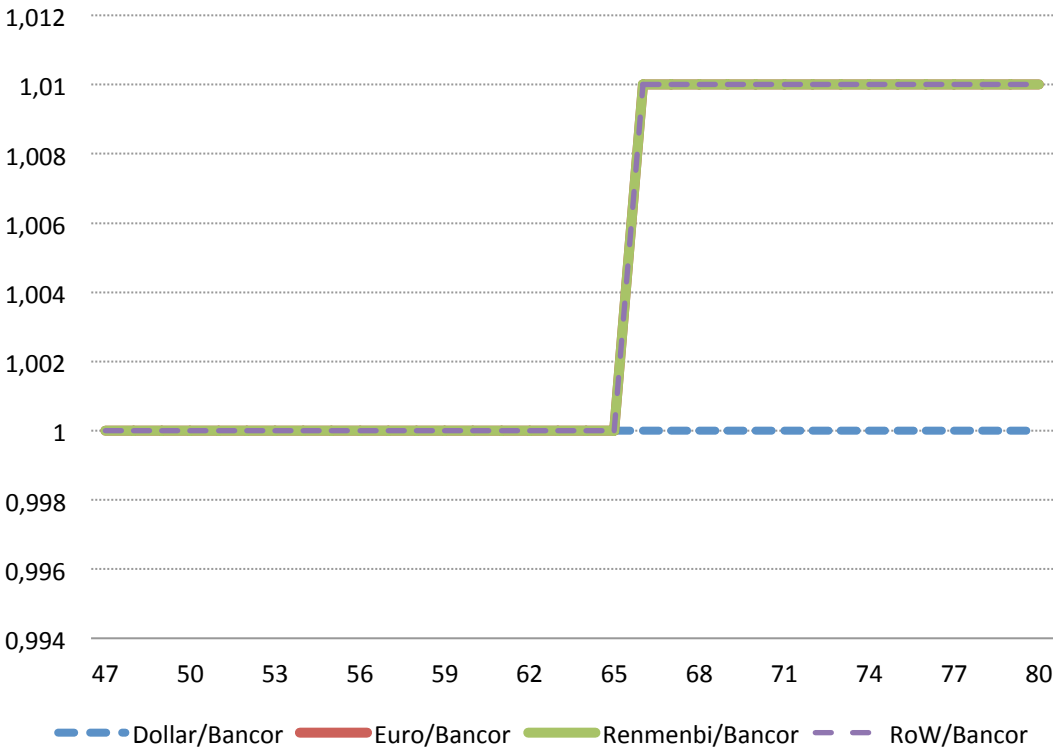
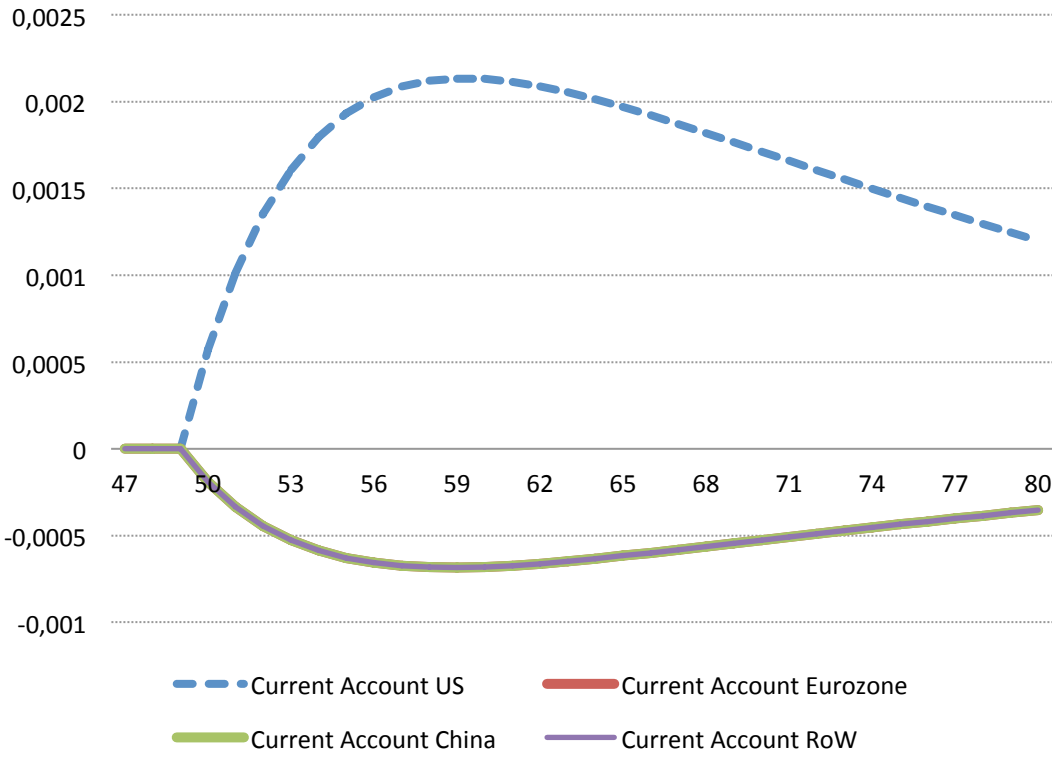


Figure 2.18: Restrictive fiscal policy in the US – Bancor model with adjustable XR



Finally, we go back to the US dollar model and show how the adjustment would be in a case where all exchange rates are allowed to float freely. This scenario is quite unrealistic since it would require that all countries agree to forgo their exchange rate policies, which does not seem likely to happen. However, it is interesting to compare how the global economy would react to the same shock analyzed before. Not surprisingly, as figure 2.19 shows, global imbalances are quickly reduced thanks to the flexibility of exchange rates. In particular, the increase in the US' public expenditures produces a current account deficit that is progressively reduced through a depreciation of the US dollar against all the currencies of all its trading partners. Although this scenario is totally in opposition to the bancor proposal since it entails no interventions at all, it still requires a high level of coordination, a sort of agreement shared by everyone on not to intervene in foreign exchange markets. What these simulations show is that the seemingly more beneficial monetary regimes appear to be the hardest to implement from a political point of view.

Figure 2.19: Restrictive fiscal policy in the US – Fully floating model



2.7 Conclusions

In this chapter we have presented the main drawbacks of the current international monetary (non)system and described some of the alternatives for reform that have been proposed since the end of the Second World War. In order to test both the working of the current (non)system and the potential dynamics that could result from the alternative proposals we developed a four-country stock-flow consistent model with the sufficient flexibility to reproduce each of these different monetary regimes with a minimum number of modifications to the baseline model.

Our simulations of the model that attempts to represent the current monetary (non)system is able to represent the problems associated to the Triffin dilemma. It is shown that if there are incompatibilities between the growth strategies of the global economy as a whole (excluding the country that issues the reserve currency) and the domestic policy goals of the country that issues the reserve currency the world economy would fall in a recession. The alternative of substituting the dollar for the SDR does not seem to provide the mechanisms that would allow the global economy to grow without producing large imbalances. On the contrary, an international monetary system based on the "rules of the game" proposed by Keynes in the beginning of the 1940s seem to yield more stable and fair dynamics over time. This results from the existence of a series of adjustment mechanisms that do not discriminate between surplus and deficit countries and that replace the current deflationary and contrationary adjustment process for one that promotes economic growth. Even though there does not seem to be economic reasons why a reform in the spirit of Keynes could be discarded, the fact that it requires a very high level of coordination at the political level may continue to make this proposal one very difficult to implement.

2.8 Annex

Horizontal and vertical conditions of portfolio equations

As it is standard in stock-flow models, in order to ensure consistency portfolio equations must fulfill the following conditions. On the one hand, as proposed by Tobin (1969), if investors want to have more of an asset they must reduce the holding of another asset. Otherwise, their balance sheet would be in disequilibrium in the sense that the change in their assets would turn out to be different from the change in the flow that determines the variation in their net worth. Similarly, following a change in the relative rates of

return of the different assets, the sum over all assets of the responses of the investors must be equal to zero. Again, this implies that after a certain change in the relative price in a given period investors modify the composition of their portfolio but keeping their net worth constant. Of course, the net worth can change dynamically as a result of capital gains or losses or valuation effects that may result from movements of the exchange rate. Moreover, Godley (1996) establishes that it should also be ensured that the demand of an assets changes in the same way when its rate of return changes (keeping constant the remaining rates of return) than when the remaining rates of return change (keeping constant the rate of return of the incumbent asset), i.e., the demand for each asset should behave in the same way with regards to changes in the relative rates of return, regardless the origin of that change. This condition is the so-called horizontal condition. The combination of the vertical and horizontal conditions can be applied to the portfolio equations by setting specific values to the relevant parameters.

First, it is easier to express the portfolio equations in matrix form. We take the portfolio equations of US banks as an example. The system could be written this way:

$$\begin{bmatrix} Bd, b_{US}^{EZ} \\ Bd, b_{US}^{CH} \\ Bd, b_{US}^{RW} \\ Bd, b_{US}^{US} \end{bmatrix} = \begin{bmatrix} \gamma_{10}^{US} \\ \gamma_{20}^{US} \\ \gamma_{30}^{US} \\ \gamma_{40}^{US} \end{bmatrix} + \begin{bmatrix} \gamma_{11}^{US}\gamma_{12}^{US}\gamma_{13}^{US}\gamma_{14}^{US} \\ \gamma_{21}^{US}\gamma_{22}^{US}\gamma_{23}^{US}\gamma_{24}^{US} \\ \gamma_{31}^{US}\gamma_{32}^{US}\gamma_{33}^{US}\gamma_{34}^{US} \\ \gamma_{41}^{US}\gamma_{42}^{US}\gamma_{43}^{US}\gamma_{44}^{US} \end{bmatrix} \cdot \begin{bmatrix} r^{EZ} \\ r^{CH} \\ r^{RW} \\ r^{US} \end{bmatrix}$$

Being the vertical conditions:

$$\begin{aligned} \gamma_{10}^{US} + \gamma_{20}^{US} + \gamma_{30}^{US} + \gamma_{40}^{US} &= 1 \\ \gamma_{11}^{US} + \gamma_{21}^{US} + \gamma_{31}^{US} + \gamma_{41}^{US} &= 0 \\ \gamma_{12}^{US} + \gamma_{22}^{US} + \gamma_{32}^{US} + \gamma_{42}^{US} &= 0 \\ \gamma_{13}^{US} + \gamma_{23}^{US} + \gamma_{33}^{US} + \gamma_{43}^{US} &= 0 \\ \gamma_{14}^{US} + \gamma_{24}^{US} + \gamma_{34}^{US} + \gamma_{44}^{US} &= 0 \end{aligned}$$

And the horizontal conditions:

$$\begin{aligned} \gamma_{11}^{US} + \gamma_{12}^{US} + \gamma_{13}^{US} + \gamma_{14}^{US} &= 0 \\ \gamma_{21}^{US} + \gamma_{22}^{US} + \gamma_{23}^{US} + \gamma_{24}^{US} &= 0 \\ \gamma_{31}^{US} + \gamma_{32}^{US} + \gamma_{33}^{US} + \gamma_{34}^{US} &= 0 \\ \gamma_{41}^{US} + \gamma_{42}^{US} + \gamma_{43}^{US} + \gamma_{44}^{US} &= 0 \end{aligned}$$

3.Alternative monetary regimes for the Euro area

3.1. 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 a deepening of intra-regional trade and financial flows was also observed. Moreover, southern countries, which had a history of inflation and sometimes experienced exchange rate devaluations as a result of their current account deficits, 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.

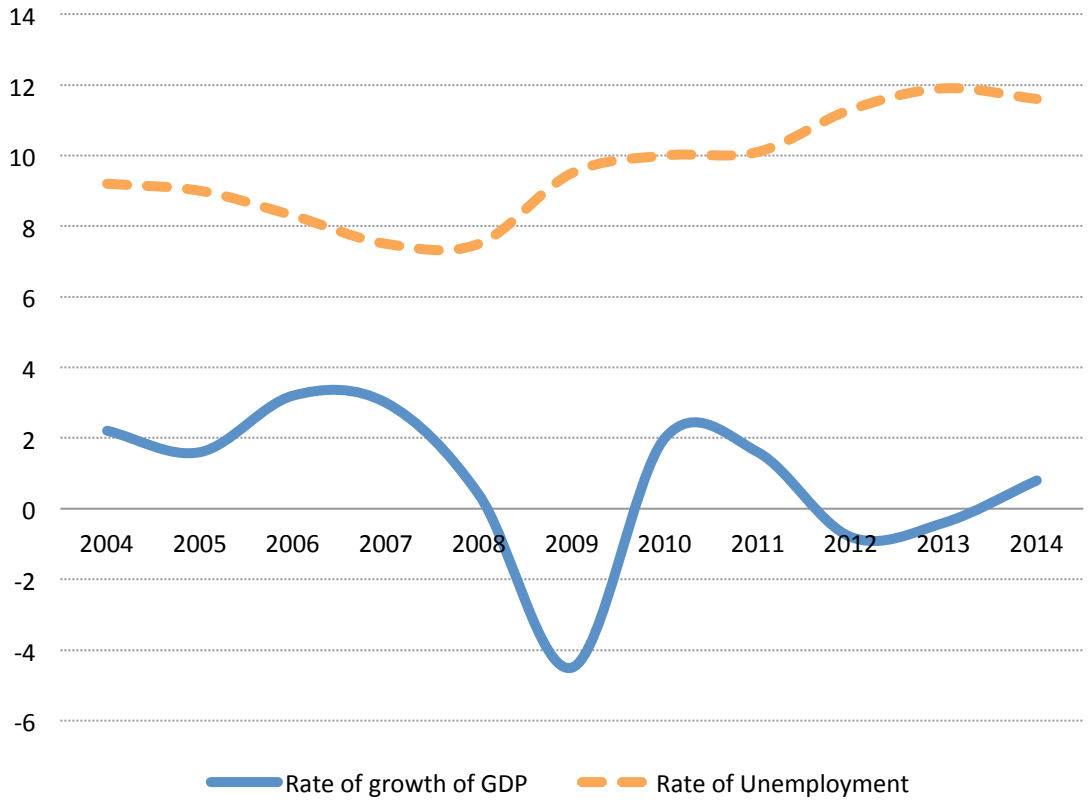
By the beginning of 2008 hardly any analyst imagined a picture as the one it is presented in Figure 3.1. As it can be observed, since the bankruptcy of Lehman Brothers (a problem that apparently concerned only the American economy) everything turned dark in the Eurozone. Not only five of its nineteen members had to be rescued, but also important countries such as France and Italy look vulnerable. As of November 2014, 18.3 million people were unemployed, yielding an 11.5% unemployment rate. To make matters worse, most of the actions taken by the European governments proved insufficient, if not useless, to reverse the negative dynamics 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 that, 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 very brief description of the historical process that

brought Western Europe to the current monetary arrangement (the European Monetary Union). Then, we describe the institutional setting in which economic relations take place within the Eurozone nowadays. Section 3.4 presents an SFC model that accounts for most of the features described in Section 3.3. Section 3.5 attempts to reproduce some of the conditions that ultimately led the Eurozone to its present crisis. Sections 3.6 and 3.7 propose some alternative configurations of the monetary system that could eventually help to take the euro area out of the present crisis. Section 3.8 presents the most important conclusions of this chapter.

Figure 3.1: Crisis in the Eurozone



Source: IMF-WEO

3.2. Historical background

The way to the European Monetary System

The end of World War II came together with a global initiative to restore international economic relations: the Bretton Woods agreements. Under this arrangement, the

currencies of participating countries were pegged to the US dollar, with the possibility of introducing small adjustments under conditions of persistent current account deficits. Since most western European countries joined this monetary system, the coordination of monetary policies at a regional level was not considered an urgent necessity[22].

Although during the 1950s the Bretton Woods system was successful in its task of providing stability for the development of international trade relations, the 1960s found Europe in some tensions in the foreign exchange markets. The sustained appreciation of both the Deutsche mark and the Dutch guilder endangered the newly established agricultural market organizations, which were designed to work in conditions of fixed exchange rates. When in 1969 Germany had to temporarily abandon the agreement, the issue of monetary coordination became one of the main topics in the European political agenda. The fact that the Bretton Woods system seemed to be in agony steps (as the US advocates of floating exchange rates were gaining more and more followers) forced European policy makers to start thinking about new monetary regimes.

A first initiative for a higher degree of monetary policy coordination at a regional level came from the Werner report, presented in 1970, whose final goal was the establishment of a monetary union before the end of that decade. However, France and Germany refrained from signing any agreement that implied transferring their policy sovereignty to a supranational entity. The result of this dilemma between the desire for a higher level of coordination without foregoing policy sovereignty was the so-called "snake". This system proved to be very unstable, leading to persistent withdrawals and re-entries.

The European Monetary System

It was not until the 1980s that a tendency towards exchange rate stability was achieved. In 1979, the EMS was launched with the aim of finally "creating an area of monetary stability". It was a system of fixed but adjustable exchange rates that provided a mechanism that allowed countries to keep their currencies within the fluctuation margins of ± 2.25%[23] of national currencies against the European currency unit (ECU). The ECU was

[22] The Treaty establishing the European Economic Community (also known as the Treaty of Rome) signed in 1957 gave no major importance to monetary policy coordination. It just stated that member states should treat their "policies in the area of exchange rates as a matter of common interest" (Article 107). As regards the establishment of monetary institutions, Article 105 created a "monetary committee" whose task was to monitor monetary policies of member states and to advise policy makers.

[23] There were some exceptions, like Italy, Spain and Portugal, which were allowed to fluctuate ± 6%.

a basket of the currencies participating in the EMS, and functioned only as a unit of account (thus, it had no material existence). In order to prevent countries from withdrawing, like it happened with the *softer* arrangements of the 1970s, the EMS contemplated the provision of loans to deficit countries. These loans allowed them to face temporary external disequilibria without devaluating their currencies beyond the fluctuation bands. Under this regime, European currencies floated freely against extra-regional currencies.

From 1979 to 1987 the EMS was rather flexible with many parity changes, especially between 1979 and 1983. This was mainly due to large divergences in the rates of inflation. After 1987 the European monetary authorities tried to promote a "new EMS", more rigid, with less exchange rates adjustments, especially after the Nyborg agreements (1987), which fixed new rules and increased short term financing of the central banks to defend monetary parities. Due to a higher level of convergence the EMS seemed to be a success, since there was only one parity change (a devaluation of the Irish pound in 1990) between 1987 and 1992. However this new configuration turned out to be unsustainable in the beginning of the 1990s, marked by a weak dollar, the economic consequences of the German reunification and the insufficient convergence. In September 1992 speculative attacks forced the UK and Italy to leave the EMS and float, while other currencies (the peseta and the escudo) were devalued. The French franc resisted thanks to the support of the Bundesbank. The year 1993 was even worse with new devaluations of the Irish pound, the peseta and the escudo and a final attack in July against the French franc, which remained unchanged in spite of the complete depletion of the foreign reserves of the Bank of France. This was possible due to the new and unlimited intervention of the Bundesbank. A new design of the EMS was decided with an enlargement of the fluctuation margins up to +/- 15%, which gave more room of maneuver.

European policy makers were convinced that in order to achieve exchange rate stability the process of monetary coordination had to be deepened. The design of the way forward was commanded to Jacques Delors, who started working on the design of a new system in 1988 and whose proposal saw the light in the Maastricht Treaty that was signed in 1992. This treaty established the convergence criteria that countries willing to participate in the European Monetary Union (EMU) had to adopt. During the 1990s the countries that had signed the treaty travelled along this convergence path without any new speculative attacks, contrary to what was expected by most of the observers. The reasons of this successful transition are twofold. First, the monetary authorities underlined the credibility and the strength of the political willingness to march towards the single currency. They

praised the efficiency and the flexibility of the new modes of intervention of the central banks, which were able to stabilize the exchange rates (the “elastic policy”).

A second argument, less put forward, concerns exchange rate misalignments, both at intra-European and extra-European levels. These misalignments were huge until the beginning of the 1990s but they had disappeared or had been sharply reduced during the 1990s thanks to several factors: the monetary adjustments in 1992 and 1993 inside the EMS, the real internal devaluation achieved by the French economy since the middle of the 1980s, the devaluation of the Deutsche mark equilibrium exchange rate due to the cost of the German reunification which has put an end to its undervaluation, the revaluation of the yen and a more undervalued dollar (Couharde/Mazier (2001)). All these elements contributed to explain the stability of the transition period, contrasting with the previous one, despite the higher flexibility of the EMS. In 1999 the euro replaced the ECU as the unit of account of the euro area. Finally, in 2002 the euro coins and banknotes entered in circulation, thereby giving the euro the status of medium of exchange and, inevitably, store of value.

3.3 The Working of the Eurosystem – General Features

The adoption of the euro implied the delegation of monetary and exchange rate policies of each member country to 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 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.

Monetary Operations within the Eurosystem

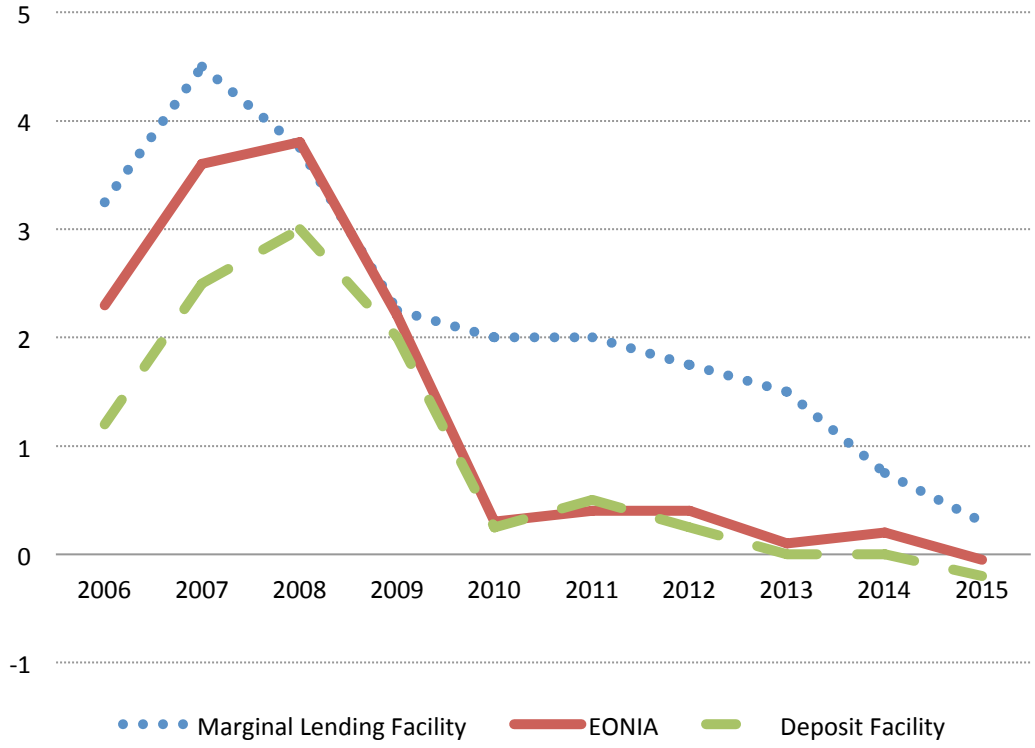
The way monetary policy is conducted in the Eurozone reflects the endogenous nature of money. Detailed explanations on how monetary policy is conducted nowadays can be

found in Wray (2012) and Lavoie (2014). In order to achieve a certain targeted inflation rate, the ECB sets an interest rate target. In order to meet its target, the ECB can decide on a set on 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 (EONIA), 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 under 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 in connection with NCB, 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 that cannot be allocated within the financial sector, those institutions that hold that undesired liquidity can deposit it at 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 3.2 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 tends to remain between 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.

Figure 3.2: Eurozone's key interest rates



Source: ECB

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. As it has been widely discussed in the heterodox literature, 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 resort 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). MRO are one-week euro liquidity-providing operations that 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) were originally three-month euro liquidity-providing operations which aim to provide additional, longer-term refinancing to the financial sector. Currently, LRTO can be of larger maturity, sometimes reaching a four-year length.

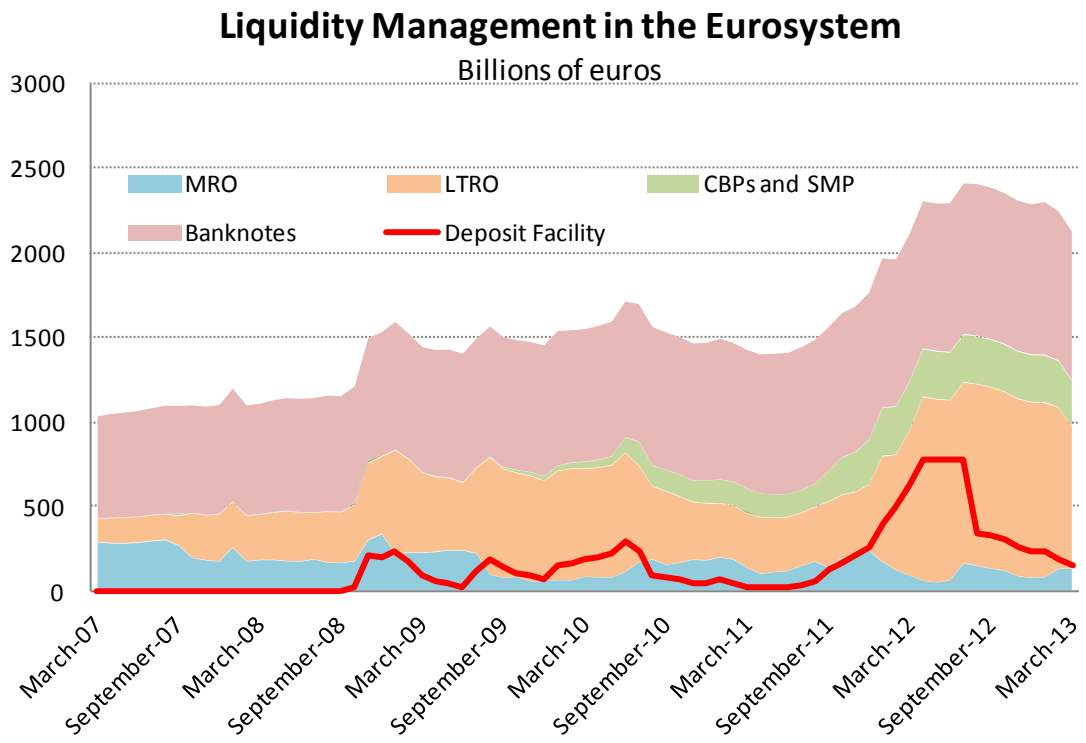
Both, MRO and LTRO are conducted via an auction mechanism. The ECB specifies the amount of liquidity it wishes to auction (called the allotted amount) and asks banks for expressions of interest. In a fixed rate tender the ECB also specifies the interest rate at which it is willing to lend money; alternatively, 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 supposedly, according to the mainstream theory, 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 the supply side. 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 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 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, 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 3.3: Liquidity management in the Eurosystem



Source: ECB

In 2010 the European authorities perceived that both the aforementioned ordinary and extraordinary monetary policy instruments were proving insufficient to deal with 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 an 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) program, 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). However, these purchases are conditional on the recipient country adopting economic policies that tend to correct the budget deficits. The main aim of this program 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.

The following table summarizes how the bailouts to member states were financed given the different mechanisms that were created during the crisis.

Table 3.1: Bailouts to member states (in billions of euros)

Country	IMF	Bilateral	GLF	EFSM	EFSF	ESM	Total
Cyprus	1	2.5				9	12.5
Greece	48.1		52.9		144.6		245.6
Ireland	22.5	4.8		22.5	18.4		68.2
Portugal	26			26	26		78
Spain						41 / 100	41 / 100

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 bailout 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

The Payments System

The way in which commercial Banks, national central banks 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 clearinghouse 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.

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 to €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 in the same amount. This is reasonable since banks are playing nothing more than an intermediary role.

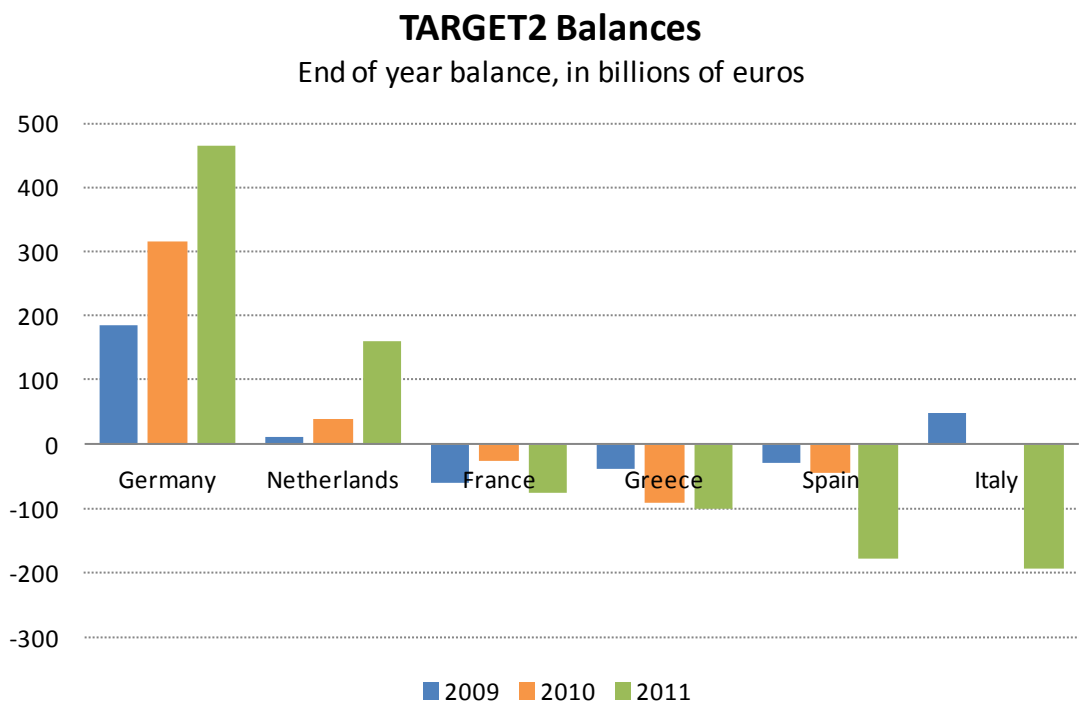
Step 3: The Banco de España reports a liability worth €100 vis-à-vis the Bundesbank which, conversely, reports a claim worth €100 against the Banco de España. At the end of the day, both the Banco de España and the Bundesbank offset all its bilateral claims and liabilities into a single net asset or liability position against the ECB. Note that since the ECB is being only a clearinghouse 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 in the same amount than its assets (Target SP).

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 (Target DE) would have increased in 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) would have increased in the same amount as its liabilities (the exporter's deposit). 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 3.4 shows the final TARGET2 position of some of the NCB of the Eurosystem. As it can be seen, the number of operations that were undertaken under this system has been increasing steadily. Moreover, the balances are a mirror of intra-Eurozone imbalances, since those countries that have been accumulating current account surpluses present a positive TARGET2 balance, while those countries that have been registering deficits exhibit a negative position.

Figure 3.4: TARGET2 balances



To conclude, it is worth analyzing 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.

The Structure of 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. As we present the balance sheets, its items will be described and we will go into the details anytime it is necessary.

Banco de España

In billions of euros, as of December 31st, 2011

ASSETS		LIABILITIES	
Gold	11,017	Banknotes in circulation	97,024
Total Claims in Foreign Currency	29,269	Liabilities to EZ credit institutions	50,933
Claims on Non-EZ Residents (€)	4,250	Liabilities to other EZ residents	5,570
Securities of EZ Residents (€)	106,385	Intra-Eurosystem Accounts	174,826
Lending to EZ Credit Institutions	168,196	Revaluation Accounts	12,012
Intra-Eurosystem Accounts	32,177		

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 euro 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 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 does 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. However, 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 at (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 at (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 for the ECB, while the remaining NCB have a specific share which is related to its 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 unrealized gains on assets, liabilities and off-balance-sheet instruments.

Bundesbank

In billions of euros, as of December 31st, 2011

ASSETS		LIABILITIES	
Gold	132,874	Banknotes in circulation	221,264
Total Claims in Foreign Currency	69,858	Liabilities to EZ credit institutions	228,873
Claims on Non-EZ Residents (€)	0	Liabilities to other EZ residents	5,501
Securities of EZ Residents (€)	71,867	Intra-Eurosystem Accounts	170,489
Lending to EZ Credit Institutions	75,797	Revaluation Accounts	129,411
Intra-Eurosystem Accounts	475,894		

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.

ECB

In billions of euros, as of December 31st, 2011

ASSETS		LIABILITIES	
Gold	19,643	Banknotes in circulation	71,090
Total Claims in Foreign Currency	46,254	Liabilities to EZ credit institutions	205
Claims on Non-EZ Residents (€)	1,456	Liabilities to other EZ residents	1,056
Securities of EZ Residents (€)	22,819	Liabilities to Non-EZ residents	77,116
Intra-Eurosystem Accounts	120,483	Intra-Eurosystem Accounts	40,307
		Revaluation Accounts	24,324

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 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 national banks, are registered under the "securities of EZ residents (€)" item.

As regards the intra-Eurosystem accounts on the assets side, it is 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 (2010: €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.

3.4 A stock-flow consistent model for the Eurozone

In the previous section we presented a general overview of the specific features of the Eurosystem, which has been 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.

Our starting point is Godley/Lavoie (2007), who present how the traditional structure of a stock-flow consistent model can be extended to build a multi-country model. Some earlier studies on open economy stock-flow models are Godley (1999) and Godley/Lavoie (2005). Lately, there has been a growing literature in this field. For instance, Lavoie/Zhao (2010) build a three-country model with fixed and flexible exchange rate regimes in order to study the effects of reserve diversification. Godley/Lavoie (2007b) use a three-country framework with two exchange rates aimed at modeling the macroeconomic dynamics between two members of the euro area and the United States. Duwicquet/Mazier (2010) use a two-country model to examine the effects of financial integration within a monetary union. Finally, Mazier/Tiou-Tagba Aliti (2012) build a four-country model to assess the contribution of potential exchange rate realignment to the narrowing of global imbalances. In the remaining of this section, we will explain how the framework proposed by Godley/Lavoie (2007) can be modified to model each of the alternatives for the reform of the institutional setting of the euro area[24]. We build a four-country model with the following features:

- ✓ The countries are: the US, Germany, Spain and the rest of the world, where 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, whereas Germany represents the surplus countries of the Eurozone.

[24] The complete description of our model can be found in:
http://www.univparis13.fr/CEPN/IMG/pdf/wp2014_03.pdf

- ✓ 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 3.3, two unusual financial assets are incorporated into the model. The following balance sheet is representative of the structure of the model, since it includes all the assets that can be traded as a result of financial investments 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 3.3. 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.

Table 3.2: Balance sheet of Spain

	Spain					
	Households	Firms	Commercial Banks	Government	Central Bank	ECB
Capital		$+K_t^{SP}$				
Cash	$+Hd_t^{SP}$				$-Hs, cb_t^{SP}$	$-Hs_t^{ECB}$
Deposits	$+Md_t^{SP}$		$-Md_t^{SP}$			
Reserves			$+R_t^{SP}$		$-R_t^{SP}$	
Advances			$-A_t^{SP}$		$+A_t^{SP}$	
Loans		$-L_t^{SP}$	$+L_t^{SP}$			
$Bonds^{SP}$			$+Bd, b_{SP_t}^{SP}$	$-Bs_{SP_t}^{SP}$	$+Bd, cb_{SP_t}^{SP}$	$+Bd_{ECB_t}^{SP}$
$Bonds^{GE}$			$+Bd, b_{SP_t}^{GE}$			$+Bd_{ECB_t}^{GE}$
$Bonds^{US}$			$+Bd, b_{SP_t}^{US}$		$+Bd, cb_{SP_t}^{US}$	$+Bd_{ECB_t}^{US}$
$Bonds^{RW}$			$+Bd, b_{SP_t}^{RW}$			
TARGET2					$+TG2_{SP_t}$	$-TG2_{ECB_t}$
IEA					$-IEA_{SP_t}$	$+IEA_{ECB_t}$
Wealth	$+Vh_t^{SP}$	$+Vf_t^{SP}$	$+Vb_t^{SP}$	$-Bs_{SP_t}^{SP}$	$+Vcb_t^{SP}$	$+V_t^{ECB}$

In order to show that this representation of the Eurosystem is including all the components of the real balance sheets shown in Section 3.3, 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 the following table.

Table 3.3: Identification of real-world assets in the model

Label in the real balance sheet	Label in our model
Banknotes in circulation	Hs
Liabilities to EZ credit institutions	R
Lending to EZ credit institutions	A
Securities of EZ residents	Bd, cb_{SP}^{SP}
Total Claims in foreign currency	Bd, cb_{SP}^{US}
Intra-Eurosystem Accounts	TG2 + IEA
Revaluation Accounts	Included in Pcb (see equations 3.182-3.183)

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 the cases of the US and the rest of the world we will not have the last two rows. This is evident since TARGET2 balances and IEAs are specific features of the Eurosystem. Also, as it is usual in every SFC model, there is a social accounting matrix and a flow of funds table from which many of the accounting identities that make up the model are derived. Together, the social accounting matrix and the flow of funds constitute the transaction matrix, where all the possible transactions in the economy are included.

Table 3.4: Matrix of Transactions

	United States								
	Households	Firms		Com.Banks		Government	Central Bank		
		Current	Capital	Current	Capital		Current	Capital	
Consumption	$-C_t^{US}$	C_t^{US}							
Investment		I_t^{US}	$-I_t^{US}$						
Gov.Spending		G_t^{US}				$-G_t^{US}$			
Net Exports		NX_t^{US}							
Wages	W_t^{US}	$-W_t^{US}$							
Taxes	$-Th_t^{US}$	$-Tf_t^{US}$				T_t^{US}			
Int.Deposits	$rd_{t-1}^{US}.Md_{t-1}^{US}$			$-rd_{t-1}^{US}.Md_{t-1}^{US}$					
Int.Loans		$-rl_{t-1}^{US}.Ld_{t-1}^{US}$		$rl_{t-1}^{US}.Ld_{t-1}^{US}$					
Int.Reserves				$rs_{t-1}^{US}.R_{t-1}^{US}$			$-rs_{t-1}^{US}.R_{t-1}^{US}$		
Int.Advances				$-r_{t-1}^{US}.A_{t-1}^{US}$			$r_{t-1}^{US}.A_{t-1}^{US}$		
$Int.Bonds^{US}$				$r_{t-1}^{US}.Bd, b_{US_{t-1}}^{US}$		$-r_{t-1}^{US}.Bs_{t-1}^{US}$	$r_{t-1}^{US}.Bd, cb_{US_{t-1}}^{US}$		
$Int.Bonds^{RW}$				$r_{t-1}^{RW}.Bs, b_{US_{t-1}}^{RW}/E4$					
$Int.Bonds^{SP}$				$r_{t-1}^{SP}.Bs, b_{US_{t-1}}^{SP}/E2$					
$Int.Bonds^{GE}$				$r_{t-1}^{GE}.Bs, b_{US_{t-1}}^{GE}/E1$					
IEA									
TARGET2									
Profits		$-Pf^{US}$	Pf^{US}	$-Pb^{US}$	Pb^{US}	Pcb^{US}	$-Pcb^{US}$		
$\Delta Cash$	$-\Delta Hd^{US}$							ΔHs^{US}	
$\Delta Deposits$	$-\Delta Md^{US}$				ΔMd^{US}				
$\Delta Loans$			ΔL^{US}		$-\Delta L^{US}$				
$\Delta Reserves$					$-\Delta R^{US}$			ΔR^{US}	
$\Delta Advances$					ΔA^{US}			$-\Delta A^{US}$	
$\Delta Bonds^{US}$					$-\Delta Bd, b_{US}^{US}$	ΔBs^{US}		$-\Delta Bd, cb_{US}^{US}$	
$\Delta Bonds^{RW}$					$-\Delta Bd, b_{US}^{RW}$				
$\Delta Bonds^{SP}$					$-\Delta Bd, b_{US}^{SP}$				
$\Delta Bonds^{GE}$					$-\Delta Bd, b_{US}^{GE}$				
ΔIEA									
$\Delta TARGET2$									
Total	0	0	0	0	0	0	0	0	

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	Rest of the World								
	Households	Firms		Com.Banks		Government	Central Bank		
		Current	Capital	Current	Capital		Current	Capital	
Consumption	$-C_t^{RW}$	C_t^{RW}							
Investment		I_t^{RW}	$-I_t^{RW}$						
Gov.Spending		G_t^{RW}				$-G_t^{RW}$			
Net Exports		NX_t^{RW}							
Wages	W_t^{RW}	$-W_t^{RW}$							
Taxes	$-Th_t^{RW}$	$-Tf_t^{RW}$				T_t^{RW}			
Int.Deposits	$rd_{t-1}^{RW}.Md_{t-1}^{RW}$			$-rd_{t-1}^{RW}.Md_{t-1}^{RW}$					
Int.Loans		$-rl_{t-1}^{RW}.Ld_{t-1}^{RW}$		$rl_{t-1}^{RW}.Ld_{t-1}^{RW}$					
Int.Reserves				$rs_{t-1}^{RW}.R_{t-1}^{RW}$			$-rs_{t-1}^{RW}.R_{t-1}^{RW}$		
Int.Advances				$-r_{t-1}^{RW}.A_{t-1}^{RW}$			$r_{t-1}^{RW}.A_{t-1}^{RW}$		
$Int.Bonds^{US}$				$r_{t-1}^{US}.Bs, b_{RW_{t-1}}^{US}.E4$			$r_{t-1}^{US}.Bs, cb_{RW_{t-1}}^{US}.E4$		
$Int.Bonds^{RW}$				$r_{t-1}^{RW}.Bd, b_{RW_{t-1}}^{RW}$		$-r_{t-1}^{RW}.Bs_{t-1}^{RW}$	$r_{t-1}^{RW}.Bd, cb_{RW_{t-1}}^{RW}$		
$Int.Bonds^{SP}$				$r_{t-1}^{SP}.Bs, b_{RW_{t-1}}^{SP}/E5$					
$Int.Bonds^{GE}$				$r_{t-1}^{GE}.Bs, b_{RW_{t-1}}^{GE}.E6$					
IEA									
TARGET2									
Profits		$-Pf^{RW}$	Pf^{RW}	$-Pb^{RW}$	Pb^{RW}	Pcb^{RW}	$-Pcb^{RW}$		
$\Delta Cash$	$-\Delta Hd^{RW}$							ΔHs^{RW}	
$\Delta Deposits$	$-\Delta Md^{RW}$				ΔMd^{RW}				
$\Delta Loans$			ΔL^{RW}		$-\Delta L^{RW}$				
$\Delta Reserves$					$-\Delta R^{RW}$			ΔR^{RW}	
$\Delta Advances$					ΔA^{RW}			$-\Delta A^{RW}$	
$\Delta Bonds^{US}$					$-\Delta Bd, b_{RW}^{US}$			$-\Delta Bd, cb_{RW}^{US}$	
$\Delta Bonds^{RW}$					$-\Delta Bd, b_{RW}^{RW}$	ΔBs^{RW}		$-\Delta Bd, cb_{RW}^{RW}$	
$\Delta Bonds^{SP}$					$-\Delta Bd, b_{RW}^{SP}$				
$\Delta Bonds^{GE}$					$-\Delta Bd, b_{RW}^{GE}$				
ΔIEA									
$\Delta TARGET2$									
Total	0	0	0	0	0	0	0	0	

Continues on next page

	Spain								
	Households	Firms		Com.Banks		Government	Central Bank		
		Current	Capital	Current	Capital		Current	Capital	
Consumption	$-C_t^{SP}$	C_t^{SP}							
Investment		I_t^{SP}	$-I_t^{SP}$						
Gov.Spending		G_t^{SP}				$-G_t^{SP}$			
Net Exports		NX_t^{SP}							
Wages	W_t^{SP}	$-W_t^{SP}$							
Taxes	$-Th_t^{SP}$	$-Tf_t^{SP}$				T_t^{SP}			
Int.Deposits	$rd_{t-1}^{SP}.Md_{t-1}^{SP}$			$-rd_{t-1}^{SP}.Md_{t-1}^{SP}$					
Int.Loans		$-rl_{t-1}^{SP}.Ld_{t-1}^{SP}$		$rl_{t-1}^{RW}.Ld_{t-1}^{RW}$					
Int.Reserves				$rs_{t-1}^{SP}.R_{t-1}^{SP}$			$-rs_{t-1}^{SP}.R_{t-1}^{SP}$		
Int.Advances				$-r_{t-1}^{GE}.A_{t-1}^{SP}$			$r_{t-1}^{GE}.A_{t-1}^{SP}$		
$Int.Bonds^{US}$				$r_{t-1}^{US}.Bs, b_{SP_{t-1}}^{US}.E2$			$r_{t-1}^{US}.Bs, cb_{SP_{t-1}}^{US}.E2$		
$Int.Bonds^{RW}$				$r_{t-1}^{RW}.Bs, b_{SP_{t-1}}^{RW}.E5$					
$Int.Bonds^{SP}$				$r_{t-1}^{SP}.Bd, b_{SP_{t-1}}^{SP}$		$-r_{t-1}^{SP}.Bs_{t-1}^{SP}$	$r_{t-1}^{SP}.Bd, cb_{SP_{t-1}}^{SP}$		
$Int.Bonds^{GE}$				$r_{t-1}^{GE}.Bs, b_{SP_{t-1}}^{GE}.E3$					
IEA							$-r_{t-1}^{GE}.IEA_{t-1}^{SP}$		
TARGET2							$r_{t-1}^{GE}.TG2_{t-1}^{SP}$		
Profits		$-Pf^{SP}$	Pf^{SP}	$-Pb^{SP}$	Pb^{SP}	$Pcb^{SP} + \alpha P^{ECB}$	$-Pcb^{SP}$		
$\Delta Cash$	$-\Delta Hd^{SP}$							$\Delta Hs, cb^{SP}$	
$\Delta Deposits$	$-\Delta Md^{SP}$				ΔMd^{SP}				
$\Delta Loans$			ΔL^{SP}		$-\Delta L^{SP}$				
$\Delta Reserves$					$-\Delta R^{SP}$			ΔR^{SP}	
$\Delta Advances$					ΔA^{SP}			$-\Delta A^{SP}$	
$\Delta Bonds^{US}$					$-\Delta Bd, b_{SP}^{US}$				
$\Delta Bonds^{RW}$					$-\Delta Bd, b_{SP}^{RW}$				
$\Delta Bonds^{SP}$					$-\Delta Bd, b_{SP}^{SP}$	ΔBs^{SP}		$-\Delta Bd, cb_{SP}^{SP}$	
$\Delta Bonds^{GE}$					$-\Delta Bd, b_{SP}^{GE}$				
ΔIEA								$-\Delta IEA^{SP}$	
$\Delta TARGET2$								$-\Delta TG2^{SP}$	
Total	0	0	0	0	0	0	0	0	

Continues on next page

	Germany								ECB		Total
	Households	Firms		Com.Banks		Government	Central Bank				
		Current	Capital	Current	Capital		Current	Capital	Current	Capital	
C	$-C_t^{GE}$	C_t^{GE}									0
I		I_t^{GE}	$-I_t^{GE}$								0
G		G_t^{GE}				$-G_t^{GE}$					0
$X-IM$		NX_t^{GE}									0
W	W_t^{GE}	$-W_t^{GE}$									0
T	$-Th_t^{GE}$	$-Tf_t^{GE}$				T_t^{GE}					0
$rd.Md$	$rd_{t-1}^{GE}.Md_{t-1}^{GE}$			$-rd_{t-1}^{GE}.Md_{t-1}^{GE}$							0
$rl.L$		$-rl_{t-1}^{GE}.Ld_{t-1}^{GE}$		$rl_{t-1}^{GE}.Ld_{t-1}^{GE}$							0
$rs.R$				$rs_{t-1}^{GE}.R_{t-1}^{GE}$			$-rs_{t-1}^{GE}.R_{t-1}^{GE}$				0
$r.A$				$-r_{t-1}^{GE}.A_{t-1}^{GE}$			$r_{t-1}^{GE}.A_{t-1}^{GE}$				0
$rb^{US}.B^{US}$				$rb_{t-1}^{US}.Bs, b_{GE_{t-1}}^{US}.E1$			$rb_{t-1}^{US}.Bs, cb_{GE_{t-1}}^{US}.E1$		$rb_{t-1}^{US}.Bd_{ECB_{t-1}}^{US}$		0
$r^{RW}.B^{RW}$				$r_{t-1}^{RW}.Bs, b_{GE_{t-1}}^{RW}/E6$							0
$r^{SP}.B^{SP}$				$r_{t-1}^{SP}.Bs, b_{GE_{t-1}}^{SP}/E3$					$r_{t-1}^{SP}.Bd_{ECB_{t-1}}^{SP}$		0
$r^{GE}.B^{GE}$				$r_{t-1}^{GE}.Bd, b_{GE_{t-1}}^{GE}$		$-r_{t-1}^{GE}.Bs_{t-1}^{GE}$	$r_{t-1}^{GE}.Bd, cb_{GE_{t-1}}^{GE}$		$r_{t-1}^{GE}.Bd_{ECB_{t-1}}^{GE}$		0
IEA							$-r_{t-1}^{GE}.IEA_{t-1}^{GE}$		$r_{t-1}^{GE}.IEA_{t-1}^{ECB}$		0
TARGET2							$r_{t-1}^{GE}.TG2_{t-1}^{GE}$		$r_{t-1}^{GE}.TG2_{t-1}^{ECB}$		0
Profits		$-Pf^{GE}$	Pf^{GE}	$-Pb^{GE}$	Pb^{GE}	$+Z$	$-Pcb^{GE}$		$-Pcb^{ECB}$		0
ΔH	$-\Delta Hd^{GE}$							$\Delta Hs, db^{GE}$		ΔHs^{ECB}	0
ΔMd	$-\Delta Md^{GE}$				ΔMd^{GE}						0
ΔL			ΔL^{GE}		$-\Delta L^{GE}$						0
ΔR					$-\Delta R^{GE}$			ΔR^{GE}			0
ΔA					ΔA^{GE}			$-\Delta A^{GE}$			0
ΔB^{US}					$-\Delta Bd, b_{GE}^{US}$						0
ΔB^{RW}					$-\Delta Bd, b_{GE}^{RW}$						0
ΔB^{SP}					$-\Delta Bd, b_{GE}^{SP}$						0
ΔB^{GE}					$-\Delta Bd, b_{GE}^{GE}$	ΔBs^{GE}		$-\Delta Bd, cb_{GE}^{GE}$			0
ΔIEA								$-\Delta IEA^{GE}$		ΔIEA^{ECB}	0
$\Delta TG2$								$-\Delta TG2^{GE}$		$-\Delta TG2^{ECB}$	0
Total	0	0	0	0	0	0	0	0	0	0	0

$Z = Pb^{GE} + (1-\alpha).P^{ECB}$

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

$$1\$ = E1€ = E2€ = E4 \ \#$$

$$1€ = E6 \ \#$$

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

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^{US}, is equal to aggregate demand, which in turn is given by the sum of household's consumption, C_t^{US}, firm's investment, I_t^{US}, government spending, G_t^{US}, and net exports (i.e., the difference between exports, X_t^{US}, and imports, IM_t^{US}).

$$Y_t^{US} = C_t^{US} + I_t^{US} + G_t^{US} + X_t^{US} - IM_t^{US} \quad (3.1)$$

$$Y_t^{RW} = C_t^{RW} + I_t^{RW} + G_t^{RW} + X_t^{RW} - IM_t^{RW} \quad (3.2)$$

$$Y_t^{SP} = C_t^{SP} + I_t^{SP} + G_t^{SP} + X_t^{SP} - IM_t^{SP} \quad (3.3)$$

$$Y_t^{GE} = C_t^{GE} + I_t^{GE} + G_t^{GE} + X_t^{GE} - IM_t^{GE} \quad (3.4)$$

All the components of aggregate demand, except for government spending 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.

$$G_t^{US} = G_0^{US} + (1 + g^{US}).\, G_{t-1}^{US} \tag{3.5}$$

$$G_t^{RW} = G_0^{RW} + (1 + g^{RW}).\, G_{t-1}^{RW} \tag{3.6}$$

$$G_t^{SP} = \begin{cases} G_0^{SP} + (1 + g^{SP}).\, G_{t-1}^{SP} & if \quad \frac{G_{t-1}^{SP} - T_{t-1}^{SP}}{Y_{t-1}^{SP}} < 0.03 \\ G_0^{SP} + (1 - g^{SP}).\, G_{t-1}^{SP} & if \quad \frac{G_{t-1}^{SP} - T_{t-1}^{SP}}{Y_{t-1}^{SP}} \geq 0.03 \end{cases} \tag{3.7}$$

$$G_t^{GE} = \begin{cases} G_0^{GE} + (1 + g^{GE}).\, G_{t-1}^{GE} & if \quad \frac{G_{t-1}^{GE} - T_{t-1}^{GE}}{Y_{t-1}^{GE}} < 0.03 \\ G_0^{GE} + (1 - g^{GE}).\, G_{t-1}^{GE} & if \quad \frac{G_{t-1}^{GE} - T_{t-1}^{GE}}{Y_{t-1}^{GE}} \geq 0.03 \end{cases} \tag{3.8}$$

Hence, government spending in each period, G_t^{US}, is given by a constant term, G_0^{US}, plus an exogenous rate of growth, g^{US}. 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 has to be equal to total imports. 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 are the ones usually used in the literature, which account for both income and price effects (the latter being both direct and indirect).

$$\log\left(IM_{GE_t}^{US}\right) = \mu 0^{US} + \mu 1^{US}.\log(Y_t^{US}) + \mu 2^{US}.\log(E1_t) + \mu 3^{US}.\log((1/E2_t).(\tfrac{1}{E4_t})) \tag{3.9}$$

$$\log\left(IM_{SP_t}^{US}\right) = \mu 4^{US} + \mu 5^{US}.\log(Y_t^{US}) + \mu 6^{US}.\log(E2_t) + \mu 7^{US}.\log((1/E4_t).(\tfrac{1}{E1_t})) \tag{3.10}$$

$$\log\left(IM_{RW_t}^{US}\right) = \mu 8^{US} + \mu 9^{US}.\log(Y_t^{US}) + \mu 10^{US}.\log(E4_t) + \mu 11^{US}.\log((1/E2_t).(\tfrac{1}{E1_t})) \tag{3.11}$$

$$\log\left(IM_{US_t}^{GE}\right) = \mu 0^{GE} + \mu 1^{GE}.\log(Y_t^{GE}) + \mu 2^{GE}.\log\left(\tfrac{1}{E1_t}\right) + \mu 3^{GE}.\log((1/E3_t).(\tfrac{1}{E6_t})) \tag{3.12}$$

$$\log\left(IM_{SP}^{GE}{}_t\right) = \mu 4^{GE} + \mu 5^{GE}\,.\log(Y_t^{GE}) + \mu 6^{GE}\,.\log\,(E3_t) + \mu 7^{GE}\,.\log((E1)\,.\,(\tfrac{1}{E6_t})) \quad (3.13)$$

$$\log\left(IM_{RW}^{GE}{}_t\right) = \mu 8^{GE} + \mu 9^{GE}\,.\log(Y_t^{GE}) + \mu 10^{GE}\,.\log\,(E6_t) + \mu 11^{GE}\,.\log((E1_t)\,.\,(\tfrac{1}{E3_t})) \quad (3.14)$$

$$\log\left(IM_{GE}^{SP}{}_t\right) = \mu 0^{SP} + \mu 1^{SP}\,.\log(Y_t^{SP}) + \mu 2^{SP}\,.\log\,(\tfrac{1}{E3_t}) + \mu 3^{SP}\,.\log((E2_t)\,.(E5)) \quad (3.15)$$

$$\log\left(IM_{US}^{SP}{}_t\right) = \mu 4^{SP} + \mu 5^{SP}\,.\log(Y_t^{SP}) + \mu 6^{SP}\,.\log\,(\tfrac{1}{E2_t}) + \mu 7^{SP}\,.\log((E3_t)\,.(E5)) \quad (3.16)$$

$$\log\left(IM_{RW}^{SP}{}_t\right) = \mu 8^{SP} + \mu 9^{SP}\,.\log(Y_t^{CH}) + \mu 10^{SP}\,.\log\,(\tfrac{1}{E5_t}) + \mu 11^{SP}\,.\log((E2_t)\,.(E3)) \quad (3.17)$$

$$\log\left(IM_{GE}^{RW}{}_t\right) = \mu 0^{RW} + \mu 1^{RW}\,.\log(Y_t^{RW}) + \mu 2^{RW}\,.\log\,(\tfrac{1}{E6_t}) + \mu 3^{RW}\,.\log((E4_t)\,.(1/E5)) \quad (3.18)$$

$$\log\left(IM_{US}^{RW}{}_t\right) = \mu 4^{RW} + \mu 5^{RW}\,.\log(Y_t^{RW}) + \mu 6^{RW}\,.\log\,(\tfrac{1}{E4_t}) + \mu 7^{RW}\,.\log((E6_t)\,.(1/E5)) \quad (3.19)$$

$$\log\left(IM_{SP}^{RW}{}_t\right) = \mu 8^{RW} + \mu 9^{RW}\,.\log(Y_t^{RW}) + \mu 10^{RW}\,.\log\,(E5_t) + \mu 11^{RW}\,.\log((E4_t)\,.(E6)) \quad (3.20)$$

It is worth mentioning that since this is a model where prices are fixed, the real exchange rate will equal 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 (3.1-3.4).

$$IM_t^{US} = IM_{GE}^{US}{}_t + IM_{SP}^{US}{}_t + IM_{RW}^{US}{}_t \quad (3.21)$$

$$IM_t^{GE} = IM_{US}^{GE}{}_t + IM_{SP}^{GE}{}_t + IM_{RW}^{GE}{}_t \quad (3.22)$$

$$IM_t^{SP} = IM_{US}^{SP}{}_t + IM_{GE}^{SP}{}_t + IM_{RW}^{SP}{}_t \quad (3.23)$$

$$IM_t^{RW} = IM_{US}^{RW}{}_t + IM_{GE}^{RW}{}_t + IM_{SP}^{RW}{}_t \quad (3.24)$$

As it was mentioned before, a trade flow is the mirror of the other. Thus, $IM_{US}^{RW}{}_t$ has to be equal to $X_{RW}^{US}{}_t$. Since it is required that every trade flow is expressed in the domestic currency of the corresponding country, the following conversion is applied:

$$X_{GE}^{US}{}_t = IM_{US}^{GE}{}_t\,.\frac{1}{E1_t} \quad (3.25)$$

$$X_{SP}^{US}{}_t = IM_{US}^{SP}{}_t . \frac{1}{E2_t} \quad (3.26)$$

$$X_{RW}^{US}{}_t = IM_{US}^{RW}{}_t . \frac{1}{E4_t} \quad (3.27)$$

$$X_{US}^{GE}{}_t = IM_{GE}^{US}{}_t . E1_t \quad (3.28)$$

$$X_{SP}^{GE}{}_t = IM_{GE}^{SP}{}_t \quad (3.29)$$

$$X_{RW}^{GE}{}_t = IM_{GE}^{RW}{}_t . \frac{1}{E6_t} \quad (3.30)$$

$$X_{US}^{SP}{}_t = IM_{SP}^{US}{}_t . E2_t \quad (3.31)$$

$$X_{GE}^{SP}{}_t = IM_{SP}^{GE}{}_t \quad (3.32)$$

$$X_{RW}^{SP}{}_t = IM_{SP}^{RW}{}_t . E5_t \quad (3.33)$$

$$X_{US}^{RW}{}_t = IM_{RW}^{US}{}_t . E4_t \quad (3.34)$$

$$X_{GE}^{RW}{}_t = IM_{RW}^{GE}{}_t . E6_t \quad (3.35)$$

$$X_{SP}^{RW}{}_t = IM_{RW}^{SP}{}_t . \frac{1}{E5_t} \quad (3.36)$$

Note that since there is no nominal exchange rate within the Eurozone, trade flows in equations (3.29) and (3.32) do not need to be converted. Finally, the same as we did with imports, we can obtain aggregate exports by adding up bilateral exports flows.

$$X_t^{US} = X_{GE}^{US}{}_t + X_{SP}^{US}{}_t + X_{RW}^{US}{}_t \quad (3.37)$$

$$X_t^{GE} = X_{US}^{GE}{}_t + X_{SP}^{GE}{}_t + X_{RW}^{GE}{}_t \quad (3.38)$$

$$X_t^{SP} = X_{US}^{SP}{}_t + X_{GE}^{SP}{}_t + X_{RW}^{SP}{}_t \quad (3.39)$$

$$X_t^{RW} = X_{US}^{RW}{}_t + X_{GE}^{RW}{}_t + X_{SPH}^{RW}{}_t \quad (3.40)$$

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 labor 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 ψ, which represents the share of wages out of total income.

$$W_t^i = \psi^i \,.\, Y_t^i \qquad \forall\, i = US, GE, SP, RW \qquad (3.41 – 3.44)$$

Although labor 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^i, which earn a yield, rd_t^i , and cash, H_t^i, which earns no yield whatsoever. Regarding tax payments, in this model, it is assumed that a fraction θh^i of total income is levied, leading to the total amount of taxes that households pay, Th_t^i.

$$Th_t^i = \theta h^i \,.\, (W_t^i + rd_{t-1}^i \,.\, M_{t-1}^i) \qquad \forall\, i = US, GE, SP, RW \qquad (3.45 – 3.48)$$

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

$$Yd_t^i = W_t^i + rd_{t-1}^i \,.\, M_{t-1}^i - Th_t^i \qquad \forall\, i = US, GE, SP, RW \qquad (3.49 – 3.52)$$

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 wealth ($\alpha 1 > \alpha 2$).

$$C_t^i = \alpha 1^i \,.\, Yd_t^i + \alpha 2^i \,.\, Vh_{t-1}^i \qquad \forall\, i = US, GE, SP, RW \qquad (3.53 – 3.56)$$

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 saving, which in turn is given by the difference between disposable income and consumption.

$$\Delta Vh_t^i = Yd_t^i - C_t^i \qquad \forall\, i = US, GE, SP, RW \qquad (3.57 – 3.60)$$

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

$$H_t^i = \varphi_t^i \,.\, C_t^i \qquad \forall\, i = US, EZ, CH, RW \qquad (3.61 - 3.64)$$

$$M_t^i = Vh_t^i - H_t^i \qquad \forall\, i = US, EZ, CH, RW \qquad (3.65 - 3.68)$$

Firm's Investment and Demand for Credit

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

$$P_t^i = Y_t^i - W_t^i \qquad \forall\, i = US, GE, SP, RW \qquad (3.69 - 3.72)$$

However, P_t^i 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.

$$Pf_t^i = P_t^i - rl_{t-1}^i \,.\, L_{t-1}^i - Tf_t^i \qquad \forall\, i = US, GE, SP, RW \quad (3.73 - 3.76)$$

$$Tf_t^i = \theta f^i \,.\, (P_t^i - rl_{t-1}^i \,.\, L_{t-1}^i) \qquad \forall\, i = US, GE, SP, RW \quad (3.77 - 3.80)$$

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^i, are incorporated into the model. Each term of this function is accompanied by a constant, z, which measures the sensibility of investment to each of its components.

$$\frac{I_t^i}{K_{t-1}^i} = z0^i + z1^i \,.\, \frac{P_t^i}{K_{t-1}^i} - z2^i \,.\, \frac{rl_{t-1}^i \,.\, L_{t-1}^i}{K_{t-1}^i} + z3^i \,.\, u_{t-1}^i \qquad \forall\, i = US, GE, SP, RW \quad (3.85 - 3.88)$$

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

$$u_t^i = \left(\frac{Y_t^i}{K_t^i}\right) \,.\, v^i \qquad \forall\, i = US, GE, SP, RW \ (3.89 - 3.92)$$

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

$$K_t^i = \left(1 - \delta^i\right).K_{t-1}^i + I_t^i \qquad \forall\, i = US, GE, SP, RW \text{ (3.93 – 3.96)}$$

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.

$$\Delta L_t^i = I_t^i - PD_t^i \qquad \forall\, i = US, GE, SP, RW \text{ (3.97 – 3.100)}$$

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

$$Vf_t^i = K_t^i - L_t^i \qquad \forall\, i = US, EZ, CH, RW \qquad \text{(3.101 – 3.104)}$$

The Government

Many features of the behavior of the government have already been introduced. Government spending, as defined by equations (3.5-3.8), 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 (3.45-3.48) and (3.77-3.80), respectively. Thus, total tax income by the government is given by the sum of taxes on households, firms and banks.

$$T_t^i = Th_t^i + Tf_t^i \qquad \forall\, i = US, GE, SP, RW \qquad \text{(3.105 – 3.108)}$$

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:

$$\Delta Bs_t^i = G_t^i - T_t^i + r_{t-1}^i\,.Bs_{t-1}^i - Pcb_t^i \qquad \forall\, i = US, RW \qquad \text{(3.109 – 3.110)}$$

$$\Delta Bs_t^i = G_t^i - T_t^i + r_{t-1}^i . Bs_{t-1}^i - Pcb_t^i - P_t^{ECB} \qquad \forall\, i = GE, SP \qquad (3.111 - 3.112)$$

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 are distributed equally among the member countries. 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 consider to be as countries with sovereign currencies, as reality has proven lately.

Commercial Banks

Thus far, commercial banks have been introduced implicitly and in a passive manner. It was showed 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 and bills to households is totally demand-led, i.e., banks supply as much credit, deposits and bills as are demanded. Although this way of describing the role of commercial banks may seem reasonable for the case of their relationship with households, some readers may disagree with the fact that credit is a demand driven phenomenon. In this regard, it is important to mention that in order to be consistent with Post Keynesian theory it is being assumed that all credit worthy firms are granted credits and those are the firms that in the end determine the investment flow described by equations (3.85-3.88).

In the real world, however, the financial sector, than not only includes commercial banks but also investment banks, hedge funds, etc. play an active role, giving rise to a process labeled 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 we do not deal with financialisation (some interesting attempts to describe this phenomenon in the framework of stock-flow models can be found in Caverzasi & Godin (2014) and van Treeck (2009)). Instead, we simply assume that commercial banks 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 their extremely liquid liabilities, i.e., the money that belongs to households. The decision about how many bonds buy from each government is a portfolio decision mainly driven by the return of each type of bond, given by the interest rate.

Following Tobin (1969) and Godley (1996) (which we have already described in detail in Annex 1) criteria we write equations (3.113 – 3.128):

$$Bd, b_{GE_t}^{US} = [(1 - \xi^{GE}).M_t^{GE}] . (\gamma 10^{GE} + \gamma 11^{GE} . r^{US} + \gamma 12^{GE} . r^{GE} + \gamma 13^{GE} . r^{SP} + \gamma 14^{GE} . r^{RW}) \quad (3.113)$$

$$Bd, b_{GE_t}^{SP} = [(1 - \xi^{GE}). M_t^{GE}] . (\gamma 20^{GE} + \gamma 21^{GE} . r^{US} + \gamma 22^{GE} . r^{GE} + \gamma 23^{GE} . r^{SP} + \gamma 24^{GE} . r^{RW}) \quad (3.114)$$

$$Bd, b_{GE_t}^{RW} = [(1 - \xi^{GE}). M_t^{GE}] . (\gamma 30^{GE} + \gamma 31^{GE} . r^{US} + \gamma 32^{GE} . r^{GE} + \gamma 33^{GE} . r^{SP} + \gamma 34^{GE} . r^{RW}) \quad (3.115)$$

$$Bd, b_{GE_t}^{GE} = [(1 - \xi^{GE}). M_t^{GE}] - Bd, b_{GE_t}^{US} - Bd, b_{GE_t}^{SP} - Bd, b_{GE_t}^{RW} \quad (3.116)$$

$$Bd, b_{US_t}^{GE} = [(1 - \xi^{US}). M_t^{US}] . (\gamma 10^{US} + \gamma 11^{US} . r^{US} + \gamma 12^{US} . r^{GE} + \gamma 13^{US} . r^{SP} + \gamma 14^{US} . r^{RW}) \quad (3.117)$$

$$Bd, b_{US_t}^{SP} = [(1 - \xi^{US}). M_t^{US}] . (\gamma 20^{US} + \gamma 21^{US} . r^{US} + \gamma 22^{US} . r^{GE} + \gamma 23^{US} . r^{SP} + \gamma 24^{US} . r^{RW}) \quad (3.118)$$

$$Bd, b_{US_t}^{RW} = [(1 - \xi^{US}).M_t^{US}] . (\gamma 30^{US} + \gamma 31^{US} . r^{US} + \gamma 32^{US} . r^{GE} + \gamma 33^{US} . r^{SP} + \gamma 34^{US} . r^{RW}) \quad (3.119)$$

$$Bd, b_{US_t}^{US} = [(1 - \xi^{US}). M_t^{US}] - Bd, b_{US_t}^{GE} - Bd, b_{US_t}^{SP} - Bd, b_{US_t}^{RW} \quad (3.120)$$

$$Bd, b_{SP_t}^{GE} = [(1 - \xi^{SP}). M_t^{SP}] . (\gamma 10^{SP} + \gamma 11^{SP} . r^{US} + \gamma 12^{SP} . r^{GE} + \gamma 13^{SP} . r^{SP} + \gamma 14^{SP} . r^{RW}) \quad (3.121)$$

$$Bd, b_{SP_t}^{US} = [(1 - \xi^{SP}). M_t^{SP}] . (\gamma 20^{SP} + \gamma 21^{SP} . r^{US} + \gamma 22^{SP} . r^{GE} + \gamma 23^{SP} . r^{SP} + \gamma 24^{SP} . r^{RW}) \quad (3.122)$$

$$Bd, b_{SP_t}^{RW} = [(1 - \xi^{SP}).M_t^{SP}] . (\gamma 30^{SP} + \gamma 31^{SP} . r^{US} + \gamma 32^{SP} . r^{GE} + \gamma 33^{SP} . r^{SP} + \gamma 34^{SP} . r^{RW}) \quad (3.123)$$

$$Bd, b_{SP_t}^{SP} = [(1 - \xi^{SP}). M_t^{SP}] - Bd, b_{SP_t}^{GE} - Bd, b_{SP_t}^{US} - Bd, b_{SP_t}^{RW} \quad (3.124)$$

$$Bd, b_{RW_t}^{GE} = [(1 - \xi^{RW}). M_t^{RW}] . (\gamma 10^{RW} + \gamma 11^{RW} . r^{US} + \gamma 12^{RW} . r^{GE} + \gamma 13^{RW} . r^{SP} + \gamma 14^{RW} . r^{RW}) \quad (3.125)$$

$$Bd, b_{RW_t}^{US} = [(1 - \xi^{RW}).M_t^{RW}] . (\gamma 20^{RW} + \gamma 21^{RW} . r^{US} + \gamma 22^{RW} . r^{GE} + \gamma 23^{RW} . r^{SP} + \gamma 24^{RW} . r^{RW}) \quad (3.126)$$

$$Bd, b_{RW_t}^{SP} = [(1 - \xi^{RW}).M_t^{RW}] . (\gamma 30^{RW} + \gamma 31^{RW} . r^{US} + \gamma 32^{RW} . r^{GE} + \gamma 33^{RW} . r^{SP} + + \gamma 34^{RW} . r^{RW}) \quad (3.127)$$

$$Bd, b_{RW_t}^{RW} = [(1 - \xi^{RW}).M_t^{RW}] - Bd, b_{RW_t}^{GE} - Bd, b_{RW_t}^{US} - Bd, b_{RW_t}^{SP} \quad (3.128)$$

In order to facilitate the understanding of the notation used above, let us take equation (3.113) as an example. This equation states that the demand of US' commercial banks of bonds denominated in euros issued by Germany $Bd, b_{GE_t}^{US}$ 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, which are defined as a fraction ξ of deposits. The

parameters γ represent the sensibility of the demand of each type of bond to changes on the relative returns that these assets yield. These parameters are written in such a way that they fulfill 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. Since the demand was just defined above, the supply can be obtained by transforming the bilateral demand of bonds by the banks through the bilateral exchange rate.

$$Bs, b_{GE_t}^{GE} = Bd, b_{GE_t}^{GE} \quad (3.129)$$

$$Bs, b_{GE_t}^{US} = \frac{Bd, b_{GE_t}^{US}}{E1_t} \quad (3.130)$$

$$Bs, b_{GE_t}^{SP} = Bd, b_{GE_t}^{SP} \quad (3.131)$$

$$Bs, b_{GE_t}^{RW} = Bd, b_{GE_t}^{RW} . E6_t \quad (3.132)$$

$$Bs, b_{US_t}^{US} = Bd, b_{US_t}^{US} \quad (3.133)$$

$$Bs, b_{US_t}^{GE} = Bd, b_{US_t}^{GE} . E1_t \quad (3.134)$$

$$Bs, b_{US_t}^{SP} = Bd, b_{US_t}^{SP} . E2_t \quad (3.135)$$

$$Bs, b_{US_t}^{RW} = Bd, b_{US_t}^{RW} . E4_t \quad (3.136)$$

$$Bs, b_{SP_t}^{SP} = Bd, b_{SP_t}^{SP} \quad (3.137)$$

$$Bs, b_{SP_t}^{GE} = Bd, b_{SP_t}^{GE} \quad (3.138)$$

$$Bs, b_{SP_t}^{US} = \frac{Bd, b_{SP_t}^{US}}{E2_t} \quad (3.139)$$

$$Bs, b_{SP_t}^{RW} = \frac{Bd, b_{SP_t}^{RW}}{E5_t} \quad (3.140)$$

$$Bs, b_{RW_t}^{RW} = Bd, b_{RW_t}^{RW} \quad (3.141)$$

$$Bs, b_{RW_t}^{GE} = \frac{Bd, b_{RW_t}^{GE}}{E6_t} \quad (3.142)$$

$$Bs, b_{RW_t}^{US} = \frac{Bd, b_{RW_t}^{US}}{E4_t} \quad (3.143)$$

$$Bs, b_{RW_t}^{SP} = Bd, b_{RW_t}^{SP} . E5_t \quad (3.144)$$

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 feature by stating that the commercial bank's demand for reserves are given by a proportion ξ^i 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.

$$R_t^i = \xi^i . M_t^i \qquad \forall\, i = US, GE, SP, RW \quad (3.145 – 3.148)$$

It is also important to describe how the banking system of these economies operates. In this model, it is assumed that the four economies are overdraft economies, which implies that commercial banks can obtain all the financing needs from the central bank (the system works differently in the U.S., but in order to keep the model simple it is assumed that the monetary system within each economy works in the same way). These are equal to the difference between their assets and the liabilities. Therefore, we denote the advances made to commercial banks by the central banks by (A_t^i), which are an asset for the central banks and a liability for the commercial banks (3.149 – 3.152).

$$A_t^{GE} = Bd, b_{GE_t}^{GE} + Bd, b_{GE_t}^{US} + Bd, b_{GE_t}^{SP} + Bd, b_{GE_t}^{RW} + L_t^{GE} + R_t^{GE} - M_t^{GE} - Vb_t^{GE} \quad (3.149)$$

$$A_t^{US} = Bd, b_{US_t}^{US} + Bd, b_{US_t}^{GE} + Bd, b_{US_t}^{SP} + Bd, b_{US_t}^{RW} + L_t^{US} + R_t^{US} - M_t^{US} - Vb_t^{US} \quad (3.150)$$

$$A_t^{SP} = Bd, b_{SP_t}^{SP} + Bd, b_{SP_t}^{GE} + Bd, b_{SP_t}^{US} + Bd, b_{SP_t}^{RW} + L_t^{SP} + R_t^{SP} - M_t^{SP} - Vb_t^{SP} \quad (3.151)$$

$$A_t^{RW} = Bd, b_{RW_t}^{RW} + Bd, b_{RW_t}^{GE} + Bd, b_{RW_t}^{US} + Bd, b_{RW_t}^{SP} + L_t^{RW} + R_t^{RW} - M_t^{RW} - Vb_t^{RW} \quad (3.152)$$

Having defined almost all the components of the banks' balance sheet, we are ready to describe the origin of banks' profits. These will be the result of two sources: interest earnings/payments and the valuation effects that arise from exchange rate movements.

$$Pb_t^{US} = r_{t-1}^{US}. Bs, b_{US_{t-1}}^{US} + r_{t-1}^{GE}. Bs, b_{US_{t-1}}^{GE} \frac{1}{E1} + r_{t-1}^{SP}. Bs, b_{US_{t-1}}^{SP} \frac{1}{E2} + r_{t-1}^{RW}. Bs, b_{US_{t-1}}^{RW} \frac{1}{E4} + Bs, b_{US_{t-1}}^{GE}. \Delta\left(\frac{1}{E1}\right) + Bs, b_{US_{t-1}}^{SP}. \Delta\left(\frac{1}{E2}\right) + Bs, b_{US_{t-1}}^{RW}. \Delta\left(\frac{1}{E4}\right) + rs_{t-1}^{US}. R_{t-1}^{US} + rl_{t-1}^{US}. L_{t-1}^{US} - rd_{t-1}^{US}. M_{t-1}^{US} - r_{t-1}^{US}. A_{t-1}^{US} \quad (3.153)$$

$$Pb_t^{GE} = r_{t-1}^{GE}. Bs, b_{GE_{t-1}}^{GE} + r_{t-1}^{US}. Bs, b_{GE_{t-1}}^{US} E1 + r_{t-1}^{SP}. Bs, b_{GE_{t-1}}^{SP} + r_{t-1}^{RW}. Bs, b_{GE_{t-1}}^{RW} \frac{1}{E6} + Bs, b_{GE_{t-1}}^{US}. \Delta(E1) + Bs, b_{GE_{t-1}}^{SP} + Bs, b_{GE_{t-1}}^{RW}. \Delta\left(\frac{1}{E6}\right) + rs_{t-1}^{GE}. R_{t-1}^{GE} + rl_{t-1}^{GE}. L_{t-1}^{GE} - rd_{t-1}^{GE}. M_{t-1}^{GE} - r_{t-1}^{GE}. A_{t-1}^{GE} \quad (3.154)$$

$$Pb_t^{SP} = r_{t-1}^{SP}.Bs,b_{SP_{t-1}}^{SP} + r_{t-1}^{GE}.Bs,b_{SP_{t-1}}^{GE} + r_{t-1}^{US}.Bs,b_{SP_{t-1}}^{US}E2 + r_{t-1}^{RW}.Bs,b_{SP_{t-1}}^{RW}E5 + Bs,b_{SP_{t-1}}^{GE} + Bs,b_{SP_{t-1}}^{US}.\Delta(E2) + Bs,b_{SP_{t-1}}^{RW}.\Delta(E5) + rs_{t-1}^{SP}.R_{t-1}^{SP} + rl_{t-1}^{SP}.L_{t-1}^{SP} - rd_{t-1}^{SP}.M_{t-1}^{SP} - r_{t-1}^{SP}.A_{t-1}^{SP} \quad (3.155)$$

$$Pb_t^{RW} = r_{t-1}^{RW}.Bs,b_{RW_{t-1}}^{RW} + r_{t-1}^{EZ}.Bs,b_{RW_{t-1}}^{GE}E6 + r_{t-1}^{SP}.Bs,b_{RW_{t-1}}^{SP}\frac{1}{E5} + r_{t-1}^{US}.Bs,b_{RW_{t-1}}^{US}E4 + Bs,b_{RW_{t-1}}^{GE}.\Delta E6 + Bs,b_{RW_{t-1}}^{SP}.\Delta\left(\frac{1}{E5}\right) + Bs,b_{RW_{t-1}}^{US}.\Delta(E4) + rs_{t-1}^{RW}.R_{t-1}^{RW} + rl_{t-1}^{RW}.L_{t-1}^{RW} - rd_{t-1}^{RW}.M_{t-1}^{RW} - r_{t-1}^{RW}.A_{t-1}^{RW} \quad (3.156)$$

The change in the stock of wealth of banks is given by their profits.

$$\Delta Vb_t^i = Pb_t^i \qquad \forall\, i = US, GE, SP, RW \qquad (3.157 – 3.160)$$

National Central Banks and the European Central Bank

Following the Post Keynesian approach to the monetary system, the central bank is considered to be a passive actor in the economy. This includes the notion of endogenous money, i.e., the central bank does not choose how much money to pump into the system but it supplies as much money as 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.

$$r_t^{US} = \overline{r^{US}} \quad (3.161)$$

$$r_t^{RW} = \overline{r^{RW}} \quad (3.162)$$

$$r_t^{SP} = \overline{r^{SP}} \quad (3.163)$$

$$r_t^{GE} = \overline{r^{GE}} \quad (3.164)$$

$$Hs_t^{US} = Hd_t^{US} \quad (3.165)$$

$$Hs_t^{RW} = Hd_t^{RW} \quad (3.166)$$

$$Hs_t^{EZ} = Hd_t^{SP} + Hd_t^{GE} \quad (3.167)$$

$$Hs,cb_t^{SP} = 0.46\, Hs_t^{EZ} \quad (3.168)$$

$$Hs,cb_t^{GE} = 0.46\, Hs_t^{EZ} \quad (3.169)$$

$$Hs_t^{ECB} = 0.08\, Hs_t^{EZ} \quad (3.170)$$

As it was explained in section 3, 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, the following 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.

$$IEA_t^{SP} = Hs, cb_t^{SP} - Hd_t^{SP} \quad (3.171)$$

$$IEA_t^{GE} = Hs, cb_t^{GE} - Hd_t^{GE} \quad (3.172)$$

$$IEA_t^{ECB} = Hs_t^{ECB} \quad (3.173)$$

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 the adjustment between the supply and the demand for bonds. However, if the country issues its own currency, the central bank could intervene in the bond market in order to achieve a certain target for the long-term rate of interest. In this model, it is assumed, 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 analyze the turbulence in the Eurozone after 2008, both interest rates will be separated in order to get a clearer representation of reality.

$$rb_t^{US} = \overline{r_t^{US}} \quad (3.174)$$

$$rb_t^{RW} = \overline{r_t^{RW}} \quad (3.175)$$

$$rb_t^{SP} = \overline{r_t^{SP}} \quad (3.176)$$

$$rb_t^{GE} = \overline{r_t^{GE}} \quad (3.177)$$

Godley/Lavoie (2007a) present two closures for an open economy model: one for the case where the exchange rate is flexible and the other one for the case of fixed exchange

rates[25]. In the first case, the bond market of one of the countries (say, the UK) is cleared through exchange rate movements, which may be upwards or downwards depending on the gap between supply and demand. The purchases and sales of domestic bonds by the central bank ensure that its balance sheet identity holds at every point of time. The other country's (say, the US) bond market is balanced through purchases and sales by the monetary authority. So we are left with the explanation of how the balance sheet identity of the monetary authority of the US is satisfied. As it happens in every stock-flow consistent model, there is an equation that does not need to be written, since it can be derived from the remaining equations of the model. In this closure, this is the case of the balance sheet identity of the central bank of the US.

In the second case, i.e., when the exchange rate is fixed, this variable can no longer ensure that the bond market of the US is in equilibrium. Thus, it is the central bank that must intervene to make supply equal demand. Moreover, since the exchange rate is fixed, the monetary authority must intervene in the foreign exchange market in order to ensure equilibrium between supply and demand at the targeted exchange rate. These interventions bring about changes in the stock of foreign reserves held by the monetary authority. As regards the bond market of the other county, it is cleared through interventions of the central bank. Once the equations for the aforementioned processes have been written, we are left with the equation that guarantees that the balance sheet identity of the central bank of the US is being held. As it happened in the flexible exchange rate closure, this is the redundant equation of the model. This same closure is used by Mazier/Tiou-Tagba Aliti (2012) who, instead of defining one exchange rate, work with three (one for each country).

In this model the rest of the world has a fixed exchange rate vis-à-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.

[25] Actually, they present four closures since the fixed exchange rate closure can be combined with endogenous foreign reserves, endogenous interest rate and endogenous government expenditures. In this paper we take the fixed exchange rate closure with endogenous foreign reserves.

First, it is necessary to define TARGET2 balances in a way that is consistent with the accounting framework presented in section 3. Consequently, the Banco de España and the Bundesbank will accumulate net TARGET2 balances, which are considered assets (in case these balances constitute a liability they 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 and outflow are recorded with a negative sign.

$$\Delta TG2_t^{SP} = X_{SP_t}^{GE} - IM_{SP_t}^{GE} + rb_{t-1}^{GE}.Bd, b_{SP_{t-1}}^{GE} - rb_{t-1}^{SP}.Bd, b_{GE_{t-1}}^{SP} + \Delta Bs, b_{SP_t}^{GE} - \Delta Bd, b_{SP_t}^{GE} \quad (3.178)$$

$$\Delta TG2_t^{GE} = X_{GE_t}^{SP} - IM_{GE_t}^{SP} + rb_{t-1}^{SP}.Bd, b_{GE_{t-1}}^{SP} - rb_{t-1}^{GE}.Bd, b_{SP_{t-1}}^{GE} + \Delta Bs, b_{GE_t}^{SP} - \Delta Bd, b_{GE_t}^{SP} \quad (3.179)$$

The only component of the balance sheet of the Banco de España and the Bundesbank that is left to define 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".

$$\Delta Bd, cb_{SP_t}^{SP} = \Delta R_t^{SP} + \Delta Hs, cb_t^{SP} - \Delta A_t^{SP} - \Delta IEA_t^{SP} - \Delta TG2_t^{SP} \quad (3.180)$$

$$\Delta Bd, cb_{GE_t}^{GE} = \Delta R_t^{GE} + \Delta Hs, cb_t^{GE} - \Delta A_t^{GE} - \Delta IEA_t^{GE} - \Delta TG2_t^{GE} \quad (3.181)$$

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 demands of bonds denominated in euros to the US. Note that, as we have been mentioning in the previous sections, E1=E2.

$$E1_t = \frac{Bs_t^{GE} + Bs_t^{SP} - Bs, b_{SP_t}^{SP} - Bs, b_{GE_t}^{GE} - Bs, b_{SP_t}^{GE} - Bs, b_{GE_t}^{SP} - Bs, b_{RW_t}^{SP} - Bs, b_{RW_t}^{GE}}{Bd, b_{US_t}^{SP} + Bd, b_{US_t}^{GE}} \quad (3.182)$$

$$E2_t = \frac{Bs_t^{GE} + Bs_t^{SP} - Bs, b_{SP_t}^{SP} - Bs, b_{GE_t}^{GE} - Bs, b_{SP_t}^{GE} - Bs, b_{GE_t}^{SP} - Bs, b_{RW_t}^{SP} - Bs, b_{RW_t}^{GE}}{Bd, b_{US_t}^{SP} + Bd, b_{US_t}^{GE}} \quad (3.183)$$

$$E3_t = \frac{E2_t}{E1_t} \quad (3.184)$$

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, which ensure the equilibrium in balance sheets of

the national central banks of Spain and Germany. As it was previously shown in the balance sheet, the variables that make up the balance sheet of the NCB are banknotes, reserves, advances, intra-Eurosystem adjustments and bonds issued by the domestic government.

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 (although, as mentioned in Section 3.3, this rule has been relaxed in order to deal with the sovereign debt crisis).

As it was also explained in section 3.3, 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 constitute the Eurozone and where the totality of real and financial transactions are assumed to be carried out through the SEPA the TARGET2 balances of the ECB will always be zero (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).

$$\Delta TG2_t^{ECB} = \Delta Hs_t^{ECB} - \Delta IEA_t^{ECB} \quad (3.185)$$

$$P_t^{ECB} = rb_{t-1}^{GE}.Bd_{ECB_{t-1}}^{GE} + rb_{t-1}^{SP}.Bd_{ECB_{t-1}}^{SP} + r_{t-1}^{GE}.IEA_{t-1}^{ECB} + r_{t-1}^{GE}.TG2_{t-1}^{ECB} + r_{t-1}^{US}.Bs_{ECB_{t-1}}^{US}.E1_t + Bs_{ECB_{t-1}}^{US}.\Delta E1_t \quad (3.186)$$

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 to keep interest rates at a certain predetermined target set.

$$E4_t = \overline{E4} \quad (3.187)$$

$$Bd, cb_{RW_t}^{RW} = Bs_t^{RW} - Bs, b_{US_t}^{RW} - Bs, b_{SP_t}^{RW} - Bs, b_{GE_t}^{RW} - Bs, b_{RW_t}^{RW} \quad (3.188)$$

Since, as equation (3.187) describes, the rest of the world has a fixed exchange rate against the US dollar the exchange rate E4 becomes exogenous. As a result, it is the demand of US government bonds by the rest of the world's central bank, $Bd, cb_{RW_t}^{US}$, that 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.

$$\Delta Bd, cb_{RW_t}^{US} = \Delta Hd_t^{RW} + \Delta Rd_t^{RW} - \Delta Ad_t^{RW} - \Delta Bd, cb_{RW_t}^{RW} \tag{3.189}$$

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

$$E5_t = \frac{E2_t}{E4_t} \tag{3.190}$$

$$E6_t = \frac{E4_t}{E1_t} \tag{3.191}$$

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 its 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 towards reserve diversification. A detailed study of this effect within a SFC framework can be found in Lavoie and Zhao (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:

$$Bd, cb_{US_t}^{US} = Bs_t^{US} - Bs, b_{US_t}^{US} - Bs, b_{GE_t}^{US} - Bs, b_{SP_t}^{US} - Bs, b_{RW_t}^{US} - Res_t - Bs_{ECB_t}^{US} \tag{3.192}$$

$$Res_t = Bs, cb_{GE_t}^{US} + Bs, cb_{SP_t}^{US} + Bs, cb_{RW_t}^{US}$$

$$Bs, cb_{RW_t}^{US} = \frac{Bd, cb_{RW_t}^{US}}{E4_t} \tag{3.193}$$

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

$$Pcb_t^{US} = r_{t-1}^{US}.Bd, cb_{US_{t-1}}^{US} - rs_{t-1}^{US}.R_{t-1}^{US} + r_{t-1}^{US}.A_{t-1}^{US} \quad (3.194)$$

$$Pcb_t^{GE} = r_{t-1}^{GE}.Bd, cb_{GE_{t-1}}^{GE} + r_{t-1}^{US}.Bs, cb_{GE_{t-1}}^{US}.E1_t + Bs, cb_{GE_{t-1}}^{US}.\Delta(E1) - rs_{t-1}^{GE}.R_{t-1}^{GE} + r_{t-1}^{GE}.A_{t-1}^{GE} + r_{t-1}^{GE}.TG2_{t-1}^{GE} \quad (3.195)$$

$$Pcb_t^{SP} = r_{t-1}^{SP}.Bd, cb_{SP_{t-1}}^{SP} + r_{t-1}^{US}.Bs, cb_{SP_{t-1}}^{US}.E2_t + Bs, cb_{SP_{t-1}}^{US}.\Delta(E2) - rs_{t-1}^{SP}.R_{t-1}^{SP} + r_{t-1}^{SP}.A_{t-1}^{SP} + r_{t-1}^{SP}.TG2_{t-1}^{SP} \quad (3.196)$$

$$Pcb_t^{RW} = r_{t-1}^{RW}.Bd, cb_{RW_{t-1}}^{RW} + r_{t-1}^{US}.Bd, cb_{RW_{t-1}}^{US} + Bs, cb_{RW_{t-1}}^{US}.\Delta(E4) - rs_{t-1}^{RW}.R_{t-1}^{RW} + r_{t-1}^{RW}.A_{t-1}^{RW} \quad (3.197)$$

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 constraint 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 constraint 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 over-determined) and is therefore used to verify that the model is consistent.

$$\Delta Rd_t^{US} + \Delta H_t^{US} - \Delta Ad_t^{US} - \Delta Bd, cb_{US_t}^{US} = 0 \quad (3.198)$$

The model has now been completely specified. We can now proceed to some simulations that attempt to represent the situation of the Eurozone before and after the outbreak of the current crisis, in 2008.

3.5. Evaluation of the model

The Eurozone before 2008

During the period between 2002 and 2008 the "periphery" of the Eurozone exhibited high growth rates, mainly Spain, Ireland, Cyprus and Greece. This process of high growth was accompanied by current account and government or private deficits (depending on the country), which were mostly financed by capital inflows from the creditor countries of the Eurozone. 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 put in question 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. 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).

There are different views that explain the order of causation of these intra-Eurozone imbalances and the role that they might have played in producing the crisis. On one side there is a view based on trade imbalances produced either by the unfavorable parities at which southern countries entered the Eurozone (Duwicquet et al (2012)), the diverging evolution of unit labor costs within the area (Lapavitsas (2012), Bibow (2012), Stockhammer (2011)) or non-price competitiveness based on differential technological structures and market-guiding industrial policies (Storm and Naastepad (2014)). On the other side, there are those who consider that imbalances are a financial phenomenon produced by the excessive liquidity and the lack of regulation that characterized the years before the crisis (Constâncio (2013) and Sinn et al (2011)). In any case, facts have shown that the current setting of the EMU suffers from the same problem of the European Monetary System (EMS), i.e., the way of solving internal imbalances is asymmetrical (De Grauwe (2013)).

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. In order to do so and following the hypotheses of Duwicquet et al (2012), Lapavitsas (2012), Bibow (2012) and Stockhammer (2012), we assume 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, μ_0^{SP}, μ_4^{SP} and μ_8^{SP}. In order to account for the larger impact of this shock in the bilateral relationship with Germany, the parameter μ_0^{SP} is increased doubly. Similarly, Germany's constant terms are proportionally reduced. Thus, the simulation of this shock requires us to shock 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, etc.) 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. Other observed phenomena, like the real estate bubble that brought about a high rate of growth (and a lot of financial instability) in Spain in the 2000s is not being modeled.

Figure 3.5: Effect of the introduction of the euro

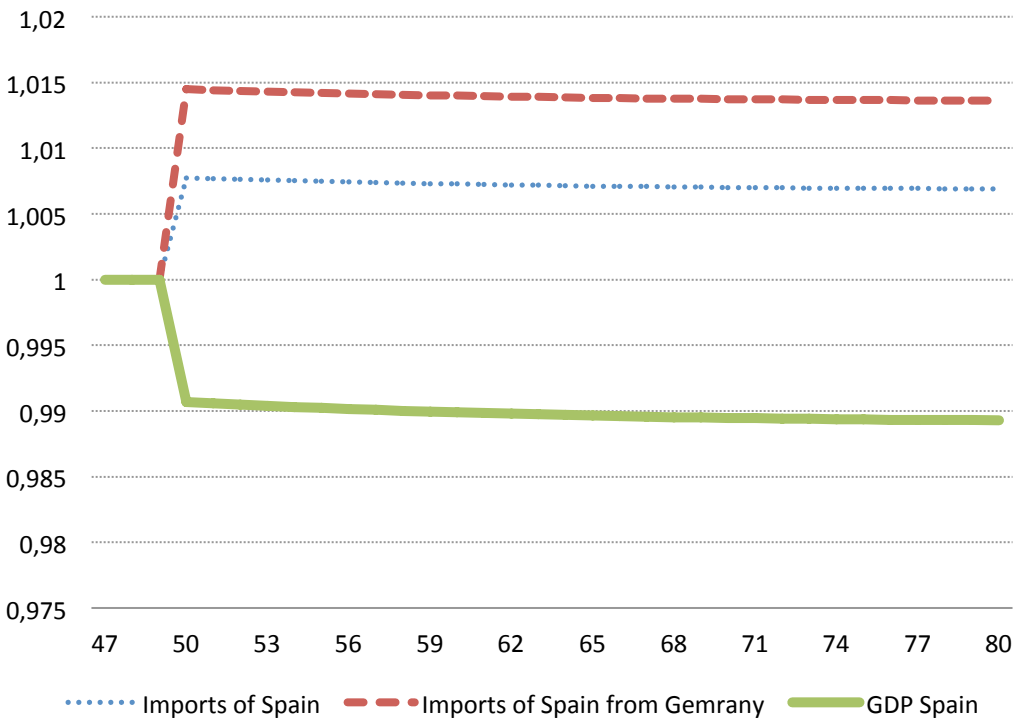
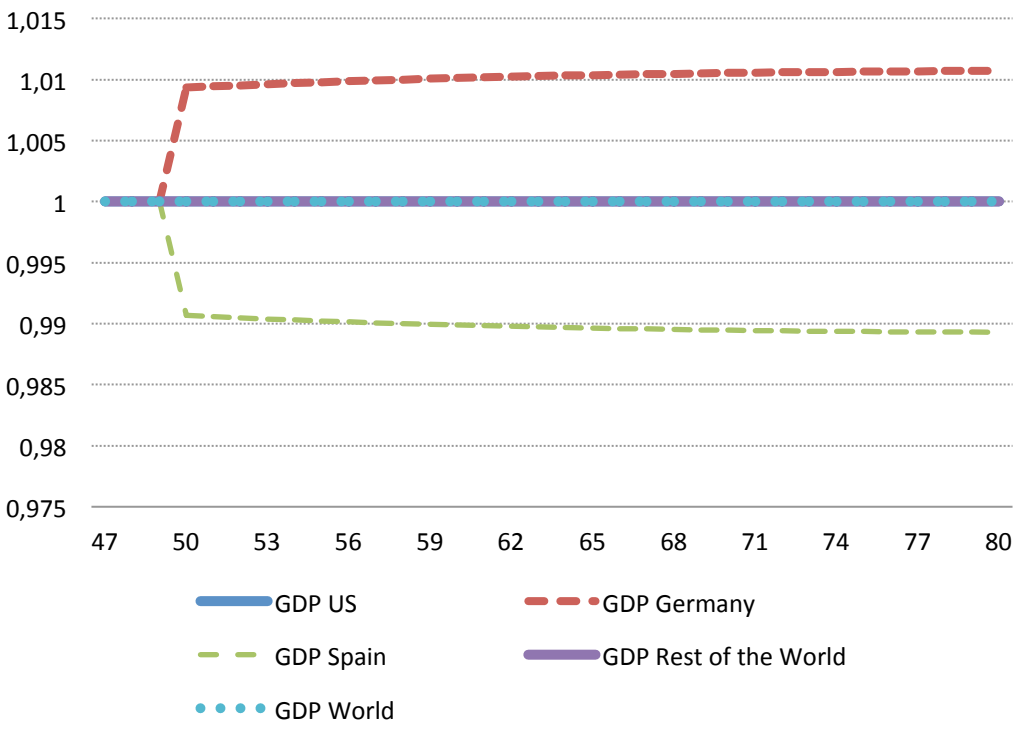
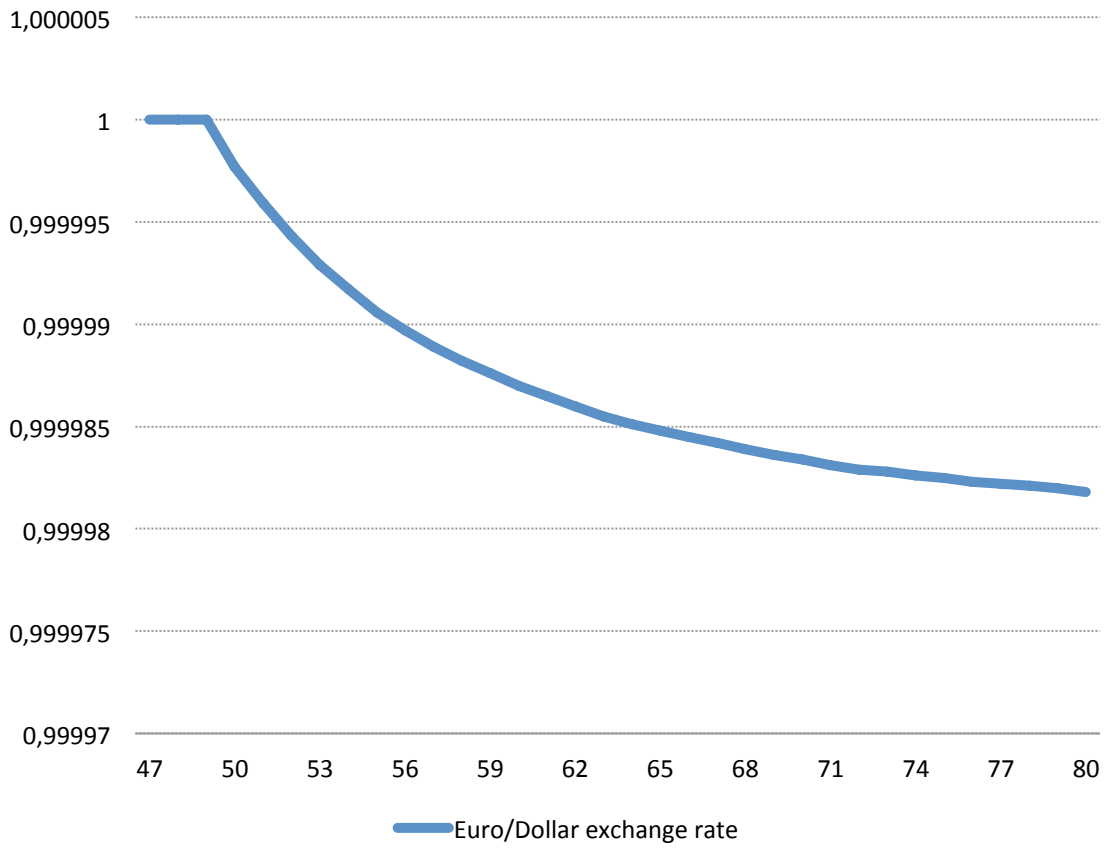


Figure 3.6: Effect of the introduction of the euro



Figures 3.5 and 3.6 show that the loss of competitiveness increases Spain's imports, thus reducing its GDP. Even though the increase in the level of activity in Germany implies a second-round benefit for the Spanish economy (since its northern neighbor will increase its imports) this effect is not enough to outweigh the intensity of the initial shock. Again, it should be born in mind that this shock is not incorporating other processes that in the 2000s allowed the Spanish economy to grow in a context of low competitiveness (like the real estate bubble). 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 3.7, the euro stays constant since no changes occur in the aggregate trading of bonds between the US and the Eurozone.

Figure 3.7: Effect of the introduction of the euro



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 3.8 and 3.9, Spain exhibits budget and current account deficits that are equal to Germany's surpluses, which implies the aggregate current account of the Eurozone is unchanged. This is another way to explain why in a context of flexible exchange rates, the euro does not fluctuate against the dollar.

Figure 3.8: Effect of the introduction of the euro

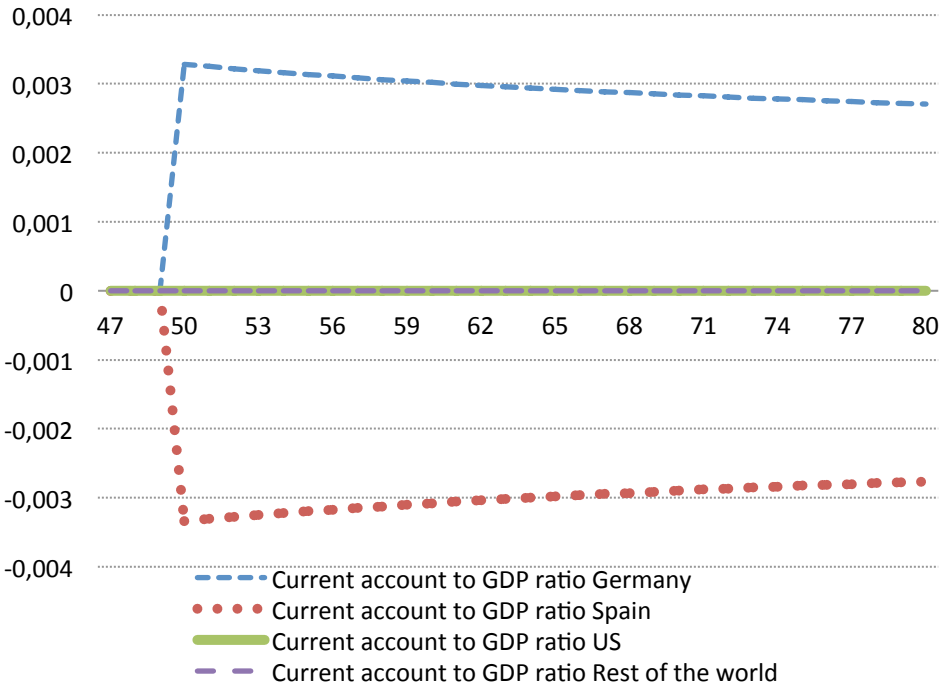
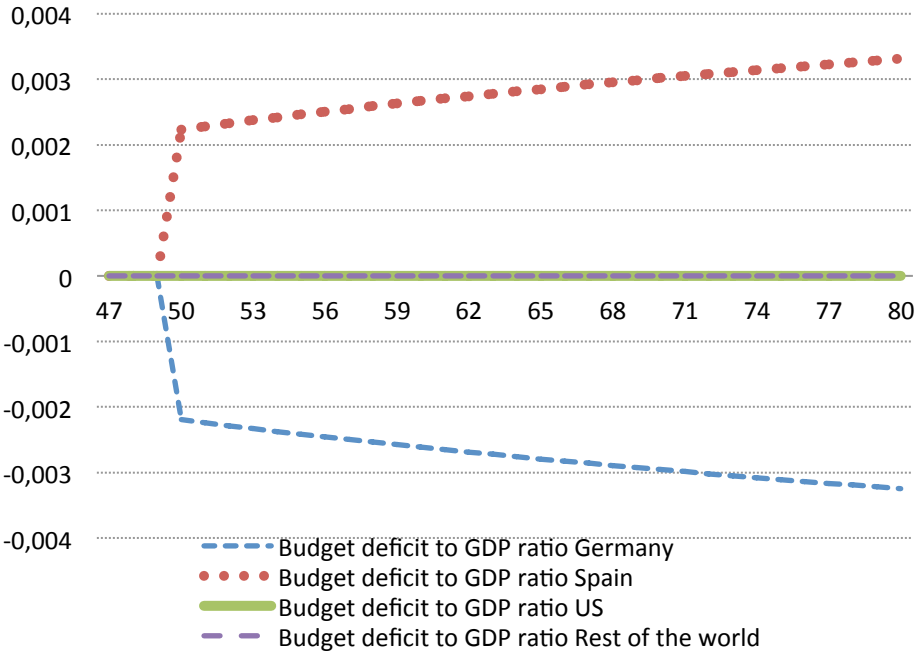


Figure 3.9: Effect of the introduction of the euro



There is usually a debate on whether current account deficits cause budget deficits or the other way around. In this case, it is clear that the causality runs from external to budget

deficits. 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.

Figures 3.10 and 3.11 show the evolution of the so-called financial balances in Spain and Germany. The behavior of budget and external balances has already been explained. In these figures, instead of plotting the current account balance we plot the current account deficits. Thus, in the case of Spain in Figure 3.10 the fact that after the shock the current account of Spain turns positive should be interpreted as a current account deficit with respect to the baseline scenario. As regards the private sector, in the short run it goes into deficit since saving drop more strongly than investment (which in turn proves that investment need not be caused by saving, 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.

Figure 3.10: Effect of the introduction of the euro

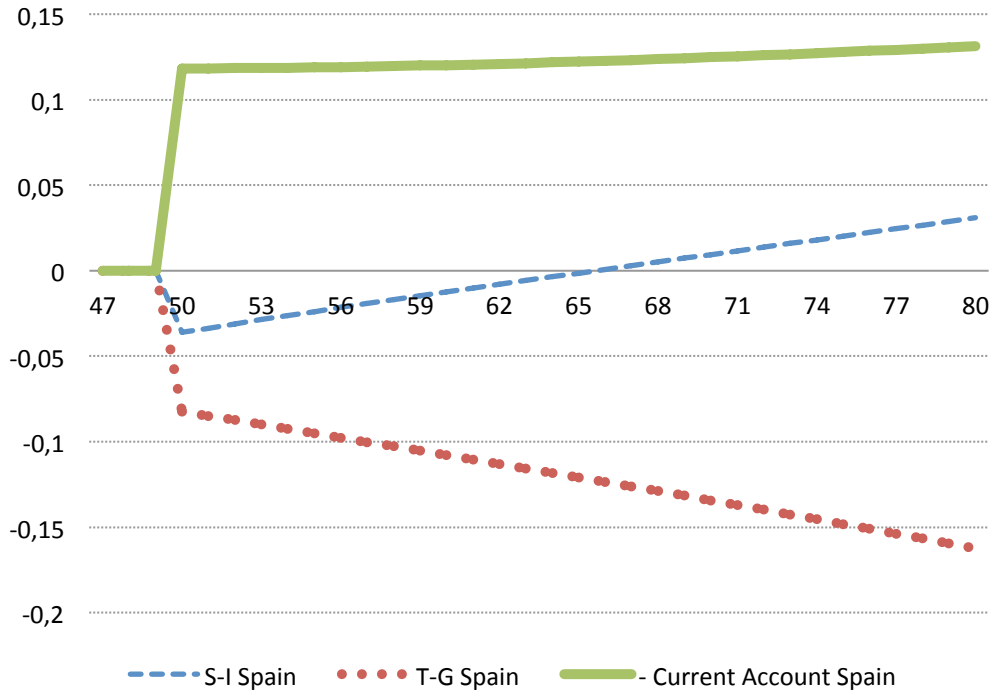
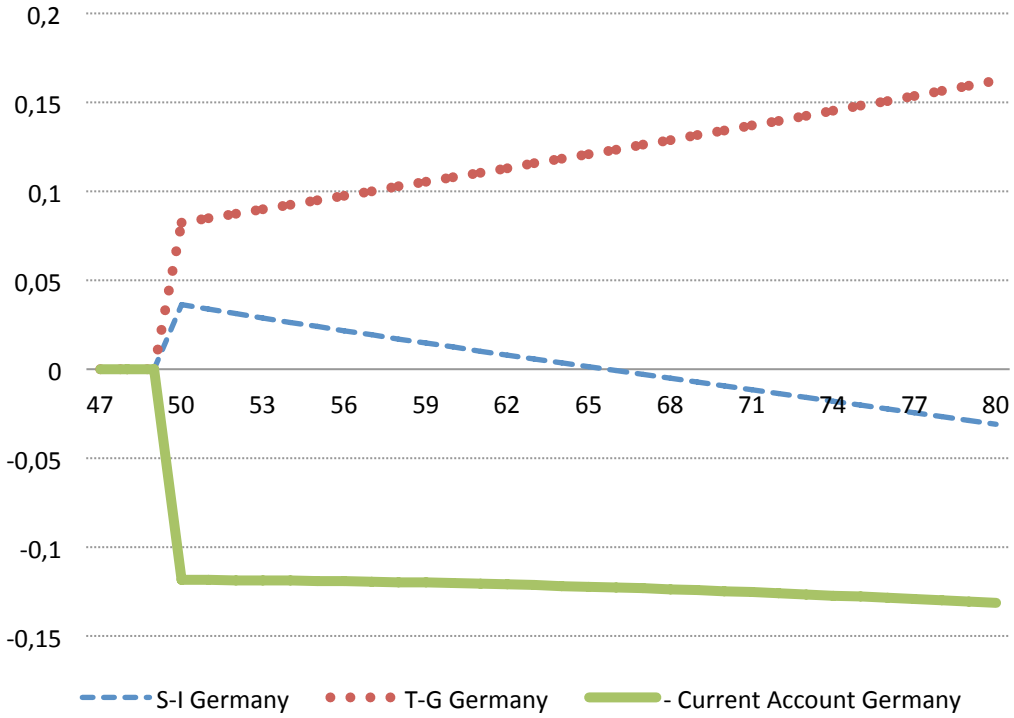
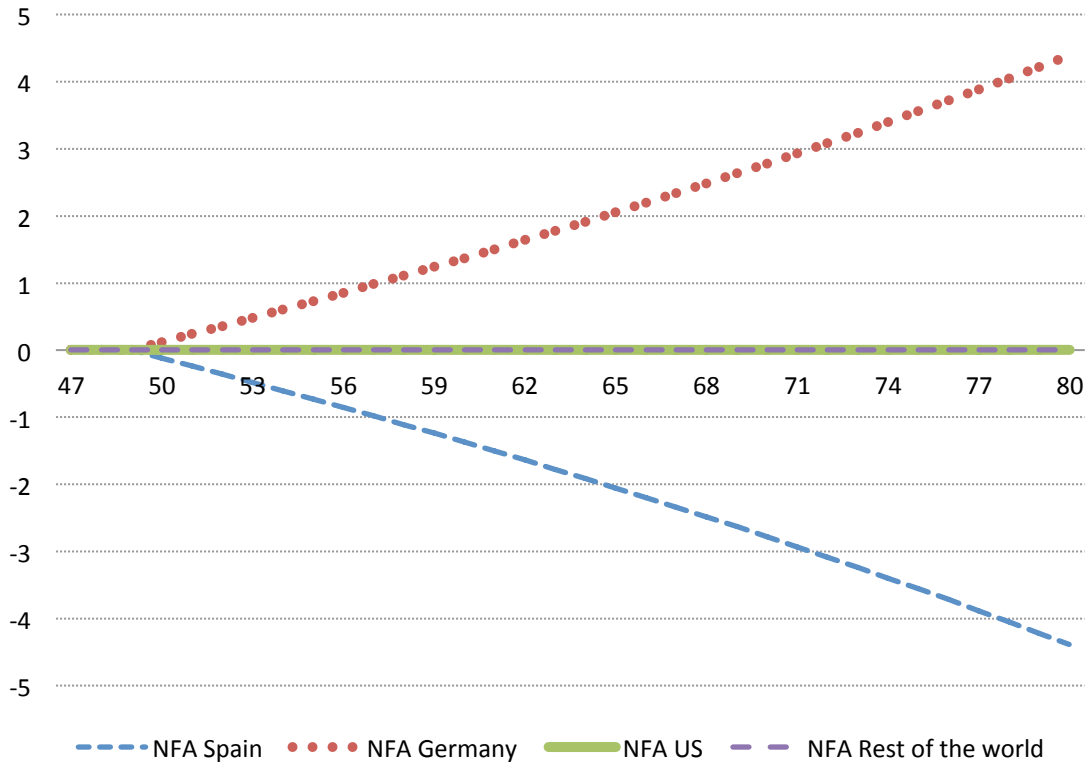


Figure 3.11: Effect of the introduction of the euro



Finally, we show that as a result of the shock there is a deterioration of 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 an issuance 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.

Figure 3.12: Effect of the introduction of the euro



The Eurozone after 2008

Since the introduction of the euro implied the abolition of national currencies, it was no longer possible to launch a speculative attack against those European countries that were engaged in the flawed system created in the Maastricht and Lisbon treaties. However, this did not prevent international investors from doubting about the capacity of southern countries to pay for their euro-denominated debts. As a result, panic took hold and quickly spread across all the countries of the European periphery. The contagion effects which were observed in the late 1990s with the Southeast Asian crisis were now affecting

supposedly developed economies. Given that there was no particular exchange rate to be attacked, the massive sales of southern countries bonds added to the difficulties that national governments found to issue new debt produced an excess supply of southern debt, which translated into higher interest rates. As it was clearly modeled by Calvo (1988), this process can be dangerous since it can derive into a self-fulfilling debt crisis, where the government ends up becoming insolvent due to the increasing debt services.

In order to model this scenario, the rate of interest of Spain needs to be endogenized. This will allow us to simulate a speculative attack against Spanish debt and to represent the state of the Eurozone after 2008. We use the model described in the previous section as our baseline and introduce the changes that are necessary to allow for variable interest rates in Spain. The first equation that requires a slight modification is equation 3.112. Since the rate of interest is normally defined as the inverse of bond prices, the latter need to be defined. Thus, unlike America, Germany and rest of the world bonds which are expressed in values, Spanish bonds will be defined in volume. In order to get values, the quantity of bonds needs to be multiplied by the price.

$$\Delta Bs_t^{SP} = \frac{G_t^{SP} - T_t^{SP} + Bs_{t-1}^{SP}.CP^{SP} - Pcb_t^{SP} - \alpha P_t^{ECB}}{pbl_t^{SP}} \quad (3.112b)$$

It should be noted that these new Spanish bonds do not pay an interest that depends on the rate of interest, but a fixed coupon which, for simplicity, may be assumed to be equal to €1. As equation 3.112b shows, a declining price of Spanish bonds (as it has been the case after 2008) may be troublesome since in order to finance a constant budget deficit the Spanish government needs to issue more debt. Taking into account this new definition of Spanish bonds, the demand functions also need to be modified accordingly. Note that the portfolio equations will no longer include Spain's rate of interest, but the amount of money that each bond pays per year, i.e., the coupon, CP^{SP}.

$$Bd, b_{US_t}^{SP} = \frac{(M_t^{US} - Rd_t^{US}).(\gamma_{20}^{US} + \gamma_{21}^{US}.rb_t^{US} + \gamma_{22}^{US}.rb_t^{GE} + \gamma_{23}^{US}.CP^{SP} + \gamma_{24}^{US}.rb_t^{RW}).E2_t}{pbl_t^{SP}} \quad (3.118bis)$$

$$Bd, b_{RW_t}^{SP} = \frac{(M_t^{RW} - Rd_t^{RW}).(\gamma_{30}^{RW} + \gamma_{31}^{RW}.rb_t^{US} + \gamma_{32}^{RW}.rb_t^{GE} + \gamma_{33}^{RW}.CP^{SP} + \gamma_{34}^{RW}.rb_t^{RW}).E5_t}{pbl_t^{SP}} \quad (3.127bis)$$

$$Bd, b_{SP_t}^{SP} = \frac{(M_t^{SP} - Rd_t^{SP}) - Bd, b_{SP_t}^{GE} - Bd, b_{SP_t}^{RW} - Bd, b_{SP_t}^{US}}{pbl_t^{SP}} \quad (3.124b)$$

$$Bd, b_{GE_t}^{SP} = \frac{(M_t^{GE} - Rd_t^{GE}).(\gamma_{20}^{GE} + \gamma_{21}^{GE}.rb_t^{US} + \gamma_{22}^{GE}.rb_t^{GE} + \gamma_{23}^{GE}.CP^{SP} + \gamma_{24}^{GE}.rb_t^{RW}).E3_t}{pbl_t^{SP}} \quad (3.114bis)$$

It is now necessary to modify the bond supply functions of Spain in order to be able to derive the price as the adjusting variable between supply and demand. It is assumed that the Spanish government's supply of bonds to the US, Germany and the rest of the world is the residual of the total supply net of domestic demand. For simplicity, this residual is distributed in equal parts. Although this way of describing the supply of bonds might seem a little bit rudimentary, the truth is that a more complex description would not change the results substantially.

$$Bs, b_{US_t}^{SP} = \frac{1}{3}\left(Bs_t^{SP} - Bd, b_{SP_t}^{SP} - Bd, cb_{SP_t}^{SP}\right) \quad (3.135b)$$

$$Bs, b_{RW_t}^{SP} = \frac{1}{3}\left(Bs_t^{SP} - Bd, b_{SP_t}^{SP} - Bd, cb_{SP_t}^{SP}\right) \quad (3.144b)$$

$$Bs, b_{GE_t}^{SP} = \frac{1}{3}\left(Bs_t^{SP} - Bd, b_{SP_t}^{SP} - Bd, cb_{SP_t}^{SP}\right) \quad (3.131b)$$

These, and not those expressed in equations (3.114bis, 3.118bis, and 3.124bis), are going to be the actual demand functions for Spanish bonds. In other words, equations (3.114bis, 3.118bis, and 3.124bis) may represent notional demand functions, while equations (3.131b, 3.135b and 3.144b) represent effective demand functions, which are supply-led given that the price adjustment mechanism is fully flexible. Thus, equations (3.114bis, 3.118bis, and 3.124bis) are not written in the model but used to derive the price of bonds. Should there be any divergence between notional and effective demand functions, the price of bonds will make the adjustment.

$$Bd, b_{US_t}^{SP} = Bs, b_{US_t}^{SP} \quad (3.118b)$$

$$Bd, b_{RW_t}^{SP} = Bs, b_{RW_t}^{SP} \quad (3.127b)$$

$$Bd, b_{GE_t}^{SP} = Bs, b_{GE_t}^{SP} \quad (3.114b)$$

Using equations (3.114b, 3.118b, 3.127b, 3.114bis, 3.118bis, and 3.124bis) we get the price of Spanish bonds. As regards the rate of interest, it is defined as the inverse of bond prices.

$$pbl_t^{SP} = \frac{J1_t + J2_t + J3_t}{Bd, b_{US_t}^{SP} + Bd, b_{GE_t}^{SP} + Bd, b_{RW_t}^{SP}} \quad (3.199b)$$

$$J1_t = (M_t^{US} - Rd_t^{US}).(\gamma_{20}^{US} + \gamma_{21}^{US}.rb_t^{US} + \gamma_{22}^{US}.rb_t^{GE} + \gamma_{23}^{US}.CP^{SP} + \gamma_{24}^{US}.rb_t^{RW}).E2_t$$

$$J2_t = (M_t^{RW} - Rd_t^{RW}).(\gamma_{30}^{RW} + \gamma_{31}^{RW}.rb_t^{US} + \gamma_{32}^{RW}.rb_t^{GE} + \gamma_{33}^{RW}.CP^{SP} + \gamma_{34}^{RW}.rb_t^{RW}).E5_t$$

$$J3_t = (M_t^{GE} - Rd_t^{GE}).(\gamma_{20}^{GE} + \gamma_{21}^{GE}.rb_t^{US} + \gamma_{22}^{GE}.rb_t^{GE} + \gamma_{23}^{GE}.CP^{SP} + \gamma_{24}^{GE}.rb_t^{RW}).E3_t$$

$$rb_t^{SP} = \frac{1}{pbl_t^{SP}} \quad (3.176b)$$

It is now necessary to take into account the fact that bank's profits are slightly changed, since instead of earning a variable interest on Spanish bonds they now earn a fixed coupon. Moreover, they may get capital gains as a result of valuation effects in case the price of bonds increases.

$$Pb_t^{US} = r_{t-1}^{US}.Bs,b_{US_{t-1}}^{US} + r_{t-1}^{GE}.Bs,b_{US_{t-1}}^{GE}\frac{1}{E1} + Bs,b_{US_{t-1}}^{SP}\frac{CP^{SP}}{E2} + r_{t-1}^{RW}.Bs,b_{US_{t-1}}^{RW}\frac{1}{E4} + Bs,b_{US_{t-1}}^{GE}.\Delta\left(\frac{1}{E1}\right) + Bs,b_{US_{t-1}}^{SP}.\Delta\left(\frac{pbl_t^{SP}}{E2}\right) + Bs,b_{US_{t-1}}^{RW}.\Delta\left(\frac{1}{E4}\right) + rs_{t-1}^{US}.R_{t-1}^{US} + rl_{t-1}^{US}.L_{t-1}^{US} - rd_{t-1}^{US}.M_{t-1}^{US} - r_{t-1}^{US}.A_{t-1}^{US} \quad (3.153b)$$

$$Pb_t^{GE} = r_{t-1}^{GE}.Bs,b_{GE_{t-1}}^{GE} + r_{t-1}^{US}.Bs,b_{GE_{t-1}}^{US}E1 + Bs,b_{GE_{t-1}}^{SP}CP^{SP} + r_{t-1}^{RW}.Bs,b_{GE_{t-1}}^{RW}\frac{1}{E6} + Bs,b_{GE_{t-1}}^{US}.\Delta(E1) + Bs,b_{GE_{t-1}}^{SP}\Delta pbl_t^{SP} + Bs,b_{GE_{t-1}}^{RW}.\Delta\left(\frac{1}{E6}\right) + rs_{t-1}^{GE}.R_{t-1}^{GE} + rl_{t-1}^{GE}.L_{t-1}^{GE} - rd_{t-1}^{GE}.M_{t-1}^{GE} - r_{t-1}^{GE}.A_{t-1}^{GE} \quad (3.154b)$$

$$Pb_t^{SP} = Bs,b_{SP_{t-1}}^{SP}CP^{SP} + r_{t-1}^{GE}.Bs,b_{SP_{t-1}}^{GE} + r_{t-1}^{US}.Bs,b_{SP_{t-1}}^{US}E2 + r_{t-1}^{RW}.Bs,b_{SP_{t-1}}^{RW}E5 + Bs,b_{SP_{t-1}}^{GE} + Bs,b_{SP_{t-1}}^{GE}.\Delta pbl_t^{SP} + Bs,b_{SP_{t-1}}^{US}.\Delta(E2) + Bs,b_{SP_{t-1}}^{RW}.\Delta(E5) + rs_{t-1}^{SP}.R_{t-1}^{SP} + rl_{t-1}^{SP}.L_{t-1}^{SP} - rd_{t-1}^{SP}.M_{t-1}^{SP} - r_{t-1}^{SP}.A_{t-1}^{SP} \quad (3.155b)$$

$$Pb_t^{RW} = r_{t-1}^{RW}.Bs,b_{RW_{t-1}}^{RW} + r_{t-1}^{EZ}.Bs,b_{RW_{t-1}}^{GE}E6 + Bs,b_{RW_{t-1}}^{SP}\frac{CP^{SP}}{E5} + r_{t-1}^{US}.Bs,b_{RW_{t-1}}^{US}E4 + Bs,b_{RW_{t-1}}^{GE}.\Delta(E6) + Bs,b_{RW_{t-1}}^{SP}.\Delta\left(\frac{pbl_t^{SP}}{E5}\right) + Bs,b_{RW_{t-1}}^{US}.\Delta(E4) + rs_{t-1}^{RW}.R_{t-1}^{RW} + rl_{t-1}^{RW}.L_{t-1}^{RW} - rd_{t-1}^{RW}.M_{t-1}^{RW} - r_{t-1}^{RW}.A_{t-1}^{RW} \quad (3.156b)$$

The equations that describe the determination of advances from the central bank to commercial banks also need to be modified.

$$A_t^{GE} = Bd,b_{GE_t}^{GE} + Bd,b_{GE_t}^{US} + Bd,b_{GE_t}^{SP}.pbl_t^{SP} + Bd,b_{GE_t}^{RW} + L_t^{GE} + R_t^{GE} - M_t^{GE} - Vb_t^{GE} \quad (3.149b)$$

$$A_t^{US} = Bd,b_{US_t}^{US} + Bd,b_{US_t}^{GE} + Bd,b_{US_t}^{SP}.pbl_t^{SP} + Bd,b_{US_t}^{RW} + L_t^{US} + R_t^{US} - M_t^{US} - Vb_t^{US} \quad (3.150b)$$

$$A_t^{SP} = Bd,b_{SP_t}^{SP}.pbl_t^{SP} + Bd,b_{SP_t}^{GE} + Bd,b_{SP_t}^{US} + Bd,b_{SP_t}^{RW} + L_t^{SP} + R_t^{SP} - M_t^{SP} - Vb_t^{SP} \quad (3.151b)$$

$$A_t^{RW} = Bd,b_{RW_t}^{RW} + Bd,b_{RW_t}^{GE} + Bd,b_{RW_t}^{US} + Bd,b_{RW_t}^{SP}.pbl_t^{SP} + L_t^{RW} + R_t^{RW} - M_t^{RW} - Vb_t^{RW} \quad (3.152b)$$

Regarding the determination of the euro/dollar exchange rate, Spanish bonds are excluded from the market since a specific market, with its own prices and quantities, was created before. Hence, the exchange rate of the Eurozone is determined as follows:

$$E1_t = \frac{Bs_t^{GE} - Bs,b_{GE_t}^{GE} - Bs,b_{SP_t}^{GE} - Bs,b_{RW_t}^{GE} - Bd_{ECB_t}}{Bd,b_{US_t}^{GE}} \quad (3.182b)$$

$$E2_t = E1_t \quad (3.183b)$$

Finally, the Banco de España may earn profits on valuation effects due to changing bond prices.

$$Pcb_t^{SP} = Bd,cb_{SP_{t-1}}^{SP}.CP^{SP} + Bd,cb_{SP_{t-1}}^{SP}.\Delta pbl_t^{SP} + r_{t-1}^{US}.Bs,cb_{SP_{t-1}}^{US}.E2_t + Bs,cb_{SP_{t-1}}^{US}.\Delta(E2) - rs_{t-1}^{SP}.R_{t-1}^{SP} + r_{t-1}^{SP}.A_{t-1}^{SP} + r_{t-1}^{SP}.TG2_{t-1}^{SP} \quad (3.196b)$$

The system of equations (3.1-3.196b) defines the model for the Eurozone where Spanish bonds have variable prices. Let us now examine the impact of the same shock that we have been working on, i.e., a loss of competitiveness of Spain vis-à-vis Germany. This set of simulations must be compared to the ones presented in Section 3.4, since the institutional setting of the Eurozone is exactly the same with the only difference that in this case the interest rate of Spain is variable.

Figure 3.13: Effect of the introduction of the euro with financial panic

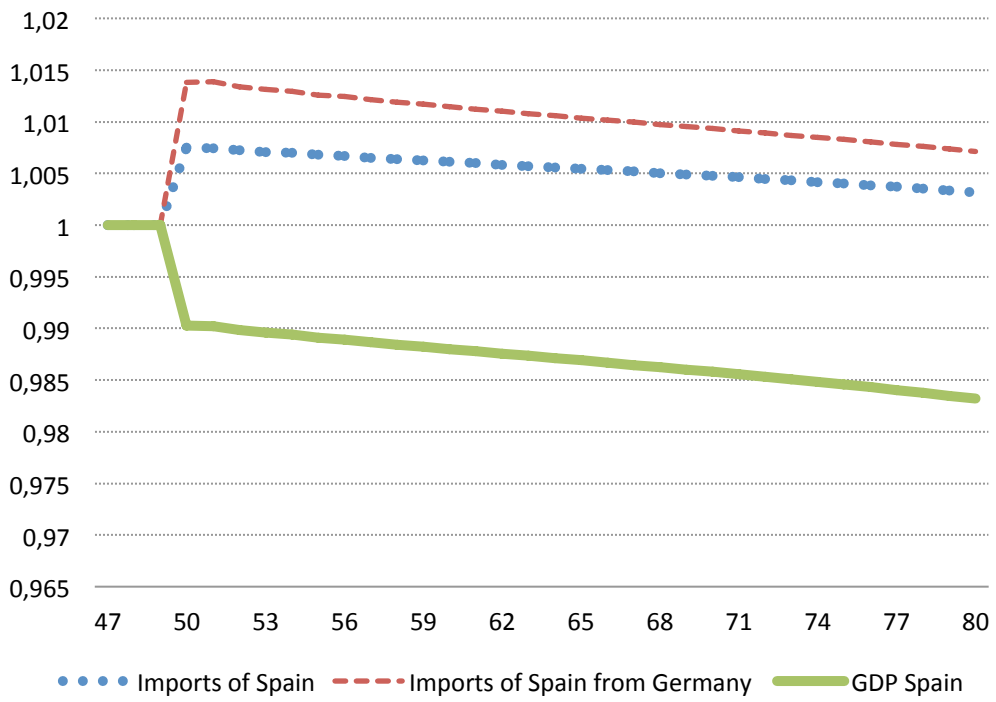
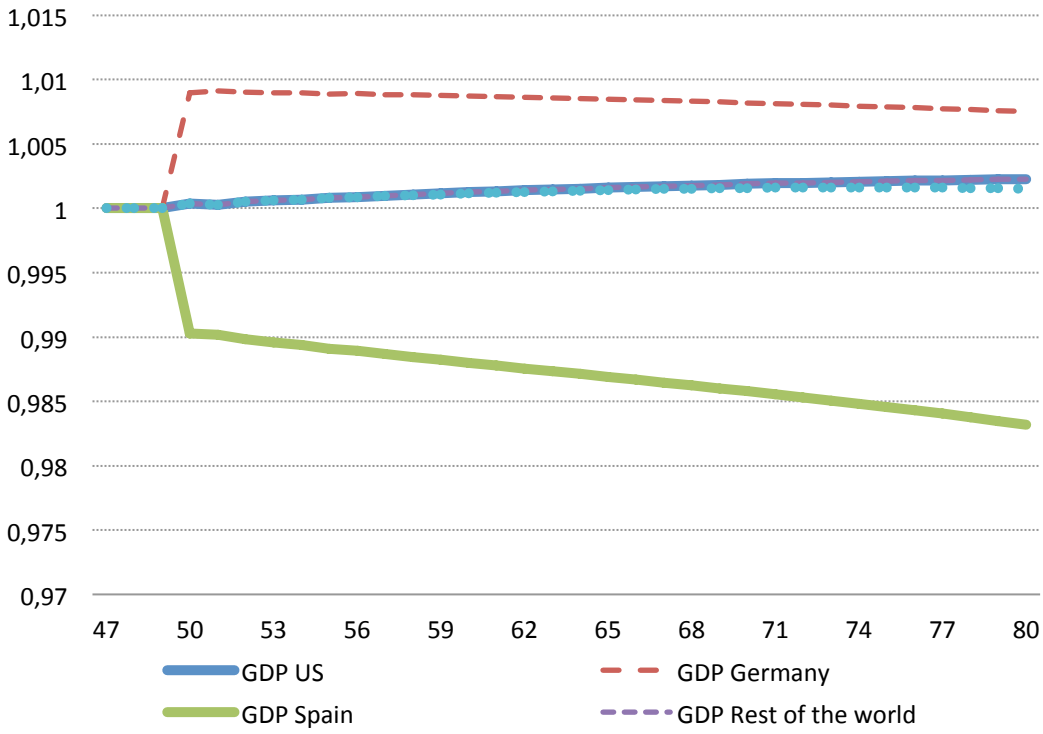
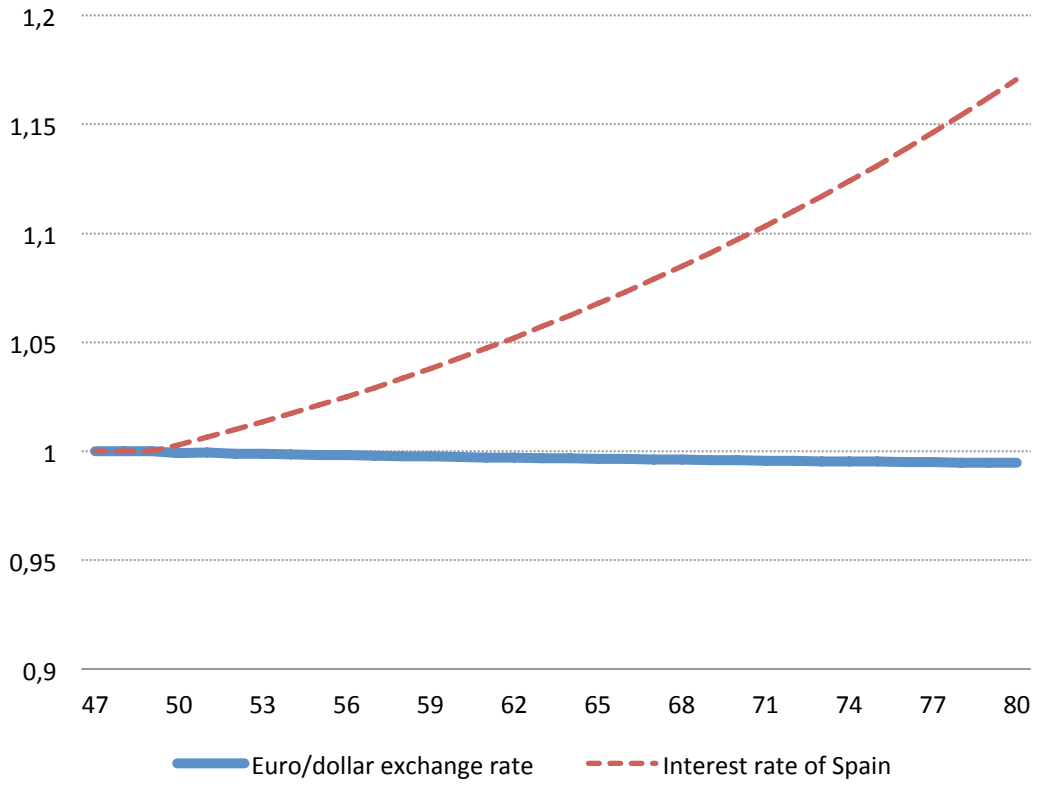


Figure 3.14: Effect of the introduction of the euro with financial panic



As it follows from the comparison of Figures 3.13 and 3.14 with respect to Figures 3.5 and 3.6, the same shock produces a deeper recession in Spain when the interest rate is variable. This happens, as it can be seen in Figure 3.15, because of the negative impact due to the higher appreciation of the euro, which strengthens the loss of competitiveness experienced by Spain, and the increase in the interest rate, which discourages investment. With regards to Germany's growth rate, it remains positive but lower than in the fixed-interest rate scenario. The reason is, again, linked to the evolution of the euro - its appreciation reduces Germany's competitiveness against the US and the rest of the world.

Figure 3.15: Effect of the introduction of the euro with financial panic



Let us now analyze the underlying forces behind the appreciation of the euro and the increase in the interest rate of Spain. Taking equation 3.199b and its components, it is observed that while the supply of bonds by the German government declines (due to the budget surplus that is registered as a result of the economic expansion), the overall demand for these assets increase. Thus, the euro appreciates. This appreciation ends up eroding Germany's competitiveness against the US and the rest of the world, thereby reducing the growth rate relative to the one observed before, when the euro stayed almost constant. The appreciation of the euro has also a negative effect for Spanish

imports, which are hit directly by the shock that we are introducing and indirectly through the exchange rate channel.

A similar analysis of the bond market in Spain leads us to the explanation of the rising interest in Spain. Since Spain's economy goes into a recession, tax collection drops while public spending stays growing exogenously. As a result, the government goes into deficit, which is financed through new issuances of bonds. Simultaneously, the private sector reduces its demand for these assets since wealth has dropped due to the negative impact of the recession, which further contributes to the creation of an excess supply. Even though banks from the US, Germany and the rest of the world may increase their demand for Spanish bonds, this is not sufficient to compensate the aforementioned excess supply. Hence, the price of bonds must go down, thereby driving interest rates upwards.

Let us now turn to the evolution of the budget and current account to GDP ratios. As regards the external position, Figure 3.16 shows that in this scenario the current account to GDP ratio of Spain ends up in a better position than the case of Figure 3.8. This is explained by two reasons: first, the absolute value of the current account in this case is better due to the higher drop of GDP (via the negative impact on investment of increasing interest rates) and, second, the denominator of the ratio, i.e., GDP, falls more largely. The appreciation of the euro in comparison to the first scenario does not seem to be enough to worsen the result of the current account with respect to the case of fixed interest rates. The current account to GDP ratio of Germany, when compared to the fixed interest rate scenario, presents a very similar increase in the short run. However, as the euro appreciates, the economy loses competitiveness against the US and the rest of the world, thereby narrowing down the initial positive effect that the shock had on the current account.

Figure 3.16: Effect of the introduction of the euro with financial panic

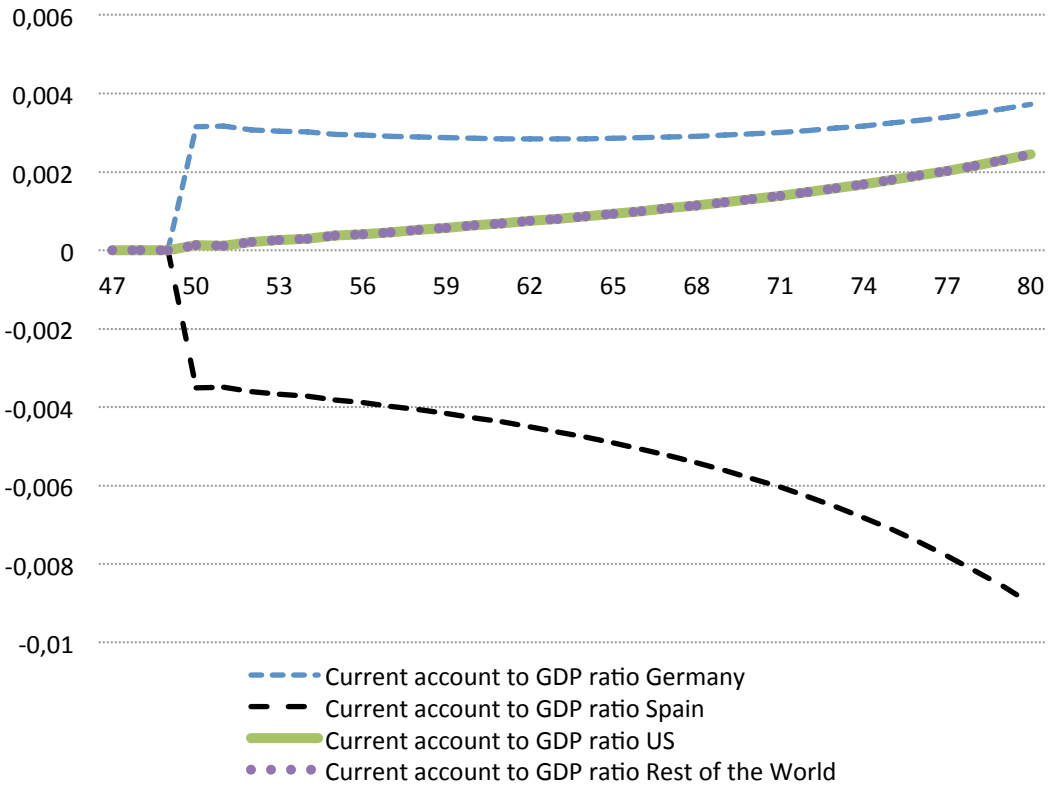
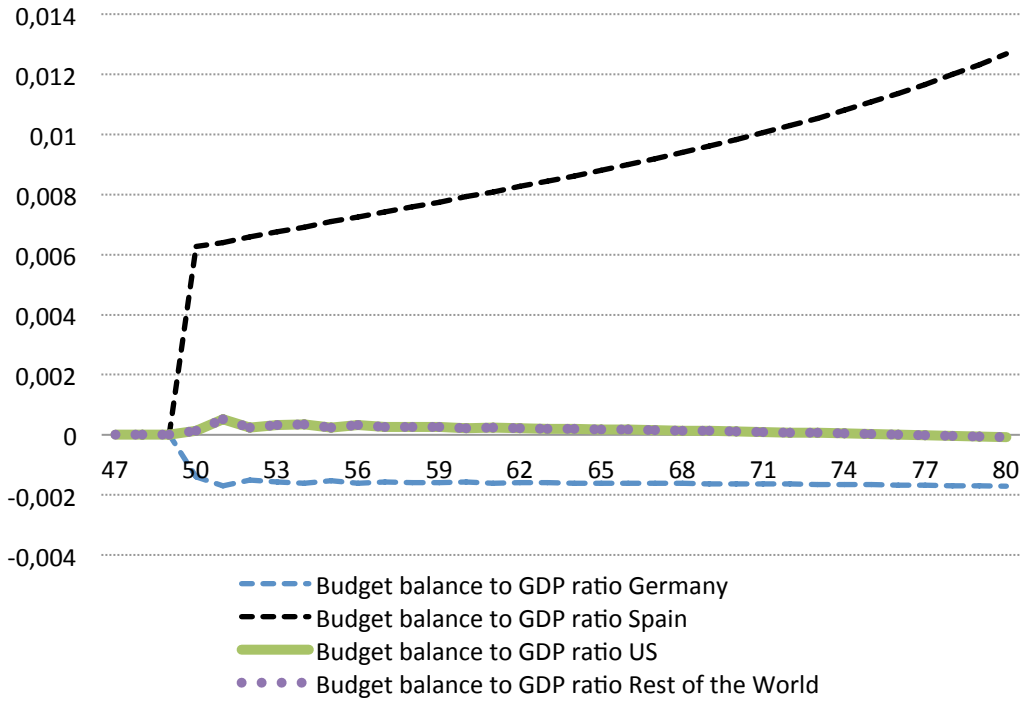


Figure 3.17: Effect of the introduction of the euro with financial panic



Regarding the evolution of the budget deficit to GDP ratio, Figure 3.17 shows that Spain experiences a three-fold increase. This is explained by both an increase in the numerator and a decrease in the denominator. The budget deficit increases more when compared to the first scenario due to the larger drop of GDP, which is explained by the combination of the weaker performance of exports (due to the loss of competitiveness against Germany and the appreciation of the euro) and the negative impact that increasing interest rates have on investment. All these effects imply a fall in income, which in turn produces a negative effect on consumption.

The analysis of financial balances yields a different result from the one observed in Figures 3.18 and 3.19. The current account of Spain presents a very similar pattern although, as it was mentioned, the negative impact was larger in the fixed interest rate scenario. It was also already mentioned why the budget balance of the Spanish government performed worse in the flexible interest rate scenario. Thus, if the current account exhibits a very similar pattern while the budget deficit triples, it follows that the private sector must be increasing its position. The reason for this is the higher drop of investment relative to saving, since investment is directly hit by the increase in the rate of interest, while saving is only a small portion of disposable income.

Figure 3.18: Effect of the introduction of the euro with financial panic

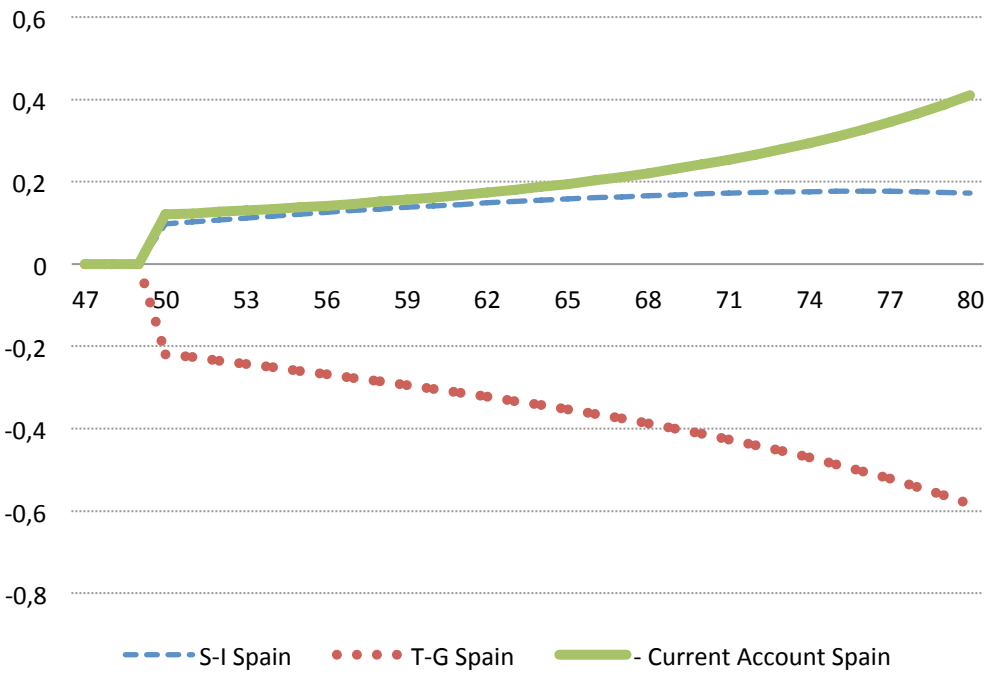
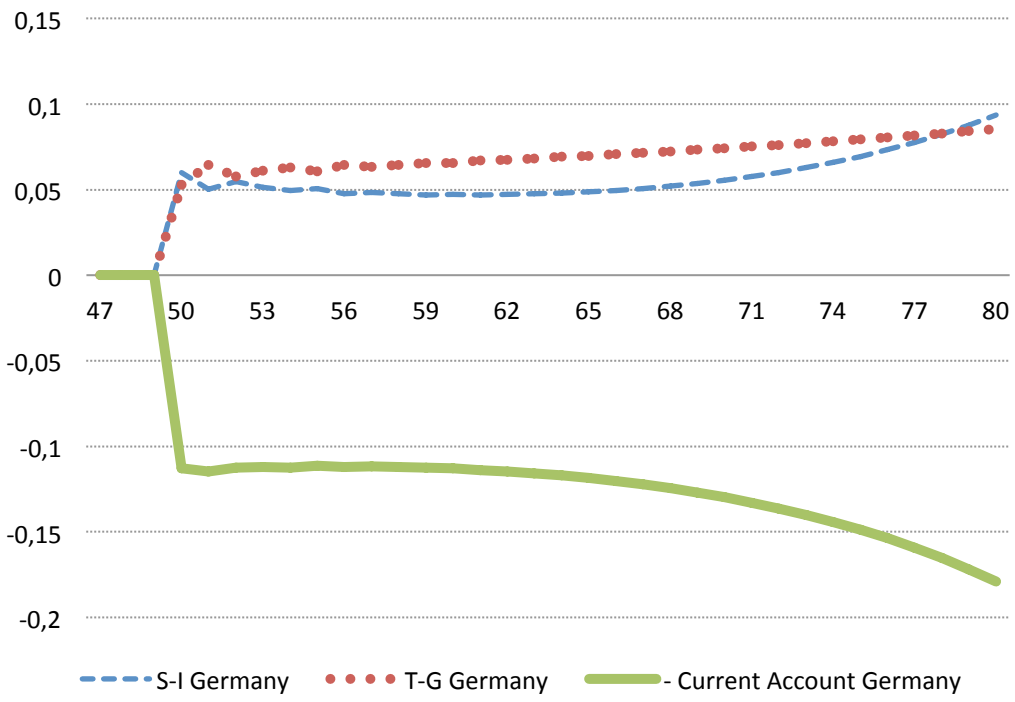


Figure 3.19: Effect of the introduction of the euro with financial panic



In Germany, the current account exhibits a slightly worse performance in comparison to the fixed interest rate scenario due to the appreciation of the euro. The interesting point is that the bulk of the external surplus is now appropriated by the private sector, unlike the previous case. This is explained by the fact that whereas in the fixed interest rate scenario investment in Germany grew strongly (due to the high economic expansion), in this case it only rises modestly since the increase of GDP is also lighter. This, in turn, explains that tax collection is now lower, thereby yielding a lower budget deficit with respect to the previous case.

The conclusion of this third scenario is that when the rate of interest of Spain is flexible, the same negative shock on its competitiveness vis-à-vis Germany produces a much larger recession through the channel of the interest rate. This implies, in turn, a worse deterioration of public finances. Not so different from what was observed after 2008. But the picture could also be better should debt payment be included. It should be born in mind that in this model it is being assumed that debts are never paid or that they are rolled over indefinitely. However, it was seen that many of the problems that Greece experienced during the last three years were linked to the necessity to pay for its debts in a context of insolvency. In such a situation, if there is no international will to cooperate,

the money needs to be taken from another place, i.e., public spending is reduced. In the end, this inevitably deepens the recession, driving the economy to a debt-recession trap.

3.6. Ways out of the crisis: alternative monetary arrangements

In this section we present different ways in which the current institutional setting of the Eurozone could be reformed in order to yield more sustainable macroeconomic dynamics. The whole structure of the model is identical to the one developed in section 4, except for the fact that TARGET2 balances and the intra-Eurosystem adjustment accounts are not considered. We made this decision in order to keep the model as simple as possible. However, we will come back to the TARGET2 balances and the peculiarities of the payments system of the euro area by the end of this section, when we deal with the Euro-bancor closure.

A Eurozone with three euros

As suggested by Lapavitsas (2012) and shown by Duwicquet et al. (2012), there is evidence to think that the introduction of the euro worked as a source of real exchange rate misalignments within the euro area. If we consider this a reasonable argument, then it makes sense to examine what would happen if these misalignments were reduced. This would not require that each country regained its monetary and exchange rate policy, but that the Eurozone split into two blocks, each of them gathering countries that are more or less similar. For instance, it seems more reasonable that Portugal shares a common exchange rate with Greece than with Germany or Finland. Thus, what we propose in this subsection is a scenario where there are two regional euros, each of them associated to a certain sub-region within the Eurozone (we keep the classification where Spain represents the deficit countries while Germany represents the surplus countries). Moreover, there would also be a global euro aimed at supporting the role of the current euro in financial markets as an international store of value.

The exchange rate of the global euro vis-à-vis the US dollar would be determined as usual, i.e., as a result of the interaction between supply and demand for euro-denominated bonds (equation 3.199c). We call the global euro/dollar exchange rate E9, in order to keep E1 and E2 as the exchange rates between Germany and Spain vis-à-vis the US. Unlike the current setting of the euro area, where Spain and Germany only issue bonds denominated in euros, in this case we assume that the issuances to foreign creditors are denominated

in global euros (for instance, $Bs, b_{GE_t}^{SP,€}$ is the supply of Spanish bonds in global euros to German banks) whereas domestic banks purchase domestic bonds denominated in national currency ($Bs, b_{SP_t}^{SP,SP}$). Moreover, we keep the assumption that the ECB holds a certain pre-existing stock of German and Spanish bonds, which are denominated in global euros.

$$E9_t = \frac{Bs_t^{GE,€} + Bs_t^{SP,€} - Bd, b_{SP_t}^{GE,€} - Bd, b_{RW_t}^{GE,€} - Bd, b_{GE_t}^{SP,€} - Bd, b_{RW_t}^{SP,€} - Bd_{ECB_t}^{GE,€} - Bd_{ECB_t}^{SP,€}}{Bd_{US_t}^{GE,€} + Bd_{US_t}^{SP,€}} \quad (3.199c)$$

Since the government debt could be denominated in national euros, in this institutional framework each sub-region would regain its monetary sovereignty. As mentioned before, the only institutional agent that can purchase domestic bonds in local currency are the home banks. But it should be born in mind that those countries that do not issue reserve currencies (like the national euros would be) might encounter limits to get external financing by issuing bonds denominated in domestic currency. In those cases, the gap between the financing needs (B_t^{SP}, for instance) and the total demand for bonds denominated in domestic currency (Bd, b_{SP}^{SP}) is filled with issuances of bonds denominated in a reserve currency. In this case, should there be any gap, it would be filled with issues of bonds denominated in global euros ($Bs_t^{SP,€}$) . These supplies are the ones that enter equation 3.199c. Since the total supply of bonds in each country is expressed in domestic currency (either Spanish or German euros), it is required to transform this stock of debt into global euros. To do so, we divide by the bilateral exchange rate of Spanish and German euros to global euros (E7 and E8, respectively, which are defined in equations 3.206c-3.207c).

$$Bs_t^{GE,€} = \frac{Bs_t^{GE} - Bs, b_{GE_t}^{GE}}{E7_t} \quad (3.206c)$$

$$Bs_t^{SP,€} = \frac{Bs_t^{SP} - Bs, b_{SP_t}^{SP}}{E8_t} \quad (3.207c)$$

The multi-speed feature of this model implies that Germany and Spain can have adjustable exchange rates according to their external performance vis-à-vis its regional trading partner. Thus, we define the Spanish euro/global euro and German euro/global euro exchange rate based on the intra-European current account (CA)[26]. We have chosen this variable as the criterion determining the intra-European exchange rate since it reflects

[26] As an example, we write Spain's current account. $CA_{SP_t}^{GE} = X_{SP_t}^{GE} - IM_{SP_t}^{GE} + r_{t-1}^{GE}.Bs, b_{SP_{t-1}}^{GE,€}.E7_t - r_{t-1}^{SP}.Bs, b_{US_{t-1}}^{SP,€}.E7_t$

the overall performance of the Spanish (German) external sector vis-à-vis the German (Spanish) counterpart. The criterion consists of keeping exchange rates fixed as long as the intra-European current account is in surplus or, if in deficit, only for a certain period of time (we base this criterion on the fact that in principle a country cannot accumulate persistent current account deficits indefinitely[27]). If a bad external performance yields a balance of payments deficit for five consecutive periods, then the national currency is adjusted. Once these intra-European exchange rates have been defined, it is also possible to derive the exchange rates vis-à-vis the dollar (equations 3.182c-3.183c) as well as the bilateral exchange rate between Spain and Germany (equation 3.184c).

$$E7_t = \begin{cases} E7_{t-1} & if\ \frac{CA^{GE}_{SP_{t-i}}}{Y^{SP}_{t-i}} \geq 0 \quad \forall\, i = 1,2,3,4,5 \\ E7_{t-1}.(1+\pi) & if\ \frac{CA^{GE}_{SP_{t-i}}}{Y^{SP}_{t-i}} < 0 \quad \forall\, i = 1,2,3,4,5 \end{cases} \tag{3.200c}$$

$$E8_t = \begin{cases} E8_{t-1} & if\ \frac{CA^{SP}_{GE_{t-i}}}{Y^{GE}_{t-i}} \geq 0 \quad \forall\, i = 1,2,3,4,5 \\ E8_{t-1}.(1+\pi) & if\ \frac{CA^{SP}_{GE_{t-i}}}{Y^{GE}_{t-i}} < 0 \quad \forall\, i = 1,2,3,4,5 \end{cases} \tag{3.201c}$$

$$E1_t = E8_t.E9_t \tag{3.182c}$$

$$E2_t = E7_t.E9_t \tag{3.183c}$$

$$E3_t = E2_t/E1_t \tag{3.184c}$$

Since Spain and Germany are now engaged in a fixed (but adjustable) exchange rate arrangement where bilateral nominal exchange rates indeed exist (not like in the current situation, where there are no nominal exchange rates within the Eurozone), national central banks must intervene in the foreign exchange markets in order to ensure that the parity holds over time. These interventions are carried out via purchases/sales of foreign reserves. We make the assumption that both countries accumulate these reserves under the form of dollar-denominated bonds issued by the US. As it is normal in stock-flow consistent models with fixed exchange rates, the central bank intervention that keeps the exchange rate constant is such that its balance sheet identity holds at every point of time (equations 3.202c-3.203c). Then, the process of reserve accumulation needs to take into

[27] In practice, it has been observed that deficit countries in the euro area have accumulated persistent negative stocks of TARGET2 balances. From our point of view, the crisis itself and the austerity policies that have been implemented in deficit countries thereafter are a symptom that shows that the financial markets are not willing to finance deficits on a permanent basis.

account the possible valuation effects that result from exchange rate movements (equations 3.205c-3.205c).

$$\Delta Bs, cb_{SP_t}^{US} = \frac{\Delta R_t^{SP} + \Delta H_t^{SP} - \Delta A_t^{SP} - \Delta Bs, cb_{SP_t}^{SP}}{E2_t} \quad (3.202c)$$

$$\Delta Bs, cb_{GE_t}^{US} = \frac{\Delta R_t^{GE} + \Delta H_t^{GE} - \Delta A_t^{GE} - \Delta Bs, cb_{GE_t}^{GE}}{E1_t} \quad (3.203c)$$

$$\Delta Bd, cb_{SP_t}^{US} = Bs, cb_{SP_{t-1}}^{US}.\Delta E2_t + \Delta Bs, cb_{SP_t}^{US}.E2_t \quad (3.204c)$$

$$\Delta Bd, cb_{GE_t}^{US} = Bs, cb_{GE_{t-1}}^{US}.\Delta E1_t + \Delta Bs, cb_{GE_t}^{US}.E1_t \quad (3.205c)$$

These equations ensure that the model is consistent. As regards the ECB, no changes are made with respect to the model described in the previous section since, as described above, we are not allowing for the interventions that it could eventually make. In the next section we will run some simulation experiments in order to assess the economic viability of this proposal.

A return to the European Monetary System (EMS)

In a similar line to the one proposed in the previous scenario, the ideas embedded in the EMS could be taken up in order to give the euro area a higher degree of stability. The proposal would consist of a split-up of the Eurozone into two sub-regions (as we did in the previous case) but instead of keeping a global euro that would be used as an international currency, there would be a European Currency Unit (ECU) that would only play the role of being a unit of account. As it did in the past, it would be the reference to which the national currencies are pegged. Hence, the ECU could be written as follows (equation 3.199d), where β represents the share of Germany in total output of the euro area:

$$\frac{1}{E9_t} = \beta.\frac{1}{E1_t} + (1-\beta).\frac{1}{E2_t} \quad (3.199d)$$

The way the ECU is constructed implies that it is a basket currency constituted partly by the German currency and partly by the Spanish currency. It is expressed in ECUs with respect to units of US dollars, i.e., 1$ = E9 ECU. The determination of each European currency vis-à-vis the ECU would be the same as the one described in the previous scenario, and would depend on the external performance of each country (equations 3.200d-3.201d, which are identical to equations 3.200c-3.201c). However, even if Spain

and Germany's currencies were pegged to the ECU, they would float against the US dollar. This implies that the bilateral nominal exchange rate could adjust in such a way that the domestic bond market is in equilibrium (equations 3.182d-3.183d). As regards the exchange rates of the Spanish currency against the German currency, it can be deduced from the other exchange rates (equation 3.184d).

$$E7_t = \begin{cases} E7_{t-1} & if\ \frac{CA_{t-i}^{SP}}{Y_{t-i}^{SP}} \geq 0 \quad \forall\, i = 1,2,3,4,5 \\ E7_{t-1}.(1+\pi) & if\ \frac{CA_{t-i}^{SP}}{Y_{t-i}^{SP}} < 0 \quad \forall\, i = 1,2,3,4,5 \end{cases} \tag{3.200d}$$

$$E8_t = \begin{cases} E8_{t-1} & if\ \frac{CA_{t-i}^{GE}}{Y_{t-i}^{GE}} \geq 0 \quad \forall\, i = 1,2,3,4,5 \\ E8_{t-1}.(1+\pi) & if\ \frac{CA_{t-i}^{GE}}{Y_{t-i}^{GE}} < 0 \quad \forall\, i = 1,2,3,4,5 \end{cases} \tag{3.201d}$$

$$E1_t = \frac{Bs_t^{GE} - Bs, b_{GE_t}^{GE} - Bs, cb_{GE_t}^{GE} - Bs, b_{SP_t}^{GE} - Bs, b_{RW_t}^{GE}}{Bd, b_{US_t}^{GE}} \tag{3.182d}$$

$$E2_t = E1_t.E3_t \tag{3.183d}$$

$$E3_t = E7_t/E8_t \tag{3.184d}$$

The adjustment of E1 ensures that the German bond market is always cleared. It is also important to note that this closure implies that the changes in E1 and E2 are such that E3 is constant. This must me the case, since this institutional arrangement of the EMS that we are examining implies that intra-European parities are fixed. Hence, if the movements of E1 and E2 were such that E3 changed continuously, the definition E3=E7/E8 would be violated. Given that E2 cannot adjust in such a way that the Spanish bond market is in equilibrium (since it is being determined endogenously by the other exchange rates in order to ensure consistency between all exchange rates) it is the Spanish central bank that, via its purchases/sales of domestic bonds, clears the bond market (equation 3.180d).

$$Bd, cb_{SP_t}^{SP} = Bs_t^{SP} - Bs, b_{SP_t}^{SP} - Bs, b_{US_t}^{SP} - Bs, b_{GE_t}^{SP} - Bs, b_{RW_t}^{SP} \tag{3.180d}$$

It is now necessary to explain how the balance sheet of the central banks of Spain and Germany are kept in equilibrium, taking into account that they are engaged in a fixed exchange rate arrangement with respect to the ECU. In practice, this does not differ from the case presented in the previous scenario. Thus, the balance sheets are closed

identically and stock-flow consistency is ensured in the same way (equations 3.202d-3.205d are identical to equations 3.202c-3.205c).

$$\Delta Bs, cb_{SP_t}^{US} = \frac{\Delta R_t^{SP} + \Delta H_t^{SP} - \Delta A_t^{SP} - \Delta Bs, cb_{SP_t}^{SP}}{E2_t} \quad (3.202d)$$

$$\Delta Bs, cb_{GE_t}^{US} = \frac{\Delta R_t^{GE} + \Delta H_t^{GE} - \Delta A_t^{GE} - \Delta Bs, cb_{GE_t}^{GE}}{E1_t} \quad (3.203d)$$

$$\Delta Bd, cb_{SP_t}^{US} = Bs, cb_{SP_{t-1}}^{US}.\Delta E2_t + \Delta Bs, cb_{SP_t}^{US}.E2_t \quad (3.204d)$$

$$\Delta Bd, cb_{GE_t}^{US} = Bs, cb_{GE_{t-1}}^{US}.\Delta E1_t + \Delta Bs, cb_{GE_t}^{US}.E1_t \quad (3.205d)$$

Finally, it is worth mentioning that since the exchange rates E1 and E2 are clearing the German and the Spanish bond market, domestic central banks no longer need to purchase domestic bonds. Hence, the stock of domestic bonds held by the monetary authority of each European country will be constant over time.

A Eurozone without the current surplus countries

One of the alternatives that has been put forward by Soros (2012) and Lordon (2013) among others, is a situation in which Germany leaves the Eurozone and lets its currency float, while the remaining European countries keep the euro, which could either be pegged to the German currency or float freely. The examination of this alternative does not require many changes with respect to the set up that we presented in the previous scenarios. First, it is required to delete the notion of the global euro or the ECU, E9, and its associated exchange rates E7 and E8. Second, the German currency/dollar exchange rate, E1, which in the "three euros" case was defined implicitly using E8 and E9 can now be defined explicitly as the ratio of the supply of German bonds to the US and the demand for German bonds by the US (as we did in the EMS scenario). Finally, what we called the Spanish currency/German currency exchange rate, E3, can be now be called euro/German currency exchange rate and could either be pegged or float freely. Let us first analyze the case where the euro is pegged to the German currency (1 GE= E3 euro).

$$E1_t = \frac{Bs_t^{GE} - Bs, b_{GE_t}^{GE} - Bs, cb_{GE_t}^{GE} - Bs, b_{SP_t}^{GE} - Bs, b_{RW_t}^{GE}}{Bd, b_{US_t}^{GE}} \quad (3.182e)$$

$$E3_t = \begin{cases} E3_{t-1} & if \ \frac{CA^{GE}_{SP_{t-i}} + FA^{GE}_{SP_{t-i}}}{Y^{SP}_{t-i}} \geq 0 \quad \forall \ i = 1,2,3,4,5 \\ E3_{t-1}.(1+\pi) & if \ \frac{CA^{GE}_{SP_{t-i}} + FA^{GE}_{SP_{t-i}}}{Y^{SP}_{t-i}} < 0 \quad \forall \ i = 1,2,3,4,5 \end{cases} \tag{3.184e}$$

$$E2_t = E1_t.E3_t \tag{3.183e}$$

This new setting requires some small changes in the closure of the model. Basically, the German central bank would no longer purchase foreign assets since there is no exchange rate to be defended. Thus, its balance sheet would be closed through purchases/sales of domestic bonds (equation 3.181e). Since the exchange rate would be floating, the domestic bond market would be cleared in the process of the determination of the exchange rate (equation 3.182e). As regards the central bank of Spain, there would be no major changes since its exchange rate would still be fixed. Thus, the monetary authority would keep on purchasing/selling US bonds in such a way that the exchange rate is fixed at every point of time (equation 3.202e).

$$\Delta Bs, cb^{US}_{SP_t} = \frac{\Delta R^{SP}_t + \Delta H^{SP}_t - \Delta A^{SP}_t - \Delta Bs, cb^{SP}_{SP_t}}{E2_t} \tag{3.202e}$$

$$\Delta Bs, cb^{GE}_{GE_t} = \Delta R^{GE}_t + \Delta H^{GE}_t - \Delta A^{GE}_t \tag{3.181e}$$

$$\Delta Bd, cb^{US}_{SP_t} = Bs, cb^{US}_{SP_{t-1}}.\Delta E2_t + \Delta Bs, cb^{US}_{SP_t}.E2_t \tag{3.204e}$$

Another way in which this alternative institutional framework could be introduced is one in which instead of being fixed, the euro floats against both the German currency and the US dollar. This alternative should ensure that every external imbalance is automatically corrected via exchange rate adjustments, thereby releasing the central bank from the task of accumulating reserves in order to defend an exchange rate. The drawback of this scenario is that one of the main reasons why the euro was introduced – avoiding the permanent fluctuations of intra-European exchange rates, with the associated adverse effects on international trade – would not be fulfilled. It is worth mentioning, however, that all the countries that stay in the Eurozone would still be having a fixed exchange rate arrangement (since they would share the same currency), which means that at least between them the benefits of a stable exchange rate on international trade would still be reaped.

Adapting the model to this possible alternative is quite simple. We just need to let the euro/German currency exchange rate, E3, float. In this case, the euro-bond market would

be automatically cleared via exchange rate movements and the central bank would ensure the equilibrium in its balance sheet through purchases/sales of domestic bonds. The rest of model would be closed as in the fixed exchange rate case.

To summarize the different proposals that we have been presenting, table 3.5 describes how each of the equations implicit on the crucial roles and columns of the flow of funds would be satisfied. The first three columns describe which variable ensures the equilibrium in the market of Spanish, German and European bond markets. The last two columns show which asset adjusts in such a way that the balance sheet identity of the central banks of Spain and Germany holds at every point of time.

Table 3.5: Alternative closures of the model

Model	B^{SP}	B^{GE}	B^{EZ}	CB^{SP}	CB^{GE}
Current setting	$E1 = E2$	$E1 = E2$	-	Bd, cb_{SP}^{SP}	Bd, cb_{GE}^{GE}
Multiple euros	Bd, b_{SP}^{SP}	Bd, b_{GE}^{GE}	$E9$	Bd, cb_{SP}^{US}	Bd, cb_{GE}^{US}
EMS	Bd, cb_{SP}^{SP}	$E1$	-	Bd, cb_{SP}^{US}	Bd, cb_{GE}^{US}
Euro zone without GE (fixed)	Bd, cb_{SP}^{SP}	$E1$	-	Bd, cb_{SP}^{US}	Bd, cb_{GE}^{GE}
Euro zone without GE (flexible)	$E3$	$E1$	-	Bd, cb_{SP}^{SP}	Bd, cb_{GE}^{GE}

Assessing the viability of a multi-speed Europe

After presenting several alternatives in which a multi-speed Europe could work, it is time to examine their viability. We make use of the four-country stock-flow consistent model adapted to the institutional framework of the Eurozone with the corresponding modifications associated to each specific proposal[28]. The aim of this section is to show the behavior of some key macroeconomic variables in each of the scenarios described in the previous section. In the remaining of this section we present a comparative analysis of the different scenarios after a negative competitiveness shock in Spain (which is due to the overvaluation of the euro for the Spanish economy, in line with the evidence shown by Duwicquet et al (2013)).

[28] The full version of the model can be found here: http://www.univ-paris13.fr/CEPN/IMG/pdf/wp2014_03.pdf

Figure 3.20: Effect of a loss of competitiveness on Spain's trade balance

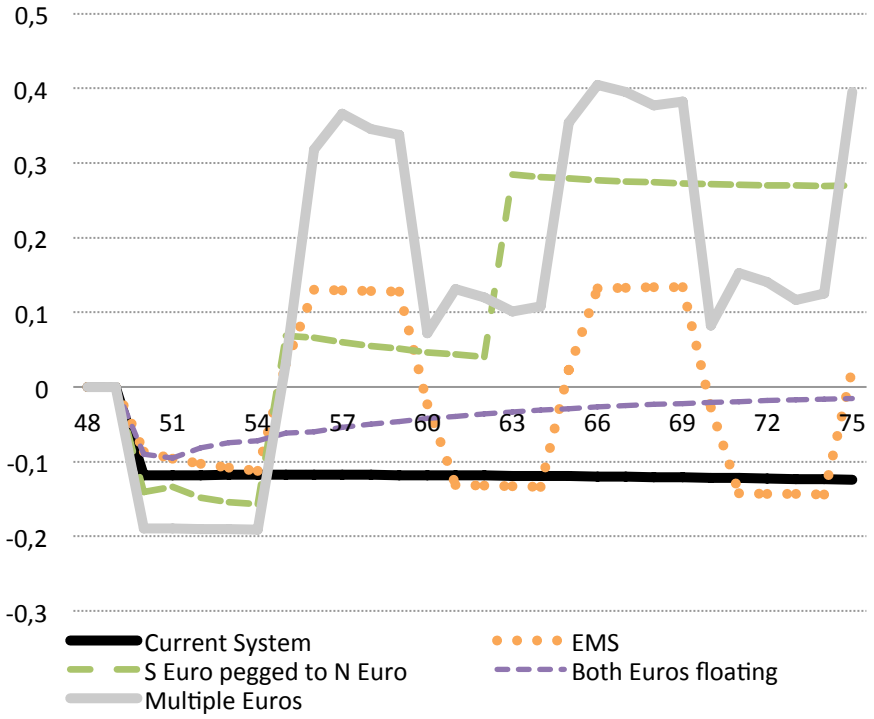


Figure 3.21: Effect of a loss of competitiveness on the Spanish euro

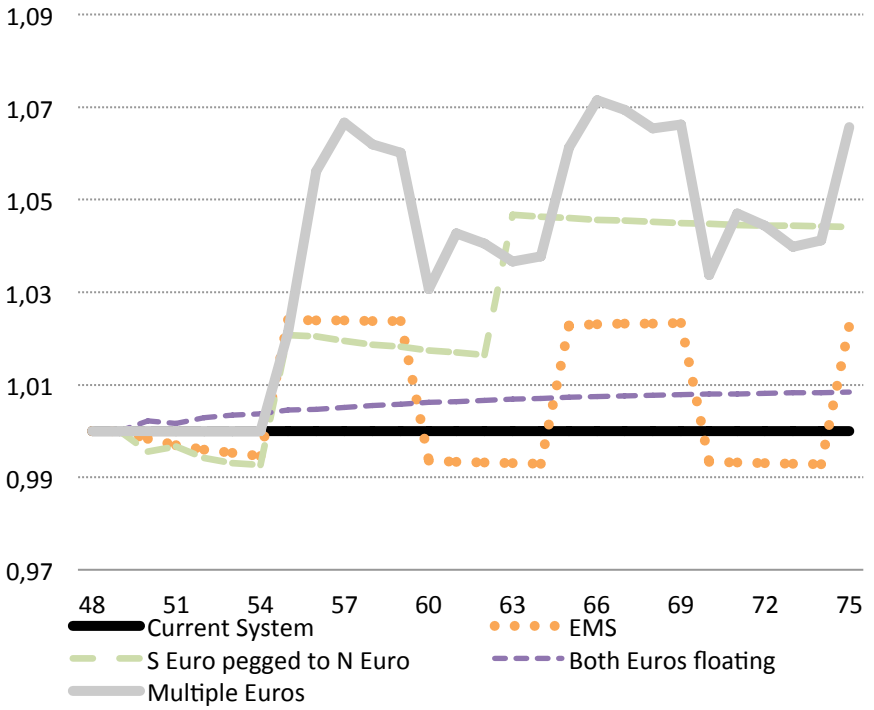


Figure 3.22: Effect of a loss of competitiveness on the German euro

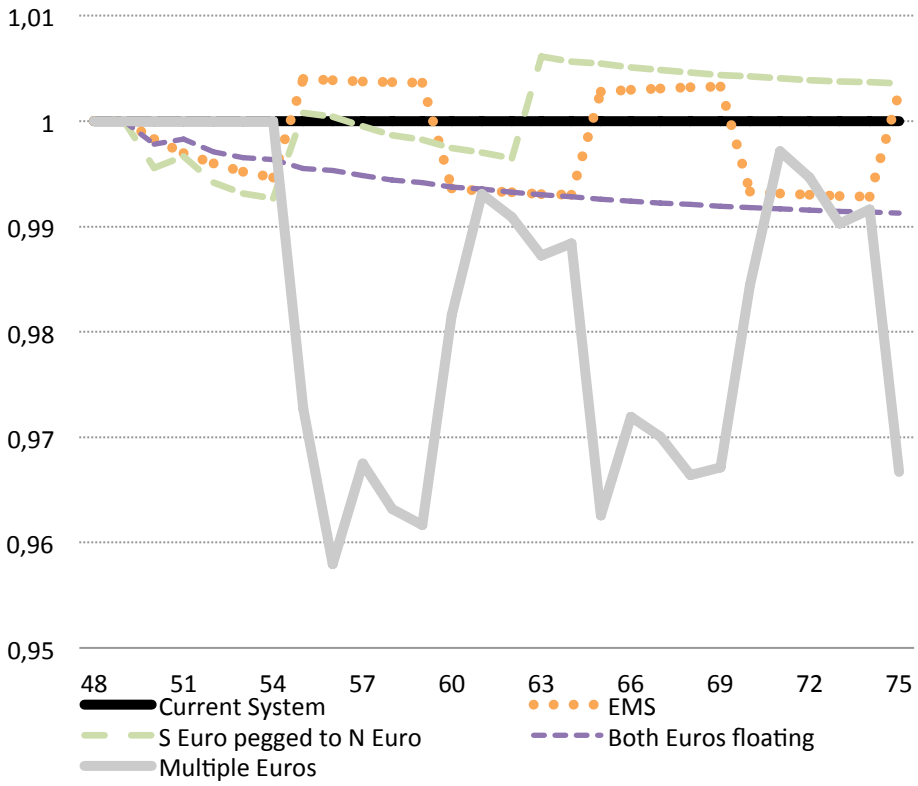


Figure 3.23: Effect of a loss of competitiveness on Spain's GDP

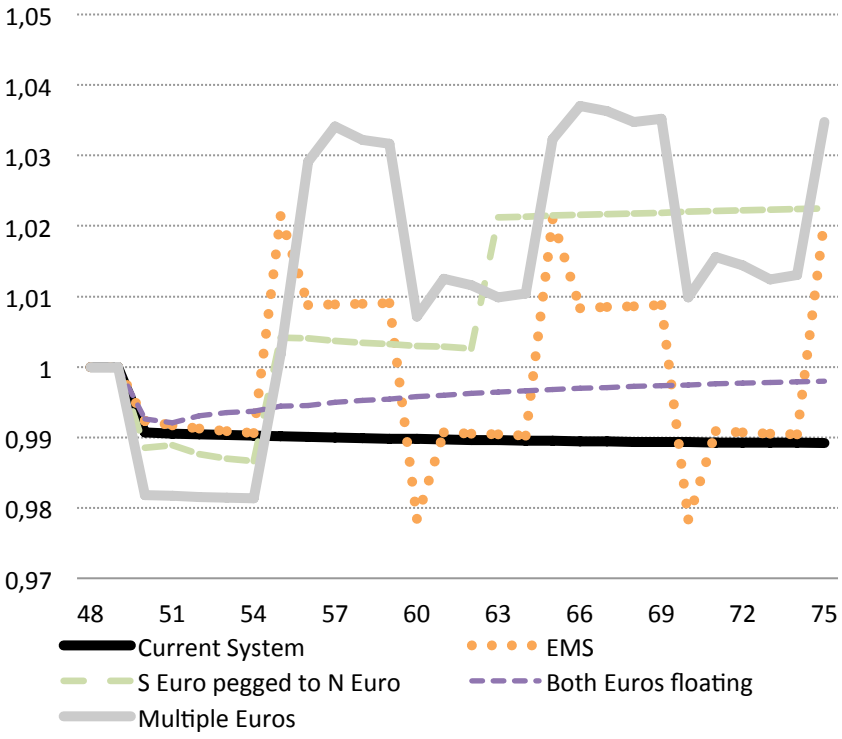
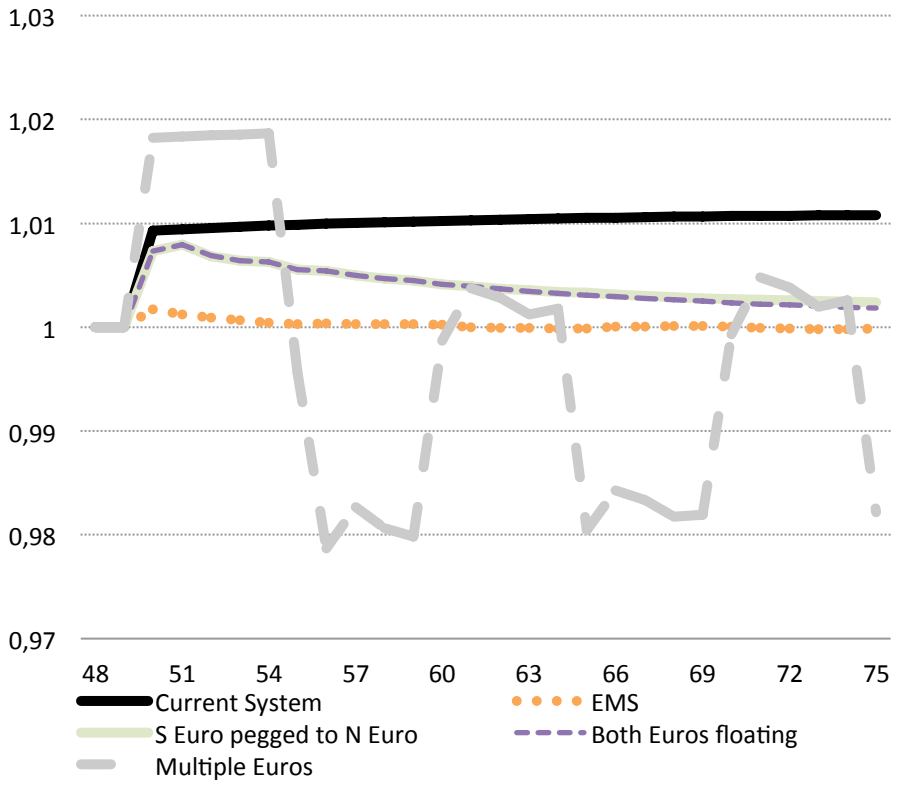


Figure 3.24: Effect of a loss of competitiveness on Germany's GDP



The three-euros scenario

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

The negative impact of the competitiveness shock on Spain's GDP can be observed in figure 3.23, most of which is explained by the deterioration of the trade balance (see figure 3.20). Figure 3.24 shows that the effect is the opposite in Germany, i.e., the trade balance goes into surplus, which in turn increases the rate of growth. Since the positive impact in Germany is neutralized by the negative effect in Spain, there is no impact in the

rate of growth of the global economy. Thus, the global euro remains unchanged vis-à-vis the US dollar.

However, the negative competitiveness shock implies that Spain starts to accumulate current account deficits. After five consecutive periods of deficits, the Spanish currency is devalued against the global euro. This adjustment is also observed in the exchange rate vis-à-vis the US dollar (see figure 3.21). This devaluation restores Spain's competitiveness, bringing the trade balance into surplus and the growth rate to a positive path. As a result of the higher level of activity, the government starts running a surplus, which implies that the supply of bonds decreases (since the financing needs of the Treasury decrease). This lower supply of bonds denominated in euros translates into an appreciated global euro (recall equation 3.199c), which also appreciates the German currency (recall that the German currency is pegged to the global euro).

The adjustment of the Spanish currency erodes Germany's competitiveness to such an extent that some periods later the German currency needs to be devalued (according to equation 3.201c). This improves Germany's trade balance, but worsens that of Spain. As a result, after some periods the Spanish currency is devalued once again. These dynamics are repeated infinitely. This implies that this setting does not produce stable results over time.[29]

The EMS scenario

Let us now analyze the impact of the same shock but in a context in which Spain has the capacity to devalue its currency against the ECU (and hence to the German currency) after some periods of accumulating current account deficits. Figure 3.21 shows that the immediate impact of the competitiveness shock is such that the Spanish currency appreciates. At first sight, this would seem counterintuitive since Spain is running a trade and current account deficit. However, it should be noted that the shock has an overall positive effect on global economic growth, thereby increasing the wealth of the private sector of all the country blocks except for Spain. As a result, portfolio investment

[29] In an extended version of this model (http://www.univ-paris13.fr/CEPN/IMG/pdf/wp2014_03.pdf) we tried out different adjustment criteria for equations 10-11. In some cases, instead of setting the adjustment threshold equal to a 0% deficit, we allow for small deficits. This modification helps to stabilize the dynamics, but such a scenario could not last too much since it would imply a continuous loss of foreign reserves. We also set an alternative adjustment criterion that states that the exchange rate is kept fixed as long as the stock of reserves is positive. In this case, balance of payments deficits can persist depending on the initial stock of foreign reserves.

increases, including the demand for bonds issued by the Spanish government. As long as the financial account surplus resulting from the demand for Spanish assets is larger than the current account deficit that arises from the loss of competitiveness, the exchange rate will appreciate. This is, indeed, what explains the downward movement of the exchange rate that is observed between periods 50 and 54. A similar behavior is observed for the case of the German currency.

According to the institutional setting of this model, Spain is allowed to devalue its currency against the ECU if it registers five consecutive periods of balance of payments deficits. Hence, in period 55 a devaluation of 2% vis-à-vis the ECU is introduced. This gain of competitiveness against Germany improves its trade surplus (see figure 3.20) thereby inducing an increase in the domestic level of activity (see figure 3.23). As regards Germany, the appreciation of its currency vis-à-vis the Spanish currency erodes its competitiveness, thereby reducing its trade, current account and fiscal surpluses. As a consequence, the German government increases the supply of bonds (or reduces the pace at which bonds are withdrawn from the market, in the case the government is running a surplus), which is reflected in a slight depreciation of the German currency (see figure 3.22). The global appreciation of the dollar that results from these movements ends up bringing about a larger devaluation of the Spanish currency vis-à-vis the US dollar (compared to the devaluation against the German currency), which is observed in figure 3.21.

The main conclusion that is drawn from this experiment is that in a context in which Spain is allowed to devalue its currency with respect to the ECU (and hence, to the German currency as well) the initial loss of competitiveness can be easily corrected, thereby preventing first a process of unsustainable current account deficits financed by financial account surpluses and, more importantly, the recessionary effect that the trade deficit may have on the level of activity and employment.

Another point that it is worth making is the instability of such a monetary regime. As it is observed in the figures, imposing an adjustment criterion on the exchange rate that is based on the bilateral performance of the current account is prone to generating cycles of continuous devaluations of the intra-European parities. During the times of the EMS this was considered a drawback of the system, mainly because of the difficulties that imposes on international trade. In this regard, the model confirms that taking up the EMS would imply the return to an undesirable situation. Hence, another alternatives should be examined.

The euro zone without Germany scenario

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

The evolution of the rest of the variables (GDP, trade balance and public debt) until the adjustment that takes place in period 55 is the same as the one observed in the EMS scenario. Once the Spanish currency is devalued, a positive effect on the trade balance (see figure 3.20) and economic growth (see figure 3.23) is observed. It should be noted that following the expansion brought about by the devaluation there is a contraction of GDP. This is explained by the positive income effect on imports, which slightly erodes the trade balance. After this adjustment has been made, Spain's overall trade balance is in surplus but deteriorating. However, the bilateral trade balance with Germany is in deficit. From this situation, it could be deduced that a 2% devaluation is not enough to bring the intra-European exchanges rates back to equilibrium. Thus, in period 63 a new devaluation is introduced, after which the same effects that had occurred after period 55 take place. The only difference is that in this case the new exchange rate parity is sufficient to restore Spain's initial competitiveness. No more adjustments take place.

Compared to the two previous scenarios, the case where Germany leaves the Eurozone and the remaining countries are pegged to the German currency seems to provide the whole system with a higher level of stability and sustainability in the medium-long run. Moreover, as shown in figure 3.24, this higher stability in the south does not come at the

cost of a recession in Germany, which exhibits a lower level of growth with respect to the baseline scenario, but positive growth still. The conclusion that can be drawn from this exercise is that a situation in which Germany leaves the Eurozone and the south is allowed to adjust its currency to a level that is more consistent with its external equilibrium can be beneficial for all: the south would not find itself immersed in a long-lasting recession with associated high levels of unemployment, and Germany would grow at a slower pace but it would avoid the politically uncomfortable subsidizing of troubled countries. Compared to a pure fiscal union or a scenario where Germany finances the bailout of the deficit countries, the institutional setting that was described in these simulations would also save Germany significant fiscal burdens.

Finally, it is worth examining the impact of an institutional setting where Germany leaves the Eurozone and the euro (now the currency of Spain) floats freely. As figure 3.22 shows, soon after the competitiveness shock the euro starts to depreciate as a result of the current account deficits. The opposite behavior is observed in the case of the German currency. As it may be intuited, an exchange rate arrangement where everything floats freely is prone to produce situations where the variables return to equilibrium. This is indeed what happens, since the initial trade deficit of Spain is progressively corrected as the euro depreciates. Eventually, the trade balance reaches equilibrium and the exchange rate stabilizes.

Our simulations of the different possible reforms of the Eurozone show under which conditions each institutional framework could work, which we consider an interesting contribution to the debate on the ways out of the crisis. We find that there are different alternatives to solve the causes that, from our point of view, explain the external fragility to which southern countries were exposed (and that finally materialized under the form of the crisis that has been affecting these economies lately). We find that a multiple euro framework (or a take-up of the EMS) might produce high levels of instability, unless the system allows for persistent but small deficits (presumably, lower than the ones observed before the crisis thanks to the possibility of adjusting exchange rates) The results would be much better if Germany left the euro area, but this would come at the cost of the loss of many of the benefits of the process of integration as a whole. In order to prevent this from happening and to keep some of these benefits, in the next section we present an alternative that could be more viable from a political point of view.

3.7 A more constructive solution: the European Clearing Union

Although in hindsight it is easy to criticize the institutional framework of the EMU, it must be said that before its implementation many economists like Godley (1992), Mazier (1992), Parguez (1999) and Kregel (1999) pointed out at the weaknesses of the system and predicted the crisis that ended up breaking out. Despite the fact of not being an optimum currency area (in the sense of Mundell (1961) and Tavlas (1991)), the EMU failed at providing its member countries with adjustment mechanisms that tended to help them to reach the long-term external and internal equilibrium. On the contrary, as the crisis has shown, the deficiencies of the international and European monetary system emerged once again. On the one hand, countries that had accumulated external deficits were forced to pursue strict structural adjustment programmes, implying cuts in public spending in a context of recession. The natural consequence of these measures was a large increase in the rate of unemployment. On the other hand, surplus countries were not forced to rebalance their growth strategies (most of them pursue export-led growth strategies at the expense of southern European countries, which lag behind in their technological capabilities).

This asymmetric way of solving external imbalances has been widely criticized (De Grauwe (2013)). In order to solve this problem, a Euro-bancor system could be introduced. The design of this regime is based on Keynes' original contributions for the post-war international economic relations, whose rules of the game were to be discussed at the Bretton Woods conference. His proposal consisted on 'generalizing the essential principle of banking, as exhibited in a closed system. The principle is the necessary equality of credits and debits, of assets and liabilities. If no credits can be removed from outside the banking system but only transferred within it, the bank itself can never be in difficulties' (Keynes (1943)). The generalization of this principle to a global scale required the creation of an international clearing union where every central bank had an account in bankers, a unit of account that would serve as the currency used for international transactions.

Although there are some differences in Keynes' drafts of the proposal, it seems fair to say that Keynes had in mind a system where all international transactions between countries were mediated by the national central banks which, in turn, found their bancor balances at the clearing union debited (credited) every time the country undertook an import (export) transaction. Moreover, to prevent leakages from the system and ensure the symmetry of the adjustment process (unlike the case of the Gold standard) Keynes proposed that both surplus and deficit countries pay interests on their bancor balances,

thereby providing incentives to purchase goods instead of hoarding reserves. Additionally, surplus countries could be eventually required to appreciate their currencies. A more updated version of Keynes proposal can be found in Davidson (2004).

As Cesaratto (2013) and Lavoie (2014) point out, the current setting of the Eurosystem may provide some of the necessary institutions to implement a Euro-bancor system. This is important from a political point of view since, unlike the alternative monetary regimes examined in the previous section, this proposal does not require the abandonment of many of the institutions created during the process of integration, like the ECB or the SEPA and its associated TARGET2 system. The ECB could keep its role of clearing house that is currently performing since the introduction of the SEPA. In the present system, all national central banks have accounts at the ECB where TARGET2 balances accumulate according to the intra-European real and financial transactions. In order to allow for a higher degree of flexibility that help deficit countries to balance their external positions, each member state would regain its national currency and peg it to the Euro-bancor, which would be only a unit of account, as the ECU was. The exchange rates within the union would be fixed, but adjustable. Finally, the ECB would collect interests on bancor balances of both surplus and deficit countries. This feature would make the system more symmetric and fair. The proceeds of these interests would be distributed to deficit countries in order to allow them to improve their external performance. In the next section we show in detail the different ways in which this could be attained.

Alternative closures

As it was mentioned in the previous section, the Euro-bancor model takes what we consider the most useful features of each of the systems that found implementation in Western Europe during the last decades. First, we borrow from the EMS the existence of a non-material unit of account to which national currencies are pegged. This currency, which in the EMS was called ECU, in Keynes' proposal was called bancor. In this model, the Euro-bancor is determined in the same way as the ECU was determined in the EMS, i.e., as a basket currency of national currencies, all measured with respect to the US dollar. Second, in Keynes' proposal countries accumulated bancor balances according to their external performance[30] – whereas those countries that exhibited trade surpluses registered an increase in their bancor account at the ICU, countries running trade deficits registered a decrease in their stock of bancors. The idea of accumulating balances of a

[30] In Keynes' proposal international capital mobility was discouraged. Thus, only real transactions could give raise to changes in the stock of bancors held by each country.

non-material currency as a result of international transactions is the same that we observe in the current TARGET2 system. This is a noteworthy issue, since it implies that most of the institutions that are required to implement a regime of this nature (a clearing union, an international unit of account and a system that registers the transactions within the region) already exist (the ECB could play the role of the ICU and the SEPA is the system that registers all the transactions) or have existed and could easily be restored (the ECU, that would play the role of the bancor).

Let us first describe the basic closure of the Euro-bancor model taking into account the features described in the previous paragraph – we will then show how other aspects of Keynes' idea can be introduced by modifying the following equations. As it is usual in every stock-flow consistent model, the whole system can be derived from a transaction matrix constituted by a social accounting matrix and a flow of funds, which are associated to a balance sheet matrix, where all the financial assets and liabilities that are included in the model are specified. Table 3.6 presents the balance sheet for Spain and the Clearing Union and Table 3.7 presents the matrices of transactions for the four country blocs, as well as for the Clearing Union.

Table 3.6: Balance sheet

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

Table 3.7: Matrices of transactions

United States	Households	Firms		Com. Banks		Government	Central Bank	
		Current	Capital	Current	Capital		Current	Capital
Consumption	$-C_t^{US}$	C_t^{US}						
Investment		I_t^{US}	$-I_t^{US}$					
Gov.Spending		G_t^{US}				$-G_t^{US}$		
Net Exports		NX_t^{US}						
Wages	W_t^{US}	$-W_t^{US}$						
Taxes	$-Th_t^{US}$	$-Tf_t^{US}$				T_t^{US}		
Int.Deposits	$rd_{t-1}^{US}.Md_{t-1}^{US}$			$-rd_{t-1}^{US}.Md_{t-1}^{US}$				
Int. Loans		$-rl_{t-1}^{US}.Ld_{t-1}^{US}$		$rl_{t-1}^{US}.Ld_{t-1}^{US}$				
Int.Reserves				$rs_{t-1}^{US}.R_{t-1}^{US}$			$-rs_{t-1}^{US}.R_{t-1}^{US}$	
Int.Advances				$-r_{t-1}^{US}.A_{t-1}^{US}$			$r_{t-1}^{US}.A_{t-1}^{US}$	
$Int.Bonds^{US}$				$r_{t-1}^{US}.Bd_{US_{t-1}}^{US}$		$-r_{t-1}^{US}.Bs_{t-1}^{US}$	$r_{t-1}^{US}.Bd_{US_{t-1}}^{US}$	
$Int.Bonds^{RW}$				$r_{t-1}^{RW}.Bd_{US_{t-1}}^{RW}$				
$Int.Bonds^{SP}$				$r_{t-1}^{SP}.Bd_{US_{t-1}}^{SP}$				
$Int.Bonds^{GE}$				$r_{t-1}^{GE}.Bd_{US_{t-1}}^{GE}$				
IEA								
Int. Bancor								
Profits		$-Pf^{US}$	Pf^{US}	$-Pb^{US}$	Pb^{US}	Pb^{US}	$-Pcb^{US}$	
$\Delta Cash$	$-\Delta Hd^{US}$							ΔHs^{US}
$\Delta Deposits$	$-\Delta Md^{US}$				ΔMd^{US}			
$\Delta Loans$			ΔL^{US}		$-\Delta L^{US}$			
$\Delta Reserves$					$-\Delta R^{US}$			ΔR^{US}
$\Delta Advances$					ΔA^{US}			$-\Delta A^{US}$
$\Delta Bonds^{US}$					$-\Delta Bd, b_{US}^{US}$	ΔBs^{US}		$-\Delta Bd, cb_{US}^{US}$
$\Delta Bonds^{RW}$					$-\Delta Bd, b_{US}^{RW}$			
$\Delta Bonds^{SP}$					$-\Delta Bd, b_{US}^{SP}$			
$\Delta Bonds^{GE}$					$-\Delta Bd, b_{US}^{GE}$			
$\Delta Bancor$								
Total	0	0	0	0	0	0	0	0

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	Rest of the World								
	Households	Firms		Com. Banks		Government	Central Bank		
		Current	Capital	Current	Capital		Current	Capital	
Consumption	$-C_t^{RW}$	C_t^{RW}							
Investment		I_t^{RW}	$-I_t^{RW}$						
Gov.Spending		G_t^{RW}				$-G_t^{RW}$			
Net Exports		NX_t^{RW}							
Wages	W_t^{RW}	$-W_t^{RW}$							
Taxes	$-Th_t^{RW}$	$-Tf_t^{RW}$				T_t^{RW}			
Int.Deposits	$rd_{t-1}^{RW}.Md_{t-1}^{RW}$			$-rd_{t-1}^{RW}.Md_{t-1}^{RW}$					
Int.Loans		$-rl_{t-1}^{RW}.Ld_{t-1}^{RW}$		$rl_{t-1}^{RW}.Ld_{t-1}^{RW}$					
Int.Reserves				$rs_{t-1}^{RW}.R_{t-1}^{RW}$			$-rs_{t-1}^{RW}.R_{t-1}^{RW}$		
Int.Advances				$-r_{t-1}^{RW}.A_{t-1}^{RW}$			$r_{t-1}^{RW}.A_{t-1}^{RW}$		
$Int.Bonds^{US}$				$r_{t-1}^{US}.Bd, b_{RW_{t-1}}^{US}$			$r_{t-1}^{US}.Bd, cb_{RW_{t-1}}^{US}$		
$Int.Bonds^{RW}$				$r_{t-1}^{RW}.Bd, b_{RW_{t-1}}^{RW}$		$-r_{t-1}^{RW}.Bs_{t-1}^{RW}$	$r_{t-1}^{RW}.Bd, cb_{RW_{t-1}}^{RW}$		
$Int.Bonds^{SP}$				$r_{t-1}^{SP}.Bd, b_{RW_{t-1}}^{SP}$					
$Int.Bonds^{GE}$				$r_{t-1}^{GE}.Bd, b_{RW_{t-1}}^{GE}$					
IEA									
Bancor									
Profits		$-Pf^{RW}$	Pf^{RW}	$-Pb^{RW}$	Pb^{RW}	Pcb^{RW}	$-Pcb^{RW}$		
$\Delta Cash$	$-\Delta Hd^{RW}$							ΔHs^{RW}	
$\Delta Deposits$	$-\Delta Md^{RW}$				ΔMd^{RW}				
$\Delta Loans$			ΔL^{RW}		$-\Delta L^{RW}$				
$\Delta Reserves$					$-\Delta R^{RW}$			ΔR^{RW}	
$\Delta Advances$					ΔA^{RW}			$-\Delta A^{RW}$	
$\Delta Bonds^{US}$					$-\Delta Bd, b_{RW}^{US}$			$-\Delta Bd, cb_{RW}^{US}$	
$\Delta Bonds^{RW}$					$-\Delta Bd, b_{RW}^{RW}$	ΔBs^{RW}		$-\Delta Bd, cb_{RW}^{RW}$	
$\Delta Bonds^{SP}$					$-\Delta Bd, b_{RW}^{SP}$				
$\Delta Bonds^{GE}$					$-\Delta Bd, b_{RW}^{GE}$				
$\Delta Bancor$									
Total	0	0	0	0	0	0	0	0	

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	Spain								
	Households	Firms		Com.Banks		Government	Central Bank		
		Current	Capital	Current	Capital		Current	Capital	
Consumption	$-C_t^{SP}$	C_t^{SP}							
Investment		I_t^{SP}	$-I_t^{SP}$						
Gov.Spending		G_t^{SP}				$-G_t^{SP}$			
Net Exports		NX_t^{SP}							
Wages	W_t^{SP}	$-W_t^{SP}$							
Taxes	$-Th_t^{SP}$	$-Tf_t^{SP}$				T_t^{SP}			
Int.Deposits	$rd_{t-1}^{SP}.Md_{t-1}^{SP}$			$-rd_{t-1}^{SP}.Md_{t-1}^{SP}$					
Int.Loans		$-rl_{t-1}^{SP}.Ld_{t-1}^{SP}$		$rl_{t-1}^{RW}.Ld_{t-1}^{RW}$					
Int.Reserves				$rs_{t-1}^{SP}.R_{t-1}^{SP}$			$-rs_{t-1}^{SP}.R_{t-1}^{SP}$		
Int.Advances				$-r_{t-1}^{GE}.A_{t-1}^{SP}$			$r_{t-1}^{GE}.A_{t-1}^{SP}$		
$Int.Bonds^{US}$				$r_{t-1}^{US}.Bd, b_{SP_{t-1}}^{US}$			$r_{t-1}^{US}.Bd, cb_{SP_{t-1}}^{US}$		
$Int.Bonds^{RW}$				$r_{t-1}^{RW}.Bd, b_{SP_{t-1}}^{RW}$					
$Int.Bonds^{SP}$				$r_{t-1}^{SP}.Bd, b_{SP_{t-1}}^{SP}$		$-r_{t-1}^{SP}.Bs_{t-1}^{SP}$	$r_{t-1}^{SP}.Bd, cb_{SP_{t-1}}^{SP}$		
$Int.Bonds^{GE}$				$r_{t-1}^{GE}.Bd, b_{SP_{t-1}}^{GE}$					
IEA							IEA_t^{SP}		
Bancor							$r_{t-1}^{EB}.EB_{t-1}^{SP}$		
Profits		$-Pf^{SP}$	Pf^{SP}	$-Pb^{SP}$	Pb^{SP}	Pcb^{SP}	$-Pcb^{SP}$		
$\Delta Cash$	$-\Delta Hd^{SP}$							$\Delta Hs, cb^{SP}$	
$\Delta Deposits$	$-\Delta Md^{SP}$				ΔMd^{SP}				
$\Delta Loans$			ΔL^{SP}		$-\Delta L^{SP}$				
$\Delta Reserves$					$-\Delta R^{SP}$			ΔR^{SP}	
$\Delta Advances$					ΔA^{SP}			$-\Delta A^{SP}$	
$\Delta Bonds^{US}$					$-\Delta Bd, b_{SP}^{US}$				
$\Delta Bonds^{RW}$					$-\Delta Bd, b_{SP}^{RW}$				
$\Delta Bonds^{SP}$					$-\Delta Bd, b_{SP}^{SP}$	ΔBs^{SP}		$-\Delta Bd, cb_{SP}^{SP}$	
$\Delta Bonds^{GE}$					$-\Delta Bd, b_{SP}^{GE}$				
$\Delta Bancor$								$-\Delta EB^{SP}$	
Total	0	0	0	0	0	0	0	0	

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	Germany and ECB								ECB		Total
	Households	Firms		Com.Banks		Government	Central Bank				
		Current	Capital	Current	Capital		Current	Capital	Current	Capital	
C	$-C_t^{GE}$	C_t^{GE}									0
I		I_t^{GE}	$-I_t^{GE}$								0
G		G_t^{GE}				$-G_t^{GE}$					0
$X-IM$		NX_t^{GE}									0
W	W_t^{GE}	$-W_t^{GE}$									0
T	$-Th_t^{GE}$	$-Tf_t^{GE}$				T_t^{GE}					0
$rd.Md$	$rd_{t-1}^{GE}.Md_{t-1}^{GE}$			$-rd_{t-1}^{GE}.Md_{t-1}^{GE}$							0
$rl.L$		$-rl_{t-1}^{GE}.Ld_{t-1}^{GE}$		$rl_{t-1}^{GE}.Ld_{t-1}^{GE}$							0
$rs.R$				$rs_{t-1}^{GE}.R_{t-1}^{GE}$			$-rs_{t-1}^{GE}.R_{t-1}^{GE}$				0
$r.A$				$-r_{t-1}^{GE}.A_{t-1}^{GE}$			$r_{t-1}^{GE}.A_{t-1}^{GE}$				0
$r^{US}.B^{US}$				$r_{t-1}^{US}.Bd, b_{GE_{t-1}}^{US}$			$r_{t-1}^{US}.Bd, cb_{GE_{t-1}}^{US}$		$r_{t-1}^{US}.Bd_{ECB_{t-1}}^{US}$		0
$r^{RW}.B^{RW}$				$r_{t-1}^{RW}.Bd, b_{GE_{t-1}}^{RW}$							0
$r^{SP}.B^{SP}$				$r_{t-1}^{SP}.Bd, b_{GE_{t-1}}^{SP}$					$r_{t-1}^{SP}.Bd_{ECB_{t-1}}^{SP}$		0
$r^{GE}.B^{GE}$				$r_{t-1}^{GE}.Bd, b_{GE_{t-1}}^{GE}$		$-r_{t-1}^{GE}.Bs_{t-1}^{GE}$	$r_{t-1}^{GE}.Bd, cb_{GE_{t-1}}^{GE}$		$r_{t-1}^{GE}.Bd_{ECB_{t-1}}^{GE}$		0
IEA							IEA_t^{GE}		$-IEA_t^{ECB}$		0
Bancor							$r_{t-1}^{EB}.EB_{t-1}^{GE}$		$r_{t-1}^{EB}.EB_{t-1}^{ECB}$		0
Profits		$-Pf^{GE}$	Pf^{GE}	$-Pb^{GE}$	Pb^{GE}	Pcb^{GE}	$-Pcb^{GE}$		$-Pcb^{ECB}$		0
ΔH	$-\Delta Hd^{GE}$							$\Delta Hs, cb^{GE}$			0
ΔMd	$-\Delta Md^{GE}$				ΔMd^{GE}						0
ΔL			ΔL^{GE}		$-\Delta L^{GE}$						0
ΔR					$-\Delta R^{GE}$			ΔR^{GE}			0
ΔA					ΔA^{GE}			$-\Delta A^{GE}$			0
ΔB^{US}					$-\Delta Bd, b_{GE}^{US}$						0
ΔB^{RW}					$-\Delta Bd, b_{GE}^{RW}$						0
ΔB^{SP}					$-\Delta Bd, b_{GE}^{SP}$						0
ΔB^{GE}					$-\Delta Bd, b_{GE}^{GE}$	ΔBs^{GE}		$-\Delta Bd, cb_{GE}^{GE}$			0
ΔEB								$-\Delta EB^{GE}$		$-\Delta EB^{ECB}$	0
Total	0	0	0	0	0	0	0	0	0	0	0

As mentioned before, the Euro-bancor (E9) is a basket currency composed by European currencies (equation (3.199f)). Unlike Keynes' proposal, where all the countries in the world are engaged in the bancor framework and thus have all fixed exchange rates, in this case European currencies are pegged to the Euro-bancor (thereby fixed with respect to each other) but they float against the currencies of the rest of the world. This feature of the system is also borrowed from the EMS. The adjustment criterion of European currencies vis-à-vis the Euro-bancor (E7 for Spain and E8 for Germany) depends on the intra-regional external performance of each country (equations 3.200f and 3.201f), unlike the case of the EMS where the overall performance was considered. The external performance of each country is evaluated taking a certain sustainability threshold for the bilateral current account. The exchange rate of each European currency against the US dollar (E1 for Germany and E2 for Spain) is such that the domestic bond market is in equilibrium (equations 3.182f and 3.183f). As was the case in the EMS, it should happen that the exchange rate of Spain vis-à-vis Germany is the same either computed through their exchange rates against the Euro-bancor or against the US dollar (equation 3.184f).

As regards the balance sheet identity of national central banks of Spain and Germany, even though they are engaged in a fixed exchange rate arrangement, the fact that the currency to which they are pegged (the Euro-bancor) does not have a physical existence, there is no need to accumulate reserves. This is one of the advantages of Keynes' proposal – the lack of a need to hoard foreign reserves could prevent potential flows of effective demand from leaking outside the system[31]. Thus, the stock of dollar-denominated bonds by the central banks of Spain and Germany will be constant (equations 3.202f and 3.203f), although when expressed in domestic currency this stock may be subject to changes due to variations in the exchange rate (equations 3.204f and 3.205f). In terms of the dynamics of the model, even though reserves are not accumulated in a context of fixed but adjustable exchange rates within Europe, the fact that the European currencies float against the currencies of the US and the rest of the world allows for consistency to be achieved.

[31] In Keynes' original proposal, international capital movements were forbidden. In our model, we do not need to do this as because we are assuming that the central bank purchases any excess supply of domestic bonds that may result from a sudden capital outflow. This assumption allows us to introduce the bancor proposal without forbidding capital movements, which seems something impossible to do in the current context of global financialisation. Phrased differently, we consider more likely to ask central banks to do "whatever it takes" to let this system work than eliminating global finance.

$$\frac{1}{E9} = \frac{Y^{GE}}{Y^{GE}+Y^{SP}} \cdot \frac{1}{E1} + \frac{Y^{SP}}{Y^{GE}+Y^{SP}} \cdot \frac{1}{E2} \quad (3.199f)$$

$$E7 = \begin{cases} E7_{-1} & if\ CA^{SP}_{GE_{t-i}} \geq T\ \ for\ all\ i = 1, \dots, 5 \\ E7_{-1}.(1+\varepsilon) & if\ CA^{SP}_{GE_{t-i}} < T\ \ for\ all\ i = 1, \dots, 5 \end{cases} \quad (3.200f)$$

$$E8 = \begin{cases} E8_{-1} & if\ CA^{GE}_{SP_{t-i}} \geq T\ \ for\ all\ i = 1, \dots, 5 \\ E8_{-1}.(1+\varepsilon) & if\ CA^{GE}_{SP_{t-i}} < T\ \ for\ all\ i = 1, \dots, 5 \end{cases} \quad (3.201f)$$

$$E1 = \frac{Bs^{GE} - Bd, b^{GE}_{GE} - Bd, cb^{GE}_{GE} - Bs, b^{GE}_{RW} - Bs, b^{GE}_{SP}}{Bd, b^{GE}_{US}} \quad (3.182f)$$

$$E2 = \frac{Bs^{SP} - Bd, b^{SP}_{SP} - Bd, cb^{SP}_{SP} - Bs, b^{SP}_{RW} - Bs, b^{SP}_{GE}}{Bd, b^{SP}_{US}} \quad (3.183f)$$

$$E3 = \frac{E7}{E8} = \frac{E2}{E1} \quad (3.184f)$$

$$Bs, cb^{US}_{SP} = \overline{Bs, cb^{US}_{SP}} \quad (3.202f)$$

$$Bs, cb^{US}_{GE} = \overline{Bs, cb^{US}_{GE}} \quad (3.203f)$$

$$\Delta Bd, cb^{US}_{SP} = Bs, cb^{US}_{SP_{-1}}.\Delta E2 \quad (3.204f)$$

$$\Delta Bd, cb^{US}_{GE} = Bs, cb^{US}_{GE_{-1}}.\Delta E1 \quad (3.205f)$$

We have already introduced some of the main features of Keynes' bancor proposal, i.e., the existence of an international unit of account and a system that registers all the transactions undertaken within the domain of this institutional arrangement. We can now introduce another key feature of this system: the clearing union. This is the institution where all the payments are cleared. Thus, every country would have an account at the clearing union. This account would be an asset for each national central bank and a liability for the clearing union, just as it happens in the current TARGET2 system.

However, unlike the current system, Euro-bancor balances would not only be composed of international trade and portfolio investment within Europe, but there would also be some specific flows characterizing Keynes' proposal. First, in order to make the external adjustment process (the trend to make all countries' current account tend to zero) more symmetric than it is today, this system would make both debtor and creditor countries share the burden of the debts[32]. Thus, all countries would pay interests on their bancor balances, shall they be positive or negative. This rule should encourage countries to make

[32] As it has been widely pointed out, in the current setting of both the international monetary system and the euro area, the external adjustment process is asymmetric because only debtor countries are forced to introduce the structural policies aimed at correcting the imbalances.

their accounts at the clearing union be as close to zero as possible, since it would always be better to consume a real good (an import) than paying an interest that entails no consumption at all.

A second flow that must be incorporated in the accumulation of Euro-bancor balances is the one related to the distribution of the funds collected by the clearing union, which result precisely from the aforementioned interest payments on Euro-bancor balances. We call these flows resulting from the redistribution process "intra-European adjustment" (IEA). The sum of all these flows determines the change in the stock of Euro-bancors held by each country's central banks (equations 3.178f and 3.179f). The sum of all the interest payments on Euro-bancor balances determines the profits of the clearing union (equation 3.206f), which distributes these funds to member countries according to the performance of the current account of each member country (equations 3.207f and 3.208f). Finally, we ensure that the balance sheet identity of the central banks of Spain and Germany holds through the purchases/sales of domestic bonds (equations 3.180f and 3.181f).

$$\Delta EB^{SP} = X_{SP}^{GE} - IM_{SP}^{GE} + r_{-1}^{GE}.Bd, b_{SP_{-1}}^{GE} - r_{-1}^{SP}.Bd, b_{GE_{-1}}^{SP} + \Delta Bs, b_{SP}^{GE} - \Delta Bd, b_{SP}^{GE} - |r_{-1}^{EB}.EB_{-1}^{SP}| + IEA^{SP}.E7 \quad (3.178f)$$

$$\Delta EB^{GE} = X_{GE}^{SP} - IM_{GE}^{SP} + r_{-1}^{SP}.Bd, b_{GE_{-1}}^{SP} - r_{-1}^{GE}.Bd, b_{SP_{-1}}^{GE} + \Delta Bs, b_{GE}^{SP} - \Delta Bd, b_{GE}^{SP} - |r_{-1}^{EB}.EB_{-1}^{GE}| + IEA^{GE}.E8 \quad (3.179f)$$

$$P^{CU} = \left|r_{-1}^{EB}.\frac{EB_{-1}^{SP}}{E7}\right| + \left|r_{-1}^{EB}.\frac{EB_{-1}^{GE}}{E8}\right| \quad (3.206f)$$

$$IEA^{SP} = \begin{cases} P^{CU} & if\ \frac{CA_{SP}^{GE}/E7}{\frac{Y^{SP}}{E7}} < \theta \\ 0.5\ P^{CU} & if\ \frac{CA_{SP}^{GE}/E7}{\frac{Y^{SP}}{E7}} \geq \theta \end{cases} \quad (3.207f)$$

$$IEA^{GE} = P^{CU} - IEA^{SP} \quad (3.208f)$$

$$\Delta Bd, cb_{SP}^{SP} = \Delta R^{SP} + \Delta H^{SP} - \Delta A^{SP} - \Delta Bd, cb_{SP}^{US} - \Delta EB^{SP} \quad (3.180f)$$

$$\Delta Bd, cb_{GE}^{GE} = \Delta R^{GE} + \Delta H^{GE} - \Delta A^{GE} - \Delta Bd, cb_{GE}^{US} - \Delta EB^{GE} \quad (3.181f)$$

Finally, there is another feature that derives from Keynes' proposal that could be introduced. In the previous paragraph we mentioned that in Keynes' proposal countries are encouraged to use their positive bancor balances to increase imports, since otherwise they would be wasting these balances - if balances are going to be cleared it is better to

use them to purchase real goods than giving them to the clearing union for nothing. This incentive to increase imports can be modeled by expanding the standard import equations used in stock-flow models. Normally, these equations depend on domestic income and the real exchange rate. In this case, as shown in equations 3.15f and 3.13f, we add an additional term that depends on the burden of the stock of Euro-bancors. The intuition behind this term would be that the higher the burden (represented by the interest payments associated to them) the higher the incentive to increase imports. Now, if imports are increased it needs to be specified what sector is going to purchase this additional flow of goods from abroad.

In this model we assume that it is the government, since in principle it is the only agent that could internalize the loss that the central bank would incur if Euro-bancor balances were gradually extinguished due to the payment of interests to the clearing union. Thus, we augment the traditional public spending equations, which consider government consumption exogenous, to incorporate this additional flow of imports (equations 3.7f and 3.8f). It is worth mentioning that in order to be consistent with Keynes' case for a non-recessionary adjustment process the import equation is only augmented when Euro-bancor balances are positive. This implies that whereas surplus countries are forced to pursue more expansionary policies, deficit countries are not forced to undertake a contractionary fiscal policy that restores the long-term balance of payments equilibrium through a recession.

$$ln(IM_{GE}^{SP}) = \begin{cases} \mu_0^{SP} + \mu_1^{SP}.\ln(Y^{SP}) + \mu_2^{SP}.\ln\left(\frac{1}{E3}\right) + \mu_3^{SP}.\ln\left[1 + \left(r^{eb}.EB_{-1}^{SP}\right)\right] & if\ EB_{-1}^{SP} > 0 \\ \mu_0^{SP} + \mu_1^{SP}.\ln(Y^{SP}) + \mu_2^{SP}.\ln\left(\frac{1}{E3}\right) & if\ EB_{-1}^{SP} \leq 0 \end{cases} \quad (3.15f)$$

$$ln(IM_{SP}^{GE}) = \begin{cases} \mu_0^{GE} + \mu_1^{GE}.\ln(Y^{GE}) + \mu_2^{GE}.\ln(E3) + \mu_3^{GE}.\ln\left[1 + \left(r^{eb}.EB_{-1}^{GE}\right)\right] & if\ EB_{-1}^{GE} > 0 \\ \mu_0^{GE} + \mu_1^{GE}.\ln(Y^{GE}) + \mu_2^{GE}.\ln(E3) & if\ EB_{-1}^{GE} \leq 0 \end{cases} \quad (3.13f)$$

$$G^{SP} = \begin{cases} G_0^{SP} + G_{-1}^{SP}.(1+\rho) + \mu_3^{SP}.\ln\left[1 + \left(r^{eb}.EB_{-1}^{SP}\right)\right] & if\ EB_{-1}^{SP} > 0 \\ G_0^{SP} + G_{-1}^{SP}.(1+\rho) & if\ EB_{-1}^{SP} \leq 0 \end{cases} \quad (3.7f)$$

$$G^{GE} = \begin{cases} G_0^{GE} + G_{-1}^{GE}.(1+\rho) + \mu_3^{GE}.\ln\left[1 + \left(r^{eb}.EB_{-1}^{GE}\right)\right] & if\ EB_{-1}^{GE} > 0 \\ G_0^{GE} + G_{-1}^{GE}.(1+\rho) & if\ EB_{-1}^{GE} \leq 0 \end{cases} \quad (3.8f)$$

Another closure implying a real-side adjustment could consist of the utilization of the flows of redistributed interests by the clearing union to finance the imports of capital goods that increase the stock of capital and eventually change the productive structure of the economy, thereby increasing competitiveness and, in the long run, reducing the

demand for imported goods. This would require the augmentation of Spain and Germany's import equations by the amount of "intra-European adjustment" flows received from the clearing union (equations 3.15g and 3.13g). The amount of imported capital goods that results from these flows of "aid" would be added to the traditional investment function used in many stock-flow consistent models (equations 3.87g and 3.88g). As it is shown in the simulations presented in the next section, the structural change effect is introduced as a gradual decrease in the income elasticity of imports of the deficit country.

$$ln(IM_{GE}^{SP}) = \mu_0^{SP} + \mu_1^{SP}.\ln(Y^{SP}) + \mu_2^{SP}.\ln\left(\frac{1}{E3}\right) + \mu_4^{SP}.\ln\left[1 + IEA^{SP}.E7\right] \quad (3.15g)$$

$$ln(IM_{SP}^{GE}) = \mu_0^{GE} + \mu_1^{GE}.\ln(Y^{GE}) + \mu_2^{GE}.\ln(E3) + \mu_4^{GE}.\ln\left[1 + IEA^{GE}.E8\right] \quad (3.13g)$$

$$\frac{I^{SP}}{K_{-1}^{SP}} = \gamma_0^{SP} + \gamma_1^{SP}.\frac{P^{SP}}{K_{-1}^{SP}} + \gamma_2^{SP}.\frac{r_{-1}^{SP}.L_{-1}^{SP}}{K_{-1}^{SP}} + \gamma_3^{SP}.u_{-1}^{SP} + \mu_4^{SP}.\ln\left[1 + IEA^{SP}.E7\right] \quad (3.87g)$$

$$\frac{I^{GE}}{K_{-1}^{GE}} = \gamma_0^{GE} + \gamma_1^{GE}.\frac{P^{GE}}{K_{-1}^{GE}} + \gamma_2^{GE}.\frac{r_{-1}^{GE}.L_{-1}^{GE}}{K_{-1}^{GE}} + \gamma_3^{GE}.u_{-1}^{GE} + \mu_4^{GE}.\ln\left[1 + IEA^{GE}.E8\right] \quad (3.88g)$$

If the structural change process if satisfactory it would be expected to observe that after some periods the deficit country starts being able to substitute imports, thereby reducing the dependence on foreign goods. In order to model this particular scenario we either endogenize the productive structure or we introduced structural change as an exogenous shock that gradually takes place some periods after the country has started to import the capital goods that will contribute to the process of import substitution. For the sake of simplicity, in this model we treat structural change as exogenous.

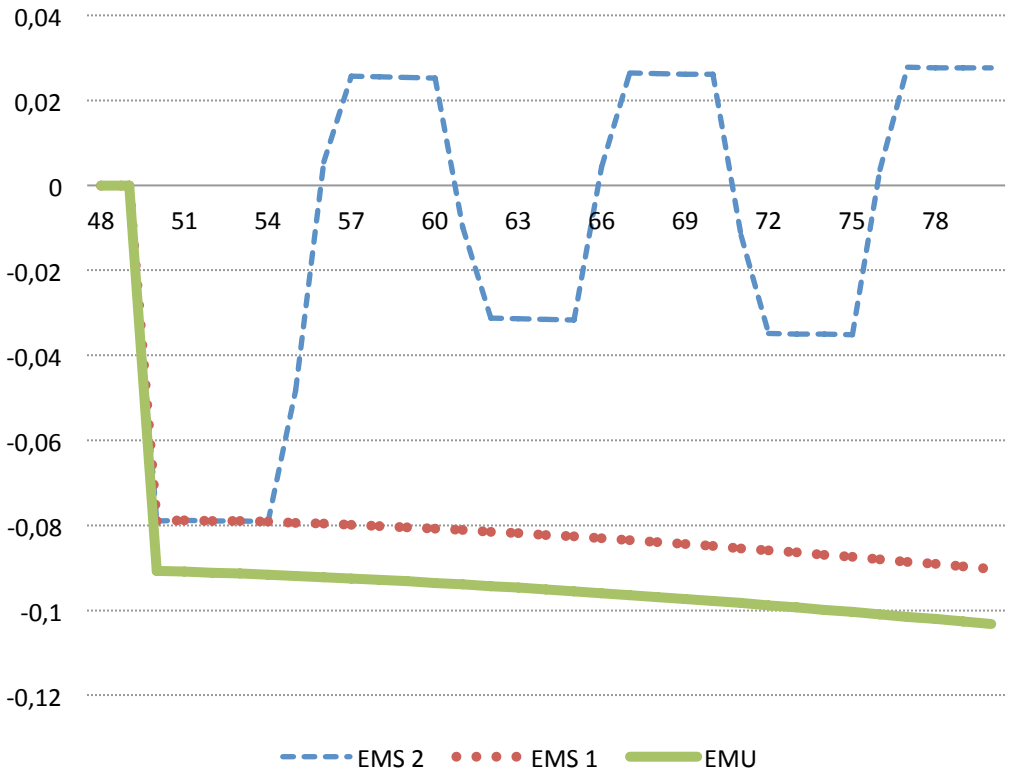
These equations complete the closure of the Euro-bancor model. We are now able to turn to the simulation experiments, in order to assess the advantages and disadvantages that this system may have in comparison to the previous experiences that took place in Europe.

Dynamic effects of the European Clearing Union

In this section we intend to show each baseline scenario described above in order to examine the different reaction of each system, which will be explained by the institutional arrangement embedded on them. Our first challenge is to "validate" our models that represent events that have already happened. Thus, we begin with EMU scenario. Our experiment consists of an introduction of a competitiveness loss in Spain. Since the

introduction of the euro, the negative competitiveness was produced by the unfavorable parities at which southern countries entered the euro (Duwicquet et al (2012)). Figure 3.25 presents the impact of this shock on the EMU model and on two versions of the EMS, which are identical to the ones analyzed in the previous section. The reason why we have two versions of the EMS model is given by the fact that we have chosen two different thresholds for the devaluation rule. In the EMS 1 model, the threshold is higher (larger current account deficits are allowed), in the EMS 2 model the threshold is lower (the size of the current account deficits that is allowed is smaller).

Figure 3.25: Spain's current account with respect to Germany

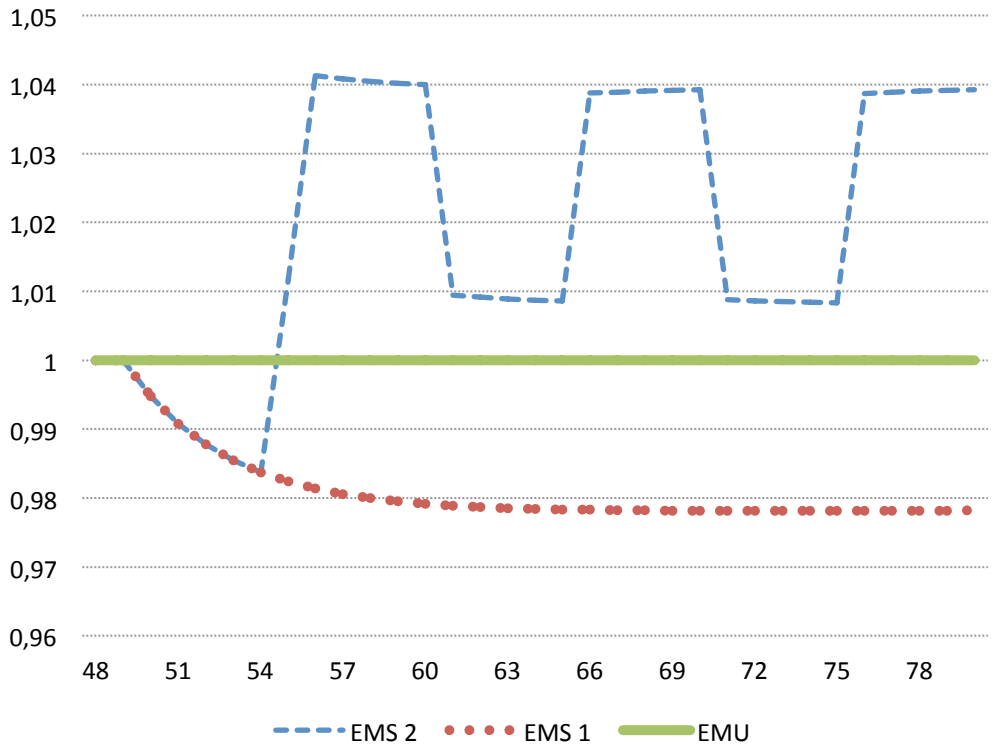


As it can be intuited the EMS 1 model is more stable than the EMS 2 one. This is because in the EMS 2 model continuous devaluations of Spain and Germany take place. After the initial negative shock on Spain, current account deficits are accumulated. Since these deficits exceed the threshold (which is set at a lower level than in the EMS 1 model), a devaluation of the Spanish currency is triggered. This brings Spain's current account into surplus, at the expense of Germany, which goes into deficit. After some periods, the German currency devalues exactly for the same reason that the Spanish currency had devaluated before: the size of the current account deficit is exceeding the predetermined threshold. These dynamics repeat regularly over time. If this cyclical behavior is not

desired (for instance, because the continuous fluctuations of exchange rates discourage international trade), the solution could be to set the threshold in a level that does not trigger these dynamics, as it is shown in model EMS 1. However, this may be hard to reach in practice because of the negative impacts that such a high threshold (meaning a threshold that allows for relatively large deficits) might have on the domestic level of activity, employment, public finances and debt sustainability. During the years of the EMS the dynamics were closer to the one described in model EMS 2 (beginning of the 1980s) and then to the one represented by model EMS 1 (end the 1980s).

It should be noted that the trajectories of the EMU and EMS 1 scenarios are very similar, being the only difference the size of the initial drop of the current account balance. This small difference is given by the behavior of the exchange rate in each of the cases. As Figure 3.26 shows, if we take the EMU scenario, since what is lost by Spain due to the competitiveness shock is earned by Germany the euro (which in this setting is also the Spanish currency) remains constant against the US dollar. In other words, the overall current account of the euro area remains unchanged. The situation is different in the EMS scenarios, where Spain regains its currency. In both cases after the initial shock an appreciation takes place, due to the appreciation of the ECU (E9). Recall that the ECU was constructed as a weighted average of the Spanish and the German currencies against the US dollar. Since after the shock Germany is running a current account surplus its exchange rate against the US dollar appreciates. As long as there are no adjustments between the Spanish and the German currencies, the initial parities are kept constant. Thus, the Spanish currency ends up appreciating as well. Depending on the threshold introduced in the adjustment rule there will be continuous devaluations or not. What the EMS1 scenario shows is a paradoxical situation, where Spain runs persistent current account deficits at the same time that its currency appreciates. As a consequence, Spain accumulates increasing stocks of external debt that eventually have to be paid. Hence, a scenario like EMS 1 does not seem feasible, as it has been illustrated by the burst of the rigid EMS in 1992-1993.

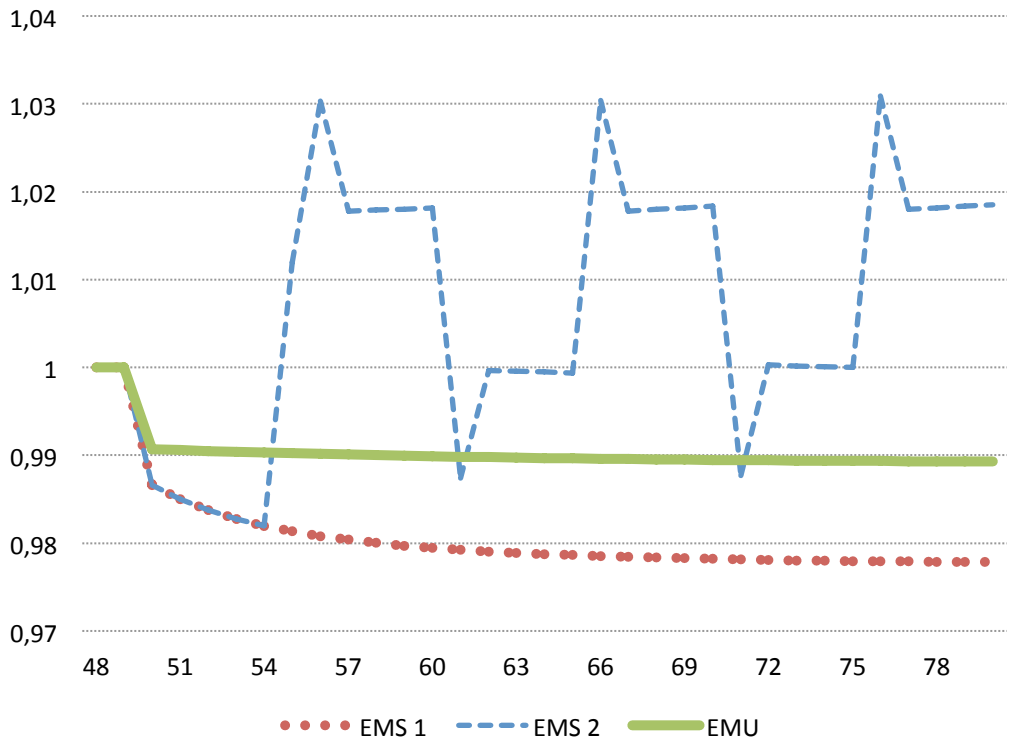
Figure 3.26: Spain's currency versus US dollar



Now that the differential evolution of the exchange rate in the EMU and EMS scenarios has been explained, we can understand why the current account of Spain against Germany exhibits a higher deterioration in the EMU scenario, as shown in Figure 3.25. As a result of the negative competitiveness shock, Spain's imports from Germany increase. This increase is higher in the EMU scenario since, as Figure 3.27 shows, GDP falls less in this case with respect to the EMS scenarios. The reason why GDP exhibits a better performance in the EMU case is related to the evolution of the exchange rate that we have just explained. Since in the EMS cases the ECU (and hence the Spanish and German currencies) appreciates Germany finds that its initial competitiveness gain is eroded. Thus, even though it keeps registering an overall current account surplus, it is lower than the one observed in the EMU scenario where there is no appreciation of its currency. The fact that Germany's competitiveness after the appreciation of the exchange rate is lower in the EMS cases than in the EMU scenario makes that its imports from Spain tend to be lower in the EMS cases. Hence, Spain's exports and GDP are also lower in both EMS scenarios, thereby undermining the initial increase in imports from Germany exogenously introduced with our shock.

Scenario EMS 1 has another problem in terms of long-term desirability. As Figure 3.27 shows, a situation where Spain accumulates persistent current account deficits implies that its GDP remains permanently below the baseline scenario. The consequences of such a situation would be damaging in terms of employment, effective demand and long-term productivity growth. An identical outcome is observed in the EMU scenario, where after the competitiveness shock Spain is condemned to grow at a slower pace, with eventual phases of high growth driven by booms in specific activities, as was the case with construction during the mid-2000s. This need not be the case if the EMU functioned in such a way that each country does not become a small and open economy that does not issue the currency in which its debts are denominated. But as long as no reforms are undertaken the future looks dismal.

Figure 3.27: Spain's GDP



Let us now turn to the different closures of the Euro-bancor model. The first one, which we label Eurobancor 1, consists of the introduction of the clearing union and Euro-bancor balances that entail interests, which are collected and distributed by the clearing union. The second closure, which we label Eurobancor 2, is the same as before but with a lower threshold on the devaluation rule, such that after an initial adjustment of the Spanish

exchange rate no exchange rate adjustments take place (current account balances remain above the threshold). The third closure, which we label Euro-bancor 3, considers a very low threshold (no current account deficits are allowed). As a result, a devaluation of the currency of Spain is followed by a devaluation of the German currency and so forth. The scenario that we call Eurobancor 4 is the one where countries use the "aid" provided by the clearing union (i.e., the redistribution of interests by the clearing union) to purchase imported capital goods that in the medium term allow for a higher degree of import substitution. We represent this by saying that after five periods of importing capital goods the country's income elasticity of imports starts decreasing gradually for ten periods, after what it remains constant over time. Finally, the model Euro-bancor 5 introduces the additional terms on the imports equations, in order to represent the higher incentive to import that surplus countries may have in this institutional setting. As mentioned before, these imports are computed as part of government consumption. For the Eurobancor 4 and 5 cases we have introduced the more generous devaluation threshold, in order to emphasize the real effect of the adjustment.

Table 3.8: Alternative closures for the Euro-bancor model

Closure	Main features	Operationalization
Eurobancor 1	Interest payments and redistribution	Surplus and deficit countries pay interests on bancor balances. The CU distributes the interests to deficit countries. The devaluation threshold (far from 0%) is never reached.
Euronabcor 2	Interest payments, redistribution and stable exchange rate adjustment	Surplus and deficit countries pay interests on bancor balances. The CU distributes the interests to deficit countries. The devaluation threshold (closer to 0%) is reached only once by the country that suffers the shock.
Eurobancor 3	Interest payments, redistribution and unstable exchange rate adjustment	Surplus and deficit countries pay interests on bancor balances. The CU distributes the interests to deficit countries. The devaluation threshold (very close to 0%) is reached persistently by both countries.
Eurobancor 4	Interest payments, redistribution and structural change	Surplus and deficit countries pay interests on bancor balances. The CU distributes the interests to deficit countries. The devaluation threshold (far from 0%) is never reached. The deficit country uses the "aid" from the CU to import capital goods that eventually change the productive structure.

Eurobancor 5	Interest payments, redistribution and adjustment through government spending	Surplus and deficit countries pay interests on bancor balances. The CU distributes the interests to deficit countries. The devaluation threshold (far from 0%) is never reached. The surplus country increases public spending of imported goods to avoid wasting the bancor balances.

Figure 3.28: Current account of Spain with respect to Germany

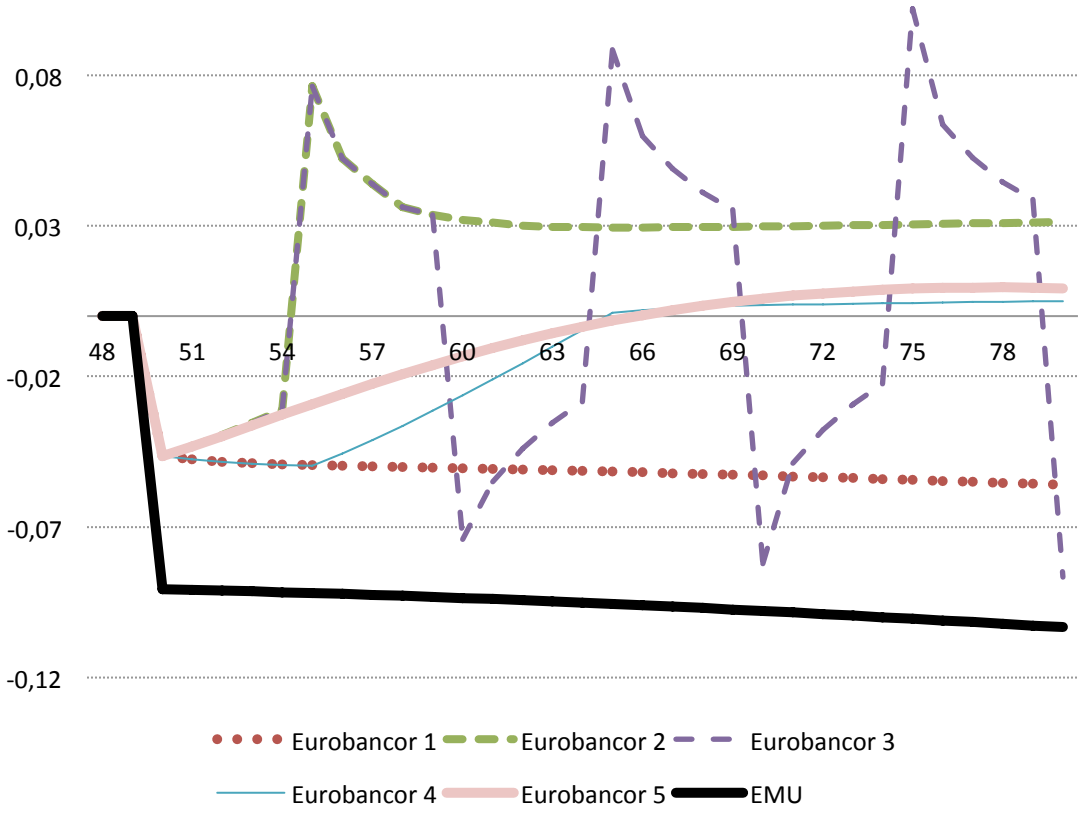


Figure 3.28 represents the reaction of each model to the same competitiveness shock analyzed before. The trajectory followed by the bilateral current account of Spain with respect to Germany in model Euro-bancor 1 is qualitatively similar to that of the EMS 1 model. This seems reasonable since in neither case the adjustment mechanisms are triggered (or if there are, like in EMS 1 and Euro-bancor 1, the threshold allows for so large deficits that no devaluation takes place).

As regards models Euro-bancor 2 and 3, the initial trajectories are very similar. We observe and initial deterioration in the current account (due to the shock) followed by an immediate improvement, explained by the transfers of the interests that the clearing union has collected (recall that in this framework the clearing union collects interests on Euro-bancor balances and transfers them to member countries according to their external performance). Since in the periods after the shock it is Spain whose current account is in deficit, the clearing union transfers the totality of the interests to Spain. However, these interests, computed as a credit in Spain's current account, are not sufficient to bring the current account balance above the threshold (neither the lower nor the higher one). Thus, the Spanish currency is devalued in period 55. The immediate effect is an increase in the current account balance, to the extent that it turns into a surplus. Hereafter, the trajectories of models Euro-bancor 2 and 3 diverge. The reason is given by the effect that the predetermined threshold has on Germany's current account.

In model Euro-bancor 3, where the threshold is lower (smaller deficits are tolerated), the devaluation of the Spanish currency and the consequent current account surplus of Spain imply a current account deficit in Germany that falls below it. This brings the German current account into surplus, at the expense of Spain. From then on, the dynamics are similar to the ones observed in model EMS 2 where one exchange rate adjustment followed another. We concluded that these dynamics were not desirable (as a matter of fact, European policy-makers decided to abandon the EMS for this reason). Model Euro-bancor 2 shows more stable dynamics for the simple reason that the devaluation threshold is higher. Thus, Germany "accepts" the current account deficit brought about by the devaluation of the Spanish currency and no more exchange rates adjustments take place. It is worth noting that this scenario implies that in the long run Spain runs a current account surplus vis-à-vis Germany.

Finally, models Euro-bancor 4 and 5 seem to provide the more stable adjustment processes. In the case of model Euro-bancor 4, after the initial shock that brings Spain's current account into deficit, the accumulation of Euro-bancor balances and the subsequent redistribution of interests by the clearing union imply an "aid" to Spain that is used to purchase imported capital goods. This additional flow of imports, which is added to the one produced by the initial shock, prevent Spain's current account from reaching equilibrium in the short run. However, after some periods, the effects of structural change take over and the country starts to substitute imports. This is reflected in the gradual

improvement of Spain's current account until it finally reaches a position that is close to equilibrium.

As regards model Euro-bancor 5, after the initial shock the accumulation of positive Euro-bancor balances by Germany produces an incentive to increase its purchases of goods from Spain. These imports are purchased by the government. In the long run, this produces a trend to balance the external positions at the same time that potential flows of effective demand do not leak from the system. We consider that the trajectories described by model Euro-bancor 4 and 5 are the ones that Keynes had in mind when designing the proposal of an international clearing union that he presented at the Bretton Woods conference, which aimed at 'the substitution of an expansionist, in place of a contractionist, pressure on world trade' (Keynes (1943)).

Let us take a quick look to the behavior of the Spanish currency vis-à-vis the US dollar under each of these alternative institutional settings, which can be seen in Figure 3.29. Since the monetary arrangement is constrained to the European economy, the exchange rate of the Spanish currency vis-à-vis the dollar floats. Taking into account that Spain is running current account deficits (both bilateral and overall) the depreciation of its currency is not surprising. In the case of Eurobancor 1, the negative impact of the shock in terms of the current account balance is followed by a succession of periods where it keeps on deteriorating but at a very slow pace. This is due to the fact that even if the level of activity has decreased, the higher propensity to import (introduced as the exogenous shock) prevents the economy from restoring external equilibrium through the income effect. This slight accumulation of current account deficits is followed by light depreciations.

The cases of Eurobancor 2 and 3 are identical to Eurobancor 1 until a first adjustment in the exchange rate of the Spanish currency against the Eurobancor takes place, in period 54. When this happens, the current account reverses its sign thereby producing an appreciation. As the trade surplus boosts economic growth, imports increase further. This not only erodes the new trade surplus but also produces an upward pressure on the exchange rate towards depreciation of the Spanish currency (see the evolution of the exchange rate in Eurobancor 2 and 3 between 56 and 59). From then on, it is observed that whereas the exchange rate remains stable in Eurobancor 2, it starts fluctuating in Eurobancor 3 (for the reasons that have already been described above).

The cases of Eurobancor 4 and 5 exhibit an initial depreciation followed by and

appreciation. After the initial shock the Spanish currency depreciates against the dollar for the same reasons examined above, i.e., the current account deficit produced by the loss of competitiveness. In the case of Eurobancor 4, where Spain is provided with "aid" to import capital goods, the trade and current account starts improving but at a slower pace than in the case of Eurobancor 5, where the adjustment mechanism implies only an increase in exports due to the higher demand for Spanish imports by the German government. Even though the relatively weaker performance of the Eurobancor 4 scenario in terms of the current account balance, Figure 3.30 shows that the country finds itself better off in terms of economic growth. This is due to the positive effect that the imports of capital goods have on investment and aggregate demand. The structural change derived from this adjustment mechanism should be more beneficial for long-run growth and should also reduce the country's exposure to another sudden competitiveness shock.

Figure 3.29: Spain's currency versus the US dollar

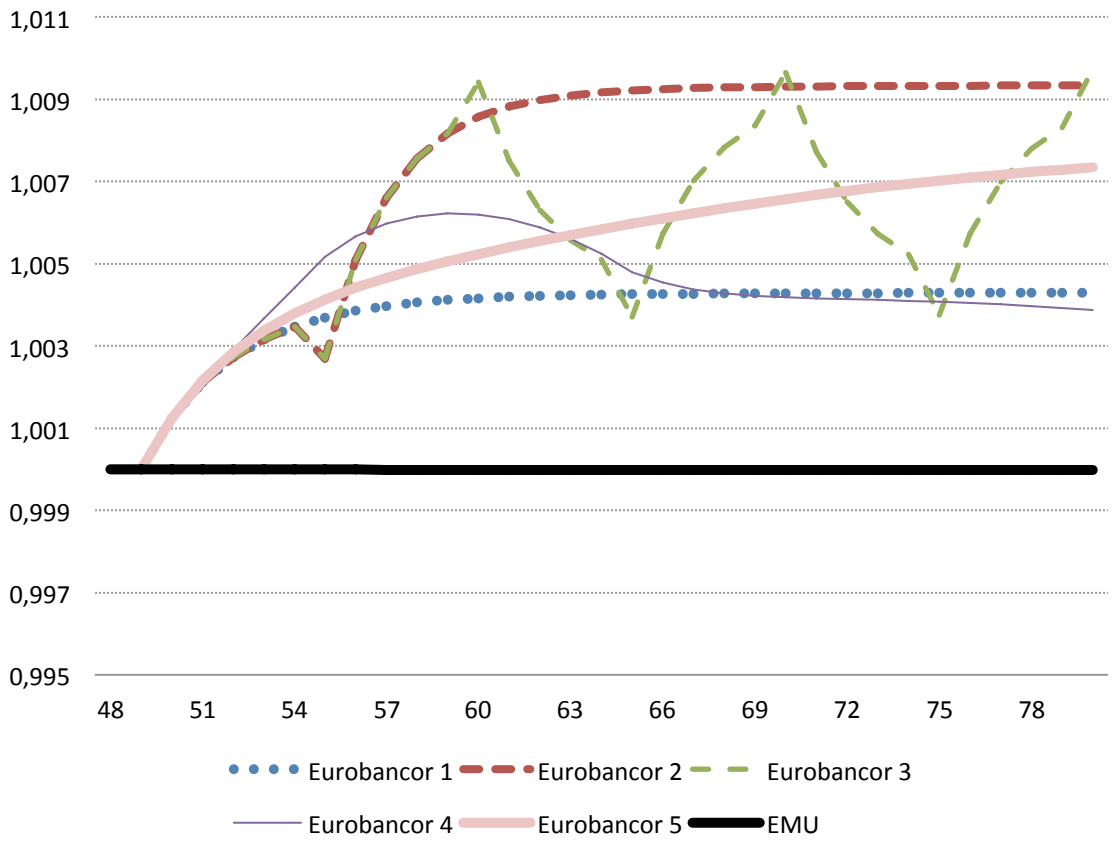
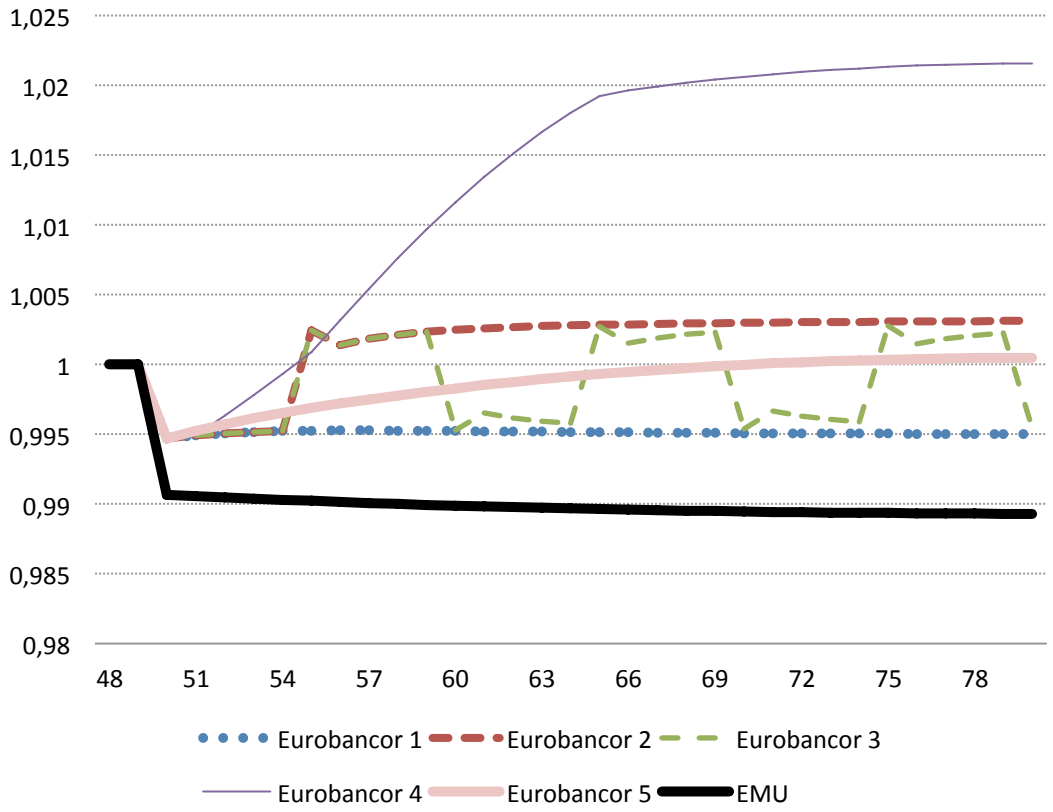
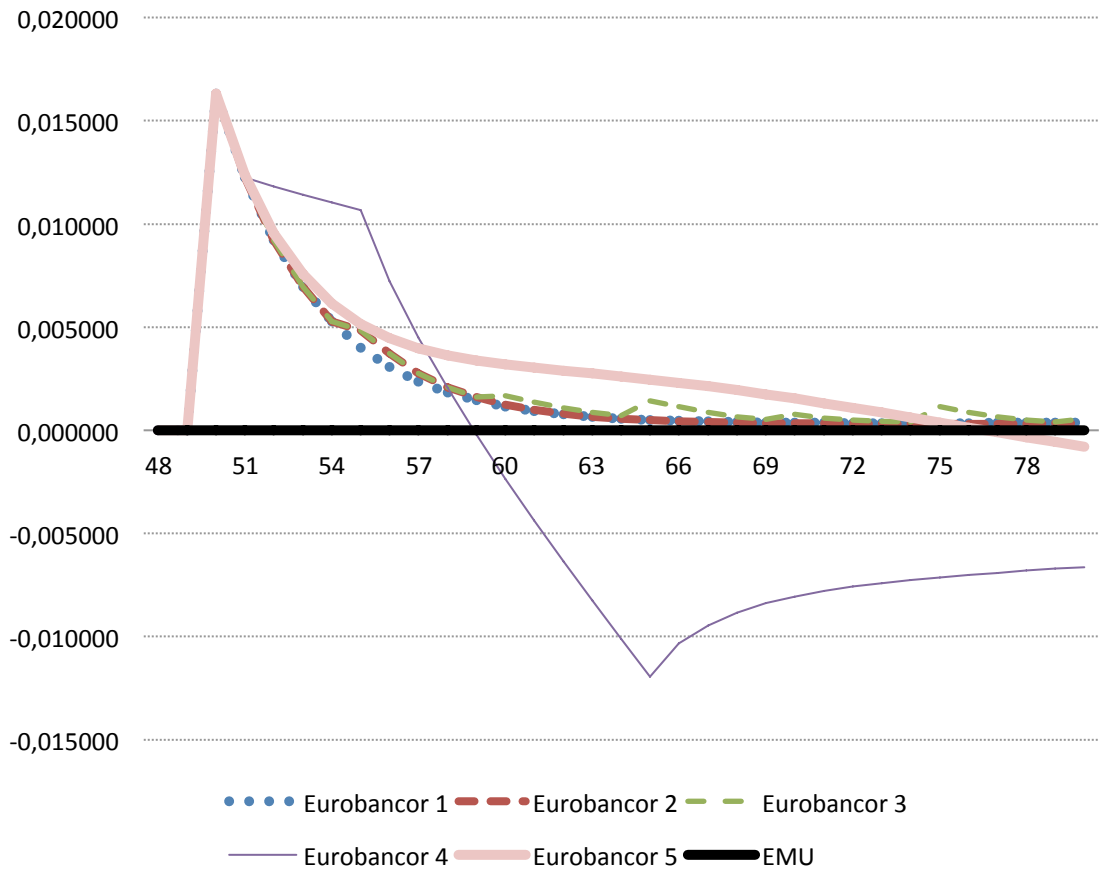


Figure 3.30: Spain's GDP



Finally it is worth analyzing the impact of the different European monetary regimes on the world imbalances, as illustrated by Figure 3.31, which plots the current account of the US. It is no surprise that, with the European Monetary Union, the negative shock on Spanish competitiveness has only intra-European effects without any impact on the US current account. With the Eurobancor regimes the shock induces an improvement of the current account of the US thanks to the appreciation of the German currency against the dollar and the increase of the German GDP. But, as the exchange rates of Spain and Germany are floating against the dollar, it allows a progressive reduction of the US surplus. It is only with the Eurobancor 4 regime that the US current account exhibits a small deficit in the long run thanks to the structural improvement of the Spanish competitiveness.

Figure 3.31: Current account of the US



To conclude, as Cesaratto (2013) and Lavoie (2014) have shown, the current payments system in the euro area is rather close to the one that Keynes proposed for the reform of the international monetary system at the beginning of the 1940s. In this section we tried to model how the clearing union proposal, associated to an international unit of account that is only used for the settlement of international payments, could be modeled in the framework of a stock-flow consistent model. We found that the Eurosystem already has many of the institutions that would play a key role under such a regime. Our simulations show in which way the existing institutions should be modified in order to make the Eurozone an area less prone to producing large imbalances that, in the absence of either a system of fiscal transfers between regions or a central bank that can provide unlimited liquidity to deficit countries, will inevitably suffer from recurrent crises.

As a general conclusion of this chapter, it could be said that as facts have shown, the flawed design of the European Monetary Union did not prevent large internal imbalances with the consequent financial instability from arising, but it has also deepened the effects

of the crisis by imposing austerity instead of promoting economic growth in the most affected countries. The use of stock-flow consistent models is helpful to understand both the way in which the Eurosystem currently works and the alternative directions in which it could be modified in order to make of the Eurozone an economic area whose members benefit from higher growth and welfare. In this chapter several proposals have been put forward, each of them accompanied by a model that comprehensively explains how it could work in practice. Should the political authorities decide to advance on the of reform of the European monetary institutions, it would be desirable that stock-flow consistent models like the ones presented in this chapter are taken into account at the time of thinking about the different paths to take.

4. Economic Structure and External Vulnerability

4.1. Introduction

Over the last few decades, macroeconomic modeling has followed the path of theory, focusing on the development of micro founded models based on methodological individualism with representative agents (Taylor, 2004). This approach emerged during the mid-1980 to solve the "weakness" of the Keynesian theory, i.e., the lack of explanations of the individual behavior of the economic agents. In this manner, macroeconomics started becoming a branch of microeconomics, into large-scale microeconomics, but with the same "laws" and the same dynamics. After several years of experimentation, dynamic stochastic general equilibrium models (DSGE) constitute the main analytical tool of the mainstream. Nowadays, every government and central bank has one of these –and those who do not, would like to have one– to use them both to understand economic processes and –mainly– to forecast.

Even though these models are mainstream in macroeconomics modeling terms, from a more heterodox standpoint, there are few arguments, if any, supporting this type of instruments when analyzing economic dynamics. Regardless of the school of thought they belong to, heterodox economists agree that both the assumptions and the methodology that these models are based on are far from representing the real performance of the economy. Therefore, little can be expected from these models not only to explain but also to forecast. In 2008, (most) heterodox economists were not surprised when the world entered the worst crisis in the last 80 years due to reasons the DSGE models had completely overlooked. The reason is simple: DSGE models had simplified the analysis so much that both the events which led to the crisis and the crisis itself were not deemed as a possible scenario within the frame of the model.

Once the crisis had arisen, some relative interest grew for those models who actually anticipated the storm which was about to come. Thus, stock-flow consistent models, mainly developed by the post-Keynesian school of thought, started drawing more attention. Over the last few years, this type of models was built both in the United States and in some European countries as well. These models represent a major breakthrough when compared to DSGE models because of two reasons. On the one hand, they do away with many of the assumptions and simplifications that led to the failure of DSGE models. On the other hand, they emphasize some accounting identities which must always be fulfilled, and therefore, have a direct impact on the behavior of different institutional

agents.

In this sense, considering the Latin American context, the development of models which account for the specific economic structure and dynamics of the region gains utmost importance. The availability of this type of tool would not only help us reach a better understanding of some impairments of the region, which prevent it from developing, but also would represent an instrument of forecast much more reliable and adapted to the Latin American context. In order to be cutting edge in macroeconomics modeling terms, we should not emulate what the core countries develop and use for their economies –which does not seem reliable– but we should design tools that describe the economic structure of our countries thoroughly and exhaustively instead.

In this paper, we will attempt to go forward in this line of thought. For that matter, in the following section, we will deal with some of the contributions which have been selected for the modeling of the framework that we will introduce in section three. As we will see below, it is an eclectic model, given the fact that it has post-Keynesian and structuralist aspects, even though in some cases certain changes must be made to these theories, which are often applied to developed economies (mainly the post-Keynesian theory), if we want to reach a more realistic description of the situation in Latin America. Afterwards, in section four, we will explain how the baseline model can be modified to represent the four types of economies which can be found in the region, roughly speaking: agro-industrial, oil, mining and maquiladora economies. In section five, we will simulate two scenarios (i.e. falling commodity prices and a transitory global recession) with the purpose of evaluating the results that the model produces. Finally, we will introduce some conclusions and the steps to follow in this investigation.

4.2. Theoretical Background

As we mentioned in the introduction, this model emerged from a post-Keynesian background because this school of thought has made the most important contributions to the development of the type of models we are discussing in this paper. In this sense, we must mention the pioneering work done by Tobin, who posed the precision in time treatment, the tracking of stocks, the introduction of multiple assets and rates of return, and the modeling of different financial and monetary policies as his most important contributions to economics (Tobin, 1982) in his own Nobel Prize conference. All these contributions were taken by Godley and Cripps, who incorporated them in the analysis of multiple economic processes which were generally analyzed only as interactions between

flow variables (Godley & Cripps, 1983). Subsequently, Godley himself developed a variety of stock-flow consistent models in order to study different macroeconomic problems, such as the common currency in Europe (Godley & Lavoie, 2007), high unemployment rates (Godley & Lavoie, 2007a) and the unsustainability of the growth process before the last crisis (Godley, 1999). This progress made in multiple directions has been concentrated in one book, which is considered the manual for anyone interested both in the potential and the learning of this type of models (Godley & Lavoie, 2007b).

However, in order to fully understand the Latin American economic reality, it is necessary to complement the stock-flow consistent models just like they were produced by the post-Keynesian school with the contributions of the pioneers of the structuralist school of thought. Among the theoretical contributions, there are two large groups of authors. On the one hand, we find Latin American authors who addressed the problem of productive heterogeneity and its repercussions over other problems such as inflation and external fragility during the second half of the 20th century. Among this group, the contributions made by Prebisch (1949), Noyola (1956), Sunkel (1960) and Pinto (1959) are considered the most relevant. These authors belong to what can be described as the hard core of the ECLAC, which gave rise to the school of thought known as “Latin American structuralism”. Furthermore, other authors’ contributions could be included within the structuralist group, such as Olivera (1964) and Diamand (1972) were considered. On the other hand, there is another group of authors who were interested in the specific problems of the region in spite of not working in Latin America. Some of the most distinguished work is from Taylor (1983) and Pasinetti (1983). The most interesting contribution by these authors may not be based on diagnosis, which was covered by Latin American authors almost completely, but on the provision of formal models to reach a better understanding of the performance of these economies.

Based on these contributions, different multisectoral models have been built over the last few years to be applied to the treatment of the type of problems that we aim to address in this paper. Most of these models are framed within the models of computable general equilibrium tradition (CGE). The work of Adelman & Robinson (1978) for South Korea and of Taylor et al (1980) for Brazil are the pioneers in this field. The interesting point of those pieces of work is that they strive to adapt some macroeconomics mechanisms to the situation in Latin American countries, unlike the traditional CGE models. A recent work which incorporates this type of contributions was developed by Serino (2009). Nevertheless, notwithstanding the important breakthrough that the introduction of the input-output relationships and links between different sectors represent, CGE models do

not feature a comprehensive description of stocks, nor do they analyze the financial field of the system in depth either. For this reason, even though we consider that CGE models are the best contribution there is in structuralist macroeconomic terms, we also believe there is still a long road ahead of us if we want to exploit the potential that macroeconomic modeling can provide to the understanding of the problems of the region.

4.3. The structuralist stock-flow consistent model

As in every stock-flow consistent model, the base structure of the system is derived from the social accounting and the flow of funds matrices, which add up all the real and financial transactions made in the economy during a certain period. The registration of the source and purpose of every transaction prevents “black holes” from existing in the accounting of the model in the sense that all the flows (whether they be real or financial transactions) come out of a sector of the economy and come into another with nothing being lost along the way. This accounting consistency is the key feature of this type of models.

Table 4.1: Matrix of transactions

	Households	A		Q		M		S		Banks		Gov.	Central Bank		RoW		
		Cur.	Cap.	Cur.	Cap.	Cur.	Cap.	Cur.	Cap.	Cur.	Cap.		Cur.	Cap.	Cur.	Cap.	
ion	$-C\$$	$C\$^A$				$C\$_h^M$		$C\$^S$							$C\$_f^M$		0
nt			$-I\$^A$		$-I\$^Q$	$\sum I\$_{j,h}^i$	$-I\$^M$		$-I\$^S$						$\sum I\$_{j,f}^i$		0
s.		$CI\$^A$		$CI\$^Q$		$CI\$^M$		$CI\$^S$							$\sum Ms\$_f^i$		0
.		$G\$^A$				$G\$^M$		$G\$^S$				$-G\$$					0
		$X\$^A$		$X\$^Q$		$X\$^M$									$-X\$$		0
		$\Delta ST\$^A$	$-\Delta ST\$^Q$	$\Delta ST\$^X$	$-\Delta ST\$^A$	$\Delta ST\$^M$	$-\Delta ST\$^M$										0
	W	$-W^A$		$-W^Q$		$-W^M$		$-W^S$									0
	$-T^H$	$-T^A$		$-T^Q$		$-T^M$		$-T^S$				T					0
.	$r^d.D^H$	$r^d.D^A$		$r^d.D^Q$		$r^d.D^M$		$r^d.D^S$		$-r^d.D$							0
l.		$-r^l.L^A$		$-r^l.L^Q$		$-r^l.L^M$		$-r^l.L^S$		$r^l.L$							0
										$r^r.R$			$-r^r.R$				0
.										$-r^a.A$			$r^a.A$				0
										$r_h^{\$}.Bd, b_h^{\$}$		$-r_h^{\$}.Bs_h^{\$}$	$r_h^{\$}.Bd, cb_h^{\$}$		$r_h^{\$}.Bd, w_h^{\$}$		0
												$-r_h^e.Bs_h^e$			$r_h^e.Bd, w_h^e$		0
										$r_f.Bd, b^f$			$r_f.Bd, cb^f$		$-r_f.Bs^f$		0
		$-NP^A$	NP^A	$-NP^Q$	NP^Q	$-NP^M$	NP^M	$-NP^S$	NP^S	$-P^B$	P^B	P^{CB}	$-P^{CB}$		CA	$-CA$	0
y	$-\Delta H$													ΔH			0
	$-\Delta D^H$		$-\Delta D^A$		$-\Delta D^Q$		$-\Delta D^M$		$-\Delta D^S$		ΔD						0
			ΔL^A		ΔL^Q		ΔL^M		ΔL^S		$-\Delta L$						0
											$-\Delta R$			ΔR			0
											ΔA			$-\Delta A$			0
											$-\Delta Bd, b_h^{\$}$	$\Delta Bs_h^{\$}$		$-\Delta Bd, cb_h^{\$}$		$-\Delta Bd, w_h^{\$}$	0
												ΔBs_h^e				$-\Delta Bd, w_h^e$	0
											$-\Delta Bd, b_f$			$-\Delta Bd, cb_f$		ΔBs_f	0
	$-\Delta V^H$	0	$-\Delta V^A$	0	$-\Delta V^Q$	0	$-\Delta V^M$	0	$-\Delta V^S$	0	$-\Delta V^B$	$-\Delta V^G$	0	$-\Delta V^{CB}$	0	$-\Delta V^W$	0

The reading of the social accounting matrix and the flow of funds matrix helps us distinguish eight institutional agents: households, four productive sectors (the agricultural sector producing food and non-food commodities (A and Q, respectively), the industrial and the services sector (M and S, respectively)), commercial banks, the government, the central bank and the rest of the world. Households supply their labor, in return for which they receive a wage, which will vary in relation to the production sector where every labor unit is employed. Firms combine the labor and the stock of capital with intermediate goods (see input-output matrix below) to produce their output, which can be consumed at both in the domestic and in the foreign markets, with the exception of the services sector, whose production is not considered to be tradable at all. Both households and firms consume part of the production of the rest of the world, the former, at final level and the latter, at intermediate level. In addition, they must pay taxes to the government in proportion to their income. This revenue is collected by government, who also plays an important role on the demand side since it purchases goods, both primary and industrial, or services.

In this model, the financial sector plays a relatively passive role in the sense that the behavior associated with financialisation, especially relevant in developed countries, is not incorporated. We believe that this assumption does not entail a significant loss of realism given the fact that in the economies of the region, the relevance of the financial sector is lower compared to other regions. However, the aspect into which an active behavior of the financial sector is incorporated is the one linked to credit rationing, which may have a strong impact on the real sector due to the potential freezing of some investment projects. In every period, firms will demand credit from banks for an amount equal to the difference between the desired investment and the retained earnings. The banks will then choose what part of the credit demand shall be met, in relation to their own portfolio decision.

The financial sector of the economy (both public, represented by the central bank, and private, i.e. commercial banks) is also linked to households, since these demand two types of financial assets to materialize their saving decisions. Saving results from the difference between disposable income and consumption, and it can be turned into wealth as bank deposits or cash. While the former represent a liability for commercial banks, the latter represents a liability for the monetary authority, who will supply as much money as households may so demand. In other words, money is endogenous.

As far as the government is concerned, we already mentioned that it receives taxes from

both households and the different productive sectors. If there was a difference between the income and the expenditure of the government (consisting of both primary expenditure and interest payments), the gap would be financed by means of debt issuance. Part of it would be denominated in the national currency (domestic bonds demanded by the local and the international financial sectors), and part of it would be denominated in foreign currency. This may configure a potential source of external vulnerability.

Table 4.2: Input-Output Matrix

	A	Q	M	S	Final Demand	Total Demand
A	$q_{AA}.Y^A$	$q_{QA}.Y^Q$	$q_{MA}.Y^M$	$q_{SA}.Y^S$	$C^A + G^A + X^A$	Y^A
Q	$q_{AQ}.Y^A$	$q_{QQ}.Y^Q$	$q_{MQ}.Y^M$	$q_{SQ}.Y^S$	X^Q	Y^Q
M	$q_{AM}.Y^A$	$q_{QM}.Y^Q$	$q_{MM}.Y^M$	$q_{SM}.Y^S$	$C_h^M + G^M + X^M + \sum I_{h,h}^i + \sum I_{f,h}^i$	Y^M
S	$q_{AS}.Y^A$	$q_{QS}.Y^Q$	$q_{MS}.Y^M$	$q_{SS}.Y^S$	$C^S + G^S$	Y^S
Labor	$q_{AN}.Y^A$	$q_{QN}.Y^Q$	$q_{MN}.Y^M$	$q_{SN}.Y^S$	$-$	
Total Supply	Y^A	Y^Q	Y^M	Y^S	GVP	

After this brief description of some of the interactions incorporated into the model, we shall proceed to present each process in detail. We shall start with production, in order to go through the different institutional agents whose actions determine aggregate demand. We shall conclude with the presentation of the local and international financial sectors, whose effects on demand and the level of activity can be gravitating, regardless of being less direct.

Production, intermediate consumption and resource utilization

Real transactions incorporated into the social accounting matrix are originated in the production process. Even though most of stock-flow consistent models assume there is only one product available in unlimited conditions (or supply is “demand-driven”, as it is often referred to), the truth is that the production process is more complex, a reason why not describing the specificities of this process can be dangerously simplistic in a case where there are several supply-side constraints. This is where the structuralist features of our model start to show up. The relations between the different sectors are represented by the production coefficients of the input-output matrix, which further specifies the different sources of final demand associated to each product. Embedded in the coefficients of the input-output matrix are some crucial features of economic dynamics, such as the configuration of the productive structure and the impact of technological

change.

From the columns of the matrix for each productive sector, we can deduce the total demand for inputs, which provide the tools to achieve a determined level of production. Since they are expressed in physical terms, the elements of the columns cannot be added. For this to be possible, we should express the matrix in values, multiplying them by the relevant price indexes. Nonetheless, the elements in the rows can indeed be added since they are all expressed in the same unit. Note that from the input-output matrix we can derive the equilibrium that *ex post* must always be met and which states that aggregate supply must be equal to aggregate demand.

From the rows of the input-output matrix, we can deduce the total number of sales (intermediate and final) for each of the three productive sectors (equations 4.1 to 4.4). Unlike what can be seen in the matrix, in the equations for sales, we express the flows in nominal terms. For instance, private consumption of the good "A", which is expressed in real terms in the matrix as C^{A}, we express it as $C\$^{A}$ in the equation of nominal sales of the good "A". It is worth mentioning that with regards to investment, we should only consider the purchase of those capital goods of national origin. This way, $I\$^{A}_{h,h_t}$ shows the investment of national companies in capital goods of national origin, and $I\$^{A}_{f,h_t}$ represents the investment of foreign companies in capital goods of national origin. The imported production will be incorporated into the imports equation. With regards to intermediate consumption, as we will explain in detail below, it is obtained by multiplying the technical coefficient by the desired production and by the relevant price index. This is where the nominal supply of manufactured goods of national origin to local agricultural companies, which we express as $Ms\$^{A}_{h_t}$, is originated. The sales in real terms can be obtained by means of adding the different components of demand but expressed in real terms (as it can be seen in the matrix), as shown in equations 4.5 to 4.8.

$$S\$^{A}_{t} = C\$^{A}_{t} + G\$^{A}_{t} + X\$^{A}_{t} + As\$^{A}_{t} + As\$^{M}_{t} + As\$^{S}_{t} + As\$^{X}_{t} \quad (4.1)$$

$$S\$^{Q}_{t} = X\$^{Q}_{t} + Qs\$^{Q}_{t} + Qs\$^{M}_{t} + Qs\$^{S}_{t} + Qs\$^{X}_{t} \quad (4.2)$$

$$S\$^{M}_{t} = C\$^{M}_{t} + G\$^{M}_{t} + X\$^{M}_{t} + I\$^{A}_{h,h_t} + I\$^{M}_{h,h_t} + I\$^{S}_{h,h_t} + I\$^{Q}_{h,h_t} + I\$^{A}_{f,h_t} + I\$^{M}_{f,h_t} + I\$^{S}_{f,h_t} + I\$^{Q}_{f,h_t} + Ms\$^{A}_{h_t} + Ms\$^{M}_{h_t} + Ms\$^{S}_{h_t} + Ms\$^{Q}_{h_t} \quad (4.3)$$

$$S\$^{S}_{t} = C\$^{S}_{t} + G\$^{S}_{t} + Ss\$^{A}_{t} + Ss\$^{M}_{t} + Ss\$^{S}_{t} + Ss\$^{Q}_{t} \quad (4.4)$$

$$S^{A}_{t} = C^{A}_{t} + G^{A}_{t} + X^{A}_{t} + As^{A}_{t} + As^{M}_{t} + As^{S}_{t} + As^{Q}_{t} \quad (4.5)$$

$$S_t^Q = X_t^Q + Qs_t^A + Qs_t^M + Qs_t^S + Qs_t^Q \quad (4.6)$$

$$S_t^M = C_t^M + G_t^M + X_t^M + I_{h,h_t}^A + I_{h,h_t}^M + I_{h,h_t}^S + I_{h,h_t}^Q + I_{f,h_t}^A + I_{f,h_t}^M + I_{f,h_t}^S + I_{f,h_t}^Q + Ms_{h_t}^A + Ms_{h_t}^M + Ms_{h_t}^S + Ms_{h_t}^Q \quad (4.7)$$

$$S_t^S = C_t^S + G_t^S + Ss_t^A + Ss_t^M + Ss_t^S + Ss_t^Q \quad (4.8)$$

As it was seen in the input-output matrix and the equations above, the intermediate demand plays a key role in the model. Intermediate consumption is deemed as endogenous and depends on the conditions of supply and demand. On the supply side, there can be a limit to the productive capacity of each sector (or imports restrictions) which may pose a maximum amount for the inputs that a given productive sector may receive, which may condition its productive potential. On the demand side, each sector will require an input amount in relation to the level of desired production. Let us then start with the determination of this latter. For that matter, it is necessary to describe the process of expectations formation with regards to future sales. To that end, we start from the level of sales registered during the preceding period and we correct it in relation to the difference between the sales and the effective production of the preceding period (equations 4.9 to 4.12). In the specific case of the desired production of services, given the fact that its production is "instantaneous", we will consider the process to be demand-led. In other words, the desired production is always equal to the effective production, which, in turn, is determined by demand.

$$Y_t^{A^D} = Y_{t-1}^A + \iota.(S_{t-1}^A - Y_{t-1}^A) \quad (4.9)$$

$$Y_t^{Q^D} = Y_{t-1}^Q + \iota.(S_{t-1}^Q - Y_{t-1}^Q) \quad (4.10)$$

$$Y_t^{M^D} = Y_{t-1}^M + \iota.(S_{t-1}^M - Y_{t-1}^M) \quad (4.11)$$

$$Y_t^{S^D} = Y_t^S \quad (4.12)$$

Once the level of desired production is established, it is possible to determine the notional intermediate demand for each productive sector. This requires a series of steps that we will describe below. First, we define a notional demand of input in relation to the desired production (equations 4.13 to 4.36). For that matter, we multiply the desired production by the relevant production coefficients. Note that for the case of the intermediate demand of manufactured goods, we incorporate its portion for imported goods. The parameter ϕ represents the ratio of goods "M" met by national production. We further

include the demand for labour and capital, which do not constitute an intermediate consumption, but which are part of the process of creation of value. We then assume that those notional demands are fully met, unless the government imposes a restriction ω (equations 4.37 to 4.48). Finally, in relation to the effective production, which will not be necessarily equal to the desired production because there may be some restrictions on the supply of some input or "factors" that constitute the productive process, we derive the effective demand for input for each activity (equations 4.49 to 4.80).

$$Md_{h_t}^{A^D} = q_{AM}.Y_t^{A^D}.\phi^A \quad (4.13)$$

$$Md_{f_t}^{A^D} = q_{AM}.Y_t^{A^D}.(1-\phi^A) \quad (4.14)$$

$$Sd_t^{A^D} = q_{AS}.Y_t^{A^D} \quad (4.15)$$

$$Kd_t^{A^D} = q_{AK}.Y_t^{A^D} \quad (4.16)$$

$$Ad_t^{A^D} = q_{AA}.Y_t^{A^D} \quad (4.17)$$

$$Qd_t^{A^D} = q_{AQ}.Y_t^{A^D} \quad (4.18)$$

$$Md_{h_t}^{Q} = q_{QM}.Y_t^{Q^D}.\phi^Q \quad (4.19)$$

$$Md_{f_t}^{Q^D} = q_{QM}.Y_t^{Q^D}.(1-\phi^Q) \quad (4.20)$$

$$Sd_t^{Q^D} = q_{QS}.Y_t^{Q^D} \quad (4.21)$$

$$Kd_t^{Q^D} = q_{QK}.Y_t^{Q^D} \quad (4.22)$$

$$Ad_t^{Q^D} = q_{QA}.Y_t^{Q^D} \quad (4.23)$$

$$Qd_t^{Q^D} = q_{QQ}.Y_t^{Q^D} \quad (4.24)$$

$$Md_{h_t}^{M^D} = q_{MM}.Y_t^{M^D}.\phi^M \quad (4.25)$$

$$Md_{f_t}^{M^D} = q_{MM}.Y_t^{M^D}.(1-\phi^M) \quad (4.26)$$

$$Sd_t^{M^D} = q_{MS}.Y_t^{M^D} \quad (4.27)$$

$$Kd_t^{M^D} = q_{MK}.Y_t^{M^D} \quad (4.28)$$

$$Ad_t^{M^D} = q_{MA}.Y_t^{M^D} \quad (4.29)$$

$$Qd_t^{M^D} = q_{MQ}.Y_t^{M^D} \quad (4.30)$$

$$Md_{h_t}^{S^D} = q_{SM}.Y_t^{S^D}.\phi^S \quad (4.31)$$

$$Md_{f_t}^{S^D} = q_{SM}.Y_t^{S^D}.(1-\phi^S) \quad (4.32)$$

$$Sd_t^{S^D} = q_{SS}.Y_t^{S^D} \quad (4.33)$$

$$Kd_t^{S^D} = q_{SK}.Y_t^{S^D} \quad (4.34)$$

$$Ad_t^{S^D} = q_{SA}.Y_t^{S^D} \quad (4.35)$$

$$Qd_t^{S^D} = q_{SX}.Y_t^{S^D} \quad (4.36)$$

With the purpose of understanding the notation, let us take the example of the notional demand of manufactured goods "M" by sector "A". In the equations 4.13 and 4.14, such demand is divided into demand of input of local origin and foreign origin, being ϕ^A the coefficient giving the share of local inputs used in the production of sector "A". These shares correspond to the productive structure of the country, which, in turn, determines the degree of productive diversification. The higher the level of diversification is, the lower will be the ratio of input the local firms will need to import. In this model, the parameter ϕ^A is considered as exogenous, which is the same as saying that the productive structure is static or constant over time. This helps us simulate scenarios designed to study the impact of a change in the productive structure, which can be instrumented by means of a change in ϕ^A (among other parameters, such as the technical coefficients of the input-output matrix). In future versions of the model, we will aim to endogenize the productive structure, thus leaving room for it to be automatically altered as the result of the own dynamics of the model.

$$Ms_{h_t}^A = Md_{h_t}^{A^D} \quad (4.37)$$

$$Ms_{f_t}^A = Md_{f_t}^{A^D}.(1-\omega^A) \quad (4.38)$$

$$Ms_{h_t}^Q = Md_{h_t}^{Q^D} \quad (4.39)$$

$$Ms_{f_t}^Q = Md_{f_t}^{Q^D}.(1-\omega^Q) \quad (4.40)$$

$$Ms_{h_t}^{M} = Md_{h_t}^{M^D} \quad (4.41)$$

$$Ms_{f_t}^{M} = Md_{f_t}^{M^D}.(1-\omega^{M}) \quad (4.42)$$

$$Ms_{h_t}^{S} = Md_{h_t}^{S^D} \quad (4.43)$$

$$Ms_{f_t}^{S} = Md_{f_t}^{S^D}.(1-\omega^{S}) \quad (4.44)$$

$$Ms_{t}^{A} = Ms_{h_t}^{A} + Ms_{f_t}^{A} \quad (4.45)$$

$$Ms_{t}^{Q} = Ms_{h_t}^{Q} + Ms_{f_t}^{Q} \quad (4.46)$$

$$Ms_{t}^{M} = Ms_{h_t}^{M} + Ms_{f_t}^{M} \quad (4.47)$$

$$Ms_{t}^{S} = Ms_{h_t}^{S} + Ms_{f_t}^{S} \quad (4.48)$$

$$As_{h_t}^{A} = Ad_{t}^{A^D} \quad (4.49)$$

$$As_{h_t}^{Q} = Ad_{t}^{Q^D} \quad (4.50)$$

$$As_{h_t}^{M} = Ad_{t}^{M^D} \quad (4.51)$$

$$As_{h_t}^{S} = Ad_{t}^{S^D} \quad (4.52)$$

$$Ss_{h_t}^{A} = Sd_{t}^{A^D} \quad (4.53)$$

$$Ss_{h_t}^{Q} = Sd_{t}^{Q^D} \quad (4.54)$$

$$Ss_{h_t}^{M} = Sd_{t}^{M^D} \quad (4.55)$$

$$Ss_{h_t}^{S} = Sd_{t}^{S^D} \quad (4.56)$$

$$Qs_{h_t}^{A} = Qd_{t}^{A^D} \quad (4.57)$$

$$Qs_{h_t}^{Q} = Qd_{t}^{Q^D} \quad (4.58)$$

$$Qs_{h_t}^{M} = Qd_{t}^{M^D} \quad (4.59)$$

$$Qs_{h_t}^{S} = Qd_{t}^{S^D} \quad (4.60)$$

$$Md_{h_t}^{A} = q_{AM}.Y_{t}^{A}.\phi^{A} \quad (4.61)$$

$$Md_{f_t}^{A} = q_{AM}.Y_t^A.(1-\phi^A) \quad (4.62)$$

$$Sd_t^A = q_{AS}.Y_t^A \quad (4.63)$$

$$Ad_t^A = q_{AA}.Y_t^A \quad (4.64)$$

$$Qd_t^A = q_{AQ}.Y_t^A \quad (4.65)$$

$$Md_{h_t}^{M} = q_{MM}.Y_t^M.\phi^M \quad (4.66)$$

$$Md_{f_t}^{M} = q_{MM}.Y_t^M.(1-\phi^M) \quad (4.67)$$

$$Sd_t^M = q_{MS}.Y_t^M \quad (4.68)$$

$$Ad_t^M = q_{MA}.Y_t^M \quad (4.69)$$

$$Qd_t^M = q_{MQ}.Y_t^M \quad (4.70)$$

$$Md_{h_t}^{S} = q_{SM}.Y_t^S.\phi^S \quad (4.71)$$

$$Md_{f_t}^{S} = q_{SM}.Y_t^S.(1-\phi^S) \quad (4.72)$$

$$Sd_t^S = q_{SS}.Y_t^S \quad (4.73)$$

$$Ad_t^S = q_{SA}.Y_t^S \quad (4.74)$$

$$Qd_t^S = q_{SQ}.Y_t^S \quad (4.75)$$

$$Md_{h_t}^{Q} = q_{QM}.Y_t^Q.\phi^Q \quad (4.76)$$

$$Md_{f_t}^{Q} = q_{QM}.Y_t^Q.(1-\phi^Q) \quad (4.77)$$

$$Sd_t^Q = q_{QS}.Y_t^Q \quad (4.78)$$

$$Ad_t^Q = q_{QA}.Y_t^Q \quad (4.79)$$

$$Qd_t^Q = q_{QQ}.Y_t^Q \quad (4.80)$$

Having determined the effective demand for each input, we can now express them in nominal terms, so that the components of the nominal sales equations are defined. For that matter, we multiply each intermediate demand flow by its respective price index (equations 4.81 to 4.100).

$$Md\$_{h_t}^{A} = Md_{h_t}^{A}.p_{h_t}^{M} \quad (4.81)$$

$$Md\$_{f_t}^{A} = Md_{f}^{A}.p_{h_t}^{IM} \quad (4.82)$$

$$Md\$_{h_t}^{M} = Md_{h_t}^{M}.p_{h_t}^{M} \quad (4.83)$$

$$Md\$_{f_t}^{M} = Md_{f}^{M}.p_{h_t}^{IM} \quad (4.84)$$

$$Md\$_{h_t}^{S} = Md_{h_t}^{S}.p_{h_t}^{M} \quad (4.85)$$

$$Md\$_{f_t}^{S} = Md_{f}^{S}.p_{h_t}^{IM} \quad (4.86)$$

$$Md\$_{h_t}^{Q} = Md_{h_t}^{Q}.p_{h_t}^{M} \quad (4.87)$$

$$Md\$_{f_t}^{Q} = Md_{f}^{Q}.p_{h_t}^{IM} \quad (4.88)$$

$$Ad\$_{t}^{A} = Ad_{t}^{A}.p_{h_t}^{A} \quad (4.89)$$

$$Ad\$_{t}^{M} = Ad_{t}^{M}.p_{h_t}^{A} \quad (4.90)$$

$$Ad\$_{t}^{S} = Ad_{t}^{S}.p_{h_t}^{A} \quad (4.91)$$

$$Ad\$_{t}^{Q} = Ad_{t}^{Q}.p_{h_t}^{A} \quad (4.92)$$

$$Sd\$_{t}^{A} = Sd_{t}^{A}.p_{h_t}^{S} \quad (4.93)$$

$$Sd\$_{t}^{M} = Sd_{t}^{M}.p_{h_t}^{S} \quad (4.94)$$

$$Sd\$_{t}^{S} = Sd_{t}^{S}.p_{h_t}^{S} \quad (4.95)$$

$$Sd\$_{t}^{Q} = Sd_{t}^{Q}.p_{h_t}^{S} \quad (4.96)$$

$$Qd\$_{t}^{A} = Qd_{t}^{A}.p_{h_t}^{Q} \quad (4.97)$$

$$Qd\$_{t}^{M} = Qd_{t}^{M}.p_{h_t}^{Q} \quad (4.98)$$

$$Qd\$_{t}^{S} = Qd_{t}^{S}.p_{h_t}^{Q} \quad (4.99)$$

$$Qd\$_{t}^{Q} = Qd_{t}^{Q}.p_{h_t}^{Q} \quad (4.100)$$

Once the quantities of input that each productive sector will need in the productive process are defined, we can define the production functions. In general, when working

with input-output matrices, the production is described by means of fixed coefficient functions, which entail that for the production of a given output, a given combination of imperfectly substitute inputs is needed. The input necessary for the production of one unit of output depends on the productivity of the sector in question. These features of the productive process are condensed in the technical coefficients presented in the input-output matrix. In this model, following the tradition of the input-output models, we assume that those coefficients are constant. Nevertheless, these are subject to change in order to evaluate the impact of a technological shock or a change in the productive structure.

$$Y_t^A = min\{q_{AA}.As_t^A; q_{AQ}.Qs_t^A; q_{AM}.Ms_t^A; q_{AS}.Ss_t^A; q_{AK}.K_t^A\} \quad (4.101)$$

$$Y_t^Q = min\{q_{QA}.As_t^Q; q_{QQ}.Qs_t^Q; q_{QM}.Ms_t^Q; q_{QS}.Ss_t^Q; q_{QK}.K_t^Q\} \quad (4.102)$$

$$Y_t^M = min\{q_{MA}.As_t^M; q_{MQ}.Qs_t^M; q_{MM}.Ms_t^M; q_{MS}.Ss_t^M; q_{MK}.K_t^M\} \quad (4.103)$$

$$Y_t^S = S_t^S \quad (4.104)$$

Equations 4.101-4.103 establish that the production of primary and manufactured goods is constrained by the scarcest input. If we take equation 4.101 as an example, we can see that each of the five components of the equation shows the amount of food that can be produced given the amount of primary and manufactured goods, services and capital (as the equation shows, these five quantities arise from the product between the input supply and capital, on the one hand, and the technical coefficients, on the other). All this entails that if four out of the five components of the function are abundant, for instance, labor, which is not part of the function because a continuous excess in supply is assumed, and one is scarce, production would be limited by this factor, thus making the abundant resources idle. With regards to the production of services, given the fact they cannot be accumulated as inventories, supply must equal demand in every period. Thus, we assume that this process is demand-led. In other words, unlike sectors “A”, “Q” and “M”, where there may be capacity restrictions, the services sector can always meet the total demand, regardless of its level.

From the real production, we can obtain the production in nominal terms, using the relevant price indexes (equations 4.105 to 4.108). We will detail the price formation process for each of the sectors below. It is worth clarifying at this point that in order to determine the nominal value of the production of the goods “A” and “Q”, two commodities whose local prices can be disassociated from the international price by

means of a series of policy instruments, it is necessary to take the international price denominated in the national currency and not the price at which the good is actually sold in the local market. Once the production is calculated in nominal terms (also known as the gross value of production), if the total intermediate consumption (of national and foreign origin) is deducted from it, we obtain each sector's value added (equations 4.109 to 4.112). Finally, in equation 4.113 we present the value added of the whole of the economy as the sum of the value added of each sector. The value added here must equal the aggregate demand (equation 4.114) and the income generated (equation 4.115). These three equations must be identical at every point of time without it being necessary to express this equivalence. It is the consistency of the model that guarantees its fulfillment. In fact, one way of verifying the consistency of the model consists in verifying that these three equations are equal.

$$Y\$_t^A = Y_t^A . p_{f_t}^A . E_t \tag{4.105}$$

$$Y\$_t^Q = Y_t^Q . p_{f_t}^Q . E_t \tag{4.106}$$

$$Y\$_t^M = Y_t^M . p_{h_t}^M \tag{4.107}$$

$$Y\$_t^S = Y_t^S . p_{h_t}^S \tag{4.108}$$

$$GVA_t^A = Y\$_t^A - Ad\$_t^A - Md\$_{h_t}^A - Md\$_{f_t}^A - Sd\$_t^A - Qd\$_t^A \tag{4.109}$$

$$GVA_t^Q = Y\$_t^Q - Ad\$_t^Q - Md\$_{h_t}^Q - Md\$_{f_t}^Q - Sd\$_t^Q - Qd\$_t^Q \tag{4.110}$$

$$GVA_t^M = Y\$_t^M - Ad\$_t^M - Md\$_{h_t}^M - Md\$_{f_t}^M - Sd\$_t^M - Qd\$_t^M \tag{4.111}$$

$$GVA_t^S = Y\$_t^S - Ad\$_t^S - Md\$_{h_t}^S - Md\$_{f_t}^S - Sd\$_t^S - Qd\$_t^S \tag{4.112}$$

$$GVA_t = GVA_t^A + GVA_t^M + GVA_t^S + GVA_t^Q \tag{4.113}$$

$$AD_t = C\$_t + I\$_t + G\$_t + X\$_t - IM\$_t + \Delta IN\$_t \tag{4.114}$$

$$Y\$_t = W_t + GOS_t \tag{4.115}$$

The nature of the primary and the manufactured goods allows them to be accumulated from period to period. This entails that the "prevision errors" made by the firms when deciding how much to produce are not necessarily translated into alterations in prices. Instead, such errors can remain uncorrected and the market can be cleared through quantity adjustments, via accumulation (decumulation) of inventories. Equations 4.116-

4.118 describe this process in value terms. Besides, equations 4.119 and 4.121 represent the accumulation of inventories in values. For that matter, we should consider not only the variation of physical volumes, but also the changes in the price.

$$\Delta Stock_t^A = Y_t^A - S_t^A \quad (4.116)$$

$$\Delta Stock_t^Q = Y_t^Q - S_t^Q \quad (4.117)$$

$$\Delta Stock_t^M = Y_t^M - S_t^M \quad (4.118)$$

$$\Delta Stock\$_t^A = Stock_{t-1}^A . \Delta p_{h_t}^A + \Delta Stock_t^A . p_{h_t}^A \quad (4.119)$$

$$\Delta Stock\$_t^Q = Stock_{t-1}^Q . \Delta p_{h_t}^Q + \Delta Stock_t^Q . p_{h_t}^Q \quad (4.120)$$

$$\Delta Stock\$_t^M = Stock_{t-1}^M . \Delta p_{h_t}^M + \Delta Stock_t^M . p_{h_t}^M \quad (4.121)$$

Having described the production process and the utilization of different intermediate inputs, we move to deduce the capacity and the labor utilization. With regards to the capital utilization, equations 4.122 to 4.125 show the capital utilized in each of the four productive sectors, Ks_t^i, results from the relation of the stock of capital that the firms are willing to utilise, Kd_t^i, previously determined in the section of the desired demand of input, and the actual stock K_t^i, which arises from the accumulation of investment flows process (net of depreciation). As long the first is lower than the second, there will be no restrictions on the capacity and the firms will be able to utilize all the capital that their sales expectations require. Afterwards, once the effective production is determined, we can obtain the effective demand for capital (equations 4.126 to 4.129). Equations 4.130 to 4.133 define the degree of utilization of capacity as the ratio between the utilized stock of capital and the total stock of capital.

$$Ks_t^A = \begin{cases} K_t^A & if\ Kd_t^{A^D} \geq K_t^A \\ Kd_t^{A^D} & if\ Kd_t^{A^D} < K_t^A \end{cases} \quad (4.122)$$

$$Ks_t^Q = \begin{cases} K_t^Q & if\ Kd_t^{Q^D} \geq K_t^Q \\ Kd_t^{Q^D} & if\ Kd_t^{Q^D} < K_t^Q \end{cases} \quad (4.123)$$

$$Ks_t^M = \begin{cases} K_t^M & if\ Kd_t^{M^D} \geq K_t^M \\ Kd_t^{M^D} & if\ Kd_t^{M^D} < K_t^M \end{cases} \quad (4.124)$$

$$Ks_t^S = \begin{cases} K_t^S & if\ Kd_t^{S^D} \geq K_t^S \\ Kd_t^{S^D} & if\ Kd_t^{S^D} < K_t^S \end{cases} \quad (4.125)$$

$$Kd_t^A = q_{AK}.Y_t^A \quad (4.126)$$

$$Kd_t^Q = q_{QK}.Y_t^Q \quad (4.127)$$

$$Kd_t^M = q_{MK}.Y_t^M \quad (4.128)$$

$$Kd_t^S = q_{SK}.Y_t^S \quad (4.129)$$

$$u_t^A = \frac{Kd_t^A}{K_t^A} \quad (4.130)$$

$$u_t^Q = \frac{Kd_t^Q}{K_t^Q} \quad (4.131)$$

$$u_t^M = \frac{Kd_t^M}{K_t^M} \quad (4.132)$$

$$u_t^S = \frac{Kd_t^S}{K_t^S} \quad (4.133)$$

With regards to unemployment, we can measure it by using the effective labor demand and making assumptions over the behavior of the labor supply. Regarding this latter, we assume that the population grows at a constant rate (equations 4.134 to 4.137). From the effective production of each good, we can obtain the effective labor demand for each sector (equations 4.138 to 4.141). Afterwards, in order to calculate the unemployment rate, we just take the ratio between the unemployed population (difference between labor supply and demand), and the economically active population, which is here reflected in the labor supply. This rate can be calculated for each productive sector (equations 4.142 to 4.145) and for the economy as a whole (equation 4.146). Once this is done, we had already determined the production, the intermediate demand and the utilization of each of the factors of production.

$$Ns_t^A = Ns_0^A + Ns_{t-1}^A.(1 + g_l) \quad (4.134)$$

$$Ns_t^Q = Ns_0^Q + Ns_{t-1}^Q.(1 + g_l) \quad (4.135)$$

$$Ns_t^M = Ns_0^M + Ns_{t-1}^M.(1 + g_l) \quad (4.136)$$

$$Ns_t^S = Ns_0^S + Ns_{t-1}^S.(1 + g_l) \quad (4.137)$$

$$Nd_t^A = q_{AN}.Y_t^A \quad (4.138)$$

$$Nd_t^Q = q_{XN}.Y_t^Q \quad (4.139)$$

$$Nd_t^M = q_{MN}.Y_t^M \quad (4.140)$$

$$Nd_t^S = q_{SN}.Y_t^S \quad (4.141)$$

$$UN_t^A = \frac{Ns_t^A - Nd_t^A}{Ns_t^A} \quad (4.142)$$

$$UN_t^Q = \frac{Ns_t^Q - Nd_t^Q}{Ns_t^Q} \quad (4.143)$$

$$UN_t^M = \frac{Ns_t^M - Nd_t^M}{Ns_t^M} \quad (4.144)$$

$$UN_t^S = \frac{Ns_t^S - Nd_t^S}{Ns_t^S} \quad (4.145)$$

$$UN_t = \frac{Ns_t^A + Ns_t^Q + Ns_t^M + Ns_t^S - Nd_t^A - Nd_t^Q - Nd_t^M - Nd_t^S}{Ns_t^A + Ns_t^Q + Ns_t^M + Ns_t^S} \quad (4.146)$$

Prices, wages and income distribution

So far, we have used different price indexes for the conversion of real variables into nominal variables. In this section, we will describe the formation process of each of these indexes. These will constitute the cornerstone for the explanation of phenomena such as inflation and income distribution. As we have presented, in this model there are four types of goods, which is why it is natural to have four price indexes. However, in the particular case of tradable goods (primary and manufactured goods), we open up the possibility of the domestic price being different from the international price, which is considered exogenous. Equations 4.147-4.162 then define all the variables related to the prices entering the different system blocks.

Equations 4.147-4.149 simply state that the international price of primary and manufactured goods are determined exogenously, reason why they are exogenous data for the local economy. From here, we can start defining the local prices. On the one hand, we can define the local price of primary goods as the international price converted to the national currency at the nominal exchange rate, plus the effect that a potential export duty may have, λ_1, which constitutes not only a collection instrument for the government, but also a mechanism which regulates the local price of exportable goods, or a subsidy, λ_2, designed to maintain the domestic price below the international level, as it is the case of oil in Venezuela. This is reflected in equations 4.150 and 4.151. As it will be shown below,

it must be noted that both the export duties and the subsidies for domestic consumption contribute to dissociate the local price from the international price, but the impact of each instrument over the fiscal accounts is the opposite: while the export duties are an income source for the government, subsidies are an expenditure.

$$P_{f_t}^{A} = \overline{P_f^A} \tag{4.147}$$

$$P_{f_t}^{Q} = \overline{P_f^Q} \tag{4.148}$$

$$P_{f_t}^{M} = \overline{P_f^M} \tag{4.149}$$

$$P_{h_t}^{A} = P_{f_t}^{A}.E_t.(1-\lambda_1-\lambda_2) \tag{4.150}$$

$$P_{h_t}^{Q} = P_{f_t}^{Q}.E_t.(1-\lambda_1-\lambda_2) \tag{4.151}$$

$$P_{h_t}^{M^*} = \frac{C\$_t^M}{\left(Y_t^M+Stock_{t-1}^M-Ms_{h_t}^A-Ms_{h_t}^Q-Ms_{h_t}^M-Ms_{h_t}^S-I_{h,h_t}^A-I_{h,h_t}^Q-I_{h,h_t}^M-I_{h,h_t}^S-I_{f,h_t}^A-I_{f,h_t}^Q-I_{f,h_t}^M-I_{f,h_t}^S-G_t^M-X_t^M\right).\left(1+\frac{1-\alpha_5}{\alpha_5}\right)} \tag{4.152}$$

$$P_{h_t}^{M^d} = \frac{(1+\eta_t^M).(q_{MN}.w_t^M+p_{h_t}^{IM}.q_{MM}.(1-\phi^M)+q_{MS}.p_{h_t}^S+q_{MA}.p_{h_t}^A+q_{MQ}.p_{h_t}^Q)}{1-(1+\eta_t^M).q_{MM}.\phi^M} \tag{4.153}$$

$$P_{h_t}^{M} = \begin{cases} P_{h_t}^{M^d} & if\ P_{h_t}^{M^d} \geq P_{h_t}^{M^*} \\ P_{h_t}^{M^*} & if\ P_{h_t}^{M^d} < P_{h_t}^{M^*} \end{cases} \tag{4.154}$$

$$P_{h_t}^{S} = \frac{(1+\eta_t^S).(q_{SN}.w_t^S+p_{h_t}^{IM}.q_{SM}.(1-\phi^S)+q_{SM}.p_{h_t}^M.\phi^S+q_{SA}.p_{h_t}^A+q_{SQ}.p_{h_t}^Q)}{1-(1+\eta_t^S).q_{SS}} \tag{4.155}$$

$$P_{h_t}^{IM} = P_{f_t}^{M}.E_t.(1+\lambda_3) \tag{4.156}$$

$$CPI_t = \varphi_{1_{t-1}}.p_{h_t}^A + \varphi_{2_{t-1}}.p_{h_t}^M + \varphi_{3_{t-1}}.p_{h_t}^{IM} + \left(1-\varphi_{1_{t-1}}-\varphi_{2_{t-1}}-\varphi_{3_{t-1}}\right).p_{h_t}^S \tag{4.157}$$

$$\varphi_{1_t} = \frac{C\$_t^A}{C\$_t} \tag{4.158}$$

$$\varphi_{2_t} = \frac{C\$_h^M}{C\$_t} \tag{4.159}$$

$$\varphi_{3_t} = \frac{C\$_f^A}{C\$_t} \tag{4.160}$$

$$\pi_t = \frac{\Delta CPI_t}{CPI_{t-1}} \tag{4.161}$$

$$CPI_t^e = CPI_{t-1}.(1 + \pi_{t-1}) \quad (4.162)$$

An aspect that must be specified in every model is related to the closure of every market. That is to say, if there are price or quantity adjustments. This model assumes a quantity adjustment: if there is an excess in supply, the price will remain constant and inventories will be accumulated, while the quantities produced in the following period will be reduced. If there is an excess demand, the price will also remain constant and inventories will be liquidated, while the desired production for the subsequent period will be increased. In case the available inventories are not enough to cover the excess in demand, the country may import the missing amount as long as there are no restrictions on the purchase of foreign exchange.

In the case of goods "A" and "Q", we assume that given the fact that they are commodities, there is a competitive global market, or, at least, the country is a price taker in the international markets. Therefore, the markets clear only through quantity adjustments, thus determining the price exogenously. With regards to the good "M", we assume an imperfectly competitive market, where the firms have some market power to set the price. Thus, equations 4.152 to 4.154 show the price determination in this market. Equation 4.152 expresses what could be denominated as the "theoretical" price. In other words, such price would result from the free interplay of supply and demand. Equation 4.153 shows the price "desired" by firms, expressed as a mark-up over variable unit costs. As equation 4.154 so shows, the effective price will arise from the comparison between the theoretical price and the desired price. As long as the desired price is higher than the theoretical price, this latter will prevail. In addition, we must consider the price of the good "M" of foreign origin. In equation 4.156, the import price is defined as the product of the international price by the nominal exchange rate plus the effect of a potential tariff, λ_3.

With regards to services, given the fact that we assume they are not tradable, their price is not ruled by the international prices. In this case, as equation 4.155 shows, we start from an exogenous mark-up, η^S, which is applied to the variable unit costs in the same way as we did before. Regarding the market closure, given the fact that the process of services production does not require too much time, like in the other three sectors (especially the agricultural sector), we assume that the market always clears through quantity adjustments (as it was described above, supply is adjusted to demand). Therefore, in the case of the services sector, we leave aside the possibility of there being an excess demand that requires an adjustment in prices.

Once the prices of the different products are defined, we can build the consumer price index, which will be used to measure the inflation. This variable is of utmost importance not only because it expresses the consequence of a series of phenomena that occur on a yearly basis in the economy, but also because it constitutes a key element for the dynamics of the model. As we will see below, inflation expectations are part of the process of wage determination, which, in turn, adversely affects the prices. In principle, we define the consumer price index (equation 4.157) as a weighted average of the different price indexes, in relation to the weight each of them has in the household consumption basket. The weighting can be fixed or variable. In this case, we assume it varies from period to period (equation 4.158 to 4.160). Equation 4.161 defines the inflation rate as it is commonly known. Finally, equation 4.162 establishes that the expected price level arises from the application of the inflation rate of the preceding period on the price index observed the period before. In other words, economic agents expect the inflation rate to remain constant.

The next step in the specification of the distributive process consists in defining the mark-up for sectors "M" and "S", and the nominal wages in the four economic sectors. For that matter, we consider the contributions made by Rowthorn (1977) and Kim (2006), where the aspirations of each sector are endogenous to the evolution of the economy. As far as the mark-up is concerned, we assume that it is an increasing function to the utilization of installed capacity of the economy. The higher the levels of utilization are, the more market power the firms will have. This is shown by equations 4.163 and 4.164. With regards to wages, we consider that the each sector's union demands a nominal wage, which is an increasing function to the expected inflation, which in this model is assumed to be given by past inflation (equations 4.165, 4.168, 4.171 and 4.174). The wage actually negotiated depends on each union's power (equations 4.166, 4.169, 4.172 and 4.175), which, in turn, depends on the level of sectoral employment (equations 4.167, 4.170, 4.173 and 4.176). Then, we define the wage bill as the sum of the product obtained by multiplying the nominal wage by the employment in each sector (equation 4.177). Finally, the wage share, also known as functional distribution of income, arises from the ratio between the wage bill and the income (equation 4.178).

$$\eta_t^M = \eta_{t-1}^M + \beta_1^M . \left(\frac{\Delta u_{t-1}^M}{u_{t-2}^M}\right) \tag{4.163}$$

$$\eta_t^S = \eta_{t-1}^S + \beta_1^S . \left(\frac{\Delta u_{t-1}^S}{u_{t-2}^S}\right) \tag{4.164}$$

$$w_t^{A^d} = w_{t-1}^A + \beta_2^A . \left(\frac{CPI_t^e - CPI_{t-1}}{CPI_{t-1}}\right) \quad (4.165)$$

$$w_t^A = \delta_t^A . w_t^{A^d} + (1 - \delta_t^A) . w_{t-1}^A \quad (4.166)$$

$$\delta_t^A = \delta_{t-1}^A . + \beta_3^A . \Delta Nd_{t-1}^A \quad (4.167)$$

$$w_t^{Q^d} = w_{t-1}^Q + \beta_2^Q . \left(\frac{CPI_t^e - CPI_{t-1}}{CPI_{t-1}}\right) \quad (4.168)$$

$$w_t^Q = \delta_t^Q . w_t^{Q^d} + \left(1 - \delta_t^Q\right) . w_{t-1}^Q \quad (4.169)$$

$$\delta_t^Q = \delta_{t-1}^Q . + \beta_3^Q . \Delta Nd_{t-1}^Q \quad (4.170)$$

$$w_t^{M^d} = w_{t-1}^M + \beta_2^M . \left(\frac{CPI_t^e - CPI_{t-1}}{CPI_{t-1}}\right) \quad (4.171)$$

$$w_t^M = \delta_t^M . w_t^{M^d} + (1 - \delta_t^M) . w_{t-1}^M \quad (4.172)$$

$$\delta_t^M = \delta_{t-1}^M . + \beta_3^M . \Delta Nd_{t-1}^M \quad (4.173)$$

$$w_t^{S^d} = w_{t-1}^S + \beta_2^S . \left(\frac{CPI_t^e - CPI_{t-1}}{CPI_{t-1}}\right) \quad (4.174)$$

$$w_t^S = \delta_t^S . w_t^{S^d} + (1 - \delta_t^S) . w_{t-1}^S \quad (4.175)$$

$$\delta_t^S = \delta_{t-1}^S . + \beta_3^S . \Delta Nd_{t-1}^S \quad (4.176)$$

$$W_t = w_t^A . Nd_t^A + w_t^M . Nd_t^M + w_t^S . Nd_t^S \quad (4.177)$$

$$\psi_t = \frac{W_t}{Y_t} \quad (4.178)$$

Private consumption and household saving

From the wage bill calculated in the preceding section, we can now start defining the disposable income of the households, which will be the base for private consumption. We define personal income (equation 4.179) as the sum of the wage bill and the interest accrued by bank deposits during the preceding period. Households pay taxes on this income. In case the government set tariffs, λ_3, households will also have to pay for the relevant imported goods. Moreover, if the government granted subsidies on the consumption of the goods "A", with the purpose of dissociating the domestic price from the international price, households would receive a subsidy λ_2 proportional to the consumption of this good. This is shown in equation 4.180. The disposable income, defined in equation 4.181, arises from the sum of personal income and the profits distributed by the firms less the taxes paid.

$$YP_t = W_t + rd_{t-1}.D^H_{t-1} \quad (4.179)$$

$$T^H_t = \theta^H.YP_t + \lambda_3.C\$^M_{f_t} - \lambda_2.C\$^A_{f_t} \quad (4.180)$$

$$YD_t = YP_t - T^H_t + DP_t \quad (4.181)$$

$$YD^e_t = YD^e_{t-1}.(1 + \frac{YD_t - YD_{t-1}}{YD_{t-1}}) \quad (4.182)$$

The determination of the aggregate private consumption takes the same form as it is observed in the stock-flow consistent models. It is a function that depends on the disposable income and the stock of wealth of the preceding period (equation 4.183). This equation is expressed in real terms, thus deflating each component by the consumer price index. We then define a notional consumption of the good "A" following Taylor (1983), as a share of the total consumption plus a term reflecting Engel's Law (equation 4.184). The effective consumption of the good "A" of national origin will depend on the capacity of the sector to meet the demand, as equation 4.185 so shows. If there was an excess demand, as we explained above, instead of there being a price adjustment, there would be increasing imports of this type of product (equation 4.186). Once this is done, we can also define the real consumption of services as a proportion of the total consumption (equation 4.187). The consumption of the good "A", both of national and foreign origin, and the consumption of the good "S" can be expressed in nominal terms by means of the relevant price indexes (equations 4.188 to 4.190).

With the information above, it is possible to determine the consumption of manufactured goods and its distribution among goods of national and foreign origin. In this sense, unlike what occurred with production, where the utilization of the good "M" of national and foreign origin was given in fixed ratios, we assume some degree of substitution in relation to the relative price. For that matter, we pose an optimization problem where the households decide to assign the cash flow available for the good "M" (equation 4.191) in relation to the best combination to reaches the higher level of consumption. It is worth mentioning that this substitution is imperfect. This is how the demanded amount of each type of the good "M" is determined (equations 4.192 and 4.193), which can be transformed into values using the relevant price indexes (equations 4.194 and 4.195). We obtain the aggregate consumption by adding the consumption of each good (equation 4.196).

$$C_t = \alpha_1.\frac{YD^e_t}{CPI^e_t} + \alpha_2.\frac{VH_{t-1}}{CPI^e_t} \quad (4.183)$$

$$C_t^{A^d} = \alpha_3 . C_t + \alpha_4 . P_{h_t}^A \quad (4.184)$$

$$C_t^A = \begin{cases} C_t^{A^d} & if \quad Int. D_t^A \leq Y_t^A + Stock_t^A \\ Y_t^A + Stock_t^A - Int. D_t^A & if \begin{cases} Int. D_t^A > Y_t^A + Stock_t^A \\ Y_t^A + Stock_t^A - G_t^A - As_t^A - As_t^M - As_t^Q - As_t^S > 0 \end{cases} \\ 0 & if \begin{cases} Int. D_t^A > Y_t^A + Stock_t^A \\ Y_t^A + Stock_t^A - G_t^A - As_t^A - As_t^M - As_t^S - As_t^Q \leq 0 \end{cases} \end{cases} \quad (4.185)$$

$$Int. D_t^A = C_t^{A^d} + G_t^A + As_t^A + As_t^M + As_t^S + As_t^Q$$

$$C_{f_t}^A = C_t^{A^d} - C_t^A \quad (4.186)$$

$$C_t^S = \alpha_7 . C_t - \alpha_4 . P_{h_t}^A \quad (4.187)$$

$$C\$_t^A = C_t^A . p_{h_t}^A \quad (4.188)$$

$$C\$_{f_t}^A = C_{f_t}^A . p_{f_t}^A . E_t \quad (4.189)$$

$$C\$_t^S = C_t^S . p_{h_t}^S \quad (4.190)$$

$$C\$_t^M = \alpha_1 . YD_t + \alpha_2 . VH_{t-1} - C\$_t^A - C\$_{f_t}^A - C\$_t^S \quad (4.191)$$

$$C_{h_t}^M = \frac{C\$_t^M}{p_{h_t}^M . \left(1 + \frac{1-\alpha_5}{\alpha_5}\right)} \quad (4.192)$$

$$C_{f_t}^M = \frac{(1-\alpha_5) . C\$_t^M}{p_{h_t}^{IM} . \left(1 + \frac{1-\alpha_5}{\alpha_5}\right) \alpha_5} \quad (4.193)$$

$$C\$_{h_t}^M = C_{h_t}^M . p_{h_t}^M \quad (4.194)$$

$$C\$_{f_t}^M = C_{f_t}^M . p_{h_t}^{IM} \quad (4.195)$$

$$C\$_t = C\$_t^A + C\$_{f_t}^A + C\$_t^S + C\$_{h_t}^M + C\$_{f_t}^M \quad (4.196)$$

Once the households' consumption decisions are defined, and having calculated their disposable income, we can now compute their saving, which is given by the difference between their disposable income and their consumption (equation 4.197). The following step consists in describing the process by which the flow of saving is materialized, that is to say, the criteria by which households accumulate their wealth. In this model, we assume that the wealth of households consists of cash and bank deposits. The amounts of cash and deposits that households desire to hold are given by an equation that incorporates both the rate of return of deposits and the ratio of expected disposable

income to expected wealth (equations 4.198 and 4.199). Expected wealth is given by the initial stock of wealth plus expected disposable income less the desired flow of consumption (equation 4.200). Households are assumed to fulfill their demand for deposits (equation 4.201) and in case of mistakes in the process of expectation formation regarding disposable income cash balances will act as a buffer (equation 4.202).

$$\Delta VH_t = YD_t - C\$_t \tag{4.197}$$

$$\frac{Hd_t^d}{VH_t^e} = \lambda_{10} + \lambda_{11}.rd_t + \lambda_{12}.\frac{YD_t^e}{VH_t^e} \tag{4.198}$$

$$\frac{D_t^d}{VH_t^e} = \lambda_{20} + \lambda_{21}.rd_t + \lambda_{22}.\frac{YD_t^e}{VH_t^e} \tag{4.199}$$

$$VH_t^e = VH_{t-1} + YD_t^e - C\$_t \tag{4.200}$$

$$D_t^H = D_t^d \tag{4.201}$$

$$Hd_t = VH_t - D_t^H \tag{4.202}$$

Investment

Turning to the firms' side, we are now able to compute the profits resulting from the production and distribution process. Equations 4.203 to 4.206 show the gross profits of national firms for each of the three sectors of the economy as the difference between their sales and their production costs. We then apply the ratio of capital in the hands of national firms over the total stock of capital, as an approximate measure of the share of local firms in the total profits of the relevant sector. On these profits, taxes must be paid, which also include export duties and import tariffs (equations 4.207 to 4.210). Then, net profits are calculated as the difference between gross profits and taxes, to which income net of interest arising from financial assets and liabilities is added (equations 4.211 to 4.214). Following the same logic, equations 4.215 to 4.226 show the same process but for the case of firms in the hands of foreign agents. Such firms are the result of foreign direct investment inflows in past periods. From the sum of each firm's gross profits, we obtain the total profits, generally known as gross operating surplus (equation 4.227). For the model to be consistent, we impute the variation of inventories as part of the gross operating surplus. In case this was not done, the aggregate demand would not equal the generated income, since we had previously computed the variation of inventories as part of the aggregate demand.

$$GP_{h_t}^{A} = \frac{K_{h_{t-1}}^{A}}{K_{t-1}^{A}}.\left(S\$_t^A - Md\$_{h_t}^A - Md\$_{f_t}^A - Ad\$_t^A - Sd\$_t^A - Qd\$_t^A - w_t^A.Nd_t^A\right) \quad (4.203)$$

$$GP_{h_t}^{Q} = \frac{K_{h_{t-1}}^{Q}}{K_{t-1}^{Q}}.\left(S\$_t^Q - Md\$_{h_t}^Q - Md\$_{f_t}^Q - Ad\$_t^Q - Sd\$_t^Q - Qd\$_t^Q - w_t^Q.Nd_t^Q\right) \quad (4.204)$$

$$GP_{h_t}^{M} = \frac{K_{h_{t-1}}^{M}}{K_{t-1}^{M}}.\left(S\$_t^M - Md\$_{h_t}^M - Md\$_{f_t}^M - Ad\$_t^M - Sd\$_t^M - Qd\$_t^M - w_t^M.Nd_t^M\right) \quad (4.205)$$

$$GP_{h_t}^{S} = \frac{K_{h_{t-1}}^{S}}{K_{t-1}^{S}}.\left(S\$_t^S - Md\$_{h_t}^S - Md\$_{f_t}^S - Ad\$_t^S - Sd\$_t^S - Qd\$_t^S - w_t^S.Nd_t^S\right) \quad (4.206)$$

$$T_{h_t}^{A} = \theta^{A}.GP_{h_t}^{A} + \lambda_1.\left(X\$_t^A.\frac{K_{h_{t-1}}^{A}}{K_{t-1}^{A}}\right) + \lambda_3.\left(I\$_{h,f_t}^{A} + \frac{K_{h_{t-1}}^{A}}{K_{t-1}^{A}}.Md\$_{f_t}^{A}\right) - \lambda_2.\left(C\$_t^A + G\$_t^A + Ad\$_t^A + Ad\$_t^M + Ad\$_t^S + Ad\$_t^Q\right)\frac{K_{h_{t-1}}^{A}}{K_{t-1}^{A}} \quad (4.207)$$

$$T_{h_t}^{Q} = \theta^{Q}.GP_{h_t}^{Q} + \lambda_1.\left(X\$_t^Q.\frac{K_{h_{t-1}}^{Q}}{K_{t-1}^{Q}}\right) + \lambda_3.\left(I\$_{h,f_t}^{Q} + \frac{K_{h_{t-1}}^{Q}}{K_{t-1}^{Q}}.Md\$_{f_t}^{Q}\right) - \lambda_2.\left(Qd\$_t^A + Qd\$_t^M + Qd\$_t^S + Qd\$_t^Q\right)\frac{K_{h_{t-1}}^{Q}}{K_{t-1}^{Q}} \quad (4.208)$$

$$T_{h_t}^{M} = \theta^{M}.GP_{h_t}^{M} + \lambda_3.\left(I\$_{h,f_t}^{M} + \frac{K_{h_{t-1}}^{M}}{K_{t-1}^{M}}.Md\$_{f_t}^{M}\right) \quad (4.209)$$

$$T_{h_t}^{S} = \theta^{S}.GP_{h_t}^{S} + \lambda_3.\left(I\$_{h,f_t}^{S} + \frac{K_{h_{t-1}}^{S}}{K_{t-1}^{S}}.Md\$_{f_t}^{S}\right) \quad (4.210)$$

$$NP_{h_t}^{A} = GP_{h_t}^{A} - T_{h_t}^{A} - rl_{t-1}.L_{t-1}^{A} + rd_{t-1}.D_{h_{t-1}}^{A} \quad (4.211)$$

$$NP_{h_t}^{Q} = GP_{h_t}^{Q} - T_{h_t}^{Q} - rl_{t-1}.L_{t-1}^{Q} + rd_{t-1}.D_{h_{t-1}}^{Q} \quad (4.212)$$

$$NP_{h_t}^{M} = GP_{h_t}^{M} - T_{h_t}^{M} - rl_{t-1}.L_{t-1}^{M} + rd_{t-1}.D_{h_{t-1}}^{M} \quad (4.213)$$

$$NP_{h_t}^{S} = GP_{h_t}^{S} - T_{h_t}^{S} - rl_{t-1}.L_{t-1}^{S} + rd_{t-1}.D_{h_{t-1}}^{S} \quad (4.214)$$

$$GP_{f_t}^{A} = \frac{K_{f_{t-1}}^{A}}{K_{t-1}^{A}}.\left(S\$_t^A - Md\$_{h_t}^A - Md\$_{f_t}^A - Ad\$_t^A - Sd\$_t^A - Qd\$_t^A - w_t^A.Nd_t^A\right) \quad (4.215)$$

$$GP_{f_t}^{Q} = \frac{K_{f_{t-1}}^{Q}}{K_{t-1}^{Q}}.\left(S\$_t^Q - Md\$_{h_t}^Q - Md\$_{f_t}^Q - Ad\$_t^Q - Sd\$_t^Q - Qd\$_t^Q - w_t^Q.Nd_t^Q\right) \quad (4.216)$$

$$GP_{f_t}^{M} = \frac{K_{f_{t-1}}^{M}}{K_{t-1}^{M}}.\left(S\$_t^M - Md\$_{h_t}^M - Md\$_{f_t}^M - Ad\$_t^M - Sd\$_t^M - Qd\$_t^M - w_t^M.Nd_t^M\right) \quad (4.217)$$

$$GP_{f_t}^{S} = \frac{K_{f_{t-1}}^{S}}{K_{t-1}^{S}}.\left(S\$_t^S - Md\$_{h_t}^S - Md\$_{f_t}^S - Ad\$_t^S - Sd\$_t^S - Qd\$_t^S - w_t^S.Nd_t^S\right) \quad (4.218)$$

$$T_{f_t}^A = \theta^A . GP_{f_t}^A + \lambda_1 . \left(X\$_t^A . \frac{K_{f_{t-1}}^A}{K_{t-1}^A} \right) + \lambda_3 . \left(I\$_{f,f_t}^A + \frac{K_{f_{t-1}}^A}{K_{t-1}^A} . Md\$_{f_t}^A \right) - \lambda_2 . \left(C\$_t^A + G\$_t^A + Ad\$_t^A + Ad\$_t^M + Ad\$_t^S + Ad\$_t^Q \right) \frac{K_{f_{t-1}}^A}{K_{t-1}^A} \quad (4.219)$$

$$T_{f_t}^Q = \theta^Q . GP_{f_t}^Q + \lambda_1 . \left(X\$_t^Q . \frac{K_{f_{t-1}}^Q}{K_{t-1}^Q} \right) + \lambda_3 . \left(I\$_{f,f_t}^Q + \frac{K_{f_{t-1}}^Q}{K_{t-1}^Q} . Md\$_{f_t}^Q \right) - \lambda_2 . \left(Qd\$_t^A + Qd\$_t^M + Qd\$_t^S + Qd\$_t^Q \right) \frac{K_{f_{t-1}}^Q}{K_{t-1}^Q} \quad (4.220)$$

$$T_{f_t}^M = \theta^M . GP_{f_t}^M + \lambda_3 . \left(I\$_{f,f_t}^M + \frac{K_{f_{t-1}}^M}{K_{t-1}^M} . Md\$_{f_t}^M \right) \quad (4.221)$$

$$T_{f_t}^S = \theta^S . GP_{f_t}^S + \lambda_3 . \left(I\$_{f,f_t}^S + \frac{K_{f_{t-1}}^S}{K_{t-1}^S} . Md\$_{f_t}^S \right) \quad (4.222)$$

$$NP_{f_t}^A = GP_{f_t}^A - T_{f_t}^A + rd_{t-1} . D_{f_{t-1}}^A \quad (4.223)$$

$$NP_{f_t}^Q = GP_{f_t}^Q - T_{f_t}^Q + rd_{t-1} . D_{f_{t-1}}^Q \quad (4.224)$$

$$NP_{f_t}^M = GP_{f_t}^M - T_{f_t}^M + rd_{t-1} . D_{f_{t-1}}^M \quad (4.225)$$

$$NP_{f_t}^S = GP_{f_t}^S - T_{f_t}^S + rd_{t-1} . D_{f_{t-1}}^S \quad (4.226)$$

$$GOS_t = GP_{f_t}^A + GP_{f_t}^Q + GP_{f_t}^M + GP_{f_t}^S + GP_{h_t}^A + GP_{h_t}^Q + GP_{h_t}^M + GP_{h_t}^S + \Delta Stock_t^A . p_{h_t}^A + \Delta Stock_t^Q . p_{h_t}^Q + \Delta Stock_t^M . p_{h_t}^M \quad (4.227)$$

As we described in the section of the income of households, there is a part of such income that comes from distributed profits. It is important to clarify that only local firms take part in this process. As we will show below, foreign firms can repatriate part of their profits, resulting in a leak of income towards other countries. Then, equations 4.228 to 4.232 show the ratio of profits that are sent to the households. The remaining funds will be utilized to finance investment projects.

$$DP_t^A = \tau^A . NP_{h_t}^A \quad (4.228)$$

$$DP_t^Q = \tau^Q . NP_{h_t}^Q \quad (4.229)$$

$$DP_t^M = \tau^M . NP_{h_t}^M \quad (4.230)$$

$$DP_t^S = \tau^S . NP_{h_t}^S \quad (4.231)$$

$$DP_t = DP_t^A + DP_t^M + DP_t^S + DP_t^Q \quad (4.232)$$

We are approaching the determination of one of the most important variables of the economic dynamics: investment. One of the factors determining the flow of investment is linked to the expectations that the firms may have with regards to the future profitability of their business. Should the entrepreneurs be optimistic, it is natural for them to be willing to carry out new investment projects to meet the potential demand, so that they can maintain or increase their market share. Conversely, should their expectations be pessimistic, the dynamics of investment will be much weaker. In order to incorporate these factors into the model, we should then describe how the expectations of the business sector are formed. In the same way as we previously defined the desired production, we assume that the entrepreneurs expect the current state of their business to remain in the future. In this manner, the gross and net profits expected by local businessmen can be defined as in equations 4.223 to 4.240.

$$GP_{h_t}^{A^e} = GP_{h_{t-1}}^{A}.\left[\frac{\Delta GP_{h_{t-1}}^{A}}{GP_{h_{t-2}}^{A}}\right] \quad (4.233)$$

$$GP_{h_t}^{Q^e} = GP_{h_{t-1}}^{Q}.\left[\frac{\Delta GP_{h_{t-1}}^{Q}}{GP_{h_{t-2}}^{Q}}\right] \quad (4.234)$$

$$GP_{h_t}^{M^e} = GP_{h_{t-1}}^{M}.\left[\frac{\Delta GP_{h_{t-1}}^{M}}{GP_{h_{t-2}}^{M}}\right] \quad (4.235)$$

$$GP_{h_t}^{S^e} = GP_{h_{t-1}}^{S}.\left[\frac{\Delta GP_{h_{t-1}}^{S}}{GP_{h_{t-2}}^{S}}\right] \quad (4.236)$$

$$NP_{h_t}^{A^e} = NP_{h_{t-1}}^{A}.\left[\frac{\Delta NP_{h_{t-1}}^{A}}{NP_{h_{t-2}}^{A}}\right] \quad (4.237)$$

$$NP_{h_t}^{Q^e} = NP_{h_{t-1}}^{Q}.\left[\frac{\Delta NP_{h_{t-1}}^{Q}}{NP_{h_{t-2}}^{Q}}\right] \quad (4.238)$$

$$NP_{h_t}^{M^e} = NP_{h_{t-1}}^{M}.\left[\frac{\Delta NP_{h_{t-1}}^{M}}{NP_{h_{t-2}}^{M}}\right] \quad (4.239)$$

$$NP_{h_t}^{S^e} = NP_{h_{t-1}}^{S}.\left[\frac{\Delta NP_{h_{t-1}}^{S}}{NP_{h_{t-2}}^{S}}\right] \quad (4.240)$$

Being aware of the expectations of the firms regarding future profits, we can now define the flow of desired investment, which depends on the expected profitability, and which will be in accordance with the debt burden, and the degree of capacity utilization as well. We assume that the higher the firms debt service is, the lower the investment will be, in

an attempt to allocate a larger part of the profits to clean the balance sheet. Equations 4.241 to 4.244 show the flow of real investments desired by the local firms. Such flow must be subsequently decomposed in capital goods of national and international origin (equations 4.245 to 4.252). In this case, we assume that given the structural features of the economy, a proportion α_6^i of the investment flow can be covered by capital goods of national origin, while the remainder is met by the imported production.

$$\frac{I_{h_t}^{A^d}}{K_{h_{t-1}}^A} = \xi_0^A + \xi_1^A \cdot \frac{GP_{h_t}^{A^e}}{K_{h_{t-1}}^A} - \xi_2^A \cdot \frac{rl_{t-1} \cdot L_{t-1}^A}{K_{h_{t-1}}^A} + \xi_3^A \cdot u_{t-1}^A \quad (4.241)$$

$$\frac{I_{h_t}^{Q^d}}{K_{h_{t-1}}^Q} = \xi_0^Q + \xi_1^Q \cdot \frac{GP_{h_t}^{Q^e}}{K_{h_{t-1}}^Q} - \xi_2^Q \cdot \frac{rl_{t-1} \cdot L_{t-1}^Q}{K_{h_{t-1}}^Q} + \xi_3^Q \cdot u_{t-1}^Q \quad (4.242)$$

$$\frac{I_{h_t}^{M^d}}{K_{h_{t-1}}^M} = \xi_0^M + \xi_1^M \cdot \frac{GP_{h_t}^{M^e}}{K_{h_{t-1}}^M} - \xi_2^M \cdot \frac{rl_{t-1} \cdot L_{t-1}^M}{K_{h_{t-1}}^M} + \xi_3^M \cdot u_{t-1}^M \quad (4.243)$$

$$\frac{I_{h_t}^{S^d}}{K_{h_{t-1}}^S} = \xi_0^S + \xi_1^S \cdot \frac{GP_{h_t}^{S^e}}{K_{h_{t-1}}^S} - \xi_2^S \cdot \frac{rl_{t-1} \cdot L_{t-1}^S}{K_{h_{t-1}}^S} + \xi_3^S \cdot u_{t-1}^S \quad (4.244)$$

$$I_{h,f_t}^{A^d} = I_{h_t}^{A^d} \cdot \left(1 - \alpha_6^A\right) \quad (4.245)$$

$$I_{h,h_t}^{A^d} = I_{h_t}^{A^d} - I_{h,f}^{A^d} \quad (4.246)$$

$$I_{h,f_t}^{Q^d} = I_{h_t}^{Q^d} \cdot \left(1 - \alpha_6^Q\right) \quad (4.247)$$

$$I_{h,h_t}^{Q^d} = I_{h_t}^{Q^d} - I_{h,f}^{Q^d} \quad (4.248)$$

$$I_{h,f_t}^{M^d} = I_{h_t}^{M^d} \cdot (1 - \alpha_6^M) \quad (4.249)$$

$$I_{h,h_t}^{M^d} = I_{h_t}^{M^d} - I_{h,f}^{M^d} \quad (4.250)$$

$$I_{h,f_t}^{S^d} = I_{h_t}^{S^d} \cdot \left(1 - \alpha_6^S\right) \quad (4.251)$$

$$I_{h,h_t}^{S^d} = I_{h_t}^{S^d} - I_{h,f}^{S^d} \quad (4.252)$$

Once the desired real investment is decomposed into capital goods of national and international origin, we can convert the flows into values by multiplying them by the relevant price index. From the sum of each component, we can obtain the flow of nominal investment desired by each sector (equations 4.253 to 4.256), which will be useful to determine the credit demanded by the firms (equations 4.257 to 4.260), considering the

expectations of net profits. It is important to clarify that even though credit is a stock variable, since it represents a debt to whomever obtains it, and the investment and the expected profits are flows, in the following equations, the desired credit demand is taken as a flow, and therefore it should not be expressed in variations, because it is senseless to accumulate desired credit demands. Every flow of credit demand that is not met during a given period does not accumulate to the following. In any case, the firm will be able to demand the same credit level the following year.

$$I\$_{h_t}^{A^d} = I_{h,f_t}^{A^d}.p_{h_t}^{IM} + I_{h,h_t}^{A^d}.p_{h_t}^{M} \quad (4.253)$$

$$I\$_{h_t}^{Q^d} = I_{h,f_t}^{Q^d}.p_{h_t}^{IM} + I_{h,h_t}^{Q^d}.p_{h_t}^{M} \quad (4.254)$$

$$I\$_{h_t}^{M^d} = I_{h,f_t}^{M^d}.p_{h_t}^{IM} + I_{h,h_t}^{M^d}.p_{h_t}^{M} \quad (4.255)$$

$$I\$_{h_t}^{S^d} = I_{h,f_t}^{S^d}.p_{h_t}^{IM} + I_{h,h_t}^{S^d}.p_{h_t}^{M} \quad (4.256)$$

$$Ld_t^{A^d} = I\$_{h_t}^{A^d} - NP_{h_t}^{A^e}.(1-\tau^A) \quad (4.257)$$

$$Ld_t^{Q^d} = I\$_{h_t}^{Q^d} - NP_{h_t}^{Q^e}.(1-\tau^Q) \quad (4.258)$$

$$Ld_t^{M^d} = I\$_{h_t}^{M^d} - NP_{h_t}^{M^e}.(1-\tau^M) \quad (4.259)$$

$$Ld_t^{S^d} = I\$_{h_t}^{S^d} - NP_{h_t}^{S^e}.(1-\tau^S) \quad (4.260)$$

To determine how much funding the firms have at their disposal to develop their investment plans, we should bear in mind the credit supplied by the banks. There will be credit rationing as long as the amount supplied by the banks is lower than the amount desired by the firms. We then define the degree of rationing, φ, as a parameter subject to changes by virtue of any decision of economic policy (in the sense that in case banks are reluctant to lend the government could launch programs aimed at increasing credit supply). In case $\varphi = 0$, the credit rationing will be total. If $\varphi = 1$, the firms will receive the whole of the credit demanded. Please note that the credit actually granted is indeed a stock variable, unlike the desired credit, which is defined as a flow.

$$\Delta L_t^A = \varphi.Ld_t^{A^d} \quad (4.261)$$

$$\Delta L_t^Q = \varphi.Ld_t^{Q^d} \quad (4.262)$$

$$\Delta L_t^M = \varphi . Ld_t^{M^d} \quad (4.263)$$

$$\Delta L_t^S = \varphi . Ld_t^{S^d} \quad (4.264)$$

From the funding received by the firms, a potential investment flow can be determined, which is the result of adding the credit granted by the banks and the retained earnings that the firms expect to have (equations 4.265 to 4.268). The logic behind these equations is that the entrepreneurs expect to fund part of the investment during the period with new flows of income. Should the expectations be wrong, as we will see below, the firms' bank deposits will be adjusted. Afterwards, once the flow of potential investment is determined, as we previously did, we should establish what part of it belongs to capital goods (of the type "M") of national and international origin. These latter, as equations 4.269 to 4.262 show, can be subjected to import quotas, σ^i, which represent quantity restrictions to the entry of goods from abroad. The demand for imported capital goods can be expressed in nominal terms by multiplying the amount by the import prices index, which is equal to the local price of the good "M", as we previously noticed in this model (equations 4.273 to 4.276).

$$I\$_{h_t}^{A^p} = \Delta L_t^A + NP_{h_t}^{A^e} . (1 - \tau^A) \quad (4.265)$$

$$I\$_{h_t}^{Q^p} = \Delta L_t^Q + NP_{h_t}^{Q^e} . (1 - \tau^Q) \quad (4.266)$$

$$I\$_{h_t}^{M^p} = \Delta L_t^M + NP_{h_t}^{M^e} . (1 - \tau^M) \quad (4.267)$$

$$I\$_{h_t}^{S^p} = \Delta L_t^S + NP_{h_t}^{S^e} . (1 - \tau^S) \quad (4.268)$$

$$I_{h,f_t}^A = \frac{I\$_{h_t}^{A^p}}{p_{h_t}^{IM}} . \left(1 - \alpha_6^A\right) . (1 - \sigma^A) \quad (4.269)$$

$$I_{h,f_t}^Q = \frac{I\$_{h_t}^{Q^p}}{p_{h_t}^{IM}} . \left(1 - \alpha_6^Q\right) . (1 - \sigma^Q) \quad (4.270)$$

$$I_{h,f_t}^M = \frac{I\$_{h_t}^{M^p}}{p_{h_t}^{IM}} . (1 - \alpha_6^M) . (1 - \sigma^M) \quad (4.271)$$

$$I_{h,f_t}^S = \frac{I\$_{h_t}^{S^p}}{p_{h_t}^{IM}} . \left(1 - \alpha_6^S\right) . (1 - \sigma^S) \quad (4.272)$$

$$I\$_{h,f_t}^A = I_{h,f_t}^A . p_{h_t}^{IM} \quad (4.273)$$

$$I\$_{h,f_t}^Q = I_{h,f_t}^Q . p_{h_t}^{IM} \quad (4.274)$$

$$I\$^{M}_{h,f_t} = I^{M}_{h,f_t}.p^{IM}_{h_t} \quad (4.275)$$

$$I\$^{S}_{h,f_t} = I^{S}_{h,f_t}.p^{IM}_{h_t} \quad (4.276)$$

Once the amount of capital goods that the firms may import is determined, and considering the technical coefficients (i.e. the amounts of national and imported capital goods necessary to produce one product unit), it is possible to determine the demand for national capital goods (equations 4.277 to 4.280). These flows can be converted into values by using the relevant price index (equations 4.281 to 4.284). Finally, the aggregate investment can be obtained, both nominal and real, for each of the sectors by adding the demand for goods of national and international origin (equations 4.285 to 4.292). With this information, plus the investment made by foreign firms, defined in the section of the rest of the world, the fixed gross domestic investment can be computed, which constitutes the final source of investment, incorporated into the aggregate demand of the system (equation 4.293).

$$I^{A}_{h,h_t} = \frac{I^{A}_{h,f_t}}{1-\alpha^{A}_{6}}.\alpha^{A}_{6} \quad (4.277)$$

$$I^{Q}_{h,h_t} = \frac{I^{Q}_{h,f_t}}{1-\alpha^{Q}_{6}}.\alpha^{Q}_{6} \quad (4.278)$$

$$I^{M}_{h,h_t} = \frac{I^{M}_{h,f_t}}{1-\alpha^{A}_{6}}.\alpha^{M}_{6} \quad (4.279)$$

$$I^{S}_{h,h_t} = \frac{I^{S}_{h,f_t}}{1-\alpha^{A}_{6}}.\alpha^{S}_{6} \quad (4.280)$$

$$I\$^{A}_{h,h_t} = I^{A}_{h,h_t}.p^{M}_{h_t} \quad (4.281)$$

$$I\$^{Q}_{h,h_t} = I^{Q}_{h,h_t}.p^{M}_{h_t} \quad (4.282)$$

$$I\$^{M}_{h,h_t} = I^{M}_{h,h_t}.p^{M}_{h_t} \quad (4.283)$$

$$I\$^{S}_{h,h_t} = I^{S}_{h,h_t}.p^{M}_{h_t} \quad (4.284)$$

$$I^{A}_{h_t} = I^{A}_{h,h_t} + I^{A}_{h,f_t} \quad (4.285)$$

$$I^{Q}_{h_t} = I^{Q}_{h,h_t} + I^{Q}_{h,f_t} \quad (4.286)$$

$$I^{M}_{h_t} = I^{M}_{h,h_t} + I^{M}_{h,f_t} \quad (4.287)$$

$$I^{S}_{h_t} = I^{S}_{h,h_t} + I^{S}_{h,f_t} \quad (4.288)$$

$$I\$^{A}_{h_t} = I\$^{A}_{h,h_t} + I\$^{A}_{h,f_t} \quad (4.289)$$

$$I\$^{Q}_{h_t} = I\$^{Q}_{h,h_t} + I\$^{Q}_{h,f_t} \quad (4.290)$$

$$I\$^{M}_{h_t} = I\$^{M}_{h,h_t} + I\$^{M}_{h,f_t} \quad (4.291)$$

$$I\$^{S}_{h_t} = I\$^{S}_{h,h_t} + I\$^{S}_{h,f_t} \quad (4.292)$$

$$I\$_t = I\$^{A}_{h_t} + I\$^{Q}_{h_t} + I\$^{M}_{h_t} + I\$^{S}_{h_t} + I\$^{A}_{f_t} + I\$^{Q}_{f_t} + I\$^{M}_{f_t} + I\$^{S}_{f_t} \quad (4.293)$$

Having calculated the flows of effective investment for each sector, the credit obtained by the firms and the net profits, we can determine the variation in the firms' bank deposits, which behave as a residue (equations 4.294 to 4.297). For instance, if the firms underestimated the amount of profits at the beginning of the period (thereby demanding an excessive amount of credit), they would find an unexpected stock of liquidity by the end of the year. In this model, we assume that such liquidity is accumulated as bank deposits. Conversely, if the firms overestimated the profits, then they would find that the actual profits were not enough to fund the whole of the investment projects by the end of the year. In this situation, the firms will apply adjustments, thus appealing to their bank deposits, which will fall by the amount necessary to close the gap.

The particular case of foreign firms is described in equations 4.298 to 4.301. We assume that these firms do not obtain credit in the local financial market, but may have bank deposits. These may increase due to undistributed profits and capital that the firms may bring from abroad, which composes the aggregate foreign direct investment, or FDI, as we will see below, and decrease in relation to the flows of investment made.

$$\Delta D^{A}_{h_t} = \Delta L^{A}_{t} + NP^{A}_{h_t}.(1 - \tau^{A}) - I\$^{A}_{h_t} \quad (4.294)$$

$$\Delta D^{Q}_{h_t} = \Delta L^{Q}_{t} + NP^{Q}_{h_t}.(1 - \tau^{Q}) - I\$^{Q}_{h_t} \quad (4.295)$$

$$\Delta D^{M}_{h_t} = \Delta L^{M}_{t} + NP^{M}_{h_t}.(1 - \tau^{M}) - I\$^{M}_{h_t} \quad (4.296)$$

$$\Delta D^{S}_{h_t} = \Delta L^{S}_{t} + NP^{S}_{h_t}.(1 - \tau^{S}) - I\$^{S}_{h_t} \quad (4.297)$$

$$\Delta D^{A}_{f_t} = FDI\$^{A}_{t}.E_t - I\$^{A}_{f_t} \quad (4.298)$$

$$\Delta D^{Q}_{f_t} = FDI\$^{Q}_{t}.E_t - I\$^{Q}_{f_t} \quad (4.299)$$

$$\Delta D_{f_t}^{M} = FDI\$_t^{M}.E_t - I\$_{f_t}^{M} \quad (4.300)$$

$$\Delta D_{f_t}^{S} = FDI\$_t^{S}.E_t - I\$_{f_t}^{S} \quad (4.301)$$

To conclude the section of firms (mainly national firms, since part of the behavior of the foreign firms will be dealt with in the section of the rest of the world), we describe the process of capital accumulation. This process consists in simply adding the investment flows to the preceding stock, net of the relevant depreciation (equations 4.302 to 4.317). For that matter, it is necessary to take into account the different types of goods that may compose the stock of capital.

$$K_{h,h_t}^{A} = K_{h,h_{t-1}}^{A}.(1-\delta^{A}) + I_{h,h_t}^{A} \quad (4.302)$$

$$K_{h,f_t}^{A} = K_{h,f_{t-1}}^{A}.(1-\delta^{A}) + I_{h,f_t}^{A} \quad (4.303)$$

$$K_{h,h_t}^{Q} = K_{h,h_{t-1}}^{Q}.(1-\delta^{Q}) + I_{h,h_t}^{Q} \quad (4.304)$$

$$K_{h,f_t}^{Q} = K_{h,f_{t-1}}^{Q}.(1-\delta^{Q}) + I_{h,f_t}^{Q} \quad (4.305)$$

$$K_{h,h_t}^{M} = K_{h,h_{t-1}}^{M}.(1-\delta^{M}) + I_{h,h_t}^{M} \quad (4.306)$$

$$K_{h,f_t}^{M} = K_{h,f_{t-1}}^{M}.(1-\delta^{M}) + I_{h,f_t}^{M} \quad (4.307)$$

$$K_{h,h_t}^{S} = K_{h,h_{t-1}}^{S}.(1-\delta^{S}) + I_{h,h_t}^{S} \quad (4.308)$$

$$K_{h,f_t}^{S} = K_{h,f_{t-1}}^{S}.(1-\delta^{S}) + I_{h,f_t}^{S} \quad (4.309)$$

$$K_{f,h_t}^{A} = K_{f,h_{t-1}}^{A}.(1-\delta^{A}) + I_{f,h_t}^{A} \quad (4.310)$$

$$K_{f,f_t}^{A} = K_{f,f_{t-1}}^{A}.(1-\delta^{A}) + I_{f,f_t}^{A} \quad (4.311)$$

$$K_{f,h_t}^{Q} = K_{f,h_{t-1}}^{Q}.(1-\delta^{Q}) + I_{f,h_t}^{Q} \quad (4.312)$$

$$K_{f,f_t}^{Q} = K_{f,f_{t-1}}^{Q}.(1-\delta^{Q}) + I_{f,f_t}^{Q} \quad (4.313)$$

$$K_{f,h_t}^{M} = K_{f,h_{t-1}}^{M}.(1-\delta^{M}) + I_{f,h_t}^{M} \quad (4.314)$$

$$K_{f,f_t}^{M} = K_{f,f_{t-1}}^{M}.(1-\delta^{M}) + I_{f,f_t}^{M} \quad (4.315)$$

$$K_{f,h_t}^{S} = K_{f,h_{t-1}}^{S}.(1-\delta^{S}) + I_{f,h_t}^{S} \quad (4.316)$$

$$K^S_{f,f_t} = K^S_{f,f_{t-1}}.(1-\delta^S) + I^S_{f,f_t} \quad (4.317)$$

From the aggregation of the different types of capital goods of each sector, we obtain a measure of the productive capacity in each of them.

$$K^A_{h_t} = K^A_{h,h_t} + K^A_{h,f_t} \quad (4.318)$$

$$K^Q_{h_t} = K^Q_{h,h_t} + K^Q_{h,f_t} \quad (4.319)$$

$$K^M_{h_t} = K^M_{h,h_t} + K^M_{h,f_t} \quad (4.320)$$

$$K^S_{h_t} = K^S_{h,h_t} + K^S_{h,f_t} \quad (4.321)$$

$$K^A_{f_t} = K^A_{f,h_t} + K^A_{f,f_t} \quad (4.322)$$

$$K^Q_{f_t} = K^Q_{f,h_t} + K^Q_{f,f_t} \quad (4.323)$$

$$K^M_{f_t} = K^M_{f,h_t} + K^M_{f,f_t} \quad (4.324)$$

$$K^S_{f_t} = K^S_{f,h_t} + K^S_{f,f_t} \quad (4.325)$$

$$K^A_t = K^A_{h_t} + K^A_{f_t} \quad (4.326)$$

$$K^Q_t = K^Q_{h_t} + K^Q_{f_t} \quad (4.327)$$

$$K^M_t = K^M_{h_t} + K^M_{f_t} \quad (4.328)$$

$$K^S_t = K^S_{h_t} + K^S_{f_t} \quad (4.329)$$

The stock of capital can also be expressed in nominal terms. For that matter, we should consider not only the quantity variation but also the valuation effect arising from the changes in the prices. Thus, equations 4.330 to 4.341 show the process of capital accumulation in nominal terms for each sector and for the economy as a whole.

$$\Delta K\$^A_{h_t} = \Delta K^A_{h,h_t}.p^M_{h_t} + K^A_{h,h_{t-1}}.\Delta p^M_{h_t} + \Delta K^A_{h,f_t}.p^{IM}_{h_t} + K^A_{h,f_{t-1}}.\Delta p^{IM}_{h_t} \quad (4.330)$$

$$\Delta K\$^Q_{h_t} = \Delta K^Q_{h,h_t}.p^M_{h_t} + K^Q_{h,h_{t-1}}.\Delta p^M_{h_t} + \Delta K^Q_{h,f_t}.p^{IM}_{h_t} + K^Q_{h,f_{t-1}}.\Delta p^{IM}_{h_t} \quad (4.331)$$

$$\Delta K\$^M_{h_t} = \Delta K^M_{h,h_t}.p^M_{h_t} + K^M_{h,h_{t-1}}.\Delta p^M_{h_t} + \Delta K^M_{h,f_t}.p^{IM}_{h_t} + K^M_{h,f_{t-1}}.\Delta p^{IM}_{h_t} \quad (4.332)$$

$$\Delta K\$^S_{h_t} = \Delta K^S_{h,h_t}.p^M_{h_t} + K^S_{h,h_{t-1}}.\Delta p^M_{h_t} + \Delta K^S_{h,f_t}.p^{IM}_{h_t} + K^S_{h,f_{t-1}}.\Delta p^{IM}_{h_t} \quad (4.333)$$

$$\Delta K\$_{f_t}^{A} = \Delta K_{f,h_t}^{A}.p_{h_t}^{M} + K_{f,h_{t-1}}^{A}.\Delta p_{h_t}^{M} + \Delta K_{f,f_t}^{A}.p_{h_t}^{IM} + K_{f,f_{t-1}}^{A}.\Delta p_{h_t}^{IM} \quad (4.334)$$

$$\Delta K\$_{f_t}^{Q} = \Delta K_{f,h_t}^{Q}.p_{h_t}^{M} + K_{f,h_{t-1}}^{Q}.\Delta p_{h_t}^{M} + \Delta K_{f,f_t}^{Q}.p_{h_t}^{IM} + K_{f,f_{t-1}}^{Q}.\Delta p_{h_t}^{IM} \quad (4.335)$$

$$\Delta K\$_{f_t}^{M} = \Delta K_{f,h_t}^{M}.p_{h_t}^{M} + K_{f,h_{t-1}}^{M}.\Delta p_{h_t}^{M} + \Delta K_{f,f_t}^{M}.p_{h_t}^{IM} + K_{f,f_{t-1}}^{M}.\Delta p_{h_t}^{IM} \quad (4.336)$$

$$\Delta K\$_{f_t}^{S} = \Delta K_{f,h_t}^{S}.p_{h_t}^{M} + K_{f,h_{t-1}}^{S}.\Delta p_{h_t}^{M} + \Delta K_{f,f_t}^{S}.p_{h_t}^{IM} + K_{f,f_{t-1}}^{S}.\Delta p_{h_t}^{IM} \quad (4.337)$$

$$K\$_{t}^{A} = K\$_{h_t}^{A} + K\$_{f_t}^{A} \quad (4.338)$$

$$K\$_{t}^{Q} = K\$_{h_t}^{Q} + K\$_{f_t}^{Q} \quad (4.339)$$

$$K\$_{t}^{M} = K\$_{h_t}^{M} + K\$_{f_t}^{M} \quad (4.340)$$

$$K\$_{t}^{S} = K\$_{h_t}^{S} + K\$_{f_t}^{S} \quad (4.341)$$

Finally, we can compute the firms' wealth as the difference between their assets and their liabilities, which have already been defined in this section.

$$VF_{h_t}^{A} = K\$_{h_t}^{A} + D_{h_t}^{A} - L_{t}^{A} \quad (4.342)$$

$$VF_{h_t}^{Q} = K\$_{h_t}^{Q} + D_{h_t}^{Q} - L_{t}^{Q} \quad (4.343)$$

$$VF_{h_t}^{M} = K\$_{h_t}^{M} + D_{h_t}^{M} - L_{t}^{M} \quad (4.344)$$

$$VF_{h_t}^{S} = K\$_{h_t}^{S} + D_{h_t}^{S} - L_{t}^{S} \quad (4.345)$$

$$VF_{f_t}^{A} = K\$_{f_t}^{A} + D_{f_t}^{A} \quad (4.346)$$

$$VF_{f_t}^{Q} = K\$_{f_t}^{Q} + D_{f_t}^{Q} \quad (4.347)$$

$$VF_{f_t}^{M} = K\$_{f_t}^{M} + D_{f_t}^{M} \quad (4.348)$$

$$VF_{f_t}^{S} = K\$_{f_t}^{S} + D_{f_t}^{S} \quad (4.349)$$

Foreign trade

The description of the trade conducted by the economy with the rest of the world requires the building of the variables of exports and imports. With regards to these latter, the reader will notice that they have already been defined when we determined the imports for private consumption, for the demand for intermediate inputs and for investment. Therefore, the total amount of imports can be expressed as the sum of all

these demands.

$$IM\$_t = C\$_{f_t}^{A} + C\$_{f_t}^{M} + I\$_{h,f_t}^{A} + I\$_{h,f_t}^{Q} + I\$_{h,f_t}^{M} + I\$_{h,f_t}^{S} + I\$_{f,f_t}^{A} + I\$_{f,f_t}^{Q} + I\$_{f,f_t}^{M} + I\$_{f,f_t}^{S} + Md\$_{f}^{A} + Md\$_{f}^{Q} + Md\$_{f}^{M} + Md\$_{f}^{S} \quad (4.350)$$

Exports, in turn, are determined by factors exogenous to the economy, such as the global growth pace. Thus, for example, there is a level of potential exports of primary goods given by the level of global demand (equations 4.351 and 4.353). Nevertheless, the effective amount of exports will depend on the physical capacity of the economy to meet such demand, given by the difference between the sum of production and inventories on the one hand, and by the different sources of domestic demand, on the other (equations 4.352 and 4.354). Since the economy is a price taker in the market of tradable goods, if there was an excess demand, the clearing of the market would not occur through price adjustments, but through quantities in the "short side". Basically, the country will export as much as the world demands insofar as there is an excess of total supply. However, if there was an excess of total demand combined with an internal excess of supply (the difference between the total supply and the domestic demand), then the economy will export the difference between total production and local demand. Finally, if there was an excess demand, both total and domestic, there will be no exports of goods "A" and "Q".

With regards to the potential exports of industrial goods, these not only depend on global growth, but are also influenced by the evolution of the real exchange rate (equation 4.355). To determine the amount of the good "M" that the economy will effectively export, we should apply the same criteria adopted for the case of goods "A" and "Q" (equation 4.356). Finally, the nominal value of exports is obtained by multiplying each real flow by the relevant price (equations 4.357 to 4.359). In equation 4.360, we see the total flow of nominal exports, which are included in the aggregate demand. Equation 4.361 shows the growth of the world economy, which is a key part of the exports dynamics.

$$\ln\left(X_t^{A^p}\right) = \mu_0 + \mu_1 . \ln\left(Y_t^*\right) \quad (4.351)$$

$$X_t^A = \begin{cases} X_t^{A^p} & if \quad Total\ Demand_t^A \leq Y_t^A + Stock_{t-1}^A \\ Y_t^A + Stock_{t-1}^A - Internal\ Demand_t^A & if \begin{cases} Total\ Demand_t^A > Y_t^A + Stock_{t-1}^A \\ Internal\ Demand_t^A < Y_t^A + Stock_{t-1}^A \end{cases} \\ 0 & if \begin{cases} Total\ Demand_t^A > Y_t^A + Stock_{t-1}^A \\ Internal\ Demand_t^A \geq Y_t^A + Stock_{t-1}^A \end{cases} \end{cases} \quad (4.352)$$

$$Total\ Demand_t^A = C_t^{A^n} + G_t^A + X_t^{A^p} + Ad_t^A + Ad_t^M + Ad_t^S + Ad_t^Q$$

$$Internal\ Demand_t^A = C_t^A + G_t^A + Ad_t^A + Ad_t^M + Ad_t^S + Ad_t^Q$$

$$\ln\left(X_t^{Q^p}\right) = \mu_0 + \mu_1.\ln\left(Y_t^*\right) \tag{4.353}$$

$$X_t^Q = \begin{cases} X_t^{Q^p} & if \quad Total\ Demand_t^Q \le Y_t^Q + Stock_{t-1}^Q \\ Y_t^Q + Stock_{t-1}^Q - Internal\ Demand_t^Q & if \begin{cases} Total\ Demand_t^Q > Y_t^Q + Stock_{t-1}^Q \\ Internal\ Demand_t^Q < Y_t^Q + Stock_{t-1}^Q \end{cases} \\ 0 & if \begin{cases} Total\ Demand_t^Q > Y_t^Q + Stock_{t-1}^Q \\ Internal\ Demand_t^Q \ge Y_t^Q + Stock_{t-1}^Q \end{cases} \end{cases} \tag{4.354}$$

$$Total\ Demand_t^Q = X_t^{Q^p} + Qd_t^A + Qd_t^M + Qd_t^S + Qd_t^Q$$

$$Internal\ Demand_t^Q = Qd_t^A + Qd_t^M + Qd_t^S + Qd_t^Q$$

$$\ln\left(X_t^{M^p}\right) = \mu_2 + \mu_3.\ln(Y_t^*) + \mu_4.\ln\left(\frac{E_t.p_{f_t}^M}{p_h^M}\right) \tag{4.355}$$

$$X_t^M = \begin{cases} X_t^{M^p} & if\ Total\ Demand_t^M \le Y_t^M + Stock_{t-1}^M \\ Y_t^M + Stock_{t-1}^M - Internal\ Dem_t^M & if \begin{cases} Total\ Demand_t^M > Y_t^M + Stock_{t-1}^M \\ Internal\ Dem_t^M < Y_t^M + Stock_{t-1}^M \end{cases} \\ 0 & if \begin{cases} Total\ Demand_t^M > Y_t^M + Stock_{t-1}^M \\ Internal\ Dem_t^M \ge Y_t^M + Stock_{t-1}^M \end{cases} \end{cases} \tag{4.356}$$

$$Total\ Demand_t^M = C_{h_t}^M + X_t^{M^p} + G_t^M + I_{h,h_t}^A + I_{h,h_t}^Q + I_{h,h_t}^M + I_{h,h_t}^S + I_{f,h_t}^A + I_{f,h_t}^Q + I_{f,h_t}^M + I_{f,h_t}^S + Md_h^A + Md_h^M + Md_h^S + Md_h^Q$$

$$Internal\ Dem_t^M = C_{h_t}^M + G_t^M + I_{h,h_t}^A + I_{h,h_t}^Q + I_{h,h_t}^M + I_{h,h_t}^S + I_{f,h_t}^A + I_{f,h_t}^Q + I_{f,h_t}^M + I_{f,h_t}^S + Md_h^A + Md_h^M + Md_h^S + Md_h^Q$$

$$X\$_t^A = X_t^A.E_t.p_{f_t}^A \tag{4.357}$$

$$X\$_t^Q = X_t^Q.E_t.p_{f_t}^X \tag{4.358}$$

$$X\$_t^M = X_t^M.p_{h_t}^M \tag{4.359}$$

$$X\$_t = X\$_t^A + X\$_t^M \tag{4.360}$$

$$Y_t^* = Y_{t-1}^*.(1 + g^w) + Y_0^* \tag{4.361}$$

The public sector

As it was already described, both households and firms pay taxes to the government. These taxes are paid for a wide variety of activities, ranging from labor to international trade. The sum of all these taxes constitutes the source through which the government will have to fund its expenditure (equation 4.362). Moreover, it should be noticed that

when the local price of the goods “A” and “Q” were defined, we allowed for the possibility of the government granting subsidies with the purpose of dissociating the domestic price from international prices. The amount of money the government spends on subsidies is given by the total amount of internal consumption multiplied by the price ratio to be subsidized (equation 4.363).

With regards to public spending, in this model, we assume that the government consumes three types of goods (it does not consume good “Q”), and that this expenditure is exogenous (equations 4.364 to 4.366). To express public spending in nominal terms, we should transform the real demand by applying the relevant price index (equations 4.367 to 4.369). Afterwards, we could do the sum, after which we deduce the total public spending in nominal terms (equation 4.370). Once the income and expenditure of the government is defined, we can obtain the financing needs for each period, which are covered by issuing bonds (equation 4.371). It must be noticed that there are additional sources of income and expenditure, such as the payment of interest accrued from the debt issued in preceding periods. Finally, we should determine what part of the debt issued by the government is denominated in the national currency and what part is denominated in foreign currency. Equation 4.372 shows that the issuance of bonds in national currency arises from the sum of the demand of local banks, the central bank and the rest of the world. Equation 4.373 shows the net wealth of the government.

$$T_t = T_t^H + T_{h_t}^A + T_{h_t}^Q + T_{h_t}^M + T_{h_t}^S + T_{f_t}^A + T_{f_t}^Q + T_{f_t}^M + T_{f_t}^S \quad (4.362)$$

$$Sub_t = \lambda_2.(C\$_t^A + C\$_{f_t}^A + G\$_t^A + Ad\$_t^A + Ad\$_t^M + Ad\$_t^S + Ad\$_t^Q + Qd\$_t^A + Qd\$_t^M + Qd\$_t^S + Qd\$_t^Q) \quad (4.363)$$

$$G_t^A = G_0^A + G_{t-1}^A.(1 + g^g) \quad (4.364)$$

$$G_t^M = G_0^M + G_{t-1}^M.(1 + g^g) \quad (4.365)$$

$$G_t^S = G_0^S + G_{t-1}^S.(1 + g^g) \quad (4.366)$$

$$G\$_t^A = G_t^A.p_{h_t}^A \quad (4.367)$$

$$G\$_t^M = G_t^M.p_{h_t}^M \quad (4.368)$$

$$G\$_t^S = G_t^S.p_{h_t}^S \quad (4.369)$$

$$G\$_t = G\$_t^A + G\$_t^M + G\$_t^S \quad (4.370)$$

$$\Delta Bs_{h_t} = G\$_t - T_t + r^h_{t-1}.Bs^h_{h_{t-1}} + r^f_{t-1}.Bs^f_{h_{t-1}} \quad (4.371)$$

$$Bs^h_{h_t} = Bd, b^h_{h_t} + Bd, cb^h_{h_t} + Bs, b^{h,h}_{f_t} \quad (4.372)$$

$$VG_t = -Bs_{h_t} \quad (4.373)$$

The financial sector

In this model, we describe a relatively simplified behavior of the banking activity, given the fact that even though the banks are not taken as mere intermediaries between those who save and those who are willing to invest, we will not provide a sophisticated description of the financialisation process, like Van Trek (2009) and Caverzasi & Godin (2014) do. Since this model focuses on Latin American economies, where the financial markets have not yet reached a development level comparable to that of core countries, we consider that the description we will provide here fits the reality of our countries fairly well. We start by defining the total stock of bank deposits as the sum of the demands for deposits of each institutional agent of the economy (equation 4.364). The banks must save a certain amount of these deposits in the central bank (equation 4.375). The difference between the deposits and the reserves represents the funds available to make their investments, which are determined by means of portfolio equations which meet the requirements set by Godley-Tobin. There are two types of financial assets in which the banks may assign the available funds to: bonds issued by the government and denominated in the national currency (equation 4.376) and foreign bonds (equation 4.377), which are naturally denominated in foreign currency. Equation 4.378 shows the supply of foreign bonds to the local banks, which is assumed to be endogenous.

Besides, as we described in the section of firms, the credit granted by the banks can be rationed exogenously. From the sum of the credit granted to each sector, we can obtain the total stock of credit of the economy, which represents an asset for the banks (equation 4.379). Once the credit is determined, we can obtain the demand for advances that the commercial banks request to the monetary authority (equation 4.380). Finally, equation 4.381 shows the profits of the financial sector as the sum of all the income and expenditure related to their intermediary and "investment" activities. These profits are capitalized and are part of their net worth (equation 4.382).

$$D_t = D^H_t + D^A_{h_t} + D^Q_{h_t} + D^M_{h_t} + D^S_{h_t} + D^A_{f_t} + D^Q_{f_t} + D^M_{f_t} + D^S_{f_t} \quad (4.374)$$

$$R_t = \theta.D_t \quad (4.375)$$

$$Bd, b_{h_t}^h = (D_t - R_t).(\gamma_{10} + \gamma_{11}.r_t^h + \gamma_{12}.r_t^f) \quad (4.376)$$

$$Bd, b_{h_t}^f = (D_t - R_t).(\gamma_{20} + \gamma_{21}.r_t^h + \gamma_{22}.r_t^f) \quad (4.377)$$

$$Bs, b_{h_t}^f = \frac{Bd, b_{h_t}^f}{E_t} \quad (4.378)$$

$$L_t = L_t^A + L_t^Q + L_t^M + L_t^S \quad (4.379)$$

$$A_t = L_t + R_t + Bd, b_{h_t}^h + Bd, b_{h_t}^f - D_t - VB_t \quad (4.380)$$

$$Pb_t = rl_{t-1}.L_{t-1} + r_{t-1}^h.R_{t-1} + r_{t-1}^h.Bd, b_{h_t}^h + r_{t-1}^f.Bs, b_{h_t}^f.E_t + Bs, b_{h_{t-1}}^f.\Delta E_t - rd_{t-1}.D_{t-1} - r_{t-1}^h.A_{t-1} \quad (4.381)$$

$$\Delta VB_t = Pb_t \quad (4.382)$$

The rest of the world

The first thing we need to define with regards to capital movements from the rest of the world towards the economy is the short-term flows of capital. In this sense, international investors can demand local bonds denominated in the national or foreign currency and bonds issued by foreign governments. Since we are dealing with the case of a small open economy, we assume that these portfolio demands are exogenous (equations 4.383 to 4.385). As we will see below, the equilibrium in the market of domestic bonds denominated in the national currency will be given by variations of the exchange rate. Besides, the total demand for foreign bonds is endogenous to the demand of the different institutional agents, both national and foreign (equation 4.386). To guarantee the consistency of the model, even though the demand for national bonds by the rest of the world entails an inflow of foreign exchange, we should denominate the supply of financial bonds by the local government in the national currency (equations 4.387 and 4.388).

$$Bd, b_{f_t}^{h,h} = \left(Bd, b_{f_{t-1}}^{h,h} + Bd, b_{f_{t-1}}^{h,f} + Bd, b_{f_{t-1}}^f\right).(1 + g^w).(\gamma_9 + \gamma_{10}.r_t^h + \gamma_{11}.r_t^f + \gamma_{12}.r_t^f) \quad (4.383)$$

$$Bd, b_{f_t}^{h,f} = \left(Bd, b_{f_{t-1}}^{h,h} + Bd, b_{f_{t-1}}^{h,f} + Bd, b_{f_{t-1}}^f\right).(1 + g^w).(\gamma_{13} + \gamma_{14}.r_t^h + \gamma_{15}.r_t^f + \gamma_{16}.r_t^f) \quad (4.384)$$

$$Bd, b_{f_t}^f = \left(Bd, b_{f_{t-1}}^{h,h} + Bd, b_{f_{t-1}}^{h,f} + Bd, b_{f_{t-1}}^f\right).(1 + g^w) - Bd, b_{f_t}^{h,h} - Bd, b_{f_t}^{h,f} \quad (4.385)$$

$$Bs_{f_t} = Bs, b_{h_t}^f + Bs, cb_{h_t}^f + Bd, b_{f_t}^f \quad (4.386)$$

$$Bs, b_{f_t}^{h,h} = Bd, b_{f_t}^{h,h}.E_t \quad (4.387)$$

$$Bs, b_{f_t}^{h,f} = Bd, b_{f_t}^{h,f}.E_t \quad (4.388)$$

The next step consists in defining the inflow of long-term capital, associated to the real investment. For that matter, we define the flow of desired investment in each sector, which depends both on the level of global income and on the sectoral profitability of the economy (equations 4.389 to 4.392). In the particular case of the investments of the sectors "A" and "Q", we also incorporate the international prices as a decision variable. Afterwards, to determine the flow of effective investment, we need to consider two elements. On the one hand, as we previously did in the analysis of the investment made by local firms, we should consider the ratio of capital goods of national and international origin for each investment flow. Once the amount of imported goods that is required to reach the desired investment level is determined, import quotas (which may eventually impose a restriction on goods entering the country) must be applied, if any. This is shown by equations 4.397, 4.399, 4.401 and 4.403). From the amounts of imported capital goods, we can determine the amount of capital goods of national origin that is demanded by the foreign firms willing to invest in the economy, by applying the relevant ratios (equations 4.398, 4.400, 4.402 and 4.404). Finally, the flows of real investment can be translated into nominal terms by multiplying them by the relevant prices indexes (equations 4.406 to 4.412). This helps us determine the foreign investment in each sector (equations 4.413 to 4.416).

$$ln\left(I_{f_t}^{A^d}\right) = ln(\delta_0) + \delta_1.ln\left(NP_{f_t}^{A^e}\right) + \delta_2.ln(Y_t^*) + \delta_3.ln\left(p_{f_t}^{A}\right) \quad (4.389)$$

$$ln\left(I_{f_t}^{Q^d}\right) = ln(\delta_4) + \delta_5.ln\left(NP_{f_t}^{Q^e}\right) + \delta_6.ln(Y_t^*) + \delta_7.ln\left(p_{f_t}^{Q}\right) \quad (4.390)$$

$$ln\left(I_{f_t}^{M^d}\right) = ln(\delta_8) + \delta_9.ln\left(NP_{f_t}^{M^e}\right) + \delta_{10}.ln(Y_t^*) \quad (4.391)$$

$$ln\left(I_{f_t}^{S^d}\right) = ln(\delta_{11}) + \delta_{12}.ln\left(NP_{f_t}^{S^e}\right) + \delta_{13}.ln(Y_t^*) \quad (4.392)$$

$$NP_{f_t}^{A^e} = NP_{f_{t-1}}^{A}.\left[\frac{\Delta NP_{f_{t-1}}^{A}}{NP_{f_{t-2}}^{A}}\right] \quad (4.393)$$

$$NP_{f_t}^{Q^e} = NP_{f_{t-1}}^{Q}.\left[\frac{\Delta NP_{f_{t-1}}^{Q}}{NP_{f_{t-2}}^{Q}}\right] \quad (4.394)$$

$$NP_{f_t}^{M^e} = NP_{f_{t-1}}^{M}.\left[\frac{\Delta NP_{f_{t-1}}^{M}}{NP_{f_{t-2}}^{M}}\right] \quad (4.395)$$

$$NP_{f_t}^{S^e} = NP_{f_{t-1}}^{S}.\left[\frac{\Delta NP_{f_{t-1}}^{S}}{NP_{f_{t-2}}^{S}}\right] \quad (4.396)$$

$$I_{f,f_t}^{A} = (1-\alpha_6).I_{f_t}^{A^d}.(1-\sigma^A) \quad (4.397)$$

$$I_{f,h_t}^{A} = \frac{I_{f,f_t}^{A}}{1-\alpha_6}.\alpha_6 \quad (4.398)$$

$$I_{f,f_t}^{Q} = (1-\alpha_6).I_{f_t}^{Q^d}.(1-\sigma^Q) \quad (4.399)$$

$$I_{f,h_t}^{Q} = \frac{I_{f,f_t}^{Q}}{1-\alpha_6}.\alpha_6 \quad (4.400)$$

$$I_{f,f_t}^{M} = (1-\alpha_6).I_{f_t}^{M^d}.(1-\sigma^M) \quad (4.401)$$

$$I_{f,h_t}^{M} = \frac{I_{f,f_t}^{M}}{1-\alpha_6}.\alpha_6 \quad (4.402)$$

$$I_{f,f_t}^{S} = (1-\alpha_6).I_{f_t}^{S^d}.(1-\sigma^S) \quad (4.403)$$

$$I_{f,h_t}^{S} = \frac{I_{f,f_t}^{S}}{1-\alpha_6}.\alpha_6 \quad (4.404)$$

$$I\$_{f,h_t}^{A} = I_{f,h_t}^{A}.p_{h_t}^{M} \quad (4.405)$$

$$I\$_{f,f_t}^{A} = I_{f,f_t}^{A}.p_{h_t}^{IM} \quad (4.406)$$

$$I\$_{f,h_t}^{Q} = I_{f,h_t}^{Q}.p_{h_t}^{M} \quad (4.407)$$

$$I\$_{f,f_t}^{Q} = I_{f,f_t}^{Q}.p_{h_t}^{IM} \quad (4.408)$$

$$I\$_{f,h_t}^{M} = I_{f,h_t}^{M}.p_{h_t}^{M} \quad (4.409)$$

$$I\$_{f,f_t}^{M} = I_{f,f_t}^{M}.p_{h_t}^{IM} \quad (4.410)$$

$$I\$_{f,h_t}^{S} = I_{f,h_t}^{S}.p_{h_t}^{M} \quad (4.411)$$

$$I\$_{f,f_t}^{S} = I_{f,f_t}^{S}.p_{h_t}^{IM} \quad (4.412)$$

$$I\$_{f_t}^{A} = I\$_{f,h_t}^{A} + I\$_{f,f_t}^{A} \quad (4.413)$$

$$I\$_{f_t}^{Q} = I\$_{f,h_t}^{Q} + I\$_{f,f_t}^{Q} \quad (4.414)$$

$$I\$_{f_t}^{M} = I\$_{f,h_t}^{M} + I\$_{f,f_t}^{M} \quad (4.415)$$

$$I\$_{f_t}^{S} = I\$_{f,h_t}^{S} + I\$_{f,f_t}^{S} \tag{4.416}$$

The only step left to complete the description of the international financial sector consists in constructing the aggregate foreign direct investment. For that matter, we first define direct investment as the new funds entering the country from abroad. This will not always be the case, even when the rest of the world is willing to invest in the economy, since the investment could be funded with profits of the preceding period. For that matter, in this model we assume that new funds coming from the rest of the world, which we will denominate as "direct investment", will enter the economy only when undistributed profits are not sufficient to fund the investment (equations 4.417 to 4.420). It should be noticed that even though both the investment within the economy and the profits allocated for its funding are flows denominated in the local currency, since the foreign funds are denominated in foreign currency, we should express them in their own currency. Afterwards, we can define the flow of foreign direct investment as the sum of the direct investment and the undistributed profits (equations 4.421 to 4.424).

$$DI\$_t^A = \begin{cases} I\$_{f_t}^A - \frac{NP_{f_t}^A \cdot (1-\tau^A)}{E_t} & if\ I\$_{f_t}^A > \frac{NP_{f_t}^A \cdot (1-\tau^A)}{E_t} \\ 0 & if\ I\$_{f_t}^A \leq \frac{NP_{f_t}^A \cdot (1-\tau^A)}{E_t} \end{cases} \tag{4.417}$$

$$DI\$_t^Q = \begin{cases} I\$_{f_t}^Q - \frac{NP_{f_t}^Q \cdot (1-\tau^Q)}{E_t} & if\ I\$_{f_t}^Q > \frac{NP_{f_t}^Q \cdot (1-\tau^Q)}{E_t} \\ 0 & if\ I\$_{f_t}^Q \leq \frac{NP_{f_t}^Q \cdot (1-\tau^Q)}{E_t} \end{cases} \tag{4.418}$$

$$DI\$_t^M = \begin{cases} I\$_{f_t}^M - \frac{NP_{f_t}^M \cdot (1-\tau^M)}{E_t} & if\ I\$_{f_t}^M > \frac{NP_{f_t}^M \cdot (1-\tau^M)}{E_t} \\ 0 & if\ I\$_{f_t}^M \leq \frac{NP_{f_t}^M \cdot (1-\tau^M)}{E_t} \end{cases} \tag{4.419}$$

$$DI\$_t^S = \begin{cases} I\$_{f_t}^S - \frac{NP_{f_t}^S \cdot (1-\tau^S)}{E_t} & if\ I\$_{f_t}^S > \frac{NP_{f_t}^S \cdot (1-\tau^S)}{E_t} \\ 0 & if\ I\$_{f_t}^S \leq \frac{NP_{f_t}^S \cdot (1-\tau^S)}{E_t} \end{cases} \tag{4.420}$$

$$FDI\$_t^A = DI\$_t^A + \frac{NP_{f_t}^A \cdot (1-\tau^A)}{E_t} \tag{4.421}$$

$$FDI\$_t^Q = DI\$_t^Q + \frac{NP_{f_t}^Q \cdot (1-\tau^Q)}{E_t} \tag{4.422}$$

$$FDI\$_t^M = DI\$_t^M + \frac{NP_{f_t}^M \cdot (1-\tau^M)}{E_t} \tag{4.423}$$

$$FDI\$_t^S = DI\$_t^S + \frac{NP_{f_t}^S.(1-\tau^S)}{E_t} \quad (4.424)$$

Finally, the variation of wealth of the rest of the world, just as it is shown by equation 4.425, is given by the sum of the net current transactions that this institutional agent conducts in the economy (reflected by the current account), less the stock of capital depreciation in the hands of the rest of the world, plus the valuation that it may experience due to changes in prices. We can now describe the current account and the financial account of the balance of payments, since all of their components have already been defined (equations 4.426 and 4.427).

$$\Delta VW_t = -CA_t - \left(\delta^A.K_{f,h_{t-1}}^A + \delta^Q.K_{f,h_{t-1}}^Q + \delta^M.K_{f,h_{t-1}}^M + \delta^S.K_{f,h_{t-1}}^S\right).p_{h_t}^M - \left(\delta^A.K_{f,f_{t-1}}^A + \delta^Q.K_{f,f_{t-1}}^Q + \delta^M.K_{f,f_{t-1}}^M + \delta^S.K_{f,f_{t-1}}^S\right).p_{h_t}^{IM} + K_{f,h_{t-1}}^A.\Delta p_{h_t}^M + K_{f,h_{t-1}}^Q.\Delta p_{h_t}^M + K_{f,h_{t-1}}^M.\Delta p_{h_t}^M + K_{f,h_{t-1}}^S.\Delta p_{h_t}^M + K_{f,f_{t-1}}^A.\Delta p_{h_t}^{IM} + K_{f,f_{t-1}}^Q.\Delta p_{h_t}^{IM} + K_{f,f_{t-1}}^M.\Delta p_{h_t}^{IM} + K_{f,f_{t-1}}^S.\Delta p_{h_t}^{IM} \quad (4.425)$$

$$CA_t = X\$_t - IM\$_t + r_{t-1}^f.\left(Bs,b_{h_{t-1}}^f + Bs,cb_{h_{t-1}}^f\right).E_t - r_{t-1}^h.Bs,b_{f_{t-1}}^{h,h} - r_{t-1}^f.Bs,b_{f_{t-1}}^{h,f} - NP_{f_t}^A - NP_{f_t}^X - NP_{f_t}^M - NP_{f_t}^S + Bs,b_{h_{t-1}}^f.\Delta E_t \quad (4.426)$$

$$FA_t = \Delta Bs,b_{f_t}^{h,h} + \Delta Bs,b_{f_t}^{h,f} - \Delta Bd,b_{h_t}^f + \left(FDI\$_t^A + FDI\$_t^Q + FDI\$_t^M + FDI\$_t^S\right).E_t - \Delta Bd,cb_{h_t}^f \quad (4.427)$$

The central bank

A key aspect of the model, which is linked to the monetary authority, is the definition of the exchange-rate regime. As we anticipated, in this model, we assume a flexible exchange-rate regime within the margins imposed by the central bank. Thus, as long as the exchange rate fluctuations do not exceed those limits, it works as the variable that clears the market of local bonds denominated in the local currency. To define the conditions under which the monetary authority intervenes in the foreign exchange market, we first express what could be denominated as a "theoretical" exchange rate given by the equilibrium between the supply and the demand of bonds (equation 4.428). From this ratio, we can calculate the percentage change from period to period, i.e., the exchange rate appreciation or depreciation (equation 4.429). The current exchange rate in the economy is determined in relation to that percentage change and to the objectives of the central bank with regards to the exchange rate (equation 4.430). This implies that under certain circumstances, the monetary authority will allow the exchange rate to float (in which case there will be no variation of the reserves) and other circumstances under which the central bank will have to purchase or sell foreign reserves in order to maintain the exchange rate within the pre-established margins.

Equation 4.431 shows that when the central bank intervenes in the foreign exchange market, the international reserves will be modified to guarantee the equilibrium in its balance sheet. However, the reserves will remain constant as long as the central bank refrains from intervening. Equation 4.432 shows the variation of reserves in national currency, for which we should consider the changes in the amount of bonds in the hands of the monetary authority but also the valuation effects that may arise from the changes of the nominal exchange rate. Finally, equation 4.433 shows the variation of the stock of local bonds held by the central bank. These bonds will close the balance sheet of the monetary authority when it does not intervene in the foreign exchange market, and will guarantee the equilibrium in the market of local bonds every time the central bank decides to intervene (this will happen when the actual exchange rate differs from the exchange rate that closes the domestic bond market). Moreover, the profits of the monetary authority are given by the sum of interest charged and paid by the holding or issuance of different financial goods (equation 4.434). The magnitude of these profits determines the variation in the stock of wealth of the central bank (equation 4.435).

$$E_t^* = \frac{Bs_{h_t} - Bd, b_{h_t}^h - Bd, cb_{h_t}^h - Bs, b_{f_t}^{h,f}}{Bd, b_{f_t}^{h,h}} \tag{4.428}$$

$$\widehat{E_t^*} = \frac{\Delta E_t^*}{E_t} \tag{4.429}$$

$$E_t = \begin{cases} E_t^* & if\ \widehat{E_t^*} < \epsilon \vee \widehat{E_t^*} > -\epsilon \\ E_{t-1}.(1+\epsilon) & if\ \widehat{E_t^*} \geq \epsilon \\ E_{t-1}.(1-\epsilon) & if\ \widehat{E_t^*} \leq -\epsilon \end{cases} \tag{4.430}$$

$$\Delta Bs, cb_{h_t}^f = \begin{cases} \frac{\Delta Hd_t + \Delta R_t + \Delta VCB_t - \Delta A_t - \Delta Bd, cb_{h_t}^f}{E_t} & if \quad \widehat{E_t^*} \geq \epsilon \vee \widehat{E_t^*} \leq -\epsilon \\ 0 & if \quad \widehat{E_t^*} < \epsilon \vee \widehat{E_t^*} > -\epsilon \end{cases} \tag{4.431}$$

$$\Delta Bd, cb_{h_t}^f = Bs, cb_{h_{t-1}}^f.\Delta E_t + \Delta Bs, cb_{h_t}^f.E_t \tag{4.432}$$

$$\Delta Bd, cb_{h_t}^h = \begin{cases} \Delta Hd_t + \Delta R_t + \Delta VCB_t - \Delta A_t - \Delta Bd, cb_{h_t}^f & if \quad \widehat{E_t^*} < \epsilon \vee \widehat{E_t^*} > -\epsilon \\ Bs_{h_t}^h - Bd, b_{h_t}^h - Bs, b_{f_t}^{h,h} & if \quad \widehat{E_t^*} \geq \epsilon \vee \widehat{E_t^*} \leq -\epsilon \end{cases} \tag{4.433}$$

$$Pcb_t = r_{t-1}^h.A_{t-1} + r_{t-1}^h.Bd, cb_{h_{t-1}}^h + r_{t-1}^f.Bs, cb_{h_{t-1}}^f.E_t - r_{t-1}^h.R_{t-1} \tag{4.434}$$

$$\Delta VCB_t = Pcb_t \tag{4.435}$$

The reader who has followed every step of the specification of the model will notice that (almost) every process incorporated into the social accounting and the flow of funds matrices has already been defined, that every goods, services and financial markets have been cleared, and that all the saving/dissaving flows of each institutional agent have been materialized as a variation of some form of wealth. The only accounting process which has not been defined yet is the one describing the equilibrium in the balance sheet of the rest of the world. As equation A so shows, this requires that the sum of the variations of assets and liabilities be equal to the variation of wealth, previously computed in equation 4.425. It is not possible to express this accounting process explicitly, since all of its components have already been defined. In other words, if we wanted to introduce this equation in the model, it would turn out to be over determined. Therefore, the common practice in stock-flow consistent modeling consists in using this missing "equation" as an instrument to verify the consistency of the model. Should the model be consistent, there would be no need to write this equation since it would be derived from all the other equations of the model.

$$\Delta Bd, b_{h_t}^{f} + \Delta Bd, cb_{h_t}^{f} + \Delta VW_t - \Delta Bs, b_{f_t}^{h,h} - \Delta Bs, b_{f_t}^{h,f} - \Delta D_{f_t}^{A} - \Delta D_{f_t}^{Q} - \Delta D_{f_t}^{M} - \Delta D_{f_t}^{S} - \Delta K\$_{f_t}^{A} - \Delta K\$_{f_t}^{Q} - \Delta K\$_{f_t}^{M} - \Delta K\$_{f_t}^{S} = 0 \quad \text{(A)}$$

In order to guarantee that the model is specified properly, it is useful to verify that the following accounting identities are also being met. In the first place, it must be noticed that the sum of the current account and the financial account of the balance of payments (including the variation of foreign reserves) is zero, which is consistent with the equilibrium in the balance of payments. In the second place, it must be verified that the gross domestic product is the same when it is computed from the production side, from the expenditures side and from the income side. Finally, it must also be verified that the net global wealth (the sum of the local economy and the rest of the world) is only given by physical goods (stock of capital and stock of goods "A" and "M"), which do not have liabilities as counterpart, unlike financial goods, which always constitute an asset for an agent and a liability for the other.

$$CA_t + FA_t = 0 \quad \text{(B)}$$

$$GVA_t = AD_t = Y_t \quad \text{(C)}$$

$$VH_t + VF_t^A + VF_t^Q + VF_t^M + VF_t^S + VB_t + VG_t + VCB_t + VW_t = K\$_t^A + K\$_t^Q + K\$_t^M + K\$_t^S + Stock\$_t^A + Stock\$_t^Q + Stock\$_t^M \quad \text{(D)}$$

Identification of different productive structures

In this subsection, we will explain how the structure developed above can be changed in order to characterize the four types of economies we aim to describe: the agro-industrial model, the oil model, the mining model and the maquila model.

To define the agro-industrial case, it is important to make sure that the sectors producing food and industrial goods have a significant share in the provision of both intermediate and final goods (sold both in the local and the foreign markets). Thus, the technical coefficients of the input-output matrix describing the production process of industrial goods should account for a high utilization of primary goods. In the same way, the production of food will require a significant portion of industrial goods, most of which will be of national origin since there is a moderately diversified production of this type of input. Something similar occurs with the demand for capital goods, part of which consists of goods of national origin, and the remainder, consists of imported machinery. The same logic is applied to the consumption of the households, which is largely met by the local production.

With regards to the oil and mining cases, the following factors should be considered. In the first place, since the primary non-food goods constitute the main export (unlike the greater diversification in the agro-industrial case), the participation of the sector both in total output and in exports will be greater than in the previous case. With regards to the intermediate and final consumption of industrial goods and investment, the ratio of inputs and final imported goods is greater than in the agro-industrial case, since we are dealing with undiversified economies. Finally, the big difference between these two cases lies in the production process: while the minerals are mainly an export, which take little part in the production of the rest of the goods (and, therefore, in their price formation process), oil is one of the main inputs. That is why its price variations have a strong impact on the rest of the variables of the economy. This difference in the role of minerals and oil in the productive structure can be represented by giving them different values in the technical coefficients of the input-output matrix.

Finally, a maquiladora economy will show similar parameters to the agro-industrial case, with the radical difference of the technical coefficient describing the demand for industrial inputs by the manufacturing sector being much higher. In turn, the ratio of these inputs coming from abroad will also be very high. In addition, unlike the agro-industrial case, where there is a relative equilibrium between the exports of food and secondary goods, in

the maquila case, the bulk of total exports is given by industrial goods.

Table 4.X: Calibration of each economic structure

Economic Structure	Input-Output Coefficients	Imported goods requirements
Agro-industrial	q_{AM} and q_{MA} high	ϕ^i,α_5 and α_6^i high
Maquila		ϕ^i,α_5 and α_6^i low
Oil	q_{AQ}, q_{QQ}, q_{MQ} and q_{SQ} high	ϕ^i,α_5 and α_6^i low
Mining	q_{AQ}, q_{QQ}, q_{MQ} and q_{SQ} zero	ϕ^i,α_5 and α_6^i low

$\forall i = A, Q, M, S$

4.4. Economic structure and external vulnerability

In this section, we will introduce a series of simulation scenarios aimed to evaluate the impact of the two types of shocks that Latin American economies can be exposed to: steadily falling commodity prices and a *sudden stop*. The purpose is to identify the differentiated impact that these scenarios may have in each case in relation to the underlying productive structure. The results should be analysed in a more qualitative sense, instead of a quantitative one, since this is a calibrated model. From the obtained results, we can draw conclusions with regards to the convenience of directing the long-term economic policy towards a specific productive structure, or, in case it cannot be easily changed, specific policy strategies can be designed for each case to reduce the vulnerability to external shocks.

Before presenting the simulation scenarios, we should explain how the model described in the preceding section is solved. As it may have been noticed, it is a system of nonlinear difference equations (the nonlinearity can be found, for example, in the production functions or in the equation for the exchange rate). Unfortunately, there are no methods available which help us find an analytical solution to this type of problems. This hinders the study of the features of the equilibrium. Nevertheless, what we can do is to apply some algorithm that can solve the system, given a series of initial conditions, to then try to understand its behaviour from the numerical solutions. The calibration stage described in the preceding section consists in assigning these initial values that help us solve the system.

Falling international prices of food commodities

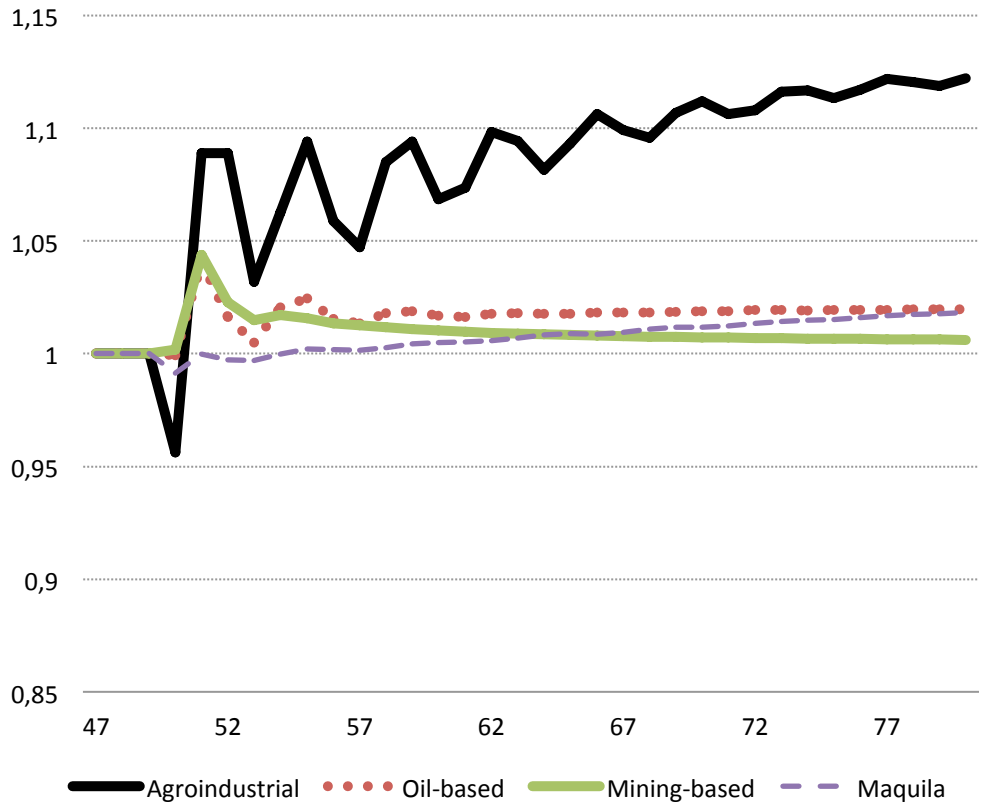
When the international price of food commodities falls by 5%, we can see a strong deterioration in the current account (measured by a GDP percentage) of the agro-

industrial country, a slight fall in the maquila case and an increase in the rest of the countries (figure 4.1). The trajectories of every variable should be interpreted as a percentage of the baseline scenario. Therefore, if the current account/GDP ratio falls to 0.92, a fall of 8% in such ratio should be interpreted. For instance, if there was a surplus of 1% in the baseline scenario after the shock, such surplus would fall to a 0.92%. The reason why the current account is deteriorated so much in the agro-industrial case is evident taking into account that the negative shock is produced on the price of the main export. Regarding the maquila case, the deterioration in the current account is due to the increasing imports resulting from the higher level of activity, which, as we will explain below, is linked to the increasing purchasing power of households that results from the shock. However, in the oil and mining cases, the effect on the current account is positive because these two types of economies are net importers of food. This entails that the falling prices of their imports improve the balance of trade, regardless of the amounts being traded.

In every case, we can see that in the period immediately after the shock, there is a rebound in the current account/GDP ratio. This positive effect seen in every case is mainly explained by the smaller demand for imported capital goods, which is the consequence of the shrinkage in investments on the food commodities sector. Since the main component of the investment function (profits) is specified with a lag, the effect is also shown with a delay of a period. The difference in the rebound of the current account (high in the agro-industrial case, low in the maquila case, and intermediate in the oil and mining cases) is explained by two factors: on the one hand, the larger relative size of the food-producing sector entails that the falling imports of capital goods is comparatively larger in the agro-industrial case than in the rest. On the other hand, as we will see below, the effect of the shock on growth impacts differently over this ratio depending on each case (in the agro-industrial case is where the nominal product suffers the largest impact, which contributes to the increase in this ratio).

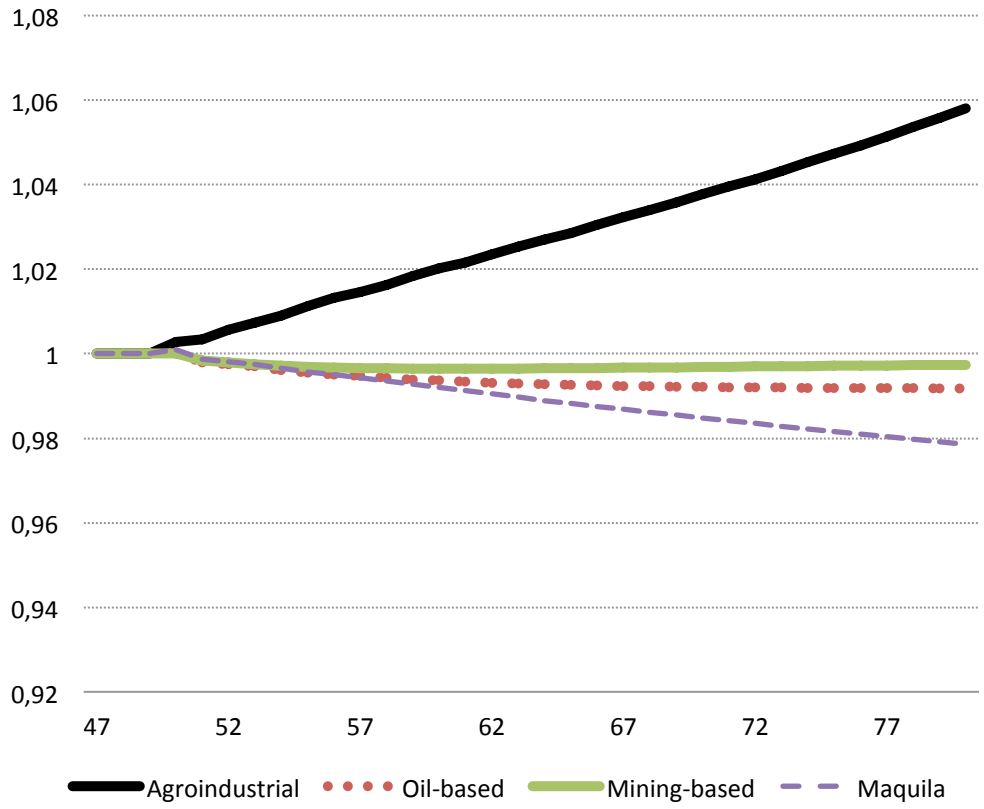
In subsequent periods, the current account tends to normalise in the oil, mining and maquila cases, while a slight improvement is shown in the agro-industrial case. This latter, which in principle seems counterintuitive given the initial shock, is explained by the fact that the falling output observed over time entails, on the one hand, a smaller need for imports, and on the other, a smaller denominator over which this ratio is computed. Therefore, this improvement in the current account in the long run cannot be considered desirable because, as we will see below, it is the result of a lower level of activity and a less favourable distribution of income for workers.

Figure 4.1. Impact of a fall in the price of "A" on the current account



As the consequence of the deterioration in the current account, and considering we defined a managed floating exchange rate regime in every case, we find a depreciation of the nominal exchange rate in the agro-industrial economy (figure 4.2). This depreciation is amplified by falling flows of foreign direct investment channelled to the food-producing sector (which depends on the price of this type of output, as we shown in the investment function), which entails a smaller inflow of foreign exchange, in comparison to the baseline scenario. Since no process capable of reversing this new tendency occurs, in other words, since the situation in which there is a foreign exchange deficit in relation to the baseline scenario, the nominal exchange rate never returns to its original level. The opposite effect is registered in the other three types of productive structures: as a result of the exceeding foreign exchange which causes falling prices of one of the main imports, the exchange rate registers a slight appreciation. In addition, since foreign investments are not mainly focused on the food-producing sector, the shock we are analysing here does not have a negative effect on the financial account of the balance of payments in the same way it occurs in the agro-industrial case.

Figure 4.2 Impact of a fall in the price of "A" on the nominal exchange rate

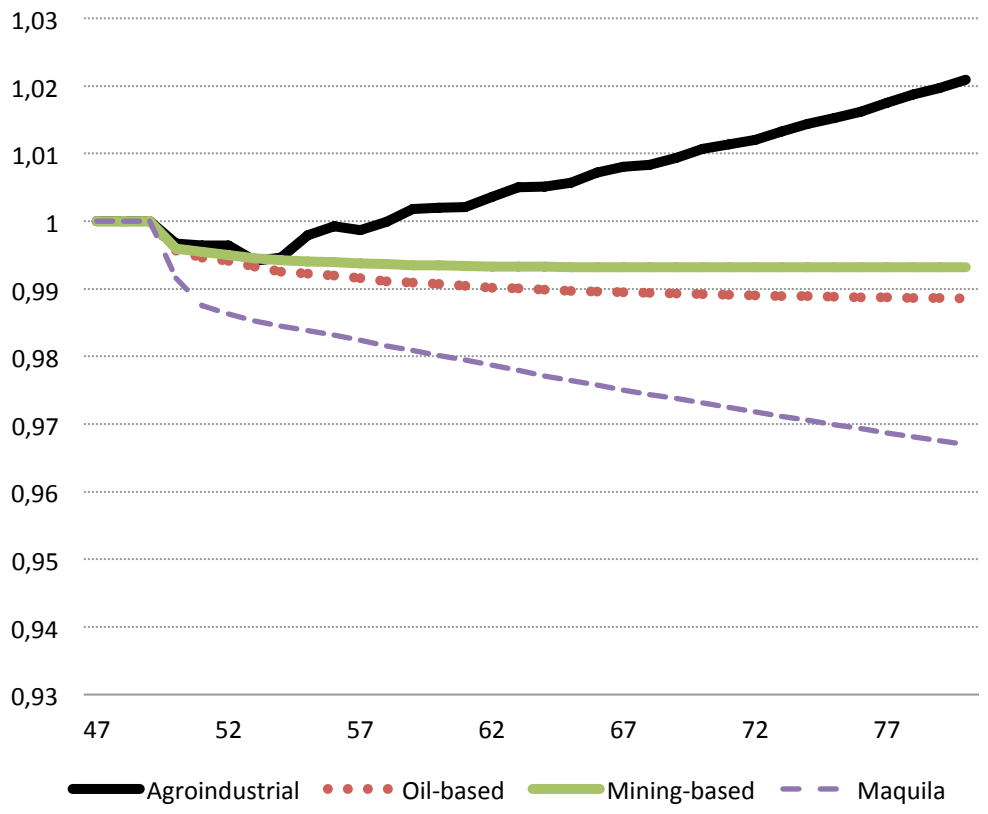


The impact of this shock on the prices in the agro-industrial case is ambiguous (figure 4.3), considering that on the one hand, falling international prices should reduce the level of domestic prices (a sort of "imported deflation"), but on the other hand, the exchange rate depreciation shown in the graph above contributes to generate the so-called *pass-through effect*. As it can be seen in the graph, although the deflation seems to prevail over the *pass-through effect* in the short run (mainly because while the price of the good "A" falls by 5%, the exchange rate depreciates less than 1%) as periods pass, the exchange rate depreciation ends up increasing the price of tradable goods, whether they be intermediate or final, which produces an increase in the local prices. Therefore, the conclusion for the agro-industrial case would be that although a shock of this nature may produce a deflationary effect in the short run, the *pass-through effect* will eventually end up dominating dynamics of prices.

The situation is different in the other three productive structures since, as we have seen in figure 4.2, the exchange rate tends towards appreciation. Therefore, in these cases, the two forces that come into play in the inflation dynamics after the shock (imported

deflation and the pass-through effect) go together in the same way, thus causing falling general prices. These differentiated trajectories are related to the uneven evolution of the exchange rate, which, in turn, is determined by the different external performance of every economy. As we have seen before, the impact of this shock affects every country differently, depending on their productive structure. Being more exposed to international prices before a scenario like this, the oil, mining and maquila countries experience a smaller deterioration in the current account (or even an improvement), a smaller exchange rate depreciation (or even an appreciation), and, therefore, a smaller impact on local prices.

Figure 4.3 Impact of a fall in the price of "A" on the local prices



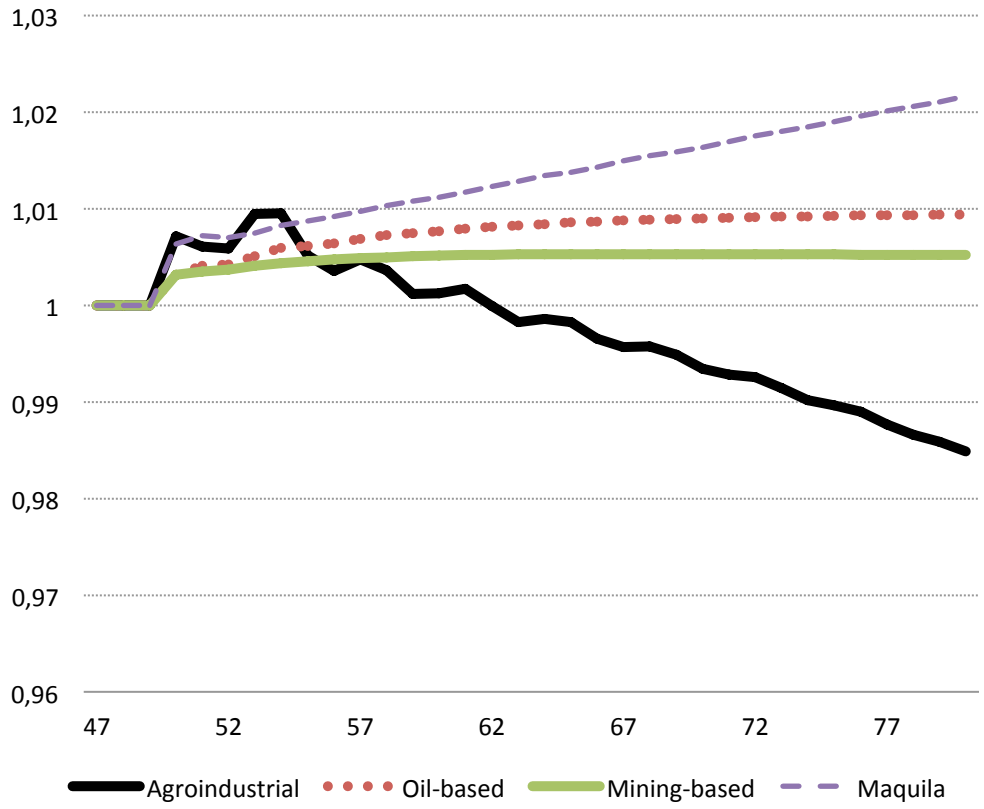
After analysing the behaviour of prices, it is interesting to see the impact of the shock on the distribution of income in every case (figure 4.4). For that matter, we should analyse the evolution of prices (which fall in every case at the moment of the shock, according to figure 4.3) together with unit labour costs, defined as the ratio between the nominal wages and the labour productivity. Therefore, in order to understand the behaviour of the labour unit costs, it is important to analyse the trajectory of the variables determining it.

At the moment that the shock occurs, which is not anticipated, nominal wages remain the same, since expectations regarding future inflation were not altered.

Moreover, with regards to labour productivity (the ratio between the real product and labour), we find that its two components are practically constant, which is logical since, when the shock occurs, there is no direct impact on real phenomena like production and employment. These, however, may be dynamically affected by the shock through other variables of the system, like for example, the exchange rate and the prices. Therefore, during the periods when the shock occurs, the productivity does not change. The combination of constant nominal wages with an unchanging productivity entails that the unitary labour costs also remain unchanged. If we added the fact that prices fell, then the general mark-up of the economy would shrink, which results in an improvement in the functional distribution of income. This is found in figure 4.4 at the moment that the shock occurs.

Although we find the same effect in qualitative terms over the four types of economies, we see that in the agro-industrial and maquila cases the improvement in the distribution of income is higher than in the oil and mining cases. This is due to the fact that the functional distribution of income is the ratio between the wage bill and the nominal income, and the latter falls more dramatically in the agro-industrial and maquila cases, thus the wage bill remains practically constant (given the fact that nominal wages lag behind and that labour tends to be weakly elastic relative to the contemporary output fluctuations, thus having late effects as well), it ends increasing the share of wages in income. The reason why nominal income falls more in the agro-industrial and maquila cases is linked to the greater importance that food commodities have in the productive structure, in comparison with the other two cases. Even though prices experienced a larger fall in the oil and mining case, as so figure 4.3 shows, it must be noticed that we referred to the consumer price index, which constitutes the most common measure of inflation. However, if we take the GDP deflator, we find that the deflation is larger in the agro-industrial and maquila cases due to the larger size of the sector whose price falls. That is why the nominal income falls more in these two cases, thus resulting in an improvement in the functional distribution of income.

Figure 4.4 Impact of a fall in the price of "A" on the functional distribution of income

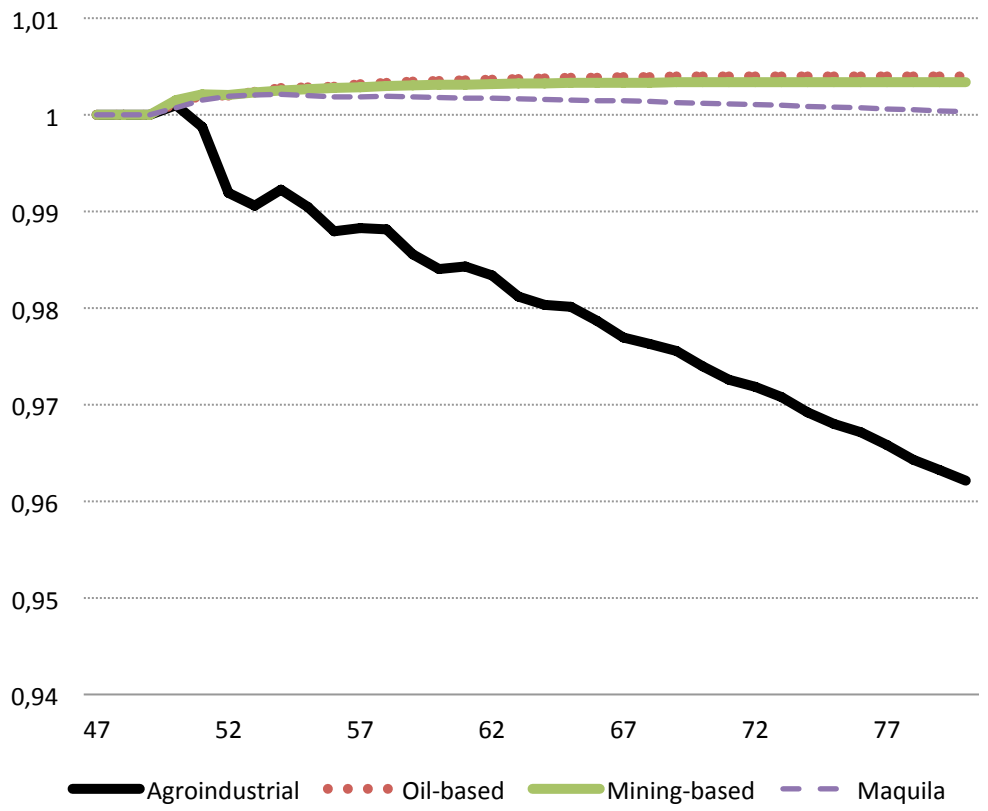


In subsequent periods, the functional distribution of income seems to follow the tendency imposed by the consumer price index, which, in turn, was strongly determined by the dynamics of the nominal exchange rate. In the agro-industrial case, which shows a price uptrend as periods pass (due to the fact that in this case the foreign sector is more adversely affected by the shock, thus causing a depreciation of the exchange rate), the distribution of income is systematically worsened. This reflects the fact that the sectors producing tradable goods set a local price equivalent to the international price converted to the national currency using the exchange rate (in the presence of instruments of trade policy this need not be the case). As long as its costs are not fully correlated to the exchange rate (which should not happen, since wages are determined by other factors), these tend to increase less, thus causing the mark-up to increase. In consequence, the distribution of income ends up being less favourable to the workers. The situation seems to be the opposite in the other three cases, where the shock over the price of food commodities induces an appreciation of the exchange rate. Therefore, the falling prices of tradable goods reduce the mark-up, which improves the distribution of income. The differences among the cases depend on the pace of exchange appreciation, which has

already been described above.

After analysing the effect of falling international prices of commodities over the distribution of income, we can now move on to analyse the impact on the level of activity (figure 4.5). This can be done both from a supply and from demand point of view. After all, both should be equal ex post. Insofar as there are no capacity restrictions, it seems appropriate, at least from a Keynesian perspective, to explain the fluctuations of the level of activity from the evolution of each component of aggregate demand. We can see prima facie that the shock has a positive impact on the GDP in every case. Then, the positive impact remains in every case, except for the agro-industrial structure.

Figure 4.5 Impact of a fall in the price of "A" on output



When we analyse the evolution of the components of the aggregate demand, we find that when the shock occurs, private consumption increases due to the increasing purchasing power of households, as the result of a fall in the general price level. This effect is compensated, though not in whole, by falling foreign investments in the food-producing sector, mainly in the agro-industrial case. Some differences start to show in subsequent

periods, due to the different trajectory shown by the functional distribution of income. In those economies where the workers increased their share of income, private consumption strengthens and, therefore, the level of activity tends to increase. In the agro-industrial case, however, the distribution of income, which is less favourable to workers, adversely affects consumption and demand. In addition, since the investment is endogenous to the level of activity (both by means of using the installed capacity and by expected profits, which depend on the current level of activity), output shrinks even more. This negative combination over the aggregate demand is under-compensated by the expansionary effect that the foreign exchange depreciation has over the exports of manufactured goods. Even though these latter rise, they do not reverse the recessive tendency that the initial shock has over the economy in the long run. Therefore, according to these simulations, the depreciation of the exchange rate tends to produce contractive results on the level of activity.

Falling prices of non-food commodities

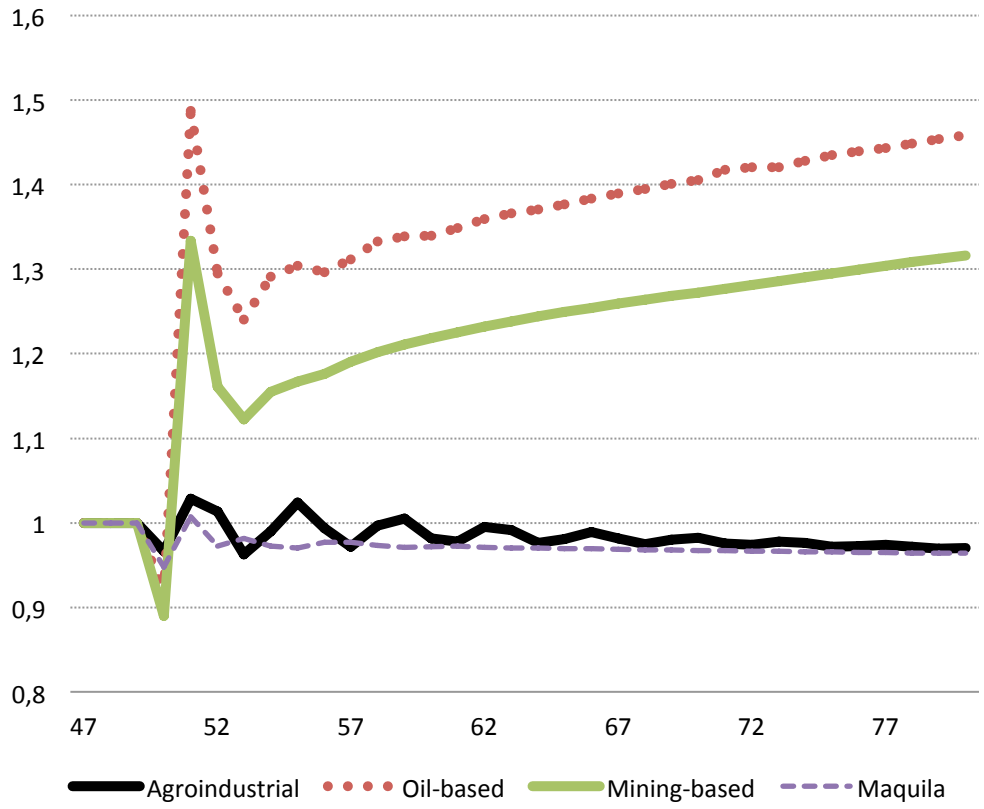
We now continue the analysis of the shocks on the prices of raw materials, focusing on the case of non-food commodities. This type of scenario will be relevant mainly for the oil and mining cases, whose productive structures are concentrated in these sectors, and their export baskets as well. Let us remember that the difference between these two types of productive structure is given by the fact that while minerals do not represent a basic input for the production of other goods of the economy, oil is. Therefore, even though the calibration we chose implies that these two economies are equally exposed to the fluctuations of the international prices from the viewpoint suggesting that this type of goods has the same importance with regards to exports, in output terms, the sector producing non-food commodities shows a relative larger size in the oil case, since its output has more demand sources in addition to exports.

After the price of non-food commodities falls by 5%, we find deterioration in the current account/GDP ratio in every case. This situation is explained by different reasons. On the one hand, a shrinkage of exports in nominal terms occurs in the oil and mining cases, which adversely affects the trade balance and the current account. This effect is compensated by falling foreign investments in the non-food commodities sector (which depends on the price), which, in turn, entails a reduction of the imports of capital goods aimed to extend the productive capacity. Since the non-food commodities sector is larger in the oil case than in the mining case (because of what was explained in the preceding paragraph), imports also fall abruptly in this case, which lets the deterioration of the trade

balance soften with regards to the mining case. This way, the current account shows a more important fall in the mining case, in comparison to the oil case. However, in the agro-industrial and maquila cases, the trade balance and the current account do not experience important direct changes since the shock occurs over a sector that is not much important in their economies. Nevertheless, as we will see below, the effect of the shock is positive on the level of activity, which raises the demand for imports of intermediate goods, which has an indirect negative effect over the trade balance and the current account.

It can be debated whether, in practice, the effect of the shock is positive or negative for net importing countries of these types of goods. Actually, the final impact of this shock ends up being an empirical question which depends, on the one hand, on the expansionary impact that falling prices will have on consumption, and on the other, on the coefficients of the imported inputs of the country (since these coefficients are higher in the maquila cases than in the agro-industrial case in this simulation, the negative effect on the current account is larger in the maquila case). Conversely, in the oil and mining countries that were directly affected by the shock, we have no doubts as to the impact on the current account being negative.

Figure 4.6 Impact of a fall in the price of "Q" on the current account



Just like it occurred in the agro-industrial case, when the shock affected the food commodities, we find that when the shock affects the non-food commodities, the current account/GDP ratio increases after the period when the shock occurs, and then reverses its sign. These dynamics, which remain through subsequent periods, are explained by two factors. In the first place, as we will see below, the oil and mining economies have falling GDPs during subsequent periods, which reduce the base to which the current account balance is compared, giving rise to a higher ratio. In the second place, since the economy starts following a path of lower growth, this requires a smaller amount of imports, which, in turn, tends to soften the falling trade balance, that arose as a result of the price contraction of the main export. The difference of level observed in the long run between the oil and mining cases is due to the fact that since the non-food commodities sector is larger in the oil case, the lower international price and lower profits induce a lower level of investments, which, in turn, entail a lower level of imports of capital goods. In addition, as we will see below, the level of activity tends to be lower in the oil case, which not only helps increase the current account/GDP ratio but also causes a lower level of imports, both of consumption and intermediate goods.

As a consequence of the dynamics of the flows of the foreign sector, we obtain the nominal exchange rate. This scenario helps us understand that in a context where the central bank does not intervene in the foreign exchange market, what determines the fluctuations of the exchange rate is the net inflow of foreign exchange, which can be both by means of the current account and the financial account of the balance of payments. Although in terms of sustainability of a given growth regime the way by which a country obtains foreign exchange is crucial, the exchange rate tends to depreciate in the short run as long as there is a net outflow of capital, regardless of its nature. For this reason, even though we find a surplus in the current account with regards to the baseline scenario in the oil and mining cases (which is the consequence of the falling level of activity, which we will explain below), the outflow of capital through the financial account due to the shrinkage of the flows of foreign direct investment (figure 4.8) cause a negative balance with regards to foreign exchange. In consequence, as figure 4.7 so shows, the exchange rate shows a depreciation in these two types of economies. However, in the agro-industrial and maquila cases, the flows of foreign direct investment are not altered (because the shock occurred over a sector which is not important for their productive structures) and the current account slightly deteriorates as the consequence of the increasing level of activity. Therefore, the nominal exchange rate shows a soft depreciation.

Figure 4.7 Impact of a fall in the price of "Q" on the exchange rate

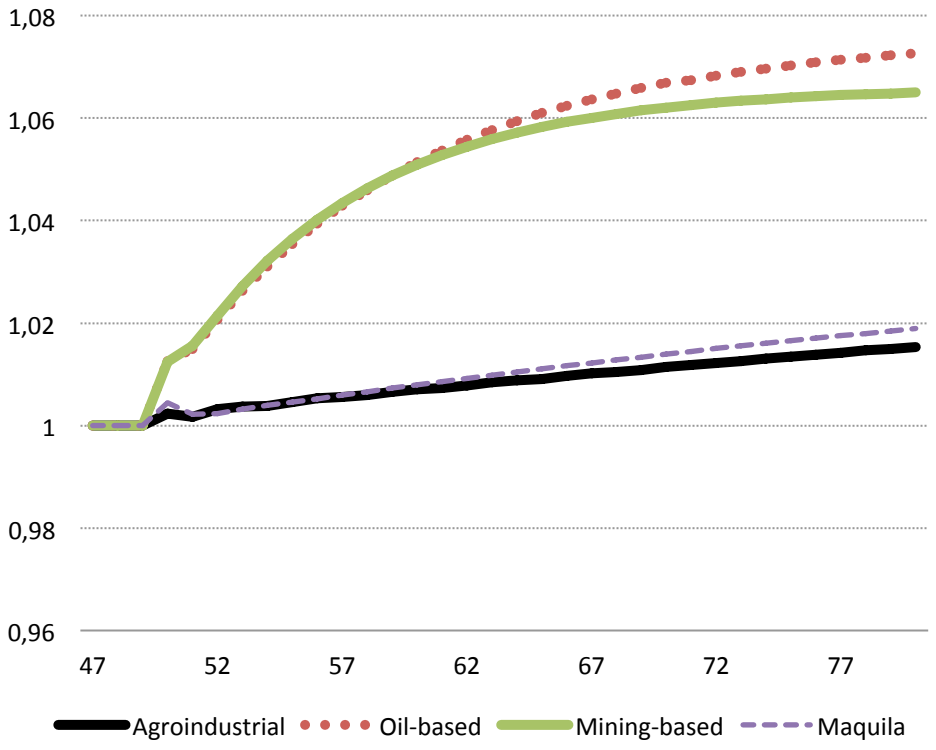
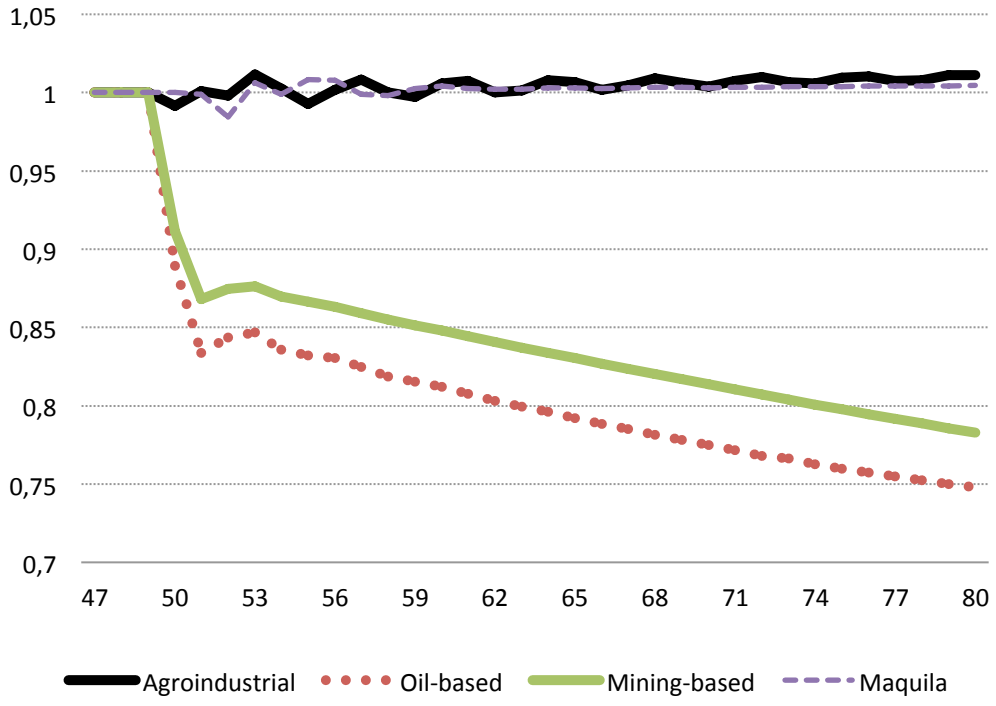


Figure 4.8 Impact of a fall in the price of "Q" on foreign direct investment



Once the trajectory of the exchange rate is explained, we can now move on to the description of price movements that the consumer faces. Just like it occurred in the previous scenario, the economies which were directly and adversely affected by the shock exhibit a larger depreciation of the exchange rate and, therefore, this is largely reflected in the local prices. The main difference between the oil and the mining case is that while oil is a basic input, the minerals are not. Therefore, whatever happens with the price of non-food commodities will have a greater effect on the rest of the prices in the oil economy. In figure 4.9, we can see that a general price increase is initially smaller in the oil case, since the effect of the initial shock prevails (the fall on the price of raw material we are dealing with). However, as the exchange rate depreciates, this ends up compensating the effect that the initial shock had on the internal prices. With regards to the agro-industrial and maquila cases, we find that after a decrease at the moment of the shock (due to the negative effect on costs), there is an uptrend, which is also explained by the trajectory of the exchange rate. The different levels between the agro-industrial and maquila cases are explained by the fact that in the latter, the consumption basket has a larger share of manufactured goods of imported origin, whose price does not fall as much as the price of those of national origin (once again, due to the negative effect on costs), which dominate the consumption basket in the agro-industrial case.

Figure 4.9 Impact of a fall in the price of "Q" on the local prices

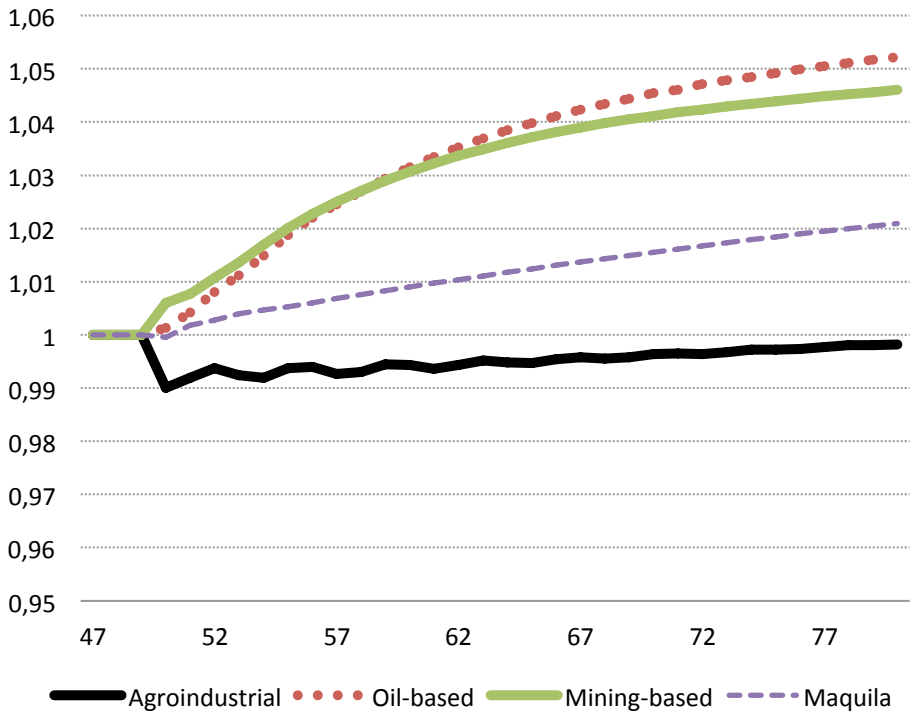
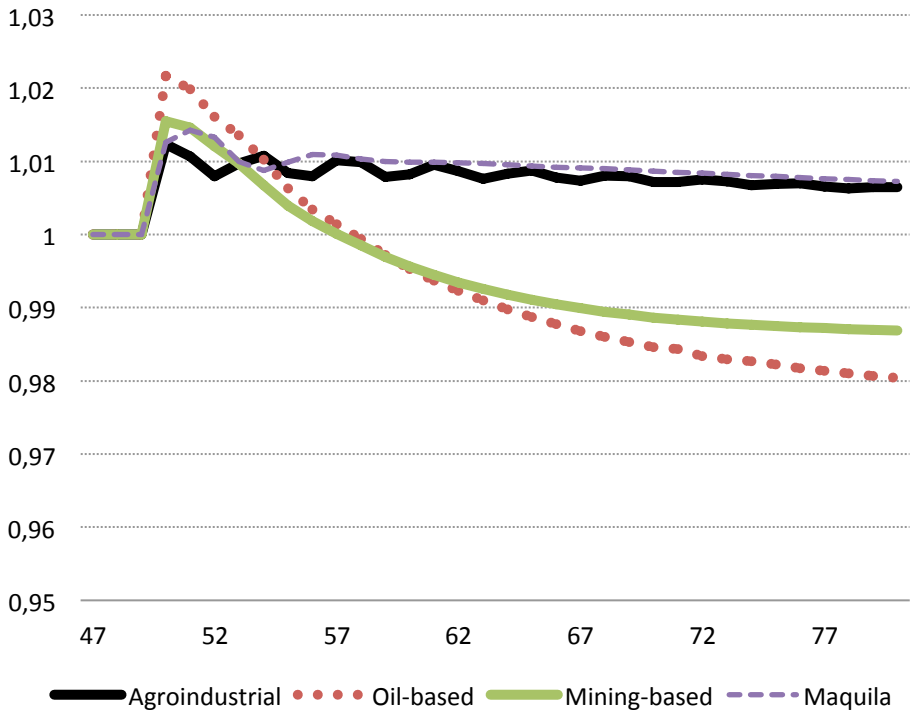


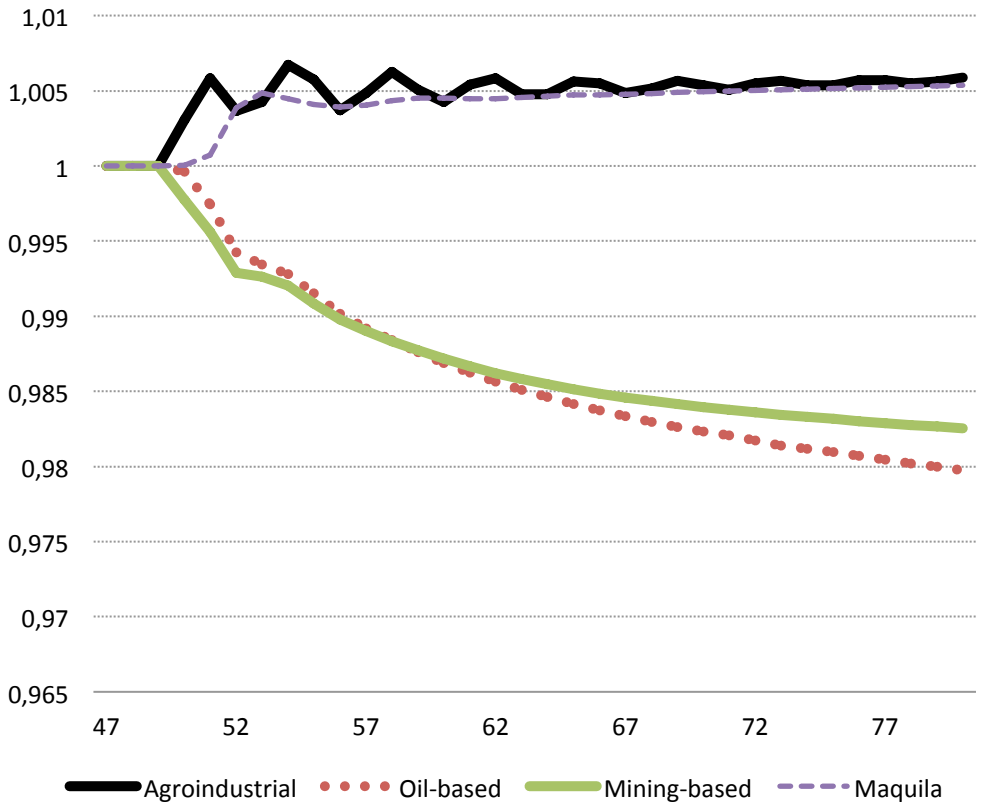
Figure 4.10 Impact of a fall in the price of "Q" on the functional distribution of income



With regards to the impact of the shock on the functional distribution of income (figure 4.10), the analysis is similar to the previous scenario. In the period when the shock occurs, falling prices (now measured by means of the GDP deflator, falling in every case) together with unit labour costs which practically remain the same (because nominal wages, labour and the output do not change) cause a decreasing mark-up, which equals an increasing share of the wage bill in the nominal income. As periods pass, the negative effects of the inflation over the distribution of income start to show, with varying intensity, depending on the case.

We now move on to the explanation of the output dynamics, which, as it is observed in figure 4.11, shows differences, depending on the case. In the first place, in the oil and mining cases, we find a falling level of activity by the moment the shock occurs as the consequence of shrinking flows of investment on the non-food commodities sector. During the subsequent periods, the workers' loss in the share of income entails a lower consumption level, which, in turn, reduces the aggregate demand. This dynamically affects investment through the utilisation rate of the installed capacity and the expectation of future profits. Therefore, the reduction in investments ends amplifying the contractive effect of the deterioration in the distribution of income. In the agro-industrial and maquila cases, however, the scenario is different due to other reasons. In the agro-industrial economy, where the pace of increasing prices is slower, we find that during several periods, these are below the baseline scenario, which increases real wages which, in turn, increase private consumption. As a consequence of this, unlike previous cases, investment is stimulated, thus increasing even more the level of activity. However, in the maquila case, consumption cannot be the engine of the aggregate demand because prices increase all the time (which entails that real wages decrease or increase very little). Nevertheless, since this economic structure depends largely on the exports of manufactured goods which, in turn, are sensitive to the evolution of the exchange rate, it is through this channel that the economy grows during the periods after the shock.

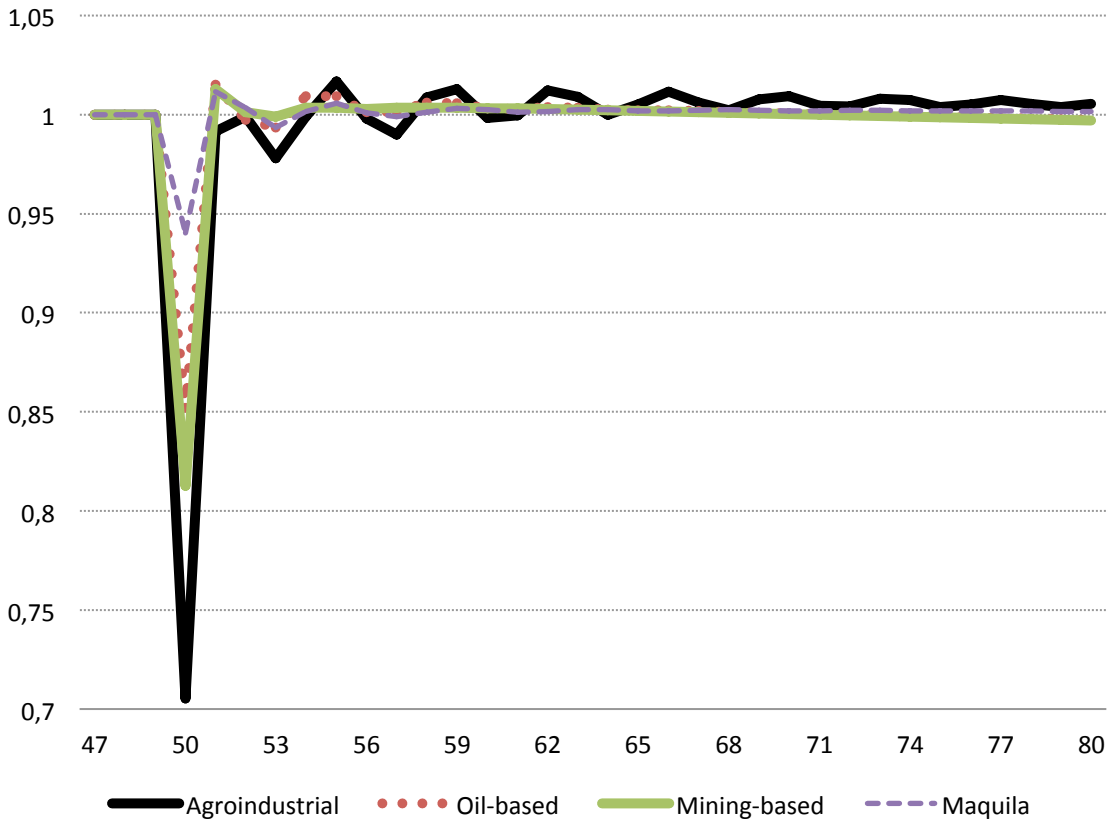
Figure 4.11 Impact of a fall in the price of "Q" on output



Increase in the international rate of interest

Another scenario we wish to analyse is where the liquidity conditions of the international markets of credit worsen, thus causing a capital outflow from the region and towards developed countries. This can be shown by means of an increasing international rate of interest, which, in the absence of a correction of the same amount in the local interest rate, would change the relative returns of the different financial goods. Consequently, the economic agents change the composition of their portfolios, thus increasing the share of assets with higher rates of return. The effect of this situation on the financial account of the balance of payments (figure 4.12) is strongly negative because not only do international investors withdraw part of their funds from the country, but also, local investors take part of their wealth out of the country.

Figure 4.12 Impact of a fall in the international interest rate on the financial account



As it can be seen in the graph, the impact of the shock on the financial account is negative in every case due to the shrinkage of the flows of portfolio investments. However, there are differences among the productive structures, with the agro-industrial case being the most adversely affected in the short run, and the maquila case being the less. This is due to the relative weight that the flows of portfolio investments have in the financial account of the balance of payments. What we find is that from an initial situation, where the share of each component of the financial account is the same in every case, as periods pass, the relative weight of portfolio investments tends to increase in countries with lower trade deficits. This is due to the fact that in economies where the trade deficit is larger, the growth rate of the economy tends to be smaller, thus also causing a smaller utilisation rate of the installed capacity. In turn, this tends to reduce the investment on the private local sector more than the investment on foreign firms, which follow the conditions of growth of the global economy. Therefore, depending on the results of the model, foreign firms tend to invest more than local firms in the countries which have a larger trade deficit, thus giving more weight to these types of flows in the financial account of the balance of payments.

Given the calibration we have chosen, the agro-industrial structure shows the smaller trade deficit, since the existence of an industrial network relatively diversified lets the local production largely supply the local market. The oil and mining cases tend to show a bigger trade deficits because there is no industrial network capable of fulfilling the needs of the population with the local production, which entails that a large part of the private consumption is covered with imports. The maquila case, however, shows the biggest trade deficit. This is due to the fact that the net exports of industrial goods are very low given the high reliance of such exports in imported input. Since this structure does not show a level of diversification capable of supplying the local market, just like in the oil and mining cases, a large part of the needs of the population has to be covered with imported goods. However, unlike those two cases, where there is a net exporting sector which helps to fund part of the imports of goods for consumption, in the maquila case, this sector need not be (in our simulations, we assume it does not exist).

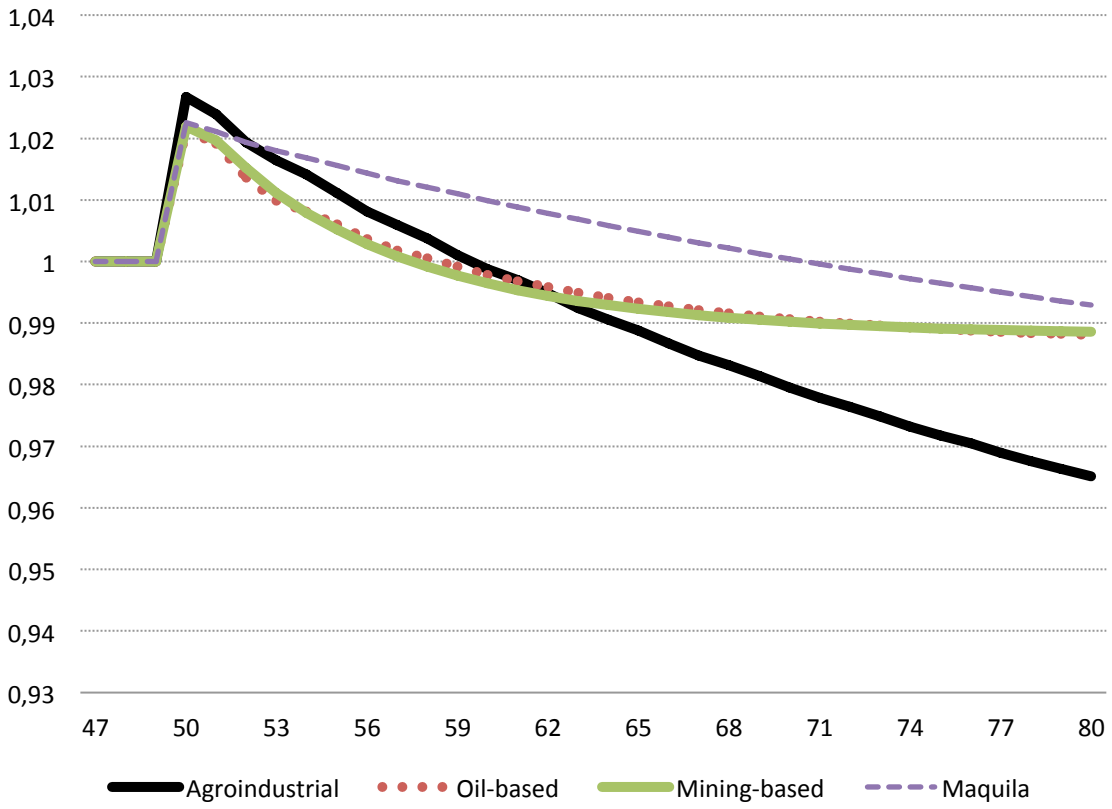
For the reasons stated in preceding paragraphs, the effect of the increasing international interest rate shows clearly in the financial account of the agro-industrial economy. Nevertheless, as it can be seen in figure 4.13, this does not entail a larger exposure in terms of the exchange rate, whose depreciation is similar in every case (the depreciation is reasonable taking into account that the shock induces a net outflow of foreign exchange). All in all, what sets the exchange rate is not the share of each component in the financial account of the balance of payments, but the net inflow of foreign exchange (which is negative at the moment the shock occurs).

In subsequent periods, we find that the financial account returns to the level of the baseline scenario and shows little fluctuations around such scenario. The reversion which occurs during the period following the shock is explained by the fact that once the investment portfolio is changed, there are no more effects on the flows of portfolio investments, which remain constant (though at a lower level). Therefore, the stock variation of portfolio investments (which is what is registered in the financial account) is zero, just like in the baseline scenario. What are actually modified during the periods following the shock are the flows of foreign direct investment. This is due to the fact that, as the consequence of the depreciation of foreign exchange, the profitability of the sectors producing tradable goods increase, which also increases the incentive to invest in the economy.

As far as foreign exchange is concerned, we find a tendency towards appreciation, as

periods pass. This tendency is produced by an effect which need not be actually found, and it is associated to the increasing returns of the portfolio investments of local investors. Given an initial stock of financial goods issued by the rest of the world, should the international interest rate increase, the interest payments received for those assets will also increase, thus improving the current account and, therefore, causing a positive effect over the net inflow of foreign exchange. In addition, should local investors increase the share of foreign assets in their portfolios, as a consequence of the shock, the profitability will tend to be better in time. However, for this to truly cause a positive effect on the net inflow of foreign exchange to the point of inducing an appreciation of the exchange rate, it is necessary that the local investors bring back the proceeds of their foreign assets (we assume this in our model), which may be arguable in practice.

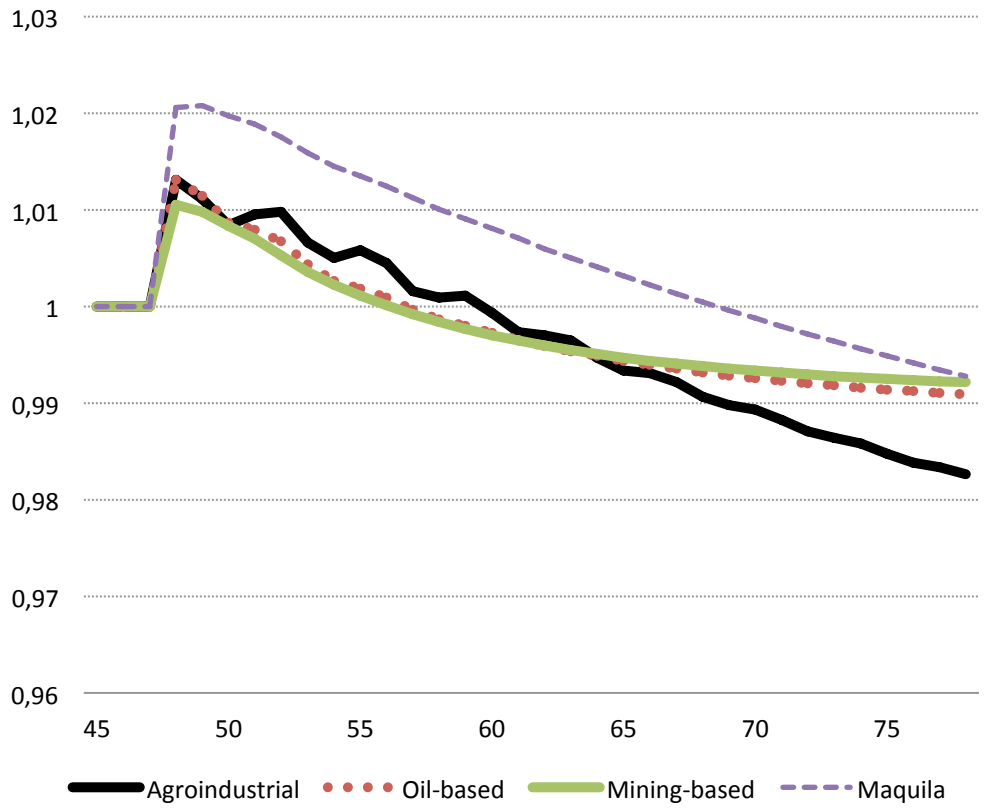
Figure 4.13 Impact of a fall in the international interest rate on the exchange rate



The analysis of the effect of the shock on local prices (figure 4.14) is similar to the analysis carried out in the two previous scenarios. Taking into account that part of the goods of the consumption basket are tradable goods, and that non-tradable goods show different

degrees of imported components (according to the productive structure), the dynamics of the foreign exchange rule the price movement. Thus, we find that when the shock occurs, prices increase and, as the depreciation starts to reverse, prices also follow a downward path. What is interesting is that in the maquila case, the transmission of the depreciation of the exchange rate to the prices seems to be larger, as the consequence of a larger imported part of the local production. In the same way that we noted in the paragraph above, the downtrend in prices in the long run has to be taken carefully since it depends on the local investors deciding to bring into the country the higher interest received for foreign assets. Should this not occur, the effect of the shock would be a higher permanent level both for the exchange rate and for the prices. In any case, what must be highlighted is that the countries of the region would face a higher inflation rate in this scenario (at least in the short run).

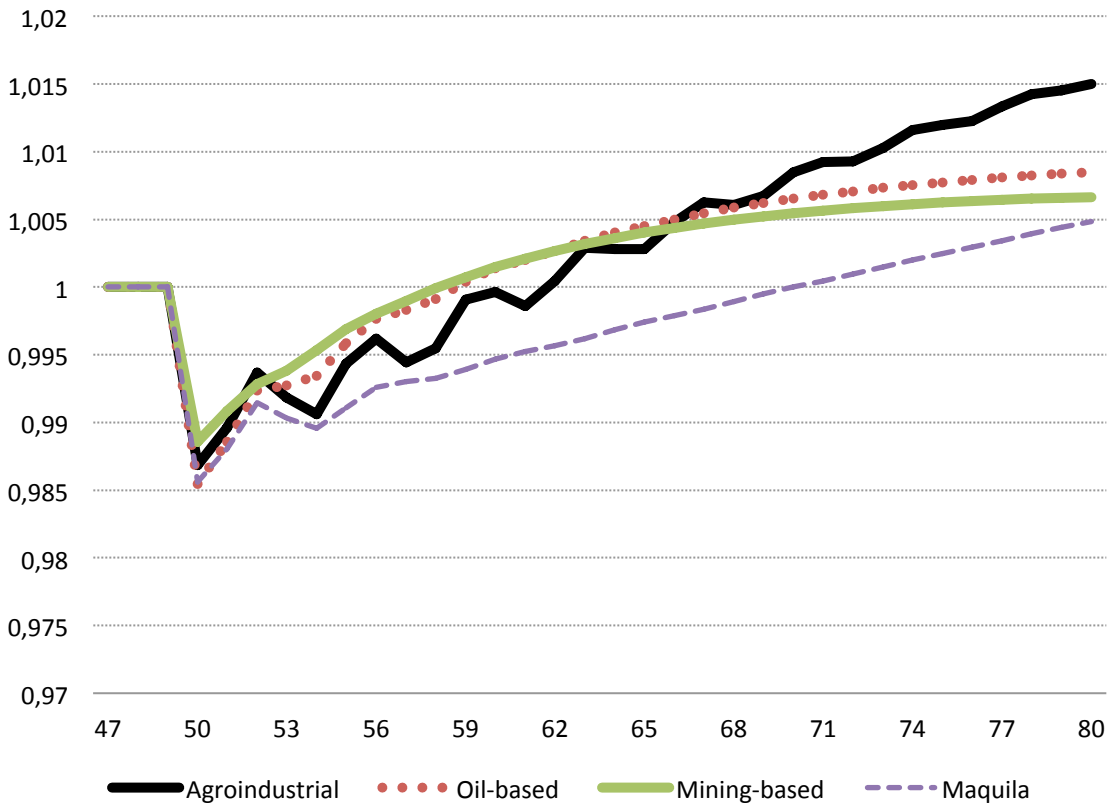
Figure 4.14. Impact of a fall in the international interest rate on prices



In figure 4.15, we can see the impact of the shock on the functional distribution of income, which, just like in previous scenarios, is heavily influenced by the price dynamics (now

measured by means of the GDP deflator). In this scenario, there is a price increase in every sector (unlike previous scenarios, where the sectors whose international price fell saw their local prices decrease), due to the increasing exchange rate. Insofar as this price increase is higher than the increase of unit labour costs, the general mark-up of the economy will increase, thus causing a falling share of the wage bill in the income of the economy. As we will see below, when the shock occurs, output exhibits a negative impact. However, as it is often seen, employment showed a smaller fall. The combination of these two factors generates a falling labour productivity which, in a context where salaries do not change (since, as we have previously defined, lag behind) generates increasing unit labour costs. Nevertheless, this increase is smaller than the price increase, thus causing a decreasing wage share in the income. Just like what happened regarding the exchange rate and the prices, the subsequent dynamics (in which a reversal of the initial deterioration of the functional distribution of income is registered) are subject to the premise that local investors actually repatriate the returns arising from foreign financial assets. Should this not be the case, the shock has a permanent negative effect on the functional distribution of income.

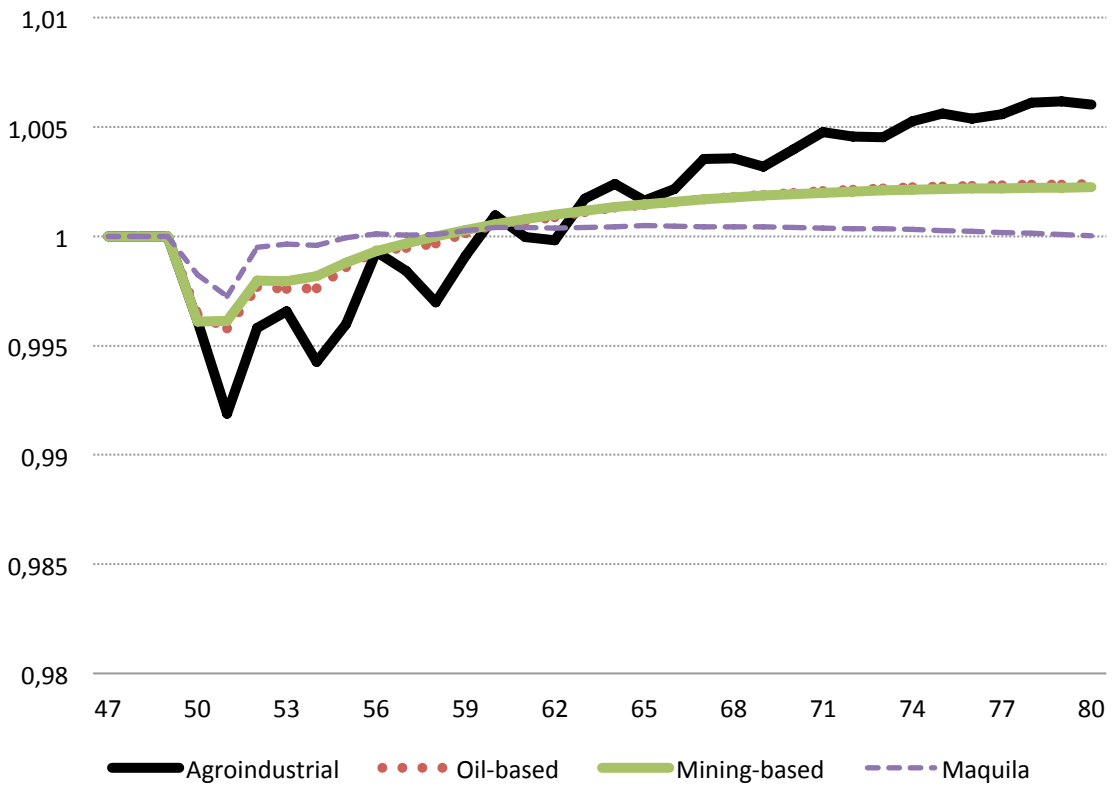
Figure 4.15 Impact of a fall in the international interest rate on income distribution



Finally, in figure 4.16 we can see the impact that the shock has on the output. What we see is that, once again, the level of activity shows a strong correlation with the distribution of income. Thus, during the periods immediately after the shock, the output falls, which is mainly explained by a shrinking consumption, due to both the deterioration in the real wages and to a falling share of the workers in the income. The size of the fall varies depending on the case, regarding the relative importance of the private consumption over the aggregate demand. Depending on the calibration we choose, the maquila structure is the most open and the agro-industrial is the most closed. Therefore, the former will be more sensitive to the shocks affecting the exports, and the latter will be more exposed to the disturbances affecting the private consumption, as it occurs in this case. During the following periods, the output is affected in an ambiguous manner, in the sense that it may increase or decrease. With regards to the investment, we find that as a consequence of the depreciation of the exchange rate, there is an increasing corporate profitability, which is an incentive to increase investments. However, this positive effect on the profits is

softened as periods pass by a falling demand, which impacts negatively on profitability. On the other hand, the depreciation of the exchange rate improves the industrial exports in the agro-industrial and maquila cases. Just like the analysis of the exchange rate and the prices, the fact that the output dynamics reverses some periods after the shock depends on the premise that local investors repatriate the returns arising from foreign financial goods. Should this not be the case, the shock would have a permanent negative impact on the activity level.

Figure 4.16 Impact of a fall in the international interest rate on output



These three simulation scenarios that we have analysed help us obtain a series of conclusions which can be useful to further contribute to what is called the macroeconomics for development (Ocampo, 2011). These models, which provide a comprehensive and consistent analytical framework, reproduce the stylised fact that the economies of the region are heavily exposed to exogenous shocks on which they cannot exert any control. The resilience degree that every country has for these types of shocks depends on the productive structure and the specific shock occurring. The main result, present in all the productive structures we have analysed, is that when the shock occurs

(whether it be by means of the falling international price of a central good in the exports basket, or by means of a strong capital outflow, caused by changes in the liquidity conditions in the international markets), the exchange rate tends to depreciate, which, in turn, produces an upward pressure on prices and jeopardises the objective that most of the countries of the region have, which is keeping the inflationary dynamics under control. In the absence of mechanisms which help the workers avoid these increasing prices to be translated into falling real wages, the final impact on growth will be negative, since the negative effect over consumption will tend to be larger than the expansionary effect that a higher exchange rate may have over the exports. Meanwhile, the investment is explained by two factors which play opposite roles in the shocks that we have analysed. On the one hand, the depreciation of the exchange rate tends to increase the profits that the firms have, thus causing a bigger expectation of future profits and, therefore, larger investments. But on the other, the deceleration caused by the falling consumption has lower levels of utilisation of the installed capacity, which tends to decrease the flow of investments by means of the accelerating effect.

The fact the countries of the region show a heavy exposure to shocks coming from the foreign sector does not imply that fate is written and that the external vulnerability is an inescapable fate. The governments have a series of policy tools to intervene in the causal chain, which goes from the initial shock to the macroeconomic aggregates over which the objectives are set. The temporary fluctuations of the international prices of raw materials should not have a direct repercussion that strong over the domestic economy if the government attempted to soften the drive coming from the foreign sector by means of using trade, tax or administrative policy tools. With regards to financial flows, the sudden changes in the international credit markets should not generate the instability we are used to seeing, should convincing methods be taken to regulate the financial account of the balance of payments. With regards to inflation, the acceleration of which is explained by the distribution conflict after an initial impulse, the establishment of institutional commitments aimed to hold the price dynamics could be more effective than the attempts to exert control by moderating the aggregated demand through the interest rate. The model developed in the preceding section is detailed enough to carry out this type of experiments, with the purpose of determining the best alternatives for the policy makers.

4.5 Conclusions

The motivation for this work consisted in building a baseline model combining the contributions from different schools of thought, each with its own standpoint and objective, but which taken together contribute to a better understanding of the economic dynamics of the Latin American economies. For that purpose, we started from the base provided by stock-flow consistent models and then incorporated the input-output matrix, which helps us describe the production process of each good precisely, and several contributions from the Latin American structuralist school, such as bottlenecks on the supply side, credit restrictions on investment, foreign currency indebtedness, the needs for imported input, etc. Once the base structure was finished, we proceeded to make the relevant changes in order to identify the four types of economic structures of the region: the agro-industrial, the mining, the oil and the maquiladora structures. From such taxonomy, each with an associated model, we proceeded to simulate three scenarios.

In the first case, we introduced falling prices of food commodities with the purpose of evaluating the impact of such scenario on output, over the distribution of income and over the external sustainability of each structure. What we find is that while the agro-industrial economy would be adversely affected by this type of shock, the other three cases would benefit from it. The transfer of this shock is produced through the exchange rate, which depreciates as the consequence of a lower net income of foreign exchange derived from the lower flow of exports in the agro-industrial case. Even though the impact of the shock on the price level is negative at the beginning, as the foreign exchange depreciates, prices start to increase, which negatively impacts on real wages and consumption. The opposite occurs in the other three cases, where the falling prices of food products not only has a positive immediate effect over real wages and consumption, but also causes an exchange appreciation (as the consequence of lower need for foreign exchange to import certain amount of food products) which helps reduce the price level in the long run. As far as the distribution of income is concerned, while in the agro-industrial case the depreciation of the foreign exchange increases the mark-up in the sectors producing tradable goods (which means a falling share of the wage bill in the income), in the other three cases, we find that the falling prices of food products help improve the distribution in favour of the workers.

The situation reverses when the international prices of non-food raw materials fall. In this case, the oil and mining structures register the larger deficits of the current account (mainly explained by the trade balance) and, as the consequence of that, have the larger depreciations of foreign exchange. This, in turn, entails a larger transmission to prices, which causes an inflationary effect which decreases the consumption and the activity

level. However, in the agro-industrial and maquila cases, net importers whose price falls, a positive effect is registered both on the current account and on real wages, on growth and the distribution of income. These differences reproduce the stylised fact that towards the inner region, there is a great productive heterogeneity which affect the countries in different ways depending on the nature of the shock, but with the common feature that an insufficient productive diversification and the absence of mechanisms which help soften the effect of such shocks, turn these countries excessively vulnerable to processes whose determination transcends them.

Finally, when the negative shock occurs over the global levels of liquidity, the effect is harmful to every country, regardless of its productive structure. The net outflow of foreign exchange, which may cause a sudden increase of the international interest rate, would cause a foreign exchange depreciation which will be translated as a greater inflation, a distribution of income less favourable for workers and lower activity levels. This would occur as the consequence of the negative effect on real wages and consumption being greater than the expansionary effect of the exchange rate (now higher) on exports, as long as there were goods to export and these are sensitive enough to prices. To avoid the negative effect that this financial shock may have over real variables of the economy, the governments should consider different ways of regulating the financial account of the balance of payments to levels that can provide the country higher levels of resilience, leaving capital movements absent.

It is clear that every simulation scenario may be target of criticism, mainly due to the fact that every type of economy was calibrated with the purpose of pinpointing the differences in every case (for example, the production coefficients associated to the primary good in the oil and mining cases), and not making any case resemble any of the economies of the region with that particular structure (for instance, it cannot be said that the mining case represents Chile). For this to be possible, we would have to adapt the calibration of the model to make every specific aspect of the country (such as the composition of the aggregate demand, the degree of development of the financial markets, and the degree of dollarization) resemble the reality. Then, this would be a different task (although perfectly possible). All in all, we consider that starting from this base, there is a long road ahead of us, should we want to achieve analytical representations which help us analyse the nature of the problems and their possible solutions in order to contribute to the development of the region.

5. Conclusions

In this thesis I presented a series of theoretical studies sharing a common methodology: the use of stock-flow consistent models. Based on the failure of the *state of the art* analytical tool of the mainstream, the so-called DSGE models, we attempted to show what are the main drawbacks of these models, which include both methodological problems and the omission of some aspects of reality that are crucial (e.g., the role of money and financial markets). In the first chapter of this thesis I showed why stock-flow consistent models offer a more accurate vehicle to the understanding of modern economies. These reasons, which are connected to a higher concern with *realisticness*, accounting accuracy and the interaction between the different economic agents and social institutions, explain why stock-flow consistent models have been successful in detecting the instabilities that were accumulating in the years before the outbreak of the global financial crisis.

Having explained the motivation for studying macroeconomic dynamics through stock-flow consistent models I have presented three chapters in which these models are adapted to the study of some specific problems of the real world, which have been and still are relevant and have a privileged place in the political agenda. The study of the different alternatives for the reform of the international monetary system analysed in the second chapter will remain an important issue as long as global imbalances persist and debtor countries are forced to pursue contractionary policies in order to balance their external positions. The examination of alternative monetary regimes within the Eurozone that is undertaken in the third chapter is an issue of paramount importance since the crisis that started in 2010, whose spread and deepening is explained by the flawed system underlying the monetary union, is still there with no end in sight. For its part, the analysis of the reaction of the different Latin American economies to some of the exogenous shocks that are expected to occur in the short term, which will depend on the underlying productive structure, is also an issue that worries the policy makers of the region.

It is expected that this thesis, whose chapters will be published separately in different journals, contributes to the diffusion of stock-flow consistent models as a useful tool both for academic and policy-making issues. There are in principle three features that should help in the promotion of these models as a superior alternative to DSGE models. First, their much more realistic description of reality (based on the higher *realisticness* of the assumptions, the adoption of a holistic approach and the concern with accounting accuracy). Second, their success at explaining and predicting recent economic events, to a

larger extent than DSGE models (which actually did not predict any of the most serious recent events and were also unable to provide reasonable explanations for what was going on). Third, their flexibility to being adapted to the study of different and diverse economic problems. If more researchers start undertaking their studies using stock-flow consistent models or, at least, appealing to their underlying logic, macroeconomics will surely become a more reliable discipline and, therefore, it could be able to make a contribution to the wellbeing of the society. This is an outstanding debt - at least since the end of the Keynesian era in the late 1970s, macroeconomic policies have brought more harm than relief to the people who are supposed to benefit from them.

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