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PRICE FORMATION, INCOME DISTRIBUTION, AND THE BUSINESS CYCLE IN A STOCK-FLOW CONSISTENT MONETARY MODEL

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﴿إنما يخشى اللهَ من عباده العلماءُ﴾

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CONTENTS

Chapter 1

INTRODUCTION

A stock-flow consistent model is a macrodynamic model based on national income and product accounts and flow of funds accounts. Godley and Lavoie (2007) introduce a promising approach to modeling and analyzing national income and product accounts and flow of funds accounts, emphasizing the dynamic interaction between price formation and functional income distribution. Godley and Lavoie's models are set up in such a way as to facilitate the construction of behavioral macro models in the tradition of Keynes (1936) and Kalecki (1971). Such model building results in aggregate dynamics that can be described as business cycles, that is, the models replicate observed empirical regularities.

The extended stock-flow accounting scheme underpinning any aggregate dynamics simulated in this thesis will summarize the transactions taking place within a realistic and modern financial sector that contains securities and financial facilities. This thesis will also provide some insight into the dynamics of aggregate behavior by means of numerical simulations, suggesting interesting closures grounded in Godley and Lavoie (2007).

Godley and Lavoie divide the economy into five sectors: firms, households, government, the central bank, and private banks[1]. These sectors are designed in such a way that the income inflows to one sector are outflows from other sectors. The same is true for financial transactions. These flows, when they accumulate over time, as they must in a dynamic context, become stocks; thus, the models are stock flow consistent.

Price formation, income distribution, and business cycles play an important role in Keynes-Kalecki type monetary economic modeling, via the treatment of inventories and interest costs. Price formation depends mainly upon factor shares—or functional income distribution—and the real interest rate. Combining alternative possibilities of interaction among these variables results in a behavioral macroeconomic model that can be analyzed computationally, even when strict analytical techniques may fail[2].

The aim of this thesis is to use the stock flow consistent approach to study and analyze some phenomena that could be involved in, or affected by, the recent global financial crisis. This thesis makes several contributions. Firstly, I am going to study how house price variations affect both the real and the financial sides of the economy. The recent financial crisis is leading the economics profession to re-evaluate the role of financial integration and globalization in the spread of the crisis. In my thesis, I am going to study financial integration and see its effects on the integrated economies. Finally, I am going to explore the impact of credit crunch and its contagion on both

[1] Most of Godley and Lavoie's models are simulated for a closed economy, and some for open economies.
[2] Of course, strictly speaking, any system of linear equations is solvable, however, in the case of very large sets of simultaneous equations, choices of initial conditions, as well as solution algorithms (for example, Gauss-Seidel) become important to reach any numerical solution, as we shall see in the pages of this thesis.

domestic and foreign economies, which is clearly relevant to the current international economy in the aftermath of the crisis.

1.1 THESIS OVERVIEW

1.1.1 PART ONE (CHAPTER THREE)

This part of my thesis deals with the impact of house price variations on the economy. In this model I am simulating a one-time increase in the expected house prices using a stock flow consistent monetary model grounded in Godley and Lavoie and building on the work of Zezza (2007) and (2008). The importance of modeling house prices is to show the short and long term impacts on the whole economy. The recent US house price bubble is considered one of the main reasons behind the recent financial crisis. Modeling these phenomena is necessary for developing proper fiscal and monetary policies to prevent crises from happening in the future.

The model describes a closed economy with five sectors: households, firms (non-financial sector), government, central bank, and private banks. Each sector is assumed to acquire assets (+) and have liabilities (-).

The model is simulated for 51 periods for each scenario. The first scenario assumes a one-time increase in the expected house prices. This assumption leads the economy to fluctuate at the beginning before it return to its previous level. The second scenario assumes that the government increases its expenditure to stimulate the economy as a fiscal policy tool in its hands. The third scenario assumes a decline in the advances interest rate as a monetary policy taken by the central bank in order to stimulate the economy.

These scenarios are implemented to explore the effect of house prices variations on the different facets of the economy: production, investment, consumption, distribution of income and wealth. The goal is to investigate the effects of fiscal and monetary policies on the economy, to understand how these policies can stimulate production.

The results of these simulations show that the increase in house prices leads to an increase in the main economic indicators such as output, consumption, disposable income in the short-run, but later leads to a decline in these indicators. The proposed fiscal and monetary policies may play an important role in stimulating the economy.

1.1.2 PART TWO (CHAPTER FOUR)

The second part of my thesis aims to simulate the effects of increased financial integration on the levels of production, consumption, and output using a stock flow consistent monetary model for two economies. The study of financial integration is timely, as the current global financial crisis is leading economists to a re-evaluation of the role from international financial integration (Reinhart *et al* 2003, Baele *et al* 2004 Pang 2008)[3].

The model describes the interaction of two economies, with five sectors in each economy: households, firms (a non-financial sector), government, central bank, and private banks. Each sector is assumed to acquire assets (+) and have liabilities (-).

[3] A draft of this chapter was presented at the Eastern Economic Association meeting in Philadelphia in February 2010. Helpful comments from Profs. Duncan Foley and Marc Lavoie are greatly appreciated.

Three scenarios are simulated to tease out the effects of a specific set of fiscal and monetary policies in enhancing financial integration between the two countries. The model assumes one country is small in terms of its gross national product, and the other is large in terms of its gross national product. Using simulations we explore the effects of differing policy regimes on the degree of financial integration in both countries.

There are several ways of measuring financial integration directly or indirectly. Some are based on checking the number of existing frictions and barriers to the intermediation process, so the more symmetric frictions and barriers the more the degree of financial integration. Others concentrate on the prices of assets in each economy. Still others concentrate on price dispersion in representative sectors of the integrating economies.

The main finding of chapter four is that monetary union has effects on the real and financial sides of the economy and on households' portfolio distributions, where households redistribute their portfolios towards the more profitable assets. The convergence of asset prices and returns leads to a convergence on the households demand for foreign assets.

1.1.3 PART THREE (CHAPTER FIVE)

The third part of my thesis describes credit crises, their contagion effects, and analyzes those effects on income distribution and the business cycle, again using a stock flow consistent monetary model. A credit crunch is assumed to spread within the banking system in the country. The crisis also spreads to other countries' banks that have connections with the infected banks[4].

The model describes two open economies with five sectors in each economy: households, firms (non-financial sector), government, a central bank, and private banks. Each sector, as before, is assumed to acquire assets (+) and have liabilities (-). The crucial assumption of this model is that the private banking sector in both economies is composed of two representative banks. The reason behind this assumption is to see credit crunch contagion from one bank to other domestic and to foreign banks. We assume banks in this model are connected to one another through interbank loans.

A credit crunch happens because of a decline in the supply of loans to other sectors in the economy, as well as in the supply of interbank loans. Demand for loans is assumed infinitely elastic.

Two scenarios are simulated. The first scenario assumes a onetime increase in the households' non-performing loans. The second assumes an increase in the households' non-performing loans for 5 periods. The results of this chapter show how a credit crunch can spread between connected banks locally, and globally. Credit crunches have a negative effect on output, consumption, investment, income in both countries and this effect continues as long as defaults in loans continue.

[4] Several strands in the literature describe this channel: for example Ben Bernanke et al (1991), Furman and Stiglitz (1998), and Gai and Kapadia (2010).

1.2 THESIS PROBLEM

The aim of this dissertation is to investigate how economic shocks and policies affect the transaction flows between economic sectors and the level of stocks in each sector that, in turn, underpin an aggregate macrodynamic model. Specifically, in this thesis I am going to answer the following questions:

- How are models' matrices—balance sheets and transactions flows—going to be constructed?
- What are the theoretical foundations of the behavioral equations in the model?
- What closure assumptions need to be followed?
- What are the effects of some economic shocks and/or policies on the economy given specific scenarios
- What is the role of policy analysis in such model?

1.3 THESIS DESIGN

This thesis is going to follow the stock flow consistent approach in macro modeling. This approach depends upon the national income and product accounts and flow of funds accounts supplemented by the balance sheets for all economic sectors.

The Godley and Lavoie approach describes the interactions between all economic sectors based on a discrete-time macro modeling of the transaction flow and balance sheets matrices (see Taylor 2008). As mentioned above, the novelty of this thesis is to make an extension of Godley and Lavoie models to study the impacts of a certain economic or financial shock on the economy to understand how fiscal or monetary policies can be used to overcome such shocks and correctly manage the economy.

Each model in this thesis is built in three stages: construction of model matrices, setting-up of model equations and identities, and finally, running simulation experiments (termed scenarios in this thesis).

In the first stage, I will construct the balance sheet of all economic sectors: for example, table 1.1 is a simple balance sheet for economic sectors in a closed economy. Table 1.1 describes the assets (with plus sign) and liabilities (with negative sign) of all economic sectors in a closed economy. The subscripts *h*, *f*, *b*, *g*, and *cb* mean households, firms, banks, government, and the central bank respectively. Each row shows that the assets of a sector are liabilities of other sectors. All rows and columns in the balance sheet sum to zero except for tangible capital—the actual stock of machines and inventories accumulated by firms and the dwellings of households—which is an asset that does not have a liability. The column sum of each sector gives its net worth; thus, adding net worth with a negative sign to the other components must yield a zero result. The matrix shows that the net worth of the whole economy is equal to the value of tangible capital assets.

After completing the balance sheets, I construct the transaction flow matrix, which describes the flow of funds and the interaction between all economic sectors. Transaction flow matrix shows the sources and uses of funds between all economic sectors, i.e., we can see from this matrix how a transaction can be a supply of funds for sectors and a use of funds for other sectors.

Table 1.1: *Simple Balance Sheet for a Closed Economy*

	Households	**Production Firms**	**Banks**	**Government**	**Central Bank**	**Σ**
Tangible Capital	$+K_h$	$+K_f$				$+K$
Bills	$+B_h$		$+B_b$	$-B$	$+ B_{cb}$	0
Cash	$+H_h$		$+H_b$		$-H$	0
Deposits	$+M_h$		$-M$			0
Loans	$-L_h$	$-L_f$	$+L$			0
Equities	$+E_h$	$-E_f$	$-E_b$			0
Net Worth	$-NW_h$	$-NW_f$	$-NW_b$	$-NW_g$	0	$-K$
Σ	0	0	0	0	0	0

Source: W. Godley and M. Lavoie (2007: 32)

Table 1.2 shows a simple transaction flow matrix for a closed economy. As in the balance sheet, the rows and columns of the transaction flow matrix must sum to zero. The value with a plus sign means that it is a source of funds, and the value with a negative sign means that it is a use of funds. The zero-sum rule for each column represents the budget constraint of that sector, and the zero-sum rule for each row means that everything that comes from somewhere must go somewhere.

Table 1.2: *Transaction Flow Matrix for a Closed Economy*

		Households	Firms		Gov.	Central Banks		Banks		Σ
			Current	Capital		Current	Capital	Current	Capital	
Consumption		$-C$	$+C$							0
Investment		$-I_h$	$+I$	$-I_f$						
Gov. Expenditure			$+G$		$-G$					0
Wages		$+WB$	$-WB$							0
Profits, firms		$+FD_f$	$-F_f$	$+FU_f$						0
Profits, banks		$+FD_b$						$-F_b$	$+FU_b$	0
Profits, central bank					$+F_{cb}$	$-F_{cb}$				0
Interest on	Loans	$-r_{l-1}.L_{h-1}$	$-r_{l-1}.L_{f-1}$					$+r_{l-1}.L_{-1}$		0
	Deposits	$+r_{m-1}.M_{h-1}$						$-r_{m-1}.M_{-1}$		0
	Bills	$+r_{b-1}.B_{h-1}$			$-r_{b-1}.B_{-1}$	$+r_{b-1}.B_{cb-1}$		$+r_{b-1}.B_{b-1}$		0
Taxes - transfers		$-T_h$	$-T_f$		$+T$			$-T_b$		0
Change in the stocks of	Loans	$+\Delta L_h$		$+\Delta L_f$					$-\Delta L$	0
	Cash	$-\Delta H_h$		$-\Delta H_f$			$+\Delta H$		$-\Delta H_b$	0
	Deposits	$-\Delta M_h$							$+\Delta M$	0
	Bills	$-\Delta B_h$			$+\Delta B$		$-\Delta B_{cb}$		$-\Delta B_b$	0
	Equities	$-(\Delta e_f.P_{ef} + \Delta e_b.P_{eb})$		$+\Delta e_f.P_{ef}$					$+\Delta e_b.P_{eb}$	0
Σ		0	0	0	0	0	0	0	0	0

In the second stage, I will set up the equations and identities that describe the economic sectors. Table 1.3 shows the structure of the system of equations for all economic sectors. The equations summarize the decision behavior, satisfy the balance sheet constraints, and satisfy the steady state conditions.

Table 1.3: *The Structure of the System of Equations for a Closed Economy*

Firms	Equations describing output and investment decisions
	Equations describing costing decisions
	Equations describing pricing decisions
	Equations describing portfolio decisions
	Equations describing financial implications
Households	Equations describing income and consumption decisions
	Equations describing personal loans decisions
	Equations describing portfolio decisions
Public sector	Equations describing the government decisions
	Equations describing the central bank decisions
Banks	Equations describing their duties
	Equations describing the determination of interest rates
	Equations describing the balance sheet constraints

Once the system of equations is complete, I will determine the closure of the model, which includes the steady state conditions, policy variables, and constraints that determine the long-run behavior of the model. Choosing the initial conditions depends on some plausible stock to flow ratios and parameters. These values must insure the model convergence, consistency, and to be in line with the status quo. Such models are not concerned about the exact values of the main variables of the model. The aim of these models is analyze the evolution of the economy and how it behaves after a certain shock. Values can be hypothetical and not need to be real but must satisfy the above conditions.

Due to the high number of equations and identities in this model, calibrating the model will be not an easy task. It can be simulated using a software package. In this model E-views program is used for simulations.

Different closure assumptions give different results. There are a variety of closure assumptions in the literature such as Davidson (1972, 1994), Godley (1996, 1997, 1999A), Minsky (1975, 1982, 1986), Tobin (1980, 1982a).

Closure assumptions as in Godley and Lavoie treat variables as endogenous or exogenous, that is, they make some variables be fixed and allow for others to float, for example in most Godley and Lavoie models they treat real government expenditure and the interest rate on treasury bills as exogenous variables, so they can use the first as a fiscal policy lever and the second as a monetary policy lever. Tobin (1980) assumes that growth rates of some real variables to be exogenous like government expenditure growth rate, population growth rate, fixed capital growth rate.

Taylor (2008) proposes a different closure to those in Godley and Lavoie. Instead of fixing the values of the interest rate on government treasury bills and a fixed exchange rate, Taylor fixes the values of treasury bills acquired by the central banks and the values of reserves, so the banking authorities determine the money supply in both countries. Macroeconomic accounting identities and figuring out how variables influence one another are the main determinants of stating which variables are endogenous or exogenous in a system of equations (Taylor, 1991: 41).

This thesis will solve each model computationally using the software package E-Views[5]. Given the values for parameters and exogenous variables, which contain the policy variables in addition to the initial values of stocks and endogenous variables, solving the system will provide us with the baseline scenario.

In the third stage, I will run simulation experiments. In each scenario, there will be an exploration of what will happen and how the whole economy will behave in the short- and long-runs starting from a given initial condition. These scenarios are based on one or more of the following: changes in one or more of the policy variables, changes in one or more of the values of the parameters, changes in or more of the initial values, or changes in the behavior of the domestic or foreign agents or institutions.

Results of the baseline and alternative scenarios depend upon the specifications of the behavioral equations, values of the parameters, values of the exogenous variables, and the initial values of the stocks and endogenous variables. Any change in the above will change the steady state values and the pattern of the economic behavior for macro model that describe a growing economy *which does not spontaneously find a steady state even in the long-run*.

The data and the values of parameters, endogenous variables, and initial stocks and endogenous variables used in the model can be real data or *hypothetical values*. Choosing these values depends on some plausible stock to flows ratios such as capital

[5] To be consistent with the method used by Godley and Lavoie.

to output ratio and parameters such as the marginal propensities to consume out of disposable income and wealth and tax rates. These values must ensure the model convergences, retains its consistency, and be broadly in line with the status quo. As we are not concerned about the exact values of the main variables of the model after running the simulation, we don't need real-world values.

1.4 STRUCTURE OF THE THESIS

The material in this thesis is presented in six chapters including the introductory chapter.

Chapter 2 provides an overview of the relevant literature regarding the stock-flow consistent approach.

Chapter 3 is the first application of a stock flow consistent monetary model. In this chapter I introduce the phenomenon of the increase in the expected house prices and its effects on income distribution and the business cycle for a closed economy with an endogenous money supply. At the beginning I give a brief explanation to the problem of house price bubble happened in the US and how the economy was affected, mainly real output and consumption.

Section two of this chapter gives a description for the model to be simulated to explore the effects of increase in house price expectations on the economy. This section is divided into three subsections. In the first subsection, I construct the model matrices, balance sheets matrix and transactions flows matrix. In the second subsection, I set up model equations and identities. The last subsection provides the model scenarios, in which I run some simulation experiments to see the effect of a certain shock or policy on the economy.

The third section concludes. All model details like equations, variable codes, and parameters values are included in appendices at the end of the chapter.

Chapters 4 and 5 are the second and third application of the stock flow consistent monetary models. Chapter 4 is concerns financial integration and chapter 5 is about credit crunch and contagion. The contents of these chapters follow the same structure as in chapter 3.

Chapter *6* concludes the thesis.

Chapter 2

STOCK-FLOW CONSISTENT APPROACH

Monetary economics is concerned with the effects of monetary institutions and economic policies on economic variables such as income, wealth output, employment, and inflation (McCallum, 1996).

Godley and Lavoie claim that since the death of Keynes, two paradigms have existed each with its own interpretation of Keynes's work: the mainstream or neoclassical paradigm and the post-Keynesian or the "Structuralist" paradigm (Godley and Lavoie, 2007: 1).

The main difference between these two paradigms is that the mainstream is based on agents as the main players in the economy who, through their rational behavior, markets clear, and hence there is no systematic need and place for the interaction of institutions and specifically for loans, money, and banks.

Post-Keynesians—of almost every variety—believe that there is an important role for institutions and distributional relationships in determining the macro behavior of the economy (Taylor, 2004b), and thus there is an essential need for loans, money and banks.

One of the shortcomings of the neoclassical paradigm, as pointed by Hahn (1982b: 1), is that '*The most serious challenge that the existence of money poses to the theorist is this: the best developed model of the economy cannot find room for it*'. Rogers (1989) says that Hahn in the above quotation refers to Arrow-Debreu model. But Rogers think that the difficulty extends beyond the Arrow-Debreu model to all other neo-Walrasian models, which cannot find a role for money. Rogers' argument is persuasive, and certainly offers evidence that there is a need to include more realistic descriptions of money within large scale macroeconomic models.

Neoclassical monetary theories are generally based on the neutrality of money i.e. money doesn't matter, which means that the nominal stock of money have little or no independent causal role to play in the economy and have no close relation with other economic variables. Specifically is that an exogenous change in the nominal stock of money has temporary effect (if any) on real variables and the long-run effect will be a proportional rescaling of nominal variables (Rogers, 1989).

Post-Keynesian monetary theory deals with monetized production, so there will not be a separate analysis of money without the analysis of the overall action of the system, following Eichner and Kregel's, (1975). The general post-Keynesian view is that money matters, i.e. the variation in the nominal money stock has an important role in causing fluctuations in income, output, and employment in the short-run and in governing the inflation rate in the medium and long run in the sense of Milton Friedman (1968), and finally, a change in the nominal money stock has a persistent effects on the economy's real variables (Cottrell, 1992).

Another shortcoming of the neoclassical monetary theory is the assumption that the stock of nominal money is determined exogenously as one can see in most macroeconomic textbooks. According to Post-Keynesians[6], the stock of nominal money is determined endogenously, and central banks do not have control over the stock of nominal money.

Post-Keynesians assume that changes in the money stock are driven by the private sector, i.e. commercial banks are obliged to satisfy the demand for loans by the private sector. To satisfy this obligation commercial banks have to attract more deposits from the private sector, and thus private reserves must increase to meet the reserves required by the central bank. Moore (1988) and also Kaldor (1964, 1970a, and 1982) claim that in a credit money system the supply of money is always and necessarily equal to the demand for money *'supply is not only endogenously demand driven, but actually has no existence independent of demand'* (Cottrell, 1992: 19).

The assumption of endogeneity of the money stock requires the interest rate to be exogenous (decision of the central bank). This is true in the case of the central bank's discount rate, but leaves other rates of interest to be determined. While in the neoclassical monetary theory, the interest rate plays the key role to equilibrate the supply and the demand for money stock (Rogers 1989).

Fiscal and monetary policies affect real economic activities, and macroeconomists build systems of simultaneous equations or a framework that describes the whole economy and explore the effects of fiscal and monetary policies on the economy. Tobin (1982a), in his Nobel lecture, observes that these frameworks depend upon exogenous parameters including the parameters that reflect these

[6]See Godley (1999); Godley and Lavoie (2007); Kaldor and Trevithick (1981); Moore (1988). See also Kaldor (1964, 1970a, 1982), Moore (1979, 1983), Rousseas (1986), Arestis and Eichner (1988), and Wray (1990).

policies such as government expenditure or tax rates a fiscal policies and interest rates or reserve requirements as a monetary policies.

National income and product accounts and the flow of funds accounts provide the basis for these frameworks. There are three areas of data organization and analysis (Patterson and Stephenson, 1988): the balance sheet, the flow of funds and income flows. Any change in the balance sheet is reflected in income and in the allocation of the flow of funds; these accounts describe the stocks and flows in the economy. The stock flow consistent approach is a natural outcome of the Keynesian macro model in the 1960s and 1970s (Dos Santos, 2006).

Let us first define the stock-flow consistency. Siegel (1979) defines stock-flow consistency as follows: consider two variables $x(t)$ and $y(t)$, then these two variables are stock-flow consistent if,

$y(t) = dx(t)/dt$ in the continuous time, and

$y(t) = \Delta x(t)$ in the discrete time.

To put this definition in an economic context, if $x(t)$ is the real value of wealth, and then $y(t)$ is savings—the change in the real value of wealth over time—then real savings is the difference between income flows including the revaluation of the existing net wealth and the consumption of non-durables and services (Patterson and Stephenson, 1988).

The stock flow consistent approach is most closely associated with the names of James Tobin and Wynne Godley. James Tobin introduces in his Nobel Prize lecture (1982) an alternative framework to the Keynes-Hicks model. Tobin (1982a) argued:

> *"Hicks's "IS-LM" version of Keynesian and classical theories has been espatially influential, reaching not just proffisional economists but, as the standarad macro model of textbooks, also generation of college students. It's simple aparatus is the trained intuition of many of us when we confront questions of policy and analysis, whatever more elaborate method we may employ in further study. But the framework has a number of defects that have limited its usefulness and subjected it to attack. In this lecture I wish to describe an alternative framework, which tries to repair some of those defects."*

Tobin's alternative framework is what we call now the stock-flow consistent approach. Tobin's framework is based on five principal features that differentiate it from the standard macromodel:

1- Precision regarding time. Short-run macroeconomic models refer to a slice of time, it is one step in a dynamic model not a repetitive equilibrium in which the economy settles.
2- Tracking of stocks. An essential part of the process is the dynamics of flows and stocks such as investment and capital and savings and wealth. It is not defensible to ignore these relations on the excuse that the analysis refers to so short time such that stocks do not change significantly.
3- Several assets and rate of returns. Nonmonetary asset aggregation does not permit analysis of some important policies, institutional structure, and events. Disaggregation of assets is essential for analyzing, among other phenomena, financing of capital accumulation and government deficits, details of monetary and debt management policies, international capital movements and foreign exchange markets, and financial intermediation.

4- Modeling financial and monetary policy operations. Too often macroeconomic models describe monetary policy as a change in the stock of money whose time path is chosen by the central authority without describing the operations that implement the policy. In fact government transactions with the public, or by similar transactions between banks and nonbank public affects the supply of money stocks. "*What transactions are the source of variation of money stocks makes a difference, depending on how they alter the wealth and the portfolio positions of economic agents*" (Tobin 1982a: 173).
5- Sectoral budget and adding-up constraints. Walras's law says that excess demand functions of an economic agent must sum to zero. The law imposes the consistency of meeting the budget constraint on the schedules of demand and supply, which agents communicate to all the markets in which they participate.

Godley in the 1990s makes a link between his previous work—tracking income flows and the money/debt stock through time—and Tobin's work, which focuses on portfolio choice by economic actors, and rates of return.

Other features of stock flow consistent models are first, to *incorporate real and financial relations* for all economic sectors in a consistent way (Dos Santos and Zezza, 2005); consequently, all flows to one economic sector are coming from other sectors, so inflows to one sector are outflows from other sectors (there cannot be any black holes). Second, *'the fact that money stocks and flows must satisfy accounting identities in individual budgets and in an economy as a whole provides a fundamental law of macroeconomics analogous to the principle of conservation of energy in physics'* (Godley and Cripps, 1983: 18). Third, there are *intrinsic dynamics* that reflect the dynamic behavior of a certain logical relationships, which constrain the system of equations of the model. Fourth, there are *lag dynamics,* which insure that causes precede effects, and these lags are important to avoid telescoping time (Hicks, 1965).

Another important feature of the stock flow consistent models is the quadruple entry principle, which is attributed to Copeland (1949 (1996: 8)). Copeland pointed out that, *'because moneyflows transactions involve two transactors, the social accounting approach to moneyflows rests not on a double-entry system but on a quadruple-entry system'*. Any change in the sources of funds of a sector must be compensated by at least one change in the uses of funds of the same sector. But any transaction must have counterparty. Therefore the above two changes must be accompanied by at least two changes in the uses and sources of funds of another sector.

In stock flow consistent models there is no need for rational expectations; agents react to disequilibria on the basis of partial adjustment functions. In Godley's models, agents are assumed to be reasonably rational, *they react to new information*, *they entertain norms*, and *they may revise these norms*.

Among these norms is that real households' consumption function determined by the real stock of households' wealth inherited from the previous period together with the expected flow of real disposable income. There are lots of firms norms, among these norms is that firms operating within the normal range of outputs at which running cost per unit of output are constant, and that they base their decision regarding production, prices, and employment on the quantity they expect to sell profitably plus an adjustment to inventory levels they wish to achieve. In the case of the government, these norms are well known, where political discussion often concentrate on sustainable debt to GDP ratio.

Stock flow consistent models can best be solved by simulations, because these models easily run up a high number of equations (Godley and Lavoie, 2007). Stock flow consistent models can be calibrated, but it will be a difficult task given the high number of variables and parameters.

Godley and Lavoie provide a promising approach by building a stock flow consistent macroeconomic model in a discrete-time frame. Most post-Keynesian economists concentrate on flows and prices rather than stocks of assets and liabilities and on comparative statics rather than dynamic analysis of policy changes; omission of these stocks from a model may lead to false predictions of the policy changes (Davis, 1987). The stock flow consistent approach was created to prevent these problems from happening (Dos Santos, 2006; Tobin, 1982a: 188).

Godley and Lavoie models have Kaleckian and/or Kaldorian overtones because most of the Kaleckian or Kaldorian features are incorporated in Godley and Lavoie models—the real markets (products and labor) are assumed to be demand-led but supply constrained, imperfect competition, imperfect information, markup pricing, fixed technical coefficients, the relevance of income distribution, the role of capacity utilization and corporate retained profits, the importance of lags and time, long-run trends being conceived as '*a slowly changing component of a chain of short period situations*' (Kalecki, 1971).

In neoclassical theory, markets are assumed to clear through changes in prices, while in the stock flow consistent approach markets clear either by assuming that quantity supplied adjust to demand within the period or because of buffers. The price mechanism plays a role in the demand and the supply in the stock market equities (Godley and Lavoie, 2007). Stock flow consistent models normally have a buffer for each sector such as stocks of inventories and loans for producing firms, Money deposits for households, Bills held, or advances from the central bank, for private banks, Bills issued for the government.

However, Godley and Lavoie construct FAMs with complex cross-holdings of various securities by economic sectors, but do not take into consideration decades of financial innovations (Taylor, 2008). Another limit of Godley and Lavoie stock flow consistent models is when more realistic models are been considered, the number of equations rise very quickly i.e. we'll have large models. Finally, in Godley and Lavoie models there was no attempt at calibration, and it needs more efforts to put in calibration and put into empirical work.

Taylor (2008) published a review article of Godley and Lavoie. He derived some interesting macrodynamic modeling consequences of the Godley and Lavoie type of stock flow consistent model, in particular, the possibility of deriving a concise macroeconomic model of price formation, (functional) income distribution, and business cycles, underpinned by strict stock-flow consistency *at many levels of disaggregation*. The resulting macrodynamic model encapsulates aggregate money dynamics built up from consistent inter-sectoral real-money flows.

The main contribution of this thesis will be to extend Godley and Lavoie models in a way to include more securities and present a more modern financial system for the years leading into 2007. Another attempt will be to model and analyze the recent shocks, which cause or trigger the recent financial crisis like the house price bubble, credit crunch, and financial integration.

Chapter 3

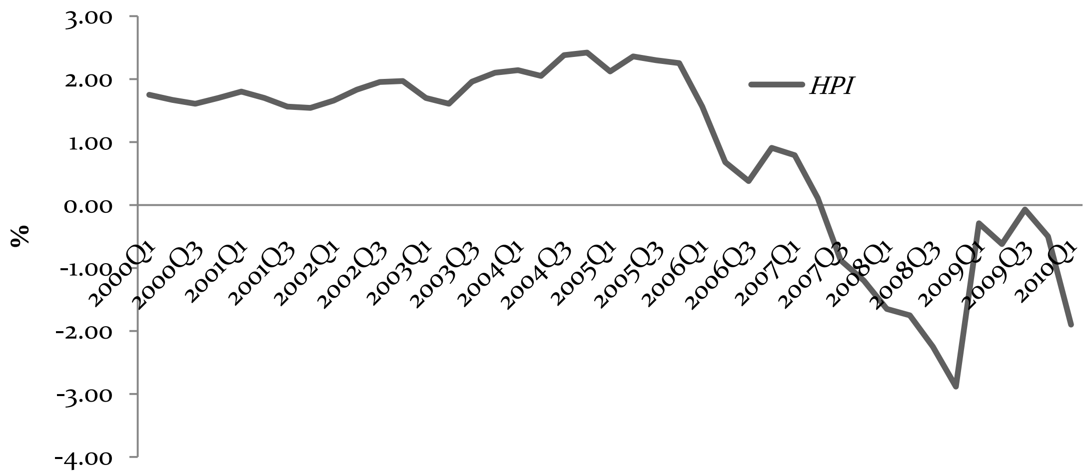
HOUSE PRICE VARIATIONS

3.1 INTRODUCTION

The collapse in housing and credit markets are two of the most visible effects of the recent financial crisis. Proposed causes of these collapses include, *inter alia*: the inability of home owners to make their mortgage payments, overextension by borrowers, predatory lending, speculation and overbuilding during the boom period, risky mortgage products, high personal and corporate debt levels, monetary policy, international trade imbalances, and inappropriate government regulations (Stiglitz, 2008; Steverman, 2009; and Roubini, 2009).

Figure 3.1 shows the quarterly appreciation of the house price index (HPI) for US during the period 2000Q1 – 2010Q1. The index shows the increase in the house prices in the US until the end of the second quarter of 2007. After this, house prices started to fall until 2010.

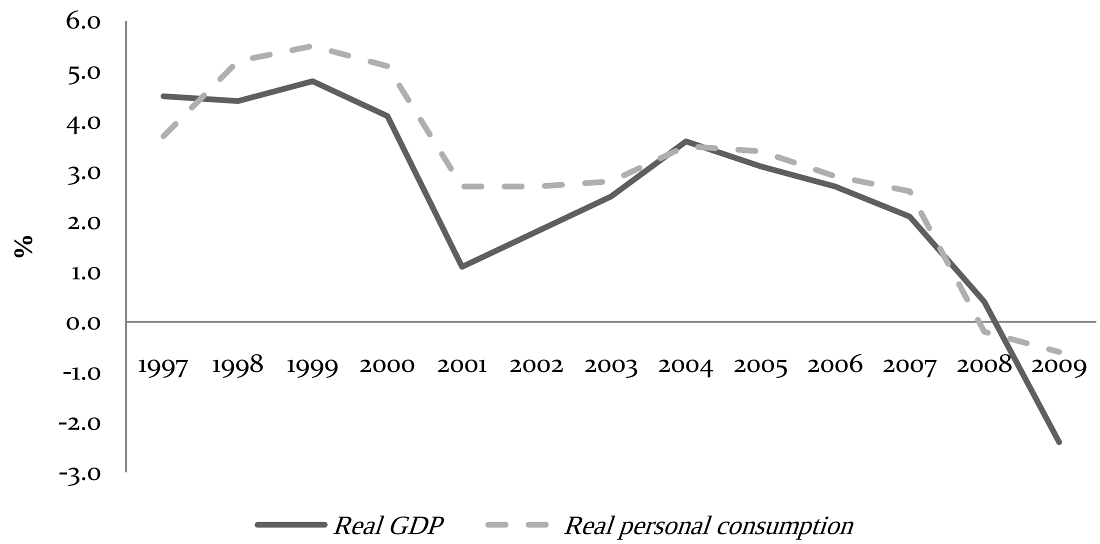
Figure 3.1: *Seasonally adjusted house price index for USA (qarterly appreciation)*



Source: Federal Housing Finance Agency.

The decline in house prices has a direct impact not only on home valuations, but also on credit markets, home builder activities, real estate, households, and national output. Due to the sharp decline in house prices, homeowners found themselves in a position of negative equity: with mortgage debt higher than the value of the property. Under conditions of negative equity, households become unable to fulfill their obligations, which can lead to failures in the banking system. Under negative equity, household consumption may decline, which of course affects any measure of national output. Figure 3.2 shows the percentage change of real GDP and real personal consumption in the US during the period 1997 – 2009. The figure shows that the real GDP and the real personal consumption start to slow after 2004 and the start to decline in 2008 in the US.

Figure 3.2: *Percentage change of real GDP and real personal consumption in the US*



Source: Bureau of economic analysis.

Baker (2002) argues that there is no fundamental reason behind the increase in home prices since 1995 in the US. Baker contends the only plausible explanation for the increase in home prices is the existence of a house-price bubble, which means that the only factor driving housing sales is the expectation that housing prices will be higher in the future. Baker predicts that the collapse of the housing bubble will lead to a loss in housing wealth and a slow in the economy via derailing housing construction and its attendant impacts on consumption through wealth effects.

Bernanke (2007), in his speech, states that the decline in housing markets across the US has been sharp since the summer of 2005. Sales of new and existing homes declined significantly, house prices declined, and the residential construction declined, which reduced the annual rate of US economic growth.

Igan and Rebucci (2008) use the vector autoregression (VAR) model for several advanced countries to estimate the implications of the housing sector in the business cycle and in the monetary policy transmission mechanism of each country. Their results show that due to the innovations in mortgage markets, the housing sector could be a source of macroeconomic instability. They claim that monetary policy is now transmitted more through the price of homes than through residential investments.

McCarthy and Peach (2004) use a VAR model of the US housing market in the years before 2004 and find a little evidence to support the existence of a house price bubble. Their analysis is based on house price to income ratio and rent to house price ratio from 1980 until 2003. A structural model is built in such a way that the equilibrium price per unit of housing established in the market for the existing stock determines the rate of gross addition. They argue that the key variables determining demand for existing stock of houses are the permanent income and the user cost of residential buildings. Their econometric results suggest that home prices have risen in line with the increase in personal income and declines in nominal interest rates.

Bjornland and Jacobsen (2010) analyze the role of housing prices in the monetary policy transmission mechanism in Norway, Sweden, and the UK using VAR models. They find, in contrast to McCarthy and Peach, that the role of house prices in the monetary transmission mechanism to increase considerably in these countries. Bjornland and Jacobsen also find that the interest rate responds systematically to change in house prices, while the timing of the response varies between the countries.

Steiner (2010) estimates the determinants of the residential capital stock, residential investment, and housing prices in Switzerland in a stock-flow framework. Her empirical results indicate that the desired level of residential capital stock can diverge from the existing residential capital stock for several years (3 to 5 years). The results show that housing prices clear the imbalances between the desired and the existing residential capital stock.

Zezza published two papers in 2007 and 2008 on the US housing market using a stock-flow consistent approach. The two papers present a model for a closed growing economy with a housing market and two classes of households, capitalists and workers. In his models both capitalists and workers express demand for houses, but capitalists finance their demand for houses from their equity/ wealth, which contains financial assets while workers, whose only incomes come from wages and interests on their bank deposits, finance their demand for houses by taking mortgage loans from private banks.

In both models, Zezza assumes an exogenous shock to expected house prices. The short-run results show an increase in actual house prices, increase in demand for houses, and increases in real output. But later, each of these variables declines to levels close to pre-shock levels.

Price variations in the housing market are not broadly analyzed in stock flow consistent models and the importance of modeling price variations is to show its short and long term impact on the whole economy, especially since house price bubbles are considered to be one of the main reasons of the recent financial crisis. Modeling these phenomena is necessary for developing proper fiscal and monetary policies to prevent such crises from happening.

This chapter is organized as follows: in the second section, the model is constructed in which a description of the model will be introduced, model matrices will be constructed, and some simulation experiments will be conducted. The third section concludes.

3.2 THE MODEL

The model deployed in this chapter describes a steady state country with five sectors: households, firms (non-financial sector), government, central bank, and private banks. Each sector is assumed to acquire assets (+) and have liabilities (-). This model builds on Zezza (2007) and (2008), but with one class of households and assumes a steady state economy instead of growing economy.

3.2.1 MODEL MATRICES

Table 3.1 provides the balance sheet of the model. As described above the model contains five sectors. Regarding the households sector, it's assumed that households acquire houses (+*Ho*), high powered money ($+H_{h\,d}$), bank deposits ($+M_d$), government securities, treasury bills used as a proxy of government securities, ($+B_{h\,d}$), and firm equities ($+e_d.p_e$). Households are assumed to take mortgages from banks ($-L_{m\,d}$) in order to finance part of their demand for houses. The sum of all households' assets and liabilities is households' wealth (V).

Table 3.1: *Balance sheet matrix*

	Households	Firms	Government	Central Bank	Banks	Σ
Fixed Capital		$+K$				$+K$
Houses	$+Ho$	$+Hu$				$+Ho+Hu$
HPM	$+H_{h\,d}$			$-H_s$	$+H_{b\,d}$	0
Advances				$+A_s$	$-A_d$	0
Deposits	$+M_d$				$-M_s$	0
Bills	$+B_{h\,d}$		$-B_s$	$+B_{cb\,d}$	$+B_{b\,d}$	0
Equities	$+e_d.P_e$	$-e_s.P_e$				0
Loans		$-L_{f\,d}$			$+L_{f\,s}$	0
Mortgages	$-L_{m\,d}$				$+L_{m\,s}$	
Balance	$-V$	$-NW_f$	$-NW_g$	0	0	$-(K+Ho+Hu)$
Σ	0	0	0	0	0	0

Firms are assumed to own tangible assets—fixed capital (+K) and a stock of unsold houses (+Hu). Fixed capital and unsold houses have no counterpart liabilities in other sectors. Fixed capital is only an asset; it is not simultaneously an asset and a liability, as is the case of financial capital. Firms take loans from banks (-$L_{f\,d}$) and supply equities to households (-$e_s.p_e$) to finance their investments. The sum of these assets and liabilities is the net worth of firms (NW_f).

The government is assumed to supply securities (treasury bills, -B_s) to other sectors in the economy. These securities are the negative net worth of the government (NW_g). The central bank is assumed to acquire government securities (+$B_{cb\,d}$) and supply advances (+A_s) to banks on demand. The central bank uses these assets to supply high powered money (+H_s) to households and to banks.

Regarding private banks, they are assumed to have vault cash (+$H_{b\,d}$), acquire government securities (+$B_{b\,d}$), supply mortgages to households (+$L_{m\,s}$), and supply loans to firms (+$L_{f\,s}$). Banks also accept deposits (-M_s) from households and take advances from the central bank (-A_d).

Table 3.2 describes the transactions and flows within, and between, economic sectors in the country in a given period of time. Variables with (+) sign describe *sources* of funds, and variables with (-) sign describe *uses* of funds. Each row and column in the transactions flows matrix must sum to zero. In the firms' current account column, firms produce consumption goods and services to households (+C_s) and to the government (+G_s), investment to its capital account (+I_f), and construct new houses (+$p.hn$).

Firms pay taxes on sales to the government (-T), wages to households (-WB), interests on loans (-$r_{l\text{-}1}.L_{f\,d\text{-}1}$), and keep part of their funds to cover any depreciation in their fixed capital ($-\delta_k.K$). The depreciation allowances go the firms' capital accounts. The difference between sources and uses of funds in the firm's current account is its profits ($-F_f$), which transferred to households as they are considered to be the owners of firms.

Other sources of funds besides the depreciation allowance, which appear in the capital account column are new loans ($+\Delta L_{f\,d}$) and new equities ($+\Delta\ e_s.P_e$). These sources of funds are used to cover new investments on tangible capital and the stock of unsold houses, which appears in the capital account of firms.

Households in this model are assumed to earn wages from firms; profits from firms ($+F_f$) and banks ($+F_b$), interests on their deposits ($+r_{m-1}.M_{d-1}$), and interests on their holdings of treasury bills ($+r_{b-1}.B_{h\,d-1}$). Households use part of their income to cover for their consumption.

Households use sources of funds to pay for their consumption to firms and interests, on mortgages, to banks ($-r_{mo-1}.L_{m\,d-1}$). Households use their savings to buy real and financial assets and use new mortgages to cover part of the acquired houses.

The government receives taxes ($+T$) from firms and takes the central bank profits ($+F_{cb}$). The government pays interests on treasury bills supplied to the other sectors ($-r_{b-1}.B_s$). The sum of the government's sources and uses of funds determines the public sector borrowing requirement (*PSBR*). The government is assumed to cover its *PSBR* by issuing new treasury bills ($+\Delta B_s$).

Table 3.2: *Transactions flows matrix*

		Households	Firms		Gov.	Central Banks		Banks		Σ
			Current	**Capital**		**Current**	**Capital**	**Current**	**Capital**	
Consumption		$-C$	$+C$							0
Gov. Expenditure			$+G$		$-G$					0
Investment in F. capital			$+I_f$	$-I_f$						0
Depreciation of F. capital			$-\delta_k.K_{-1}$	$+\delta_k.K_{-1}$						0
Investment in housing		$-p_h.[\Delta ho+\delta_h.ho_{-1}]$	$+p_h.hn$	$-p_h.\Delta hu$						0
Sales Tax			$-T$		$+T$					0
Wages		$+WB$	$-WB$							0
Entrepreneurial Profits		$+F_f$	$-F_f$							0
Bank Profits		$+F_b$						$-F_b$		0
Central Bank Profits					$+F_{cb}$	$-F_{cb}$				0
Interest on	Advances					$+r_{a-1}.A_{s-1}$		$-r_{a-1}.A_{d-1}$		0
	Loans		$-r_{l-1}.L_{f\,d-1}$					$+r_{l-1}.L_{f\,s-1}$		0
	Mortgages	$-r_{mo-1}.L_{m\,d-1}$						$+r_{mo-1}.L_{m\,s-1}$		0
	Deposits	$+r_{m-1}.M_{d-1}$						$-r_{m-1}.M_{s-1}$		0
	Bills	$+r_{b-1}.B_{h\,d-1}$			$-r_{b-1}.B_{s-1}$	$+r_{b-1}.B_{cb\,d-1}$		$+r_{b-1}.B_{b\,d-1}$		0
Change in the stocks of	Advances						$-\Delta A_s$		$+\Delta A_d$	0
	Loans			$+\Delta L_{f\,d}$					$-\Delta L_{f\,s}$	0
	Mortgages	$+\Delta L_{m\,d}$							$-\Delta L_{m\,s}$	0
	Cash	$-\Delta H_{h\,d}$					$+\Delta H_s$		$-\Delta H_{b\,d}$	0
	Deposits	$-\Delta M_d$							$+\Delta M_s$	0
	Bills	$-\Delta B_{h\,d}$			$+\Delta B_s$		$-\Delta B_{cb\,d}$		$-\Delta B_{b\,d}$	0
	Equities	$-\Delta\ e_d.\ P_e$		$+\Delta\ e_s.\ P_e$						0
Σ		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

The central bank receives interests on its holdings of treasury bills from the government, ($+r_{b-1}.B_{cb\ d-1}$), and from its supply of advances to banks ($+r_{a-1}.A_{s-1}$). The sum of these various interests, as shown in the current column, is the central bank's profits, and they are transferred completely to the government as shown in table 3.2. The central bank acquires treasury bills ($-\Delta B_{cb\ d}$) and supplies advances ($-\Delta A_s$) to private banks. These uses of funds are compensated by issuing more high-powered money ($+\Delta H_s$) to households and to private banks as shown in the capital account column.

Banks receive interests on mortgages to the households sector, on loans to firms, and on their holdings of treasury bills ($+r_{b-1}.B_{b\ d-1}$). Banks pay interests to households on money deposits ($+r_{m-1}.M_{s-1}$) and to the central bank on advances ($-r_{a-1}.A_{d-1}$). The difference between the ingoing interests and outgoing interests, as shown in the current account column, equals to the bank profits ($-F_b$), which go to households. The change in banks' financial assets and liabilities sum to zero due to the assumption that banks do not have net worth as shown in the capital account column.

3.2.2 MODEL EQUATIONS

In this subsection, a general description of model equations and identities are introduced. Detailed equations and identities can be found in appendix 3.A. These equations and identities describe the balance sheets and transactions flows constraints and the behavior of each economic sector. The uppercase variables are in nominal values and the lower case variables are in real terms. Most of the model equations and identities are taken from Godley and Lavoie (2007).

Firms' nominal output, GDP, equal to the values of consumption, government expenditure, and investment.

$$Y \quad = C \quad + G \quad + I$$

Firm's real sales are the sum of real households' consumption, real government expenditure, and real investment.

$$s \quad = c \quad + g \quad + i$$

Firms' decision regarding production is equal to their expected sales.

$$y \quad = s^e$$

At any period, t, the price level of goods and services is a mark up, φ, on unit costs. All profits earned by firms as a result of the mark up are assumed to be transferred to the households as they are considered to be the owners of firms.

$$p \quad = (1 + \tau).(1 + \varphi).UC$$

where τ is the tax rate on firms' sales.

Residential construction firms, which considered in this model as a part of the firms sector, set the price of newly built houses as a function of unsold houses and general price level.

$$\Delta p_h \ = \eta_1.(hu^n - hu_{-1}) + \eta_2.\Delta p$$

where hu^n is the normal level of unsold houses. Residential construction firms work to guarantee that they have stock of houses to be available in case of an increase in the demand for houses. The following equations state that the change in the normal stock of unsold houses is a portion of the difference between the expected stock of existing houses and the previous level of stock of existing houses acquired by households.

$$\Delta hu^n = \psi . (ho^e - ho_{-1})$$

where ho^e is the expected stock of existing houses in the households sector.

Firms' real investment decision is divided into two parts: the first is the investment on physical capital and the other is the investment in housing. Investment in physical capital is a function of the difference between the actual and the target real fixed capital plus the depreciation allowance of fixed capital.

$$i_f = \gamma_k . \left(k^T - k_{-1}\right) + \delta_k . k_{-1}$$

$$\text{where } k^T = \kappa . y_{-1}$$

Firms' supply of new houses equals the difference between expected stock of existing houses and the previous stock of existing houses acquired by households, the difference between the normal level of unsold houses and the stock of unsold houses left from the previous period, and the depreciation allowance on existing houses acquired by households.

$$hn = (ho^e - ho_{-1}) + (hu^n - hu_{-1}) + \delta_h . ho_{-1}$$

Total firms volume of investment is equal to the sum of investment in physical capital and the investment in houses.

The new level of unsold houses is equal to what is left form the new built houses after what has been sold in addition to the depreciation in houses.

$$\Delta hu = hn - \Delta ho - \delta_h . ho_{-1}$$

Firms in this model are assumed to take new loans and issue new equities to cover for their net investment on physical capital and the value of new unsold houses.

$$\Delta L_{f\,d} = \left(I_f - \delta_k . K_{-1}\right) + p_h . \Delta hu - \Delta e_s . p_e$$

Households' disposable income is equal to what they earn in terms of wages, profits, and interests minus what they pay as interests on mortgages to banks. Households in this model are assumed to pay no tax to the government.

$$YD = WB + F_f + F_b + r_{m-1} . M_{d-1} + r_{b-1} . B_{h\,d-1} - r_{mo-1} . L_{m\,d-1}$$

Households' savings or the change in their wealth is what left from their disposable income after consumption.

$$\Delta V = YD - C$$

Households' real consumption is a function of their expected real disposable income and their real wealth level in the previous period.

$$c = \alpha_0 + \alpha_1 . yd + \alpha_2 . v_{-1}$$

Households are assumed to acquire real capital like houses and financial assets like cash money, deposits, treasury bills, and firms' equities. Demand for cash money is considered to be a portion of the households' consumption. Demand for other financial assets depends on the rates of return of those assets, as in Tobin (1969) and in Godley and Lavoie (2007). Equations of households' portfolio decision on financial assets are listed in appendix 3.A. It is worth noting that the demand for deposits in the households' sector play the buffer role as described in appendix 3.A. Demand for new houses depends upon their disposable income and the expected rate of return on houses, $r^e{}_h$.

$$\Delta ho = \zeta_1 . \Delta yd + \zeta_1 . \Delta r_h^e$$

where $r^e{}_h$ depends on the growth rate of expected house prices, $p^e{}_h$, interest rate on mortgages, and rental rate on houses. Interest rate on mortgages and the rent inter considered as the opportunity costs of acquiring houses.

$$r_h = \frac{(p_h^e - p_h)}{p_h} - r_{mo} + rent$$

where, $p_h^e = p_{h-1} + \mu$.

Households are assumed to take new mortgages to cover part of their demand for houses.

$$\Delta L_{m\,d} = \upsilon . p_h . [\Delta ho + \delta_h . ho_{-1}] - rep$$

where *rep* is mortgage repayments each period, which is assumed to be 10% of mortgage value.

The government is assumed to sell treasury bills to households, banks, and the central bank. In this model, the government is assumed to cover its borrowing requirements by issuing new treasury bills.

$$PSBR = G + r_{b-1} . B_{s-1} - (T + F_{cb})$$

$$\Delta B_s = PSBR$$

The central bank is assumed to take what is left from treasury bills after what has been sold to households and to private banks.

$$B_{cb\,s} = B_s - B_{h\,s} - B_{b\,s}$$

The central bank is assumed to supply advances to banks equal to their demand. Thus, central bank receives interests on its holdings of treasury bills and its supply of advances. These interests considered as the central bank profits, which are totally transferred to the government. The central bank supplies high-powered money to households and banks based on its holdings of treasury bills and its supply of advances to banks. The central bank supply of high powered money is constrained by its balance sheet, see table 3.1.

$$H_s = B_{cb\,d} + A_s$$

Banks are assumed to accept deposits from households, supply loans and mortgages to firms and households respectively based on their demand, take advances from the central bank, acquire treasury bills, and keep vault cash. The last is assumed to be a portion of deposits; this portion is set by the central bank. Advances taken from the central bank is to keep a certain level of liquidity. If bank liquid assets decline, then it asks for advances to fulfill its short-term obligations.

$$A_d = \omega.(M_s - B_{b\,d})$$

Bank's demand for treasury bills is assumed to be constrained by its balance sheet.

$$B_{b\,d} = M_s + A_d - L_{f\,s} - L_{m\,s} - H_{b\,d}$$

Finally, banks set the interest rate on loans and mortgages as functions depend upon their profit margin and the interest rate on advances. Banks set the interest rate on deposits as a function depend upon their liquidity ratio and interest rate on advances. The detailed equations are in appendix 3.A.

In this model, the redundant, or the hidden, equation is that the central bank supplies high powered money to banks on demand.

$$H_{b\,s} = H_{b\,d}$$

The above equation can be derived from equation 3.59 (see appendix 3.E). Including the redundant equation in the model makes it over determined and the model will not solve, and thus, the redundant equation will be excluded from the model.

3.2.3 MODEL SIMULATIONS

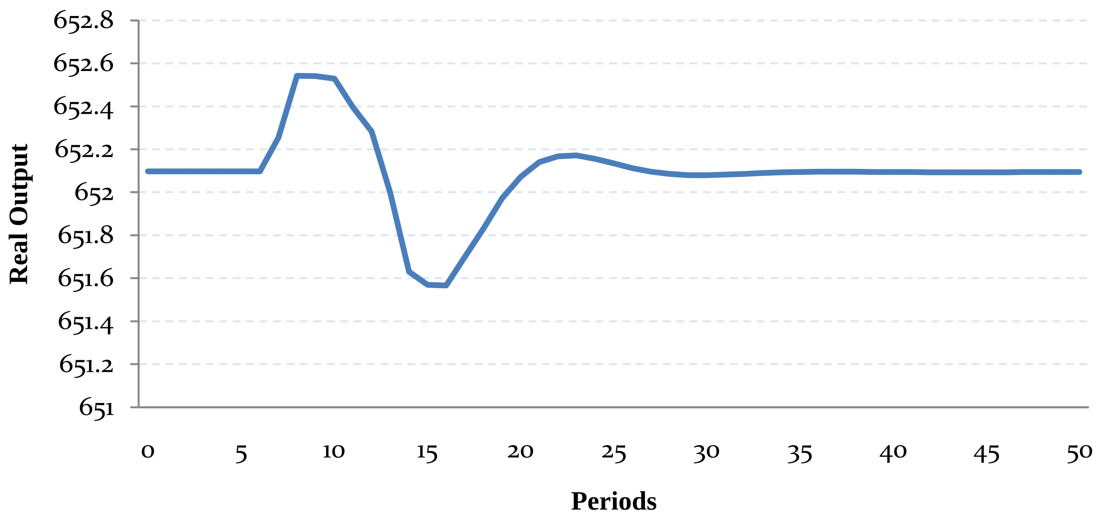
The baseline scenario assumes that the economy is in a steady state condition, in other words, stocks do not change and flows stays on the same level. The simulation of each scenario will be for various random seeds, over a 51 notional periods.

The first scenario (increase in the expected house prices)

The first scenario assumes that households expect that house prices are going to increase. Expected house prices are assumed to equal house prices in the present period plus a random variable (μ) that may have a positive or negative value, see equation 3.19 in appendix 3.A. When households expect house prices to increase, μ will have a positive value and expected house prices will continue increasing as long as μ has a positive value. In this scenario it is also assumed that expected house prices increase for one period and stay there for another four periods before they return to their previous level before the shock. The simulation of this scenario will explore the effect of a 0.5 point increase in the expected house prices starting from period 5.

Figure 3.3 shows that effect of the increase in expected house prices on real output. The figure shows that real output increases after the shock. This increase lasts for several periods but later a substantial decline happened to real output.

Figure 3.3: *Evolution of real output after the increase in expected house prices*



After the increase in expected house prices, households demand for houses increases due to the increase on the rate of return in housing, see equation 3.40. The increase in the demand for houses leads to a decline in the stock of unsold houses and as a consequence, firms increase housing construction, which leads to an increase in the output. Figure 3.4 shows the evolution of the demand and the supply of houses after the shock.

The figure shows that the supply of houses increases after one period of the increase in the demand for houses because construction of houses depends upon the expected change in the demand for houses. Another thing, the shock leads to imbalances in the demand for and the supply of houses. These imbalances last for several periods before they return to the levels before the shock. The increase in demand for houses leads to an increase in actual house prices. Figure 3.5 shows the evolution of house prices and expected house prices after the shock.

Figure 3.4: *Demand and supply of houses after the increase in expected house prices*

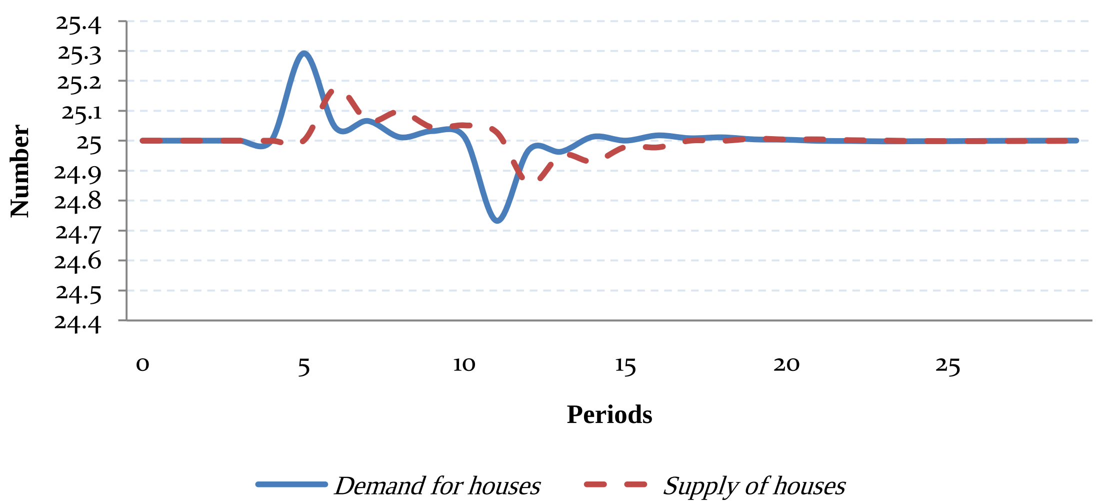
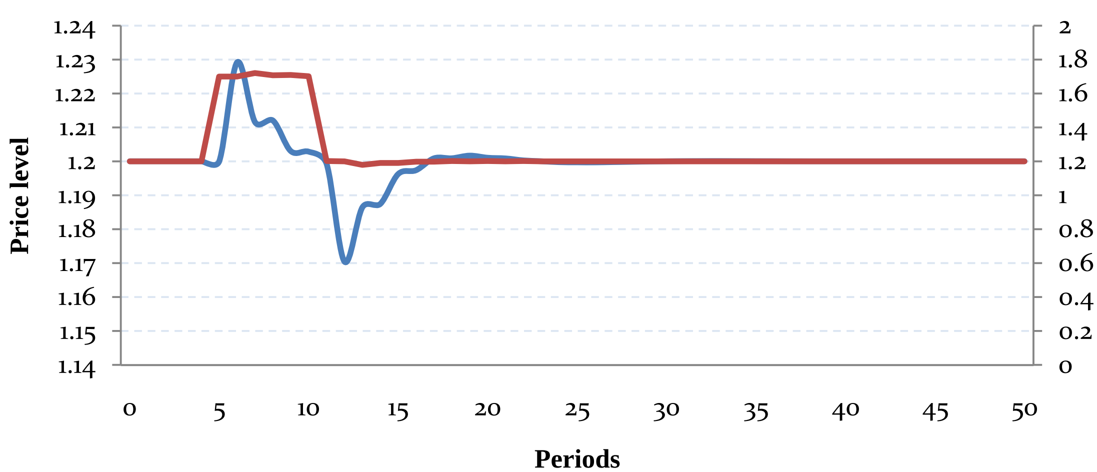
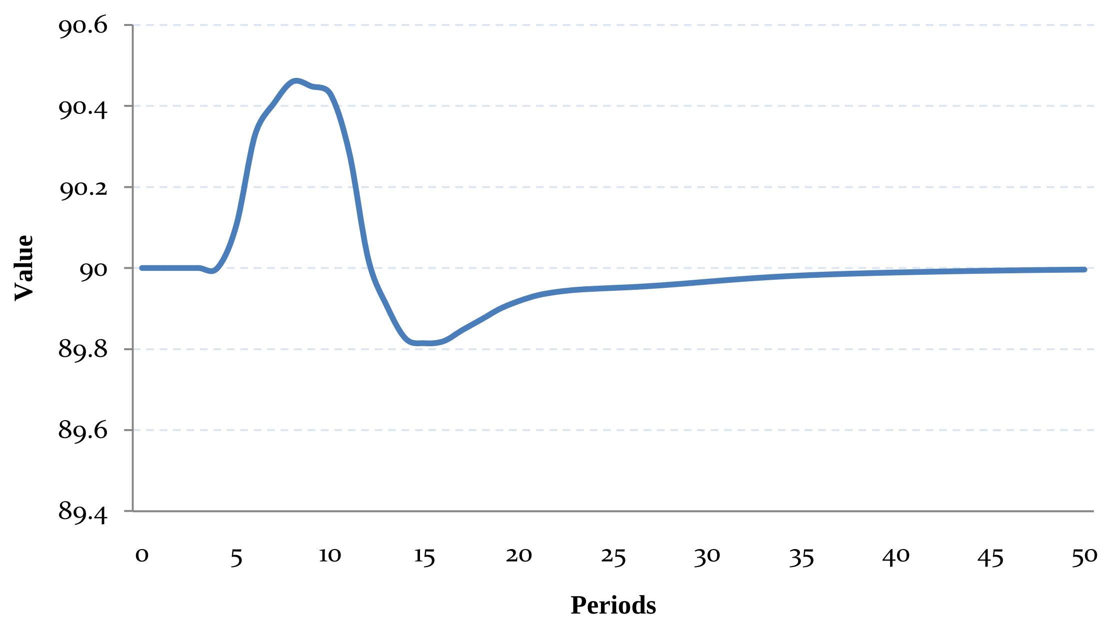


Figure 3.5: *Evolution of house prices after the increase in expected house prices*



The increase in the demand for houses and the increase in the value of existing houses acquired by households lead to an increase in the demand for mortgages. Figure 3.6 shows the evolution of mortgages demand after the increase in expected house prices.

Figure 3.6: *Evolution of mortgages demand after the increase in expected house prices*



The increase in house prices lead to an increase in households' wealth and the increase in firms' sales of houses leads to an increase in their profits and also wages, and thus households' disposable income. Both factors lead to an increase in households' consumption. Figure 3.7 shows the evolution of real households' wealth, disposable income, and consumption.

Figure 3.7: *Evolution of real households' wealth, real disposable income, and real consumption after the increase in expected house prices*

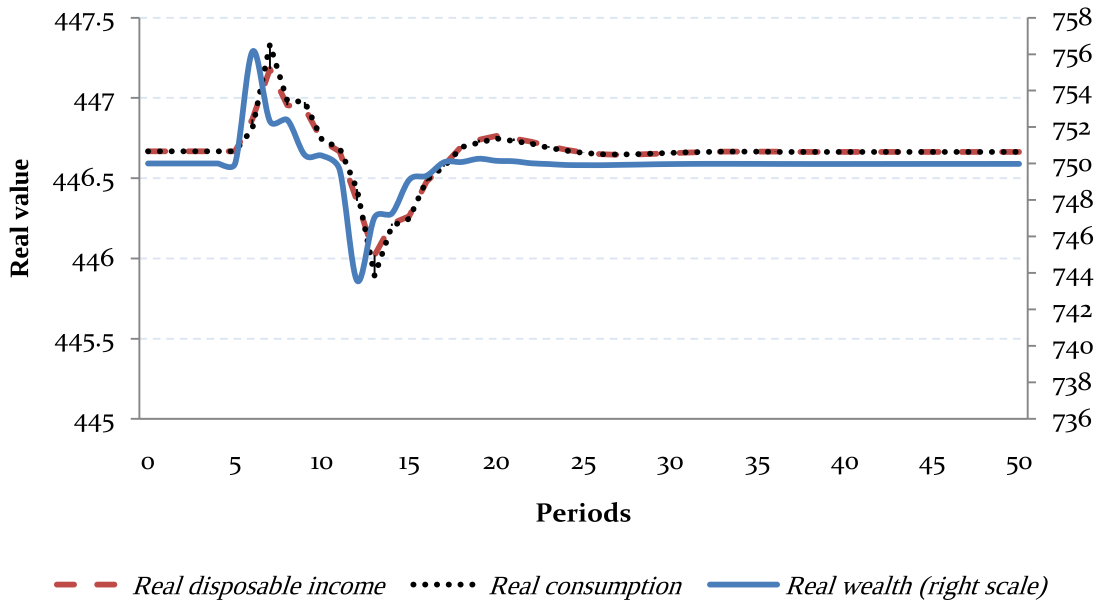


Figure 3.8 shows the change in the demand for deposits, treasury bills, and equities as a share of (V_{fma}) against the baseline values after the shock. The volatility in the demand for financial assets comes from the volatility in the demand for houses and from the volatility in the disposable income. The increase in firms' profits increases the rate of return on equities, which leads to an increase in households' demand for equities and a decline in the demand for treasury bills. The residual of financial market assets wealth goes for deposits, which explains the increase in the demand for deposits as the value of wealth increases.

Figure 3.8: *Change of deposits, T. bills, and equities as a share of financial market assets wealth against the baseline values after the increase in the expected house prices*

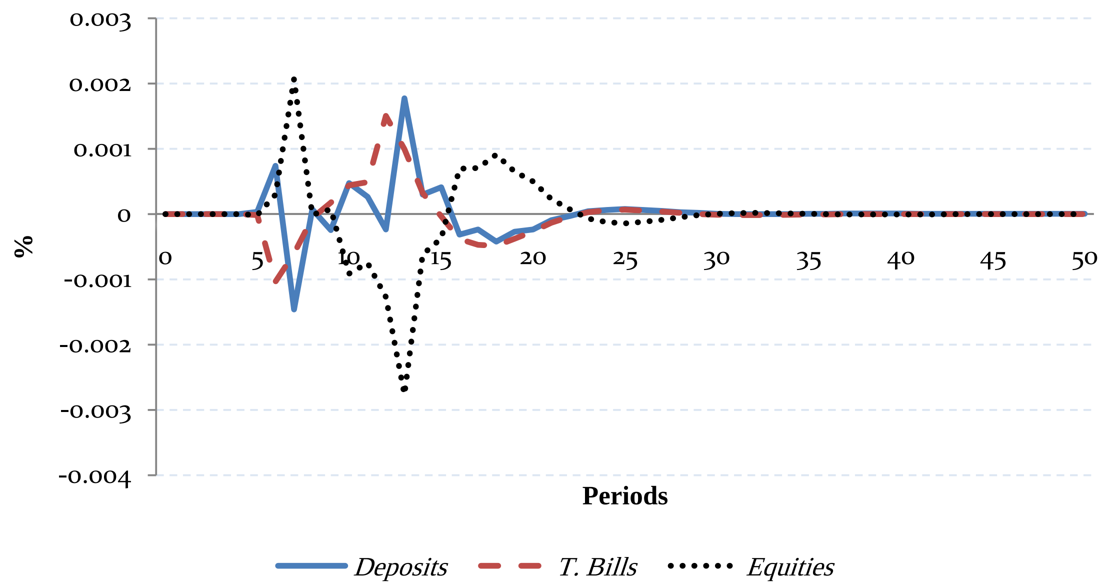


Figure 3.9 shows the change in banks the demand for advances, the demand for treasury bills, and the supply of loans to firms against the baseline values after the shock in expected house prices. The increase in house prices leads to a direct increase in the demand for mortgages as shown in figure 3.6. With the increase in households' demand for deposits and with the decline in firms' demand for loans, banks' demand for bills increases and their demand for advances decreases noting that the increase in banks' demand for bills is higher than households' demand for deposits. Due to the decline in the stock of unsold houses and the increase in the supply of equities to households, firms' demands for new loans tend to decline.

Figure 3.9: *Change in banks' advances, T. bills, and loans to firms after an increase in the expected house prices*

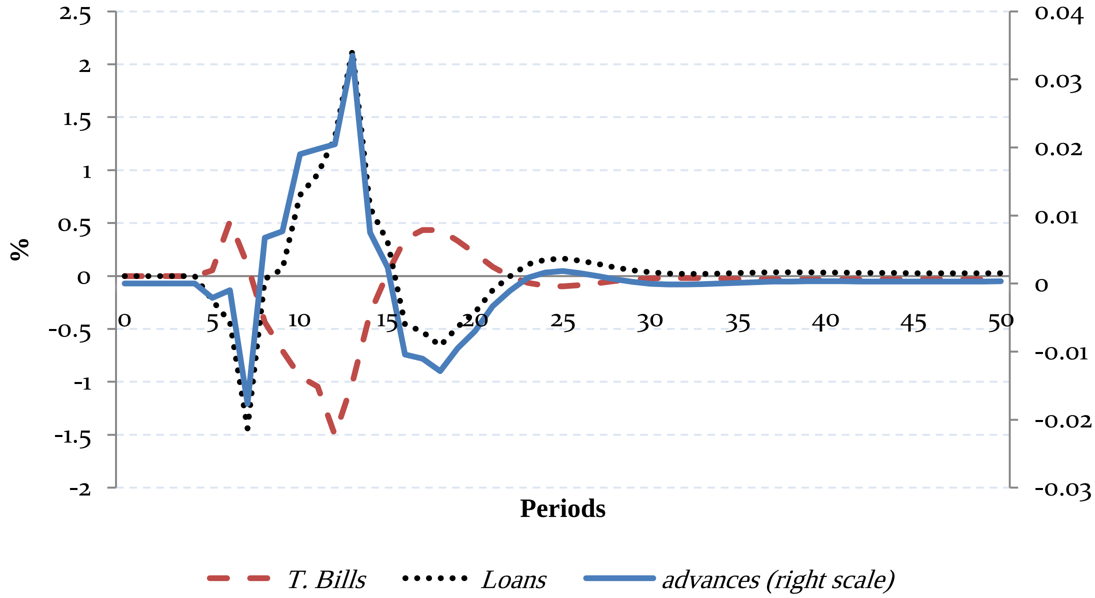


Figure 3.10: *Evolution of government budget balance after an increase in the expected house prices*

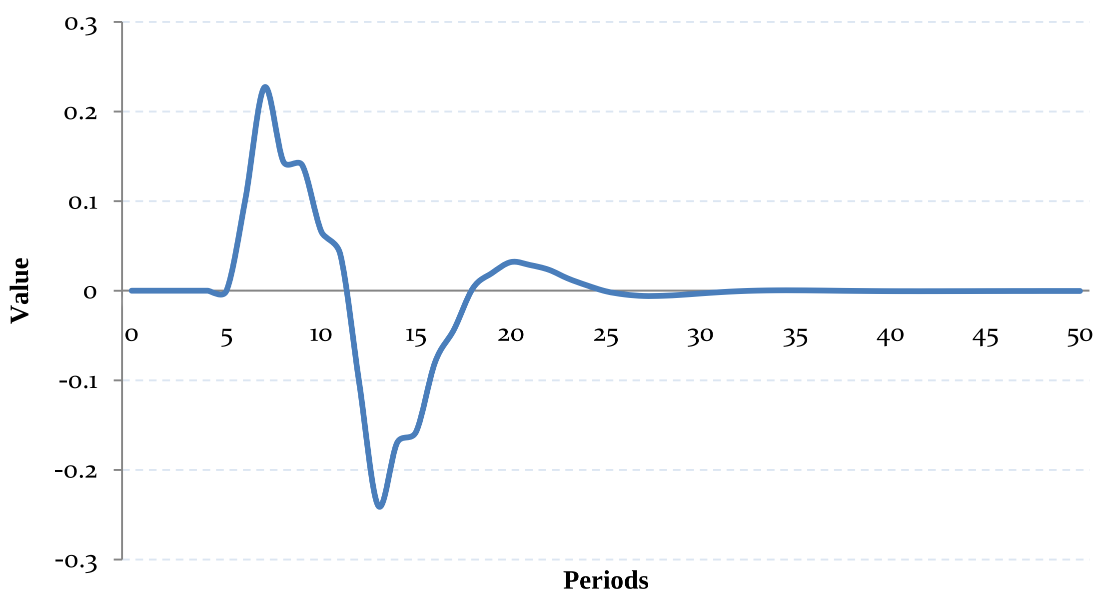


Figure 3.10 in this scenario shows the evolution of government budget balance after the shock in the expected house prices. Due to the increase in firms' sales, taxes on sales increase, which leads to a government budget surplus in the short run, but later the surplus starts to decline and turn to deficit.

Figure 3.3 above shows that real output starts to decline after several periods of increase. This decline is due to two factors, the first is the decline in households' consumption and the second is the decline in firms' construction of new houses. Expected house prices are assumed to increase 0.5 points for 5 periods and after that they return to their previous levels before the shock. The return in house price expectations lead to a decline in the demand for houses and thus housing sales and thus house prices. The decline in the existing house prices leads to a decline in households' wealth and thus consumption. When new house sales decline, firms' profits decline and also wages, this leads to a decline in households' disposable income and thus consumption.

The decline in new houses construction leads to a decline in firms' investments. Both factors, the decline in households' consumption and firms' investments lead to a decline in the real output, which can be seen in the figures above.

The imbalances between the demand and the supply of houses after the shock play an important role in the volatility of real output and the other main indicators. Figure 3.4 shows that the supply of houses goes higher than the demand after the shock. Due to the excess supply, stock of unsold houses increases, which leads to a decline in the construction of new houses to levels lower than the demand for houses. This mechanism continues until the demand for houses equals the supply of houses and the end of the shock helps the economy as a whole to return to its previous levels before the shock.

The second scenario (increase in government expenditure)

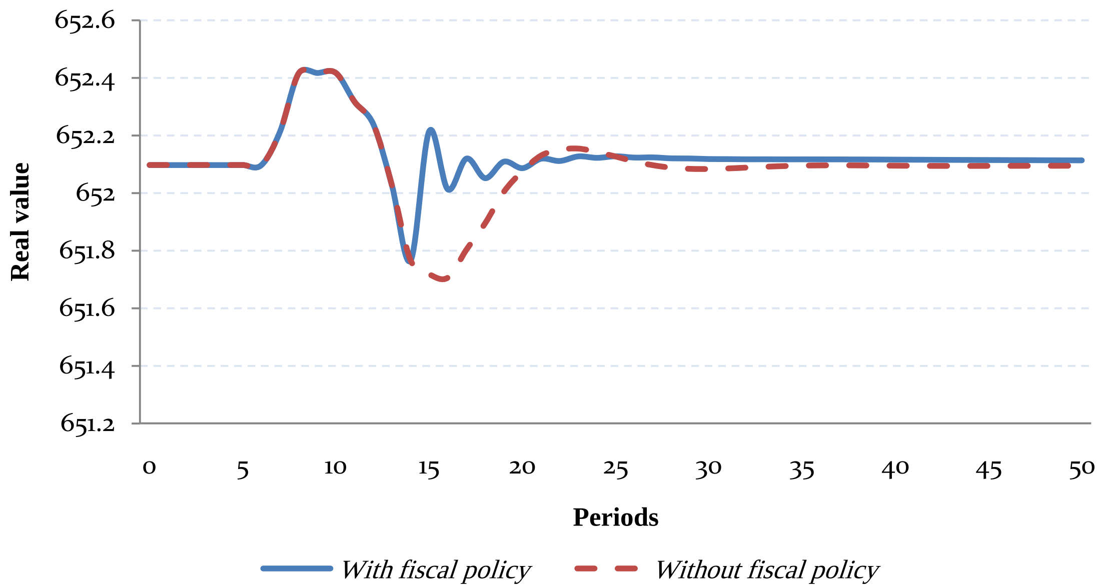
The second scenario assumes that due to the decline in the real output, the government intervenes to help the economy to stop the decline and to stimulate the economy. In this scenario, the government increases its expenditure, as a fiscal policy, by 0.3% for one period only then return to its previous level.

Figure 3.11 shows the evolution of the real output after the increase in the expected house prices and the increase in the real government expenditure. As shown in the figure, increasing real government expenditure increases the real output. The increase in real output lasts for one period then declines, because the policy is taken for one period only. But this policy makes the economy better off compared with the first scenario.

Increasing real government expenditure will stimulate the economy as a whole, by increasing the sales, which will be reflected on profits, wages, disposable income, consumption, and wealth. Regarding the government budget balance, due to the increased government expenditure, the deficit will increase but later, the deficit declines due to the increase in sales tax collections.

The increase in households' disposable income increases the demand for houses and also the demand for mortgages. The increase in households' demand for houses stimulates firms' investments, which in turn increases sales and thus output.

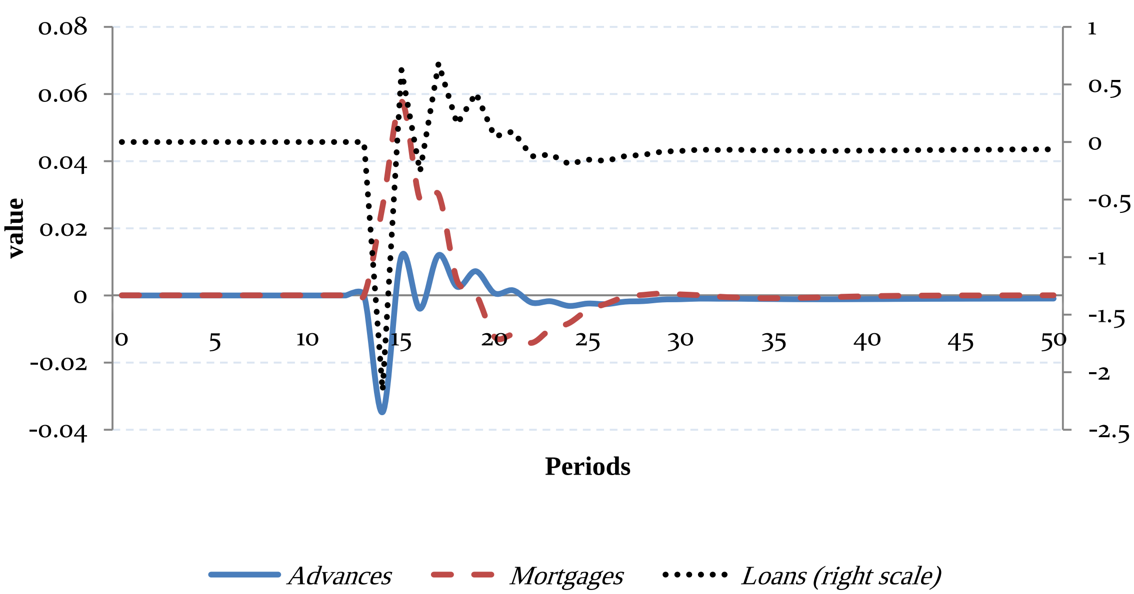
Figure 3.11: *Evolution of the real output before and after the fiscal policy*



The increase in firms' profits increases the demand for equities by households and thus firms need less of loans. Given that the increase in the demand for mortgages is less than the decline in loans demand, banks' demand for advances from the central bank declines and the demand for treasury bills increases.

Figure 3.12 shows the difference between banks' demand for advances, supply of mortgages and loans in the case of fiscal policy (second scenario) and no fiscal policy (first scenario).

Figure 3.12: *The difference between banks' demand for advances, supply of mortgages and loans in the case of fiscal policy and in the case of no fiscal policy*



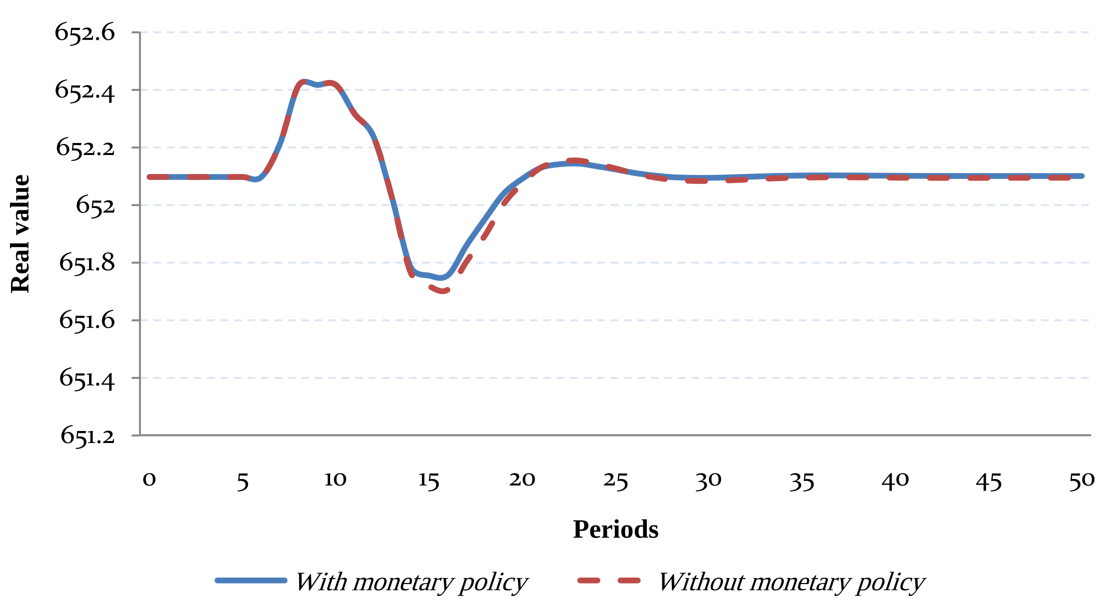
The third scenario (decreasing interest rate on advances)

The third scenario assumes that the central bank decreases the interest rate on advances as a monetary policy tool. The central bank decides to decrease the interest rate by half for five periods starting from period 12. When the central bank decreases the interest rate on advance, banks will decrease the interest rate on deposits, loans, and mortgages, see equations 3.73, 3.77, and 3.81 in appendix 3.A. The decline in mortgage interest rate will increase the demand for houses and the demand for mortgages by households; see equations 3.39 and 3.37 in appendix 3.A. Regarding firms, it is assumed in this model that firms' demand for loans does not depend upon loans interest rate, but the increase in demand for houses will affect the stock of unsold houses, which affects firms' demand for loans, see equations 3.13 and 3.26 in appendix 3.A.

Figure 3.13 shows the evolution of real output after applying monetary policy. It shows that the applied monetary policy makes the real output slightly better off. As shown in the figure, the applied monetary policy do not succeed to stop the decline in the real output but it succeeds to decrease the degree of fall.

Interest rate on advances has a direct effect on the interest rate on deposits, mortgages, and loans. In this model decreasing interest rate on advances does not affect either the demand for advances or the demand for loans by firms, because the demand for advances and loans do not depend upon their respective interest rate, see equations 3.26 and 3.70. When the interest rate on mortgages declines in response to the decline in the interest rate on advances, rate of return on housing increases and leads to an increase in demand for houses, which stimulates investment and thus real output. When firms' sales increase firms' profits increase too, which leads to an increase in households' disposable income and consumption and thus the real output.

Figure 3.13: *Evolution of the real output before and after the monetary policy*



3.3 CONCLUSION

The model presented in this chapter describes the impact of house price variations on the business cycle using a stock flow consistent model. This chapter builds on Zezza (2007) and (2008), but with single households' class and a deeper analysis for the real and financial sides of the economy.

Despite the fact that the model does not necessarily reflect the real world, it can explain a part of the recent financial crisis by modeling the house price bubble, which considered as one of the main contributors of the recent financial crisis. The model shows that the increase in expected house prices leads to an increase in the most macroeconomic variables, but several periods after the incidence of the shock, a fall in the output of almost all economic activities and in households' wealth and income takes place due to the fact that, in this model, expected house prices go back down after several periods of increase.

Due to the assumption of several periods' increase in expected house prices, the effect of this shock is not going to continue in the long-run, but it will have an effect on the short and medium-runs. An intervention by the government and/ or the central bank is needed to recover the economy to levels before the shock particularly when such shocks continue for longer periods. Three simulation experiments (scenarios) are conducted in addition to the baseline scenario, which assumes a stationary steady state in the economy.

The first scenario assumes an increase in the expected house prices in the economy, the second introduces a fiscal policy to see if the economy recovers after the decline in the economy, and the third assumes that the central bank implements a monetary policy. These scenarios are analyzed to determine what will happen to the economy after the decline[7].

The model shows that the economy experiences a boom at the beginning after the house prices increase. This boom has a positive effect on the economy, wealth, and the distribution of income, but after some periods the economy starts to deteriorate when expected house prices drop. This chapter proposes that an increase in assets' prices (real or financial) will have a positive effects on the economy in the short-run, but after some periods will turn to have negative effects and these effects will be bigger as long as the shock continues. The results show that fiscal and monetary policies are important in stimulating the economy, but more specific policies are also needed to help the economy and prevent such shocks from happening in the future.

The model shows that fiscal policy has a more direct effect on the economy than monetary policy. Increasing pure real government expenditure (fiscal policy) leads to a direct turning point in the economy and starts the recovery phase and does not take long time to return to its previous levels, while the monetary policy implemented in this model has a very minor effect on the decline.

Several steps can be taken to expand this model to better reflect the real world. One direction is to assume a permanent shock in expected house prices and/ or permanent fiscal and monetary measures. One could expand this model for an open economy, and/ or includes two classes of households. Another dimension is to see

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[7] Another scenario can be conducted in this model, which assumes both fiscal and monetary policies implemented to see the effect on the economy. One can predict that both fiscal and monetary policies can help the economy better than one policy alone.

the effects of the shock on a more complex financial sector than presented here or one can check the effect of an increase in households' debt burden due to the increase in house prices and mortgages, which is not modeled in this chapter.

3.4 APPENDIX 3.A: MODEL EQUATIONS

Production sector equations

$$Y = S = C + G + I \tag{3.1}$$

$$y = s^e \tag{3.2}$$

$$s = c + g + i \tag{3.3}$$

$$s^e = \beta_1 . s_{-1} + (1 - \beta_1). s^e_{-1} \tag{3.4}$$

$$k = k_{-1} + i_f - \delta_k . k_{-1} \tag{3.5}$$

$$i_f = \gamma_k . (k^T - k_{-1}) + \delta_k . k_{-1} \tag{3.6}$$

$$k^T = \kappa . y_{-1} \tag{3.7}$$

$$N = \frac{y}{pr} \tag{3.8}$$

$$WB = W.N \tag{3.9}$$

$$UC = \frac{WB}{y} \tag{3.10}$$

$$hn = (ho^e - ho_{-1}) + (hu^n - hu_{-1}) + \delta_h . ho_{-1} \tag{3.11}$$

$$ho^e = \beta_2 . ho_{-1} + (1 - \beta_2). ho^e_{-1} \tag{3.12}$$

$$\Delta hu = hn - \Delta ho - \delta_h . ho_{-1} \tag{3.13}$$

$$\Delta hu^n = \psi . (ho^e - ho_{-1}) \tag{3.14}$$

$$i = i_f + hn \tag{3.15}$$

$$p = (1 + \tau). (1 + \varphi). UC \tag{3.16}$$

$$\pi = \frac{p}{p_{-1}} - 1 \tag{3.17}$$

$$\Delta p_h = \eta_1 . (hu^n - hu_{-1}) + \eta_2 . \Delta p \tag{3.18}$$

$$p^e_h = p_h + \mu \tag{3.19}$$

$$S = s.p \tag{3.20}$$

$$K = k.p \tag{3.21}$$

$$I = i.p \tag{3.22}$$

$$I_f = i_f.p \tag{3.23}$$

$$Hn = hn.p \tag{3.24}$$

$$Hu = hu.p_h \tag{3.25}$$

$$\Delta L_{f\,d} = \left(I_f - \delta_k.K_{-1}\right) + p_h.\Delta hu - \Delta e_s.p_e \tag{3.26}$$

$$F_f = S - T - WB - r_{l-1}.L_{f\,d-1} - \delta_k.K_{-1} - \delta_h.p_h.ho_{-1} \tag{3.27}$$

$$e_s = e_d \tag{3.28}$$

$$r_k = \frac{F_f}{p_{e-1}.e_{s-1}} \tag{3.29}$$

<u>Households sector equations</u>

$$YD = WB + F_f + F_b + r_{m-1}.M_{d-1} + r_{b-1}.B_{h\,d-1} - r_{mo-1}.L_{m\,d-1} \tag{3.30}$$

$$yd = \frac{YD}{p} \tag{3.31}$$

$$\Delta V = YD - C \tag{3.32}$$

$$v = \frac{V}{p} \tag{3.33}$$

$$c = \alpha_0 + \alpha_1.yd + \alpha_2.v_{-1} \tag{3.34}$$

$$C = c.p \tag{3.35}$$

$$yd^e = \beta_3.yd_{-1} + (1 - \beta_3).yd^e_{-1} \tag{3.36}$$

$$\Delta L_{m\,d} = v.p_h.[\Delta ho + \delta_h.ho_{-1}] - rep \tag{3.37}$$

$$rep = 0.1(L_{m\,d-1}) \tag{3.38}$$

$$\Delta ho = \zeta_1.\Delta yd + \zeta_1.\Delta r^e_h \tag{3.39}$$

$$r_h = \frac{(p^e_h - p_h)}{p_h} - r_{mo} + rent \tag{3.40}$$

$$rent = constant \tag{3.41}$$

$$Ho = ho.p_h \tag{3.42}$$

$$H_{h\,d} = \lambda.C \tag{3.43}$$

$$V_{fma} = V - H_{h\,d} + L_{m\,d} - Ho \tag{3.44}$$

$$\frac{M_d}{V_{fma}} = \lambda_{10} + \lambda_{11}.r_m + \lambda_{12}.r_b + \lambda_{13}.r_k + \lambda_{14}.\left(\frac{YD}{V_{fma}}\right) \tag{3.45}$$

$$\frac{B_{h\,d}}{V_{fma}} = \lambda_{20} + \lambda_{21}.r_m + \lambda_{22}.r_b + \lambda_{23}.r_k + \lambda_{24}.\left(\frac{YD}{V_{fma}}\right) \tag{3.46}$$

$$\frac{e_d.p_e}{V_{fma}} = \lambda_{30} + \lambda_{31}.r_m + \lambda_{32}.r_b + \lambda_{33}.r_k + \lambda_{34}.\left(\frac{YD}{V_{fma}}\right) \tag{3.47}$$

$$M_d = V_{fma} - B_{h\,d} - e_d.p_e \tag{3.48}$$

Government sector equations

$$g = constant \tag{3.49}$$

$$G = g.p \tag{3.50}$$

$$T = \tau.S \tag{3.51}$$

$$PSBR = G + r_{b-1}.B_{s-1} - (T + F_{cb}) \tag{3.52}$$

$$\Delta B_s = PSBR \tag{3.53}$$

$$B_{h\,s} = B_{h\,d} \tag{3.54}$$

$$B_{b\,s} = B_{b\,d} \tag{3.55}$$

$$B_{cb\,s} = B_s - B_{h\,s} - B_{b\,s} \tag{3.56}$$

Central bank equations

$$H_s = B_{cb\,d} + A_s \tag{3.57}$$

$$H_{h\,s} = H_{h\,d} \tag{3.58}$$

$$H_{b\,s} = H_s - H_{h\,s} \tag{3.59}$$

$$B_{cb\,d} = B_{cb\,s} \tag{3.60}$$

$$A_s = A_d \tag{3.61}$$

$$r_a = \sigma . r_b \tag{3.62}$$

$$F_{cb} = r_{b-1} . B_{cb\ d-1} + r_{a-1} . A_{s-1} \tag{3.63}$$

Private banks equations

$$M_s = M_d \tag{3.64}$$

$$L_{f\ s} = L_{f\ d} \tag{3.65}$$

$$L_{m\ s} = L_{m\ d} \tag{3.66}$$

$$H_{b\ d} = \rho . M_s \tag{3.67}$$

$$B^n_{b\ d} = M_s - L_{f\ s} - L_{m\ s} - H_{b\ d} \tag{3.68}$$

$$BLR^n = \frac{B^n_{b\ d}}{M_s} \tag{3.69}$$

$$A_d = \omega . (M_s - B^n_{b\ d}) \tag{3.70}$$

$$B_{b\ d} = M_s + A_d - L_{f\ s} - L_{m\ s} - H_{b\ d} \tag{3.71}$$

$$BLR \quad = \frac{B_{b\ d}}{M_s} \tag{3.72}$$

$$\Delta r_m = \xi_m . (Z_1 - Z_2) + \xi_b . \Delta r_a \tag{3.73}$$

$$Z_1 = 1 \quad iff \quad BLR^n < bot \tag{3.74}$$

$$Z_2 = 1 \quad iff \quad BLR^n > top \tag{3.75}$$

$$F_b = r_{l-1} . L_{f\ s-1} + r_{mo-1} . L_{m\ s-1} + r_{b-1} . B_{b\ d-1} - r_{a-1} . A_{d-1} - r_{m-1} . M_{s-1} \tag{3.76}$$

$$\Delta r_l = \xi_l . (Z_3 - Z_4) + \Delta r_a \tag{3.77}$$

$$Z_3 = 1 \quad iff \quad BPM < botpm \tag{3.78}$$

$$Z_4 = 1 \quad iff \quad BPM > toppm \tag{3.79}$$

$$BPM = \frac{(F_b + F_{b-1})}{(M_{s-1} + M_{s-2})} \tag{3.80}$$

$$\Delta r_{mo} = \xi_{mo} . (Z_3 - Z_4) + \Delta r_a \tag{3.81}$$

3.5 APPENDIX 3.B: MODEL CODES

Before defining the variables, the following notations must take into consideration:

1- The subscript *b* refers bank.
2- The subscript *cb* refers central bank.
3- The subscript *d* refers to demand.
4- The superscript *e* refers expected value or volume.
5- The subscript *f* = firms.
6- The subscript *h* = households.
7- The subscript *l* refers loans.
8- The subscript *m* refers deposits.
9- The subscript *mo* refers mortgages.
10- The superscript *T* refers target value or volume.

A	Advances
B	Government security (treasury bills) e.g. $B_{h\,d}$ is households demand treasury bills
$B^{n}_{b\,d}$	Notional bank demand for treasury bills
BLR	Bank liquidity ratio
BLR^{n}	Bank liquidity ratio net of advances
BPM	Bank profit margin
C	Nominal consumption
c	Real consumption
e	Number of equities
F_b	Bank profits
F_{cb}	Central bank profits
F_f	Firms profits
G	Nominal government expenditure

g	Real government expenditure
H_s	High powered money supplied by the central bank
H_b	Vault cash
H_h	Households cash money
Hn	Value of new houses
hn	Number of new houses
Ho	Value of households' housing stock
ho	Number of existing houses acquired by households
Hu	Value of unsold houses
hu	Number of unsold houses
I	Nominal investment
i	Real investment
K	Nominal fixed capital
k	Real fixed capital
κ	Target capital ratio
L_f	Firms loans
L_m	Mortgages
M	Money deposits
N	Number of employees
p	General price level
p_e	Equity price
P_h	Existing houses price level
φ	Price mark-up
π	Price inflation
pr	Workers' productivity
$PSBR$	Public sector borrowing requirement

r_a	Interest rate on advances
r_b	Treasury bills interest rate
r_h	Rate of return in housing
r_k	Rate of return on equities
r_l	Loans interest rate
r_m	Deposits interest rate
r_{mo}	Mortgages interest rate
$rent$	Houses rent service
rep	Households' mortgage repayments
S	Nominal sales
s	Real sales
T	Taxes
UC	Unit cost
V	Nominal wealth
V_{fma}	Financial market assets wealth
v	Real wealth
W	Wage rate
WB	Wage bill
Y	Nominal output or GDP
y	Real GDP
YD	Nominal disposable income
Yd	Real disposable income
yd^e	Expected real disposable income

3.6 APPENDIX 3.C: PARAMETERS VALUES

Parameter	Value	Parameter	Value
$\boldsymbol{\alpha_0}$	96.5	λ_c	0.1
$\boldsymbol{\alpha_1}$	0.7	Ω	0.015603
$\boldsymbol{\alpha_2}$	0.05	φ	0.12782
$\boldsymbol{\beta_1}$	0.5	ψ	0.5
$\boldsymbol{\beta_2}$	0.5	ρ	0.1
$\boldsymbol{\delta_h}$	0.1	σ	1.0
$\boldsymbol{\delta_k}$	0.1	τ	0.2481
$\boldsymbol{\varepsilon}$	0.5	ξ_b	0.0001
$\boldsymbol{\eta_1}$	0.1	ξ_l	0.0001
$\boldsymbol{\eta_2}$	0.5	ξ_{mo}	0.0001
$\boldsymbol{\gamma_k}$	0.5	ζ_1	0.1
$\boldsymbol{\kappa}$	0.35782	ζ_2	0.5
$\boldsymbol{\lambda_{20}}$	0.197238		
$\boldsymbol{\lambda_{21}}$	-0.5		
$\boldsymbol{\lambda_{22}}$	1.0		
$\boldsymbol{\lambda_{23}}$	-0.5		
$\boldsymbol{\lambda_{24}}$	-0.5		
$\boldsymbol{\lambda_{30}}$	0.475459		
$\boldsymbol{\lambda_{31}}$	-0.5		
$\boldsymbol{\lambda_{32}}$	-0.5		
$\boldsymbol{\lambda_{33}}$	1.0		
$\boldsymbol{\lambda_{34}}$	-0.5		

3.7 APPENDIX 3.D: EXOGENOUS VARIABLES VALUES

Parameter	Value
bot	0.47
$botpm$	0.01
g	157.10
μ	0.00
P_e	1.00
Pr	1.00
r_b	0.03
$rent$	0.056
top	0.51
$toppm$	0.01
W	0.80

Chapter 4

FINANCIAL INTEGRATION

4.1 INTRODUCTION

Financial integration has substantially increased in the past two decades not just between developed economies but also between developed and emerging economies (Anderson and Moreno 2005). Two countries or markets are said to be financially integrated if, as Baele *et al* (2004) defined, all potential participants with the same relevant characteristics:

1- Face the same set of rules when they decide to deal with financial instruments and/ or services;
2- Have equal access to those financial instruments and/ or services;
3- Are treated equally when they are active in the market.

Perhaps because of the multifaceted nature of the issue of financial integration, opinions differ on what it is, and how it should be measured. Some authors aver that if assets generating identical cash flows command the same return, then two or more markets can be considered financially integrated.

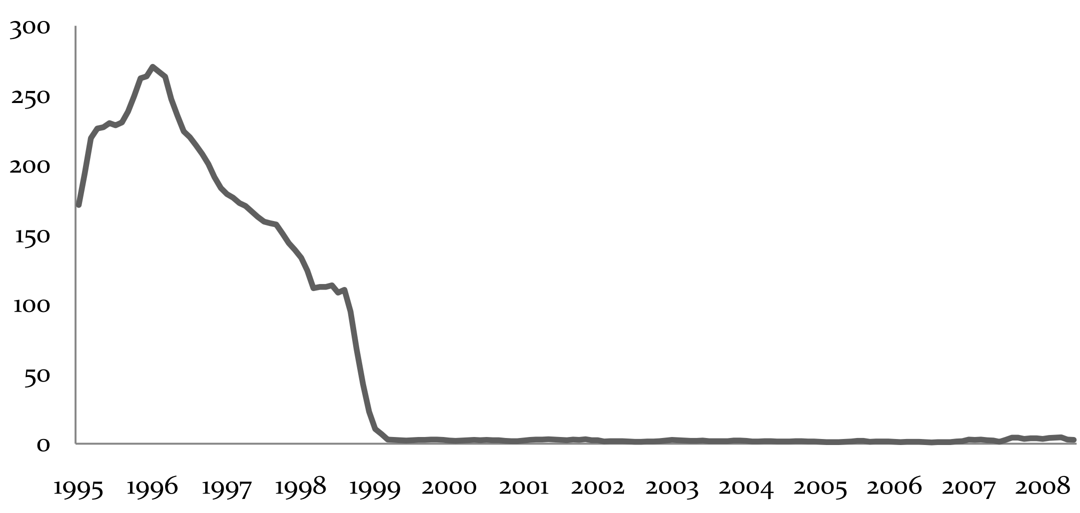
Financial integration can be measured in several ways for different markets; the most important measures are: price-based measures, yield-based measures, news-based measures, and quantity-based measures in money market, credit market, corporate bond market, government bond market, and equity market.

Economists use some statistical measures—like spread, dispersion, change—to see how prices, yields, news, and quantities are close within each market. Figure 4.1 shows the cross-sectional standard deviation of the overnight lending rates among Euro countries money market.

Figure 4.1 shows how the dispersion of the overnight lending rate of all European countries declined to be close to zero after 1998. This means that, after the European monetary union and issuing the single European currency (Euro), the overnight lending rates of all Euro countries become very close to each other.

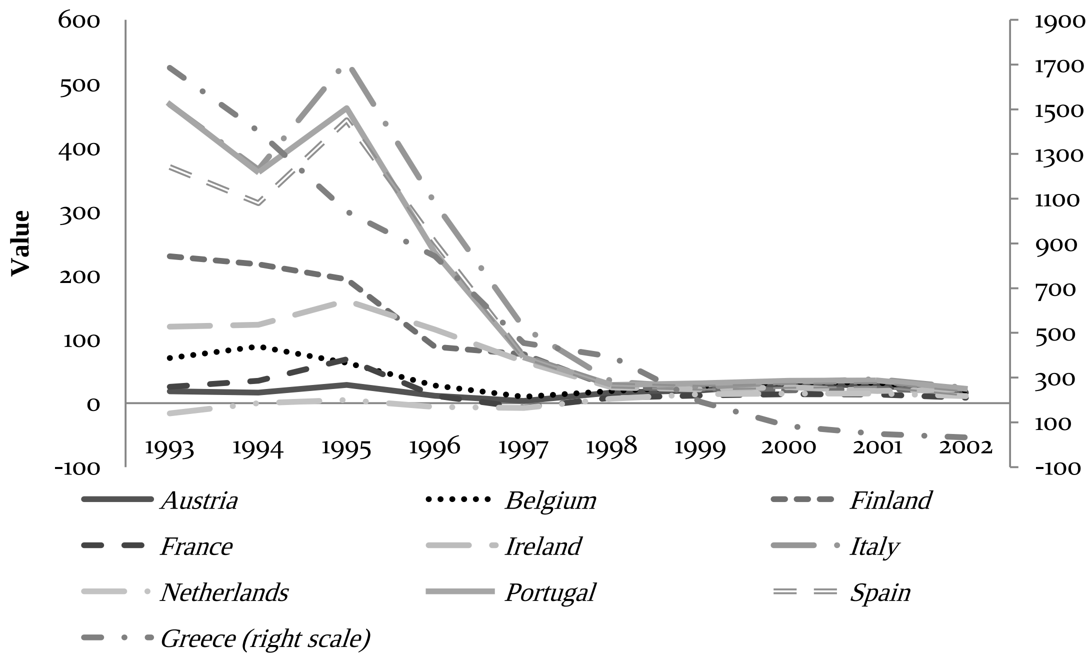
Figure 4.2 shows the average yield spread for 10-year government bond of 10 European countries relative to Germany. The figure shows a convergence in the 10-year average government bonds of the selected European countries.

Figure 4.1: *Cross-sectional standard deviation of the average overnight lending rates among Euro area countries 1995-2008*



Source: ECB.

Figure 4.2: *Average yield spread for 10-year government bonds relative to Germany 1993-2002*



Source: Baele *et al* (2004).

Financial integration between developed countries has substantially increased during the past few decades. In Europe, the creation of economic and monetary union has accelerated the pace of financial integration regionally within Europe (Eichengreen, 2007). Other regions in the world are considering the opportunity to replicate the European integration process, for example the Association of Southeast Asian Nations (ASEAN) plus three other Asian countries, the Gulf Cooperation Council, and others.

The goal of this chapter is to ask how financial integration can affect levels of production, consumption, and output using a stock-flow consistent monetary model pioneered by Godley and Lavoie (2007) in two simulated economies. This is a timely question, since the recent global financial crisis is leading to a re-evaluation of the role from international financial integration. Recent data indicate that developing countries have not required net capital inflows in order to grow (Prasad e*t al*, 2007 and Rodrik and Subramanian, 2009).

Several authors emphasize the important role of financial integration by contributing to economic growth through removing frictions and barriers to exchange (Baele *et al* 2004). The argument for financial integration avers that increasing financial markets integration improve the quality of macroeconomic management in emerging markets, that increased financial integration results in increased economic growth, decreased volatility, and smoothed inter-temporal consumption (Anderson and Moreno, 2005).

Baele et al (2004) suggest further benefits of financial integration: more opportunities of risk sharing, risk diversification and smooth consumption. Kalemli-Ozcan et al (2003) provide empirical evidence that sharing risk across countries improve specialization in production, which result in well-known benefits for the economy. Financially integrated markets provide more financial instruments, and thus diversify portfolios and share risk across countries or regions.

Theoretical models of risk sharing show that sharing risk will lead to a convergence in consumption in the financially integrated countries. Adjaoute and Danthine (2003) find that consumption growth rates in the Euro area are less correlated than are GDP growth rates.

Another benefit of financial integration is that financial integration allows for better allocation of capital among competing investment opportunities. The complete elimination of trade barriers allow firms to choose the most efficient trading, investors can invest anywhere they believe these funds will gain more.

Another implication of greater financial integration is additional economic growth. Financial integration increases risk sharing, allows for more capital allocation, and more funds flowing, which lead to more investment opportunities, more efficient use of resources, decreasing costs, and enhancing production, and thus more economic growth. Baele et al (2004) argue that financial integration increases competition within less developed regions, which improves the efficiency of their financial systems, decreasing the intermediation costs, and increasing production.

Financial integration can expose countries, and particularly those with small open economies, to external shocks, which may reduce any potential growth and consumption smoothing benefits from a process of integration. The issue of uncertain returns in emerging markets leading to flows of capital from emerging markets to developed markets (Reinhart et al, 2003 and Reinhart and Rogoff, 2004) has not been resolved in the literature. Mendoza *et al* 2009 claim that when countries differ in the level of development of their financial markets, then financial integration can be the cause of the global financial imbalances[8].

Baele *et al* (2004) claim that financial integration is insufficient to produce the most efficient outcome unless markets are complete. Hart (1975) shows in his analysis that expanding the set of financial instruments when markets are incomplete is beneficial, if the new instruments bring hedging opportunities.

Anderson and Moreno (2005) provide some factors that may account for the negative effects of financial integration.

[8] Kose *et al* (2006), for example, emphasize financial integration is beneficial for economic performance if only a threshold of financial development is attained. Quality of institutions and macroeconomic policies are therefore key variables in increasing the impact of financial integration on welfare, per capita output, and capital inflows (see Lane and Milesi-Ferretti 2001, Lane 2004, Gourinchas and Jeanne 2008, and Alfaro *et al* 2008).

First, financial integration, as gauged by measures of financial integration, has been uneven. Financial integration involves some well-known trade-offs. Gross capital flows declined in the emerging markets after 1996 after the rise in these flows at the beginning of the 1990s.

A second factor that may account for the negative effect of financial integration is that net capital has flowed from poor to rich countries. Against what theory predicts, there has been a net transfer of resources from developing to developed countries. One reason may stand behind this is that returns in emerging market countries are still highly uncertain in many asset classes.

Third, external shocks may dominate consumption smoothing effects. Empirical evidences show that external shocks, like terms of trade changes, are more important in developing countries than in the developed one. Some evidences show that markets should reach a certain level of development and proper institutions before reducing the vulnerability to external shocks. Most emerging markets are still below that level.

Several studies explore the degree of financial integration within the same country markets and between countries using the co-integration analysis. Voronkova (2004) shows that central Europe has become more integrated with global markets than reported previously. Yang *et al* (2003) examine the long-run co-integration relationship and short-run dynamic causal linkages among the US, Japanese, and ten Asian emerging stock markets. Results of this study show that the long-run co-integration relationships and short-run causal linkages among these markets were strengthened during the Asian financial crisis 1997-1998 and become more integrated after the crisis. While several other co-integration studies show that stock market integration is affected by the financial crisis as Yang *et al* (2003) claim.

Ibrahim (2009) investigates the progress of ASEAN+3 financial markets integration after the 1997 Asian financial crisis using co-integration test on credit and stock markets as indicators. The results show no significant improvement in the intraregional financial integration after the crisis.

Evans and Hnatkovska (2005) have built a general equilibrium model that examines how greater integration of world financial markets affects the behavior of international capital flows and financial returns. They consider two symmetric countries with production of traded and non-traded goods. Evans and Hnatkovska assume that asset prices and relative goods prices clear markets, given the state of productivity, optimal investment, consumption, saving, and portfolio decisions. Their results suggest that at the early stages of financial integration international capital flows are large and volatile. The size and volatility falls dramatically when households gain access to foreign equity markets. The model finds that global risk factors become important as integration rises and equity prices can be used as a reliable measure of financial integration.

Pang (2008) analyzes the welfare impact of financial integration in a standard monetary open economy model with nominal price rigidity. Results show that terms of trade become more volatile when international consumption risk-sharing increases.

Several studies show that ignoring the possibility of structural change can affect the power of co-integration tests and the relevance of their conclusion about the presence of co-integration. Co-integration results differ among studies depending on data used for analysis and specifications used to determine the co-integration relationships. Co-integration studies are used to analyze specific market and cannot cover all markets, while stock flow consistent models have the ability to cover all markets, like money, credit, bonds, and equity markets within the same country and between countries.

The growth in cross-border investment positions in recent years has prompted a multi-layered global debate about the macroeconomic impact of increased financial integration.

Another measure of financial integration is the index built by Lane and Milesi-Ferretti (2001a and 2007a). This index is a volume-based measure of international financial integration:

$$IFI_t^i = \frac{FA_t^i + FL_t^i}{GDP_t^i}$$

where; IFI_t^i is the index for country *i* at time *t*, FA_t^i is foreign assets held, FL_t^i is foreign liabilities held, and GDP_t^i is gross domestic product.

This measure has two advantages: first, it is the financial analogue to measuring trade openness by the ratio of exports plus imports over GDP, and so is easily interpreted. Second, the measure is well established in the literature, and so the results of our simulations can be compared with other studies such as Lane and Milesi-Ferretti (2007a, 2007b).

This chapter is organized as follows. Model's balance sheets and transactions and flows matrix, a description of the model equations and identities for both economies, and simulation experiments are presented in section 2. Section 3 concludes.

4.2 THE MODEL

This chapter contribution is exploring financial integration using the stock flow consistent approach grounded in Godley and Lavoie (2007). The model deployed in this chapter describes two steady state economies, each economy compound of five sectors: households, firms (non-financial sector), government, central bank, and private banks. Each sector is assumed to acquire assets (+) and have liabilities (-).

The model assumes that one country is small in terms of its gross national product, and the other is large. In this chapter, the aim of simulation experiments is to explore the effect of some policies and agreements on the degree of financial integration in both countries. There are several ways of measuring financial integration directly or indirectly. Some are based on checking the number of existing frictions and barriers to the intermediation process, so the more symmetric frictions and barriers are the higher the degree of financial integration. Others concentrate on the prices of assets in each economy, so the closer these relative prices are (or the smaller their coefficient of dispersion are) the more the degree of financial integration measured (Flood and Rose 2004, Pagano 2002).

4.2.1 MODEL MATRICES

Table 4.1 provides the balance sheet matrix of the model. The matrix contains five sectors in each economy. These sectors are assumed to acquire assets (+) and liabilities (-). The superscript *1* refers to the first country and *2* refers to the second one. The subscript *h* refers to households, *f* to firms, *b* to banks, *cb* to the central bank, *d* for demand, and *s* for supply. All columns and rows in the matrix sum to zero apart from the fixed capital, which is an asset that has no counterpart liability.

Households are assumed to acquire high-powered money ($+H^{j}_{h\,d}$), where j = 1 for country one and 2 for country two. They are assumed to have money deposits in banks ($+M^{j}_{d}$). Households in both countries are assumed to acquire domestic ($+B^{j}_{h\,j\,d}$) and foreign ($+B^{z}_{h\,j\,d}$) government securities, where z = 1 for country one and 2 for country two and $z \neq j$—in this model, treasury bills are taken as a proxy of the government securities. Households are also assumed to acquire firm equities ($+e^{j}.p^{j}_{e}$), where e is the number of equities and p_e is the price of the equity. The sum of households' assets gives the households wealth ($-V^{j}_{h}$). Households' wealth has a (-) sign to guarantee that the sum of households' sector column equals zero.

Firms are assumed to have fixed capital ($+K^{j}$) and take loans from banks ($-L^{j}_{f\,d}$) and supply equities to households. The sum of these assets and liabilities gives the net worth of firms' sector ($-NW^{j}_{f}$). Each government is assumed to supply treasury bills ($-B^{j}_{s}$) to domestic and foreign households, domestic banks, and its central bank. The second country government is assumed to supply treasury bills to the first country central bank. Due to the assumption that the first country is small, it is assumed that the second country central bank do not hold treasury bills from the first country. The stock of treasury bills supplied by the government is equal to its debt (net worth of government ($-NW^{j}_{g}$)).

The central bank assets are its holdings of domestic ($+B^{j}_{cb\,j\,d}$) and foreign bills ($+B^{z}_{cb\,j\,d}$). Theses foreign bills are assumed to be constant due to the assumption of floating exchange rate. The main role of the central banks is to supply money ($+H^{j}_{s}$), which are considered as a liability for the central bank.

Banks' assets are loans, vault cash ($+H^{j}_{b\,d}$), and domestic bills ($+B^{j}_{b\,d}$), while deposits are their counterpart liabilities. Banks' net worth is assumed to equal zero in this model.

Table 4.1: *Balance Sheets Matrix of Both Countries*

	Country 1					Ex. Rate	Country 2					Sum
	Households	**Firms**	**Gov.**	**C. Bank**	**Banks**		**Households**	**Firms**	**Gov.**	**C. Bank**	**Banks**	
Fixed Capital		$+K^1$				$1/E_1$		$+K^2$				ΣK
HPM	$+H^1_{h\,d}$			$-H^1_s$	$+H^1_{b\,d}$		$+H^2_{h\,d}$			$-H^2_s$	$+H^2_{b\,d}$	0
Loans		$-L^1_{f\,d}$			$+L^1_{f\,s}$			$-L^2_{f\,d}$			$+L^2_{f\,s}$	0
Deposits	$+M^1_d$				$-M^1_s$		$+M^2_d$				$-M^2_s$	0
Bills[1]	$+B^1_{h\,1\,d}$		$-B^1_s$	$+B^1_{cb\,1\,d}$	$+B^1_{b\,1\,d}$	$1/E_1$	$+B^1_{h\,2\,d}$					0
Bills[2]	$+B^2_{h\,1\,d}$			$+B^2_{cb\,1\,d}$		$1/E_1$	$+B^2_{h\,2\,d}$		$-B^2_s$	$+B^2_{cb\,2\,d}$	$+B^2_{b\,2\,d}$	0
Equities	$+e^1.P_e^1$	$-e^1.P_e^1$					$+e^2.P_e^2$	$-e^2.P_e^2$				0
Balance	$-V^1_h$	$-NW^1_f$	$-NW^1_g$			$1/E_1$	$-V^2_h$	$-NW^2_f$	$-NW^2_g$			$-\Sigma K$
Sum	0	0	0	0	0		0	0	0	0	0	0

Table 4.2 describes the transactions and flows between all economic sectors of the two economies. As with the balance sheets matrix, shown in table 4.1, all rows and columns must sum up to zero. Each country's transactions are measured in its currency. *Sources* of funds are in (+) signs and *uses* of funds are in (-) signs.

As shown in the current account column of the firms, households consumption ($+C^j$), government expenditure ($+G^j$), investment ($+I^j$), and exports ($+X^j$) are used to finance wages ($-WB^j$), taxes ($-T^j{}_f$), imports ($-IM^j$), interests on loans taken from banks ($-r^j{}_{l-1}.L^j{}_{f\ d-1}$), and profits ($-F^j{}_f$), these profits are transferred entirely to households. Firms take loans and issue equities to finance their investments, as shown in the firms' capital account column.

Households receive wages, profits, and interest on their holdings of financial assets. Households use these flows to cover for consumption and to pay taxes ($-T^j{}_h$) on their income. The residual, savings ($-\Delta V^j{}_h$), is used to acquire more financial assets. Both governments collect taxes from households and firms, and take all the central bank's profits ($+F^j{}_{cb}$) to finance the governmental expenses. The difference between the government's inflows and outflows determines the public sector borrowing requirement (*PSBR*).

Both central banks receive profits in the form of interest payments on their holdings of domestic ($+r^j{}_{b-1}.B^j{}_{cb\ j\ d-1}$) and foreign ($+r^z{}_{b-1}.B^z{}_{cb\ j\ d-1}$) assets, and they transfer these profits to the government. The change in their holdings of assets determines the quantity of money they have to supply in any period. Banks generate profits ($-F^j{}_b$) from the difference between their ingoing and outgoing interests. Change in deposits determine how much banks can give in loans and acquire in assets.

Table 4.2: *Transactions Flows Matrix of Both Countries*

Country 1	**Households**	**Firms**		**Gov.**	**Central Banks**		**Banks**		**Ex. Rate**
		Current	**Capital**		**Current**	**Capital**	**Current**	**Capital**	
Consumption	$-C^1_d$	$+C^1_s$							
Gov. Expenditure		$+G^1_s$		$-G^1_d$					
Investment		$+I^1$	$-I^1$						
Exports		$+X^1$							$1/E_1$
Imports		$-IM^1$							$1/E_1$
Taxes	$-T^1_h$	$-T^1_f$		$+T^1$					
Wages	$+WB^1$	$-WB^1$							
Entrepreneurial Profits	$+F^1_f$	$-F^1_f$							
Bank Profits	$+F^1_b$						$-F^1_b$		
CB Profit				$+F^1_{cb}$	$-F^1_{cb}$				
Interest on									
Loans		$-r^1_{l-1}.L^1_{f\,d-1}$					$+r^1_{l-1}.L^1_{f\,s-1}$		
Deposits	$+r^1_{m-1}.M^1_{d-1}$						$-r^1_{m-1}.M^1_{s-1}$		
Bills^1	$+r^1_{b-1}.B^1_{h\,1\,d-1}$			$-r^1_b.B^1_{s-1}$	$+r^1_{b-1}.B^1_{cb\,1\,d-1}$		$+r^1_{b-1}.B^1_{b\,1\,d-1}$		$1/E_1$
Bills^2	$+r^2_{b-1}.B^2_{h\,1\,d-1}$				$+r^2_{b-1}.B^2_{cb\,1\,d-1}$				$1/E_1$
Δ in the stocks of									
Loans			$+\Delta L^1_{f\,1\,d}$					$-\Delta L^1_{f\,1\,s}$	
HPM	$-\Delta H^1_{h\,d}$					$+\Delta H^1_s$		$-\Delta H^1_{b\,d}$	
Deposits	$-\Delta M^1_d$							$+\Delta M^1_d$	
Bills^1	$-\Delta B^1_{1\,d}$			$+\Delta B^1_s$		$-\Delta B^1_{cb\,1\,d}$		$-\Delta B^1_{b\,1\,d}$	$1/E_1$
Bills^2	$-\Delta B^2_{h\,1\,d}$					$-\Delta B^2_{cb\,1\,d}$			$1/E_1$
Equities	$-\Delta e^1_d.P_e^1$		$+\Delta e^1_d.P_e^1$						
Σ	0	0	0	0	0	0	0	0	

Table 4.2: *Transactions Flows Matrix of Both Countries (continued)*

Country 2	**Households**	**Firms**		**Gov.**	**Central Banks**		**Banks**		**Σ**
		Current	**Capital**		**Current**	**Capital**	**Current**	**Capital**	
Consumption	$-C^2_d$	$+C^2_s$							0
Gov. Expenditure		$+G^2_s$		$-G^2_d$					0
Investment		$+I^2$	$-I^2$						0
Exports		$+X^2$							0
Imports		$-IM^2$							0
Taxes	$-T^2_h$	$-T^2_f$		$+T^2$					0
Wages	$+WB^2$	$-WB^2$							0
Entrepreneurial Profits	$+F^2_f$	$-F^2_f$							0
Bank Profits	$+F^2_b$						$-F^2_b$		0
CB Profit				$+F^2_{cb}$	$-F^2_{cb}$				0
Interest on									0
Loans		$-r^2_{l-1}.L^2_{f\,d-1}$					$+r^2_{l-1}.L^2_{f\,s-1}$		0
Deposits	$+r^2_{m-1}.M^2_{d-1}$						$-r^2_{m-1}.M^2_{s-1}$		0
Bills^1	$+r^1_{b-1}.B^1_{h\,2\,d-1}$								0
Bills^2	$+r^2_{b-1}.B^2_{h\,2\,d-1}$			$-r^2_b.B^2_{s-1}$	$+r^2_{b-1}.B^2_{cb\,2\,d-1}$		$+r^2_{b-1}.B^2_{b\,2\,d-1}$		0
Δ in the stocks of									0
Loans			$+\Delta L^2_{f\,2\,d}$					$-\Delta L^2_{f\,2\,s}$	0
HPM	$-\Delta H^2_{h\,d}$					$+\Delta H^2_s$		$-\Delta H^2_{b\,d}$	0
Deposits	$-\Delta M^2_d$							$+\Delta M^2_d$	0
Bills^1	$-\Delta B^1_{h\,2\,d}$								0
Bills^2	$-\Delta B^2_{h\,2\,d}$			$+\Delta B^2_s$		$-\Delta B^2_{cb\,2\,d}$		$-\Delta B^2_{b\,2\,d}$	0
Equities	$-\Delta e^2_d.P_e^2$		$+\Delta e^2_d.P_e^2$						0
Σ	0	0	0	0	0	0	0	0	0

The assumption of no private holdings of foreign cash money implies that all transactions of foreign currency by trade of goods or assets are simultaneously exchanged by the central bank into domestic currency.

4.2.2 MODEL EQUATIONS

In this subsection, a general description of model equations and identities are introduced. Detailed equations and identities can be found in appendix 4.A. Most of model equations are taken from Godley and Lavoie (2007). These equations and identities describe the balance sheets and transactions flows constraints, the behavior, and the decisions taken in each economic sector for both countries. The uppercase variables are in nominal values and the lowercase variables are in real terms.

Firms' nominal output, GDP, equal to the values of consumption, government expenditure, investment, exports, and imports.

$$Y^j = C^j + G^j + I^j + X^j - IM^j$$

Firm's real sales are the sum of real households' consumption, real government expenditure, real investment, and real exports.

$$s^j = c^j + g^j + i^j + x^j$$

Real output is the sum of real consumption, real government expenditure, real investment, real exports minus real imports. The equation can be written in the following form.

$$y^1 = s^j - im^j$$

In this model five prices are considered in each country: sales price, domestic sales price, export prices, import prices, and domestic price deflator (or GDP deflator). These prices are interconnected, such that import prices affect volumes and values of exports and imports, which affect the price of sales, domestic sales price and GDP deflator, which in turn affects volume of imports and exports. This subsection will show how each price will be formed.

At any period *t*, the price level of sales is a mark up, φ^j, on costs. All profits earned by firms as a result of the mark up are assumed to be transferred to households as they are considered the owners of firms. Firm's costs are the wages they pay for workers, the value of imported commodities, and the tax on those imports, which transferred to the government. The government assigns an import tax rate on the total value of imports (τ_{im} = 10.7%), see appendix 4.A. Thus, these taxes considered as a cost for firms and enter the sales price equation. Any change in the tax rate will be reflected directly on sales prices.

$$P_s^j = \frac{\left(1+\varphi^j\right).\left(WB^j + IM^j + T_{im}^j\right)}{s^j}$$

Price of domestic sales is determined by the value of sales minus the value of exports over the volume of sales minus the volume of exports.

$$P_{ds}^j = \frac{(S^j - X^j)}{(s^j - x^j)}$$

Firms' real investment decision is a function of the difference between the actual and target real fixed capital plus depreciation allowance of fixed capital.

$$i^j = \gamma_k^j.\left(k^{Tj} - k_{-1}^j\right) + \delta_k^j.k_{-1}^j$$

Firms are assumed to ask for loans and issue equities to cover their investments. Thus, new loans, that firms demand, are equal to the value of net investment minus the new equities issued.

$$\Delta L_{f\ d}^{j} = I^{j} - \delta_{k}^{j}.K_{-1}^{j} - \Delta e_{s}^{j}.P_{e}^{j}$$

The following equations describe the trade flows between the two countries and their relevant prices. The following equations describe the import and export price levels in the first country. Import price is determined by the exchange rate, domestic and foreign prices. It shows that if the domestic currency appreciates with respect to the other country's currency then import prices decline. Import price increases with the increase in domestic price deflator and foreign price deflator. Bold characters are in logs.

$$\boldsymbol{P_{m}^{1}} = \upsilon_{0} \ - \upsilon_{1}\ .\boldsymbol{E_{1}} + \upsilon_{2}\ .\boldsymbol{P_{y}^{1}} + \upsilon_{3}\ .\boldsymbol{P_{y}^{2}}$$

Exports price level can be determined on the same way as imports price equation.

$$\boldsymbol{P_{x}^{1}} = \omega_{0} \ - \omega_{1}\ .\boldsymbol{E_{1}} + \omega_{2}\ .\boldsymbol{P_{y}^{1}} + \omega_{3}\ .\boldsymbol{P_{y}^{2}}$$

Domestic price deflator (GDP deflator) equals the value of domestic output over the volume of output.

$$p_{y}^{j} = \frac{Y^{j}}{y^{j}}$$

In this model, it is assumed that there are no transactions costs for trade, and thus import and export prices of the second country can be determined by the export and import prices of the first country multiplied by the exchange rate.

$$P_m^2 = P_x^1 . E_1$$

$$P_x^2 = P_m^1 . E_1$$

In this model, the exchange rate can be determined through capital flows between the two countries. This model assumes a floating exchange rate.

$$E_1 = \frac{B_{h\ 1\ s}^2}{B_{h\ 1\ d}^2}$$

Imports' volume in the first country responds with elasticities: $\mu^j{}_1$ with respect to import prices relative to domestic prices—valued in domestic currency—and $\mu^j{}_2$ with domestic real output.

$$\boldsymbol{im^1} = \mu_0 \ - \mu_1 \ .\left(\boldsymbol{P_{m-1}^1} - \boldsymbol{P_{y-1}^1}\right) + \mu_2 \ .\boldsymbol{y^1}$$

Exports' volume can be found in the same way, but respond with elasticities: $\varepsilon^j{}_1$ with respect to the other country's import prices relative to foreign prices and $\varepsilon^j{}_2$ with respect to the other country real output.

$$\boldsymbol{x^1} = \varepsilon_0 \ - \varepsilon_1 \ .\left(\boldsymbol{P_{m-1}^2} - \boldsymbol{P_{y-1}^2}\right) + \varepsilon_2 \ .\boldsymbol{y^2}$$

The volume of imports and exports of the second country is equal to the volume of exports and imports of the first country, thus:

$$x^2 = im^1$$

$$im^2 = x^1$$

Values of exports and imports are equal to relevant volumes multiplied by the respective price.

The following equations describe current and capital accounts of each country. The current account balance is the difference between the values of exports and imports plus the net current transfers, which in this model is the difference between ingoing and outgoing interests on treasury bills acquired in the two countries.

$$CAB^j = X^j - IM^j + r_{b-1}^z . B_{h\ j\ d-1}^z + r_{b-1}^z . B_{cb\ j\ d-1}^z - r_{b-1}^j . B_{h\ z\ s-1}^j - r_{b-1}^j . B_{cb\ z\ s-1}^j$$

The capital account balance in this model is the net change of treasury bills in each country.

$$KAB^j = \Delta B_{h\ z\ s}^j + \Delta B_{cb\ z\ s}^j - \Delta B_{h\ j\ d}^z - \Delta B_{cb\ j\ d}^z$$

Households' disposable income YD^j, as given in the following equation, is equal to the personal income YP^j minus income tax plus capital gains CG^j.

$$YD^j = YP^j - T_h^j + CG^j = \left(1 - \theta^j\right) . YP^j + CG^j$$

where personal income is the sum of wages, profits from firms and banks, and interest inflows on deposits and domestic and foreign treasury bills.

$$YP^j = WB^j + F^j + r_{m-1}^j . M_{d-1}^j + r_{b-1}^j . B_{h\ j\ d-1}^j + r_{b-1}^z . B_{h\ j\ d-1}^z$$

The difference between disposable income and consumption equals savings as shown in the following equation.

$$\Delta V^j = YD^j - C^j$$

Households' real consumption decision depends upon their real disposable income and real wealth, as given in the following equation.

$$c^j = \alpha_1^j . yd^j + \alpha_2^j . v_{-1}^j$$

Households are assumed to manage their portfolios based on Tobin's portfolio decision. Demand for financial assets as a share of wealth net of cash money (V^j_{nc}) depends upon the rate of return on those assets, see equations 4.82 – 4.89 in appendix 4.A. Cash money is assumed to be a portion of households' consumption.

The government in each country is assumed to supply treasury bills, design the fiscal policy, and set the interest rate on treasury bills, which is under its control. The difference between government expenditure and revenues is the public sector borrowing requirement (*PSBR*).

$$PSBR^j = G^j + r_{b-1}^j . B_{s-1}^j - \left(T^j + F_{cb}^j\right)$$

Both governments are assumed to cover their borrowing by issuing new treasury bills.

$$\Delta(B_s^1) = PSBR^j$$

Governments, in this model, supply treasury bills to fulfill domestic and foreign demands. The first country government is assumed to supply treasury bills to domestic and foreign households and domestic banks. The rest goes to the domestic central bank. The second country government is assumed to supply bills to domestic and foreign households, domestic banks and the foreign central bank. The rest goes to the domestic central bank.

Central banks supply high-powered money to households and banks. High-powered money is assumed not to be purchased outside the country. The following equation describes the supply of high-powered money, which depends upon the change in domestic and foreign bills acquired by the domestic and foreign central bank. Change in the foreign bills is equal to zero, which can be ignored due to the assumption of floating exchange rate.

$$\Delta H_s^j = \Delta B_{cb\ j\ d}^j + \Delta B_{cb\ j\ d}^z$$

Banks' profits, which transferred totally to households, are the difference between the ingoing and outgoing interests. Banks are assumed to supply loans to firms and accept deposits from households on demand. Banks budget constraint as shown in its balance sheet, determines the demand for treasury bills.

$$B_{b\ d}^j = M_s^j - H_{b\ d}^j - L_{f\ s}^j$$

Banks are assumed to set interest rates on deposits and loans. Interest rate on deposits depends upon two factors, treasury bills interest rate and their liquidity position. Beside the treasury bills interest rate, bank's profit margin affect the interest rate on loans, see appendix 4.A for more details.

The redundant, or the hidden, equation in this model is that the central bank in each country supplies vault cash to banks on demand.

$$H_{b\ s}^j = H_{b\ d}^j$$

The above equation can be derived from equation 4.115 or 4.116. The derivation of this equation is not an easy task due to that fact that the model is open economy model and contains a high number of equations. But with simulation the equation can be checked.

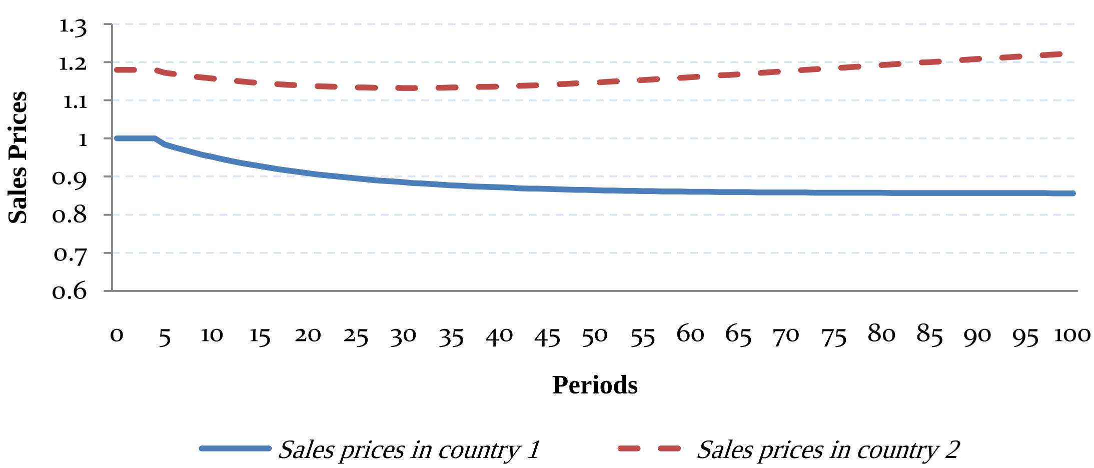
4.2.3 MODEL SIMULATIONS

The baseline scenario assumes two open countries that trade goods, services, and some financial assets. Both countries are in a steady state condition.

The first scenario (free trade)

The first scenario assumes that the two governments sign a free trade agreement, and the tax rate on imports becomes zero. In order to neutralize the effect of the government deficit, due to the decline in import taxes, on the economy, it is assumed that both governments increase the income tax levied on households such that the increase in income tax revenues offset the decline in import tax revenue. Eliminating import taxes leads to a decline in price of sales in both countries, see equations 4.15 and 4.16. Figure 4.3 shows the evolution of sales prices in both countries.

Figure 4.3: *Evolution of sales prices in both countries after freeing trade*



The decline in sales prices leads to an increase in the volume of imports and exports in both countries see equations 4.50 – 4.53. On the other hand, the decline in exports and sales prices lead to a decline in domestic sales prices, which will lead to an increase in real disposable income, real wealth, and thus real households' consumption. Figures 4.4 and 4.5 show the evolution of real households' consumption, real disposable income, and real wealth after freeing trade in both countries.

Figure 4.5: *Evolution of real consumption, real disposable income, and real wealth in the first country after freeing trade*

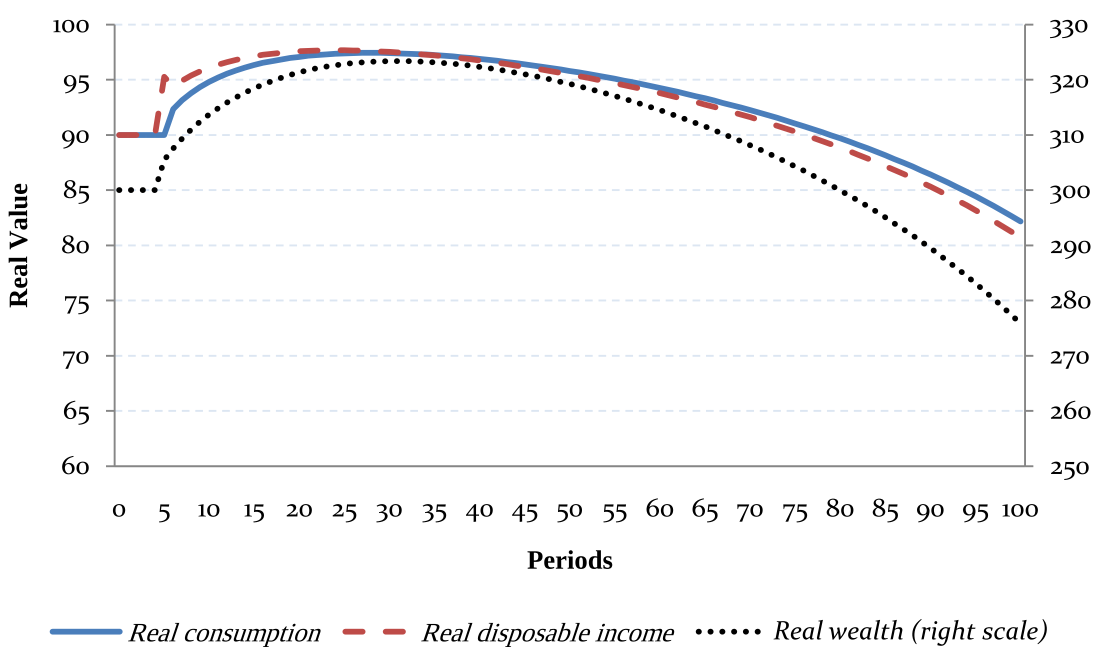
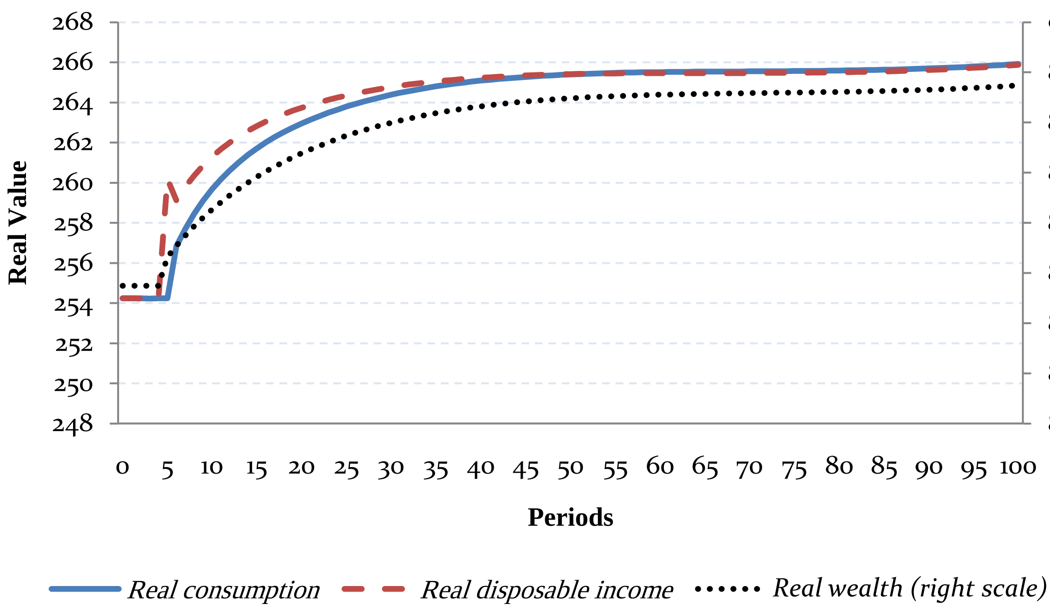


Figure 4.6: *Evolution of real consumption, real disposable income, and real wealth in the second country after freeing trade*



Figures 4.7 and 4.8 show the evolution of the real output in the first and in the second country after freeing trade.

Figure 4.7: *Evolution of the first country real output after freeing trade*

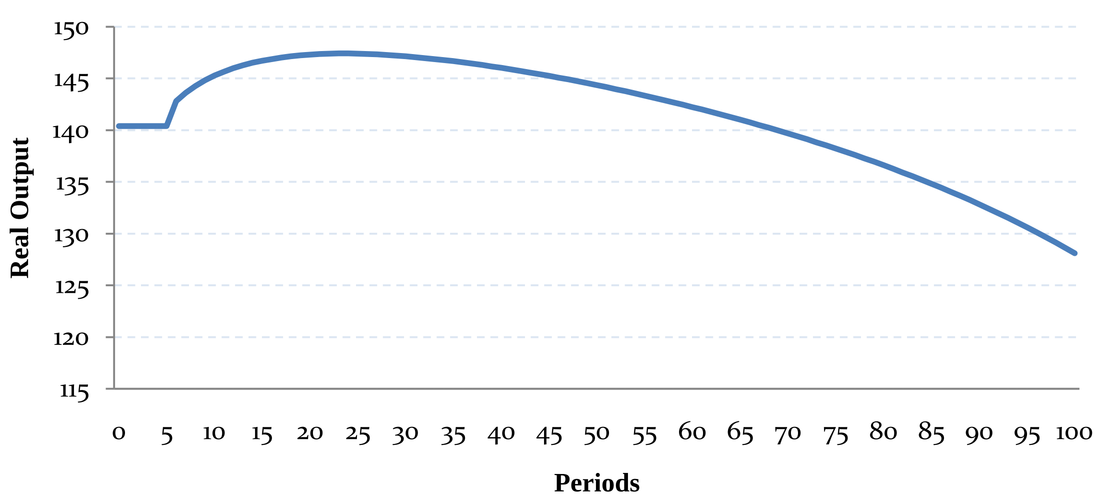
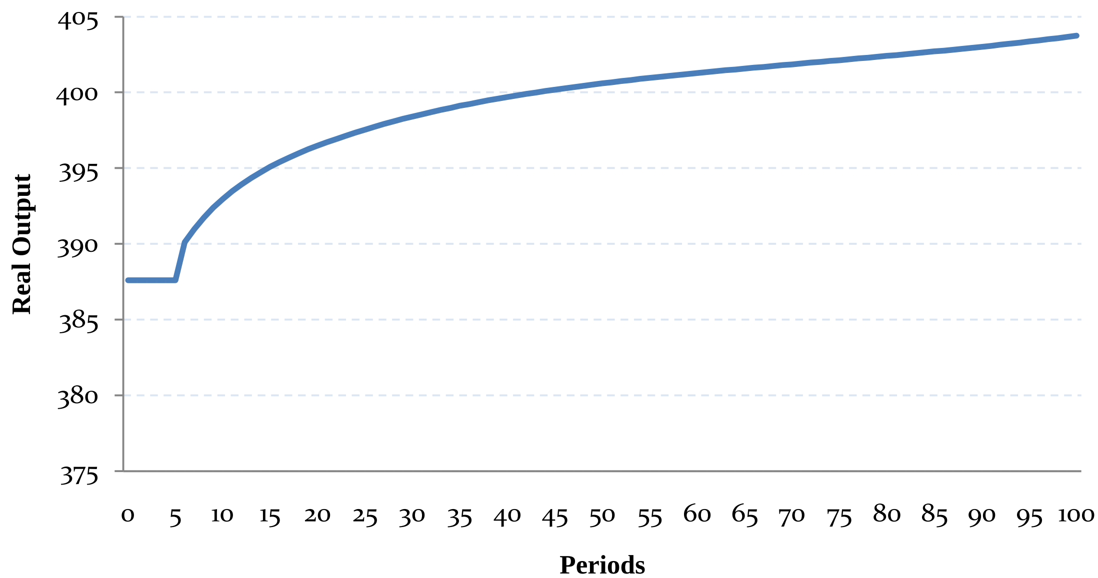


Figure 4.8: *Evolution of the second country real output after freeing trade*

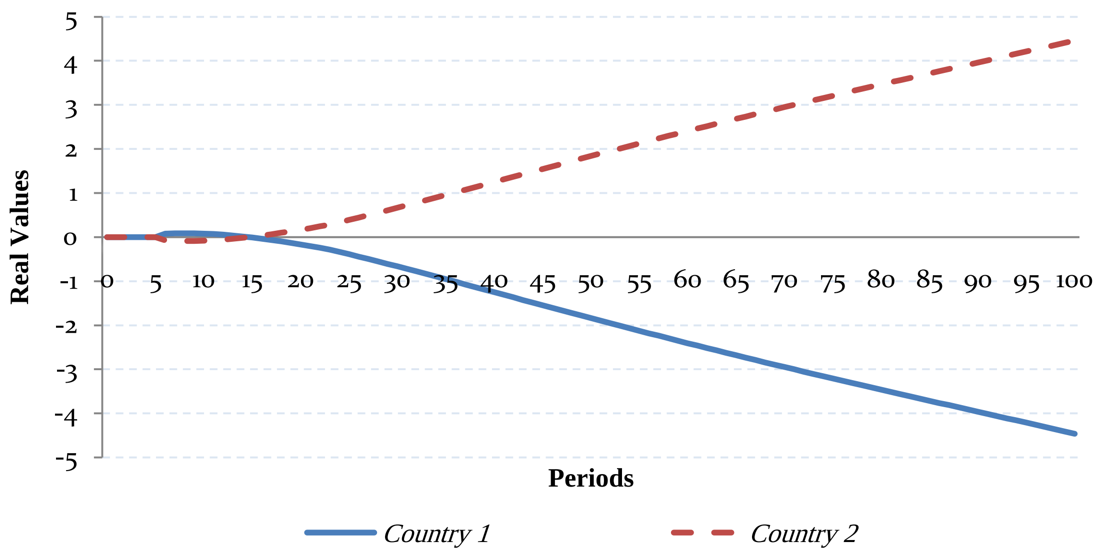


As shown in figure 4.7, real output increases to higher levels after freeing trade but several periods after it starts to decline, while in the second country real output continue increasing after freeing trade.

One main reason may stand behind the decline in the real output in the first country and the continuous increase in the real output in the second country is the trade balance in each country.

Figure 4.9 show the evolution of trade balance in both countries. Immediately after freeing trade, the first country enjoys a trade surplus while the second enjoys a trade deficit. But several periods later the second country enjoys a trade surplus while the first country enjoys deficit in its trade balance.

Figure 4.9: *Evolution of trade balances after freeing trade in both countries*



On the other hand, the trade deficit in the first country with the decline in prices lead to a decline in firms' profits and wages, which lead to a decline in households disposable income and thus consumption. This effect will lead to a decline in the real output of the first country. Figures 4.10 and 4.11 show the evolution of households' portfolio distribution in both countries after freeing trade.

Figure 4.10: *Evolution of the first country households' portfolio after freeing trade*

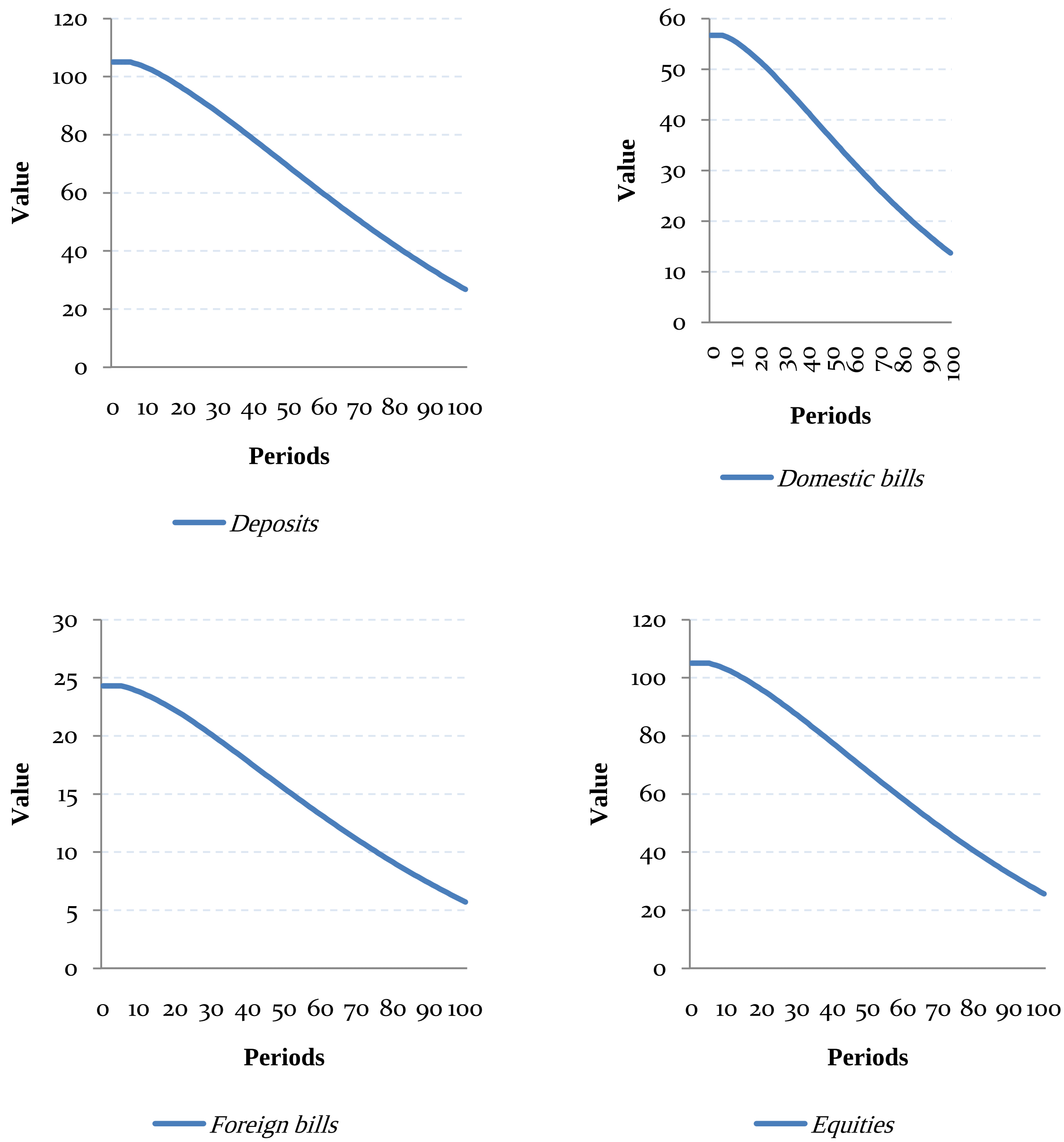
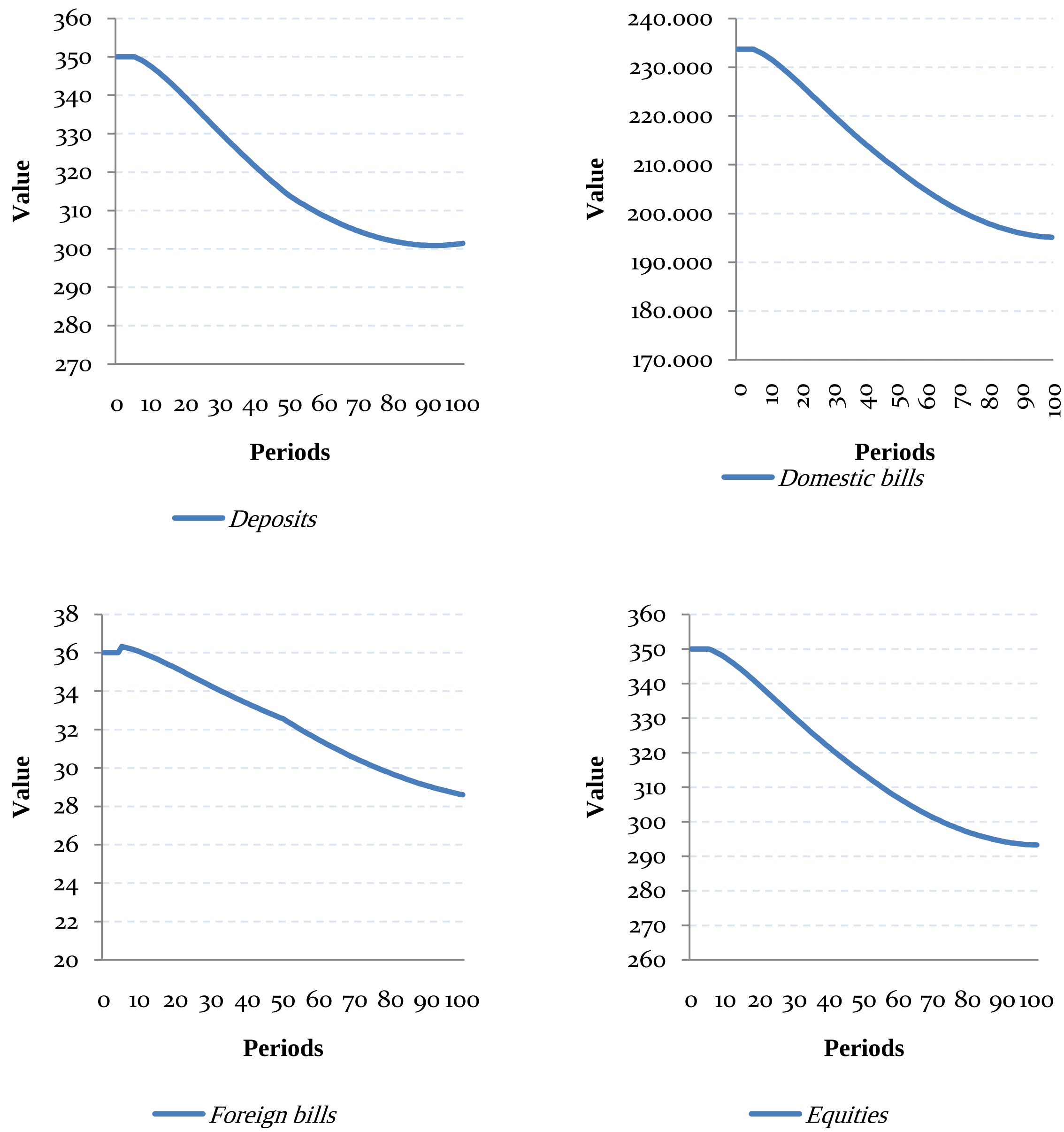


Figure 4.11: *Evolution of the second country households' portfolio after freeing trade*



The effect of the decline in prices leads to a decline in the value of households' wealth, which in turn lead to a decline in their demand for financial assets.

Figures 4.12 and 4.13 show the evolution of the current account balance (CAB), capital account balance (KAB), and the government budget balance (GBB) in both countries after freeing trade. As shown in the figure, the first country enjoys a surplus in the CAB at the beginning but later it enjoys a deficit. KAB is almost equals zero. The second country enjoys deficits in CAB at the beginning but later it enjoys a surplus in its CAB. KAB as in the first country is equal to zero. The decline in government supply of treasury bills, following the decline in demand, leads to a government budget surplus in both countries. As shown in figure 4.12, it looks that CAB and GBB converging towards zero in the long-run, but due to the increase in the exchange rate the second country need more time for its CAB and GBB to converge towards zero. Figure 4.14 shows the evolution of the exchange rate after freeing trade.

Figure 4.12: *Evolution of CAB, KAB, and GBB in the first country after freeing trade*

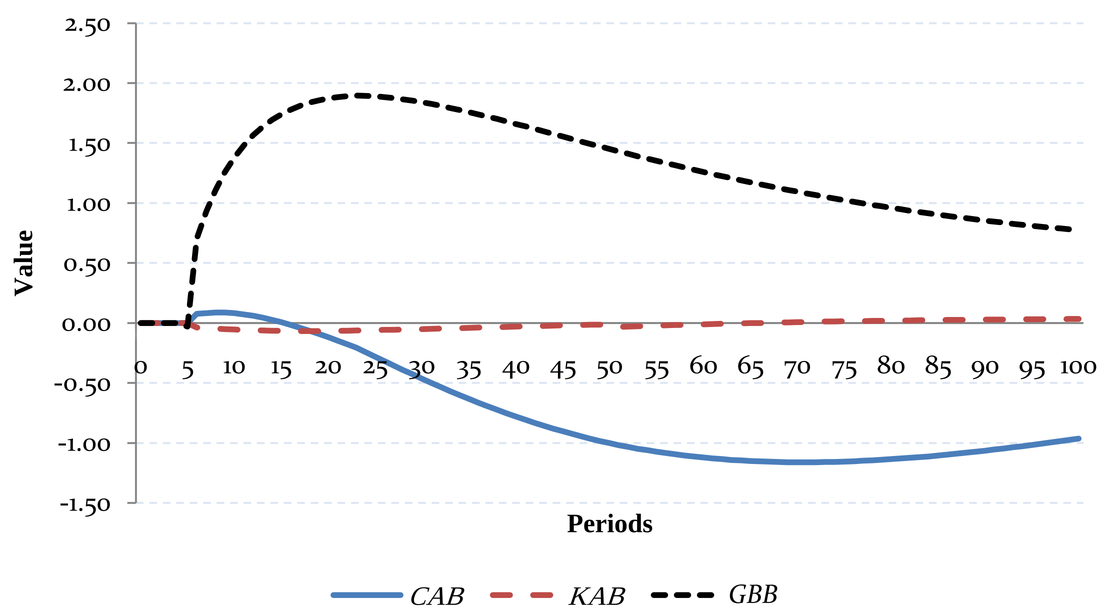


Figure 4.13: *Evolution of CAB, KAB, and GBB in the second country after freeing trade*

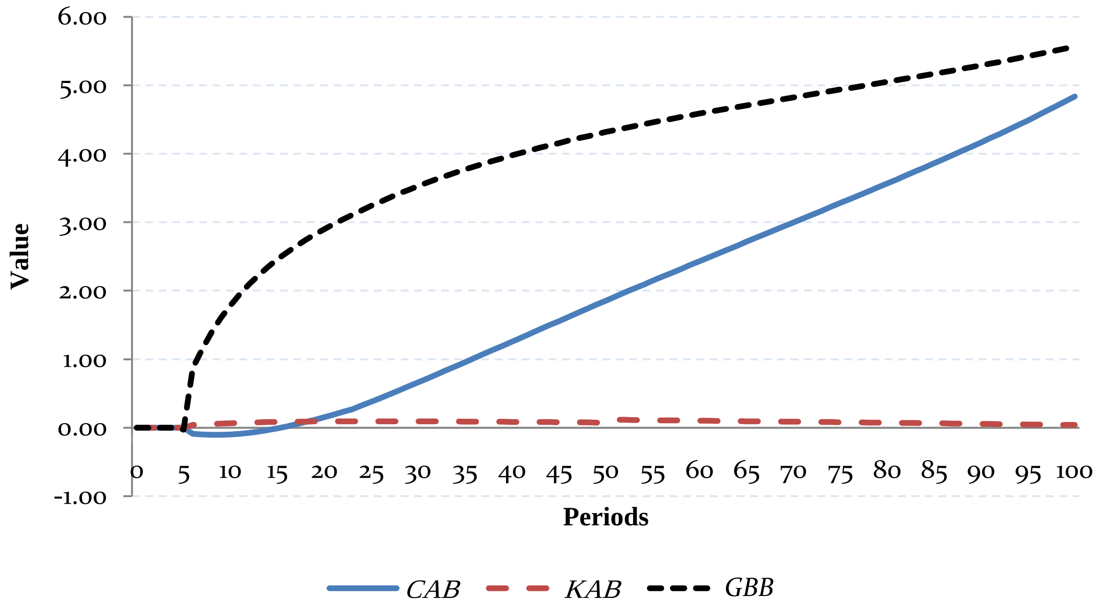
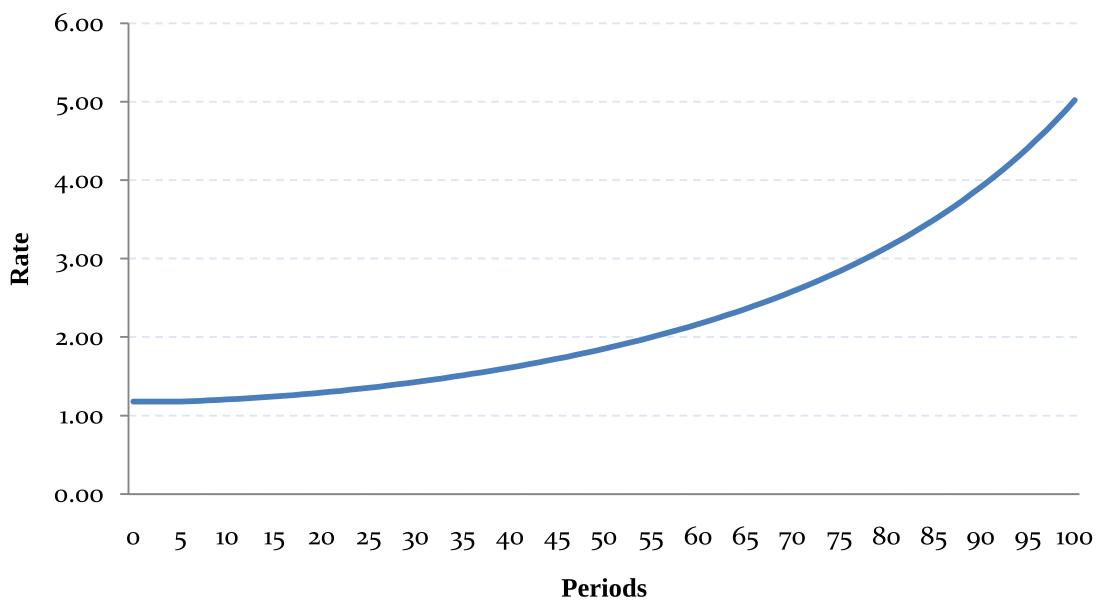


Figure 4.14: *Evolution of the exchange rate after freeing trade*



The second scenario (asymmetric treasury bills interest rates)

The second scenario assumes that both countries set the interest rate on treasury bills at different rates. Treasury bills rate in the first country is equal to 3.5 percent and in the second country is equal to 3.0 percent. Moving to interest rate parity, both bills rate are equal to 3.0 percent. In this model, the price of each Treasury bill issued by the government is equal to one unit currency of that country, one can assume that the prices are different and then equalize them to see the effect on financial integration.

Figure 4.15: *Evolution of both countries households' demand for foreign treasury bills in the case of symmetric treasury bills interest rate compared with asymmetric treasury bills interest rate*

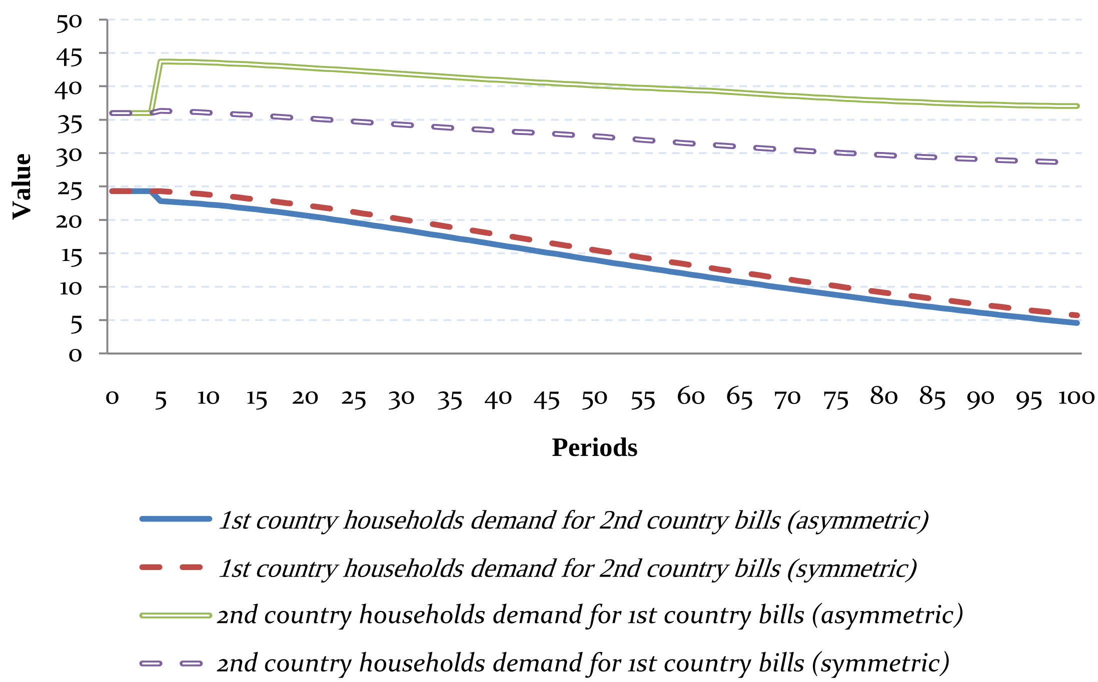


Figure 4.15 shows how demand for foreign treasury bills changes in both countries when the first country set its treasury bills interest rate equal to the second

country treasury bills interest rate. As shown in the figure, when bills rate in both countries is symmetric, then the demand for foreign assets converges or the gap between both countries demand is less, which is considered as a sign of financially integrated markets.

The third scenario (monetary union)

One may increase financial integration between countries by entering into a monetary union. This scenario assumes that both countries sign an agreement for monetary union and are now using a single currency (the second country currency). As a consequence, the value of all assets, liabilities, and stocks in the first country are valued in terms of the second country's currency[9]. It is worth noting that this scenario assumes also a free trade agreement between both countries as in the first scenario and symmetric treasury bills interest rate.

Following this scenario, the two countries now have one central bank which accepts treasury bills from both governments, issues currency to both countries based on their demand, and transfers its profits to both governments based on returns generated from its holdings of each country's assets (treasury bills).

Figure 4.12 shows the evolution of real output (real GDP) in the first country when it is in free trade and in a monetary union.

As shown in the figure, monetary union has a positive effect on the output of the first country, compared with the case of free trade only, in the short- and long-runs. The reason might stand behind this is the elimination of the effect of exchange rate, which affects the current account and trade balances in both countries.

[9] For example, if each unit of the first country currency was equal to 1.18 units of the second country currency, all val
ues in the first country will increase by 1.18.

As shown in 4.13 trade balances in both countries have changed after the monetary union in favor of the first country (the small one).

Figure 4.12: *Evolution of real output in the first country in the cases of free trade and monetary union*

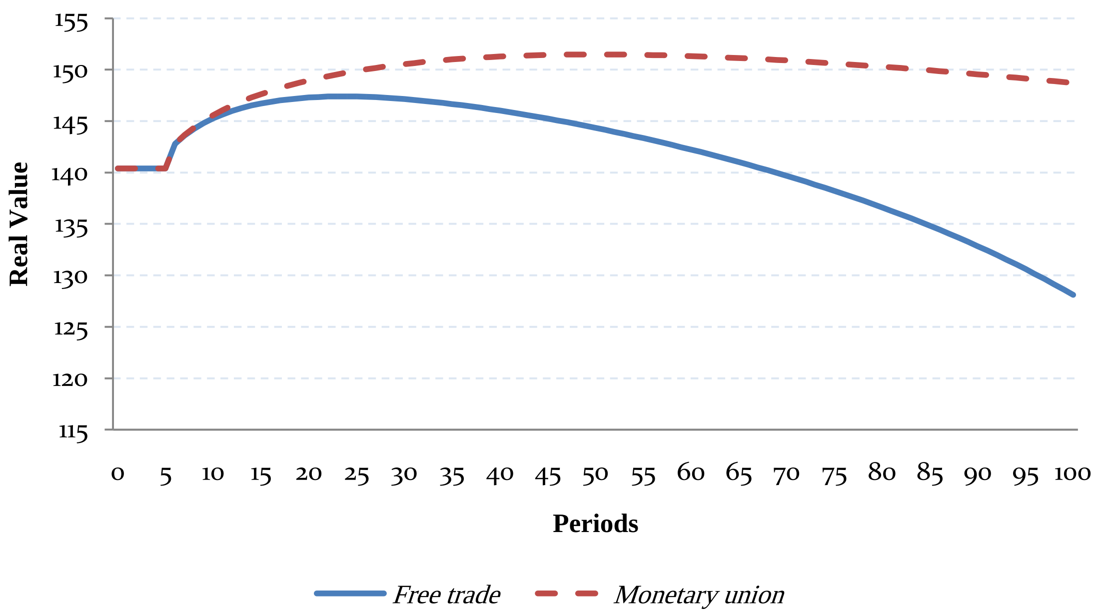


Figure 4.13: *Evolution of trade balance in both countries after the monetary union*

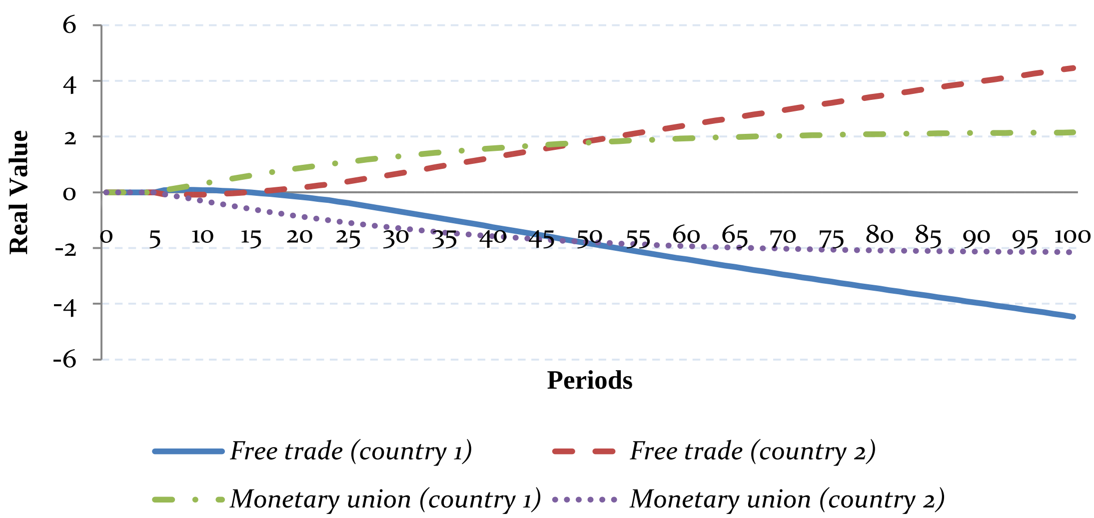


Figure 4.14 shows the evolution of the real output in cases of free trade and monetary union. The figure shows that monetary union is less beneficial for the second country than the case of free trade. This is due, as mention above, to the change in the trade balances in both countries after the monetary union.

Figure 4.14: *Evolution of real output in the second country in the cases of free trade and monetary union*

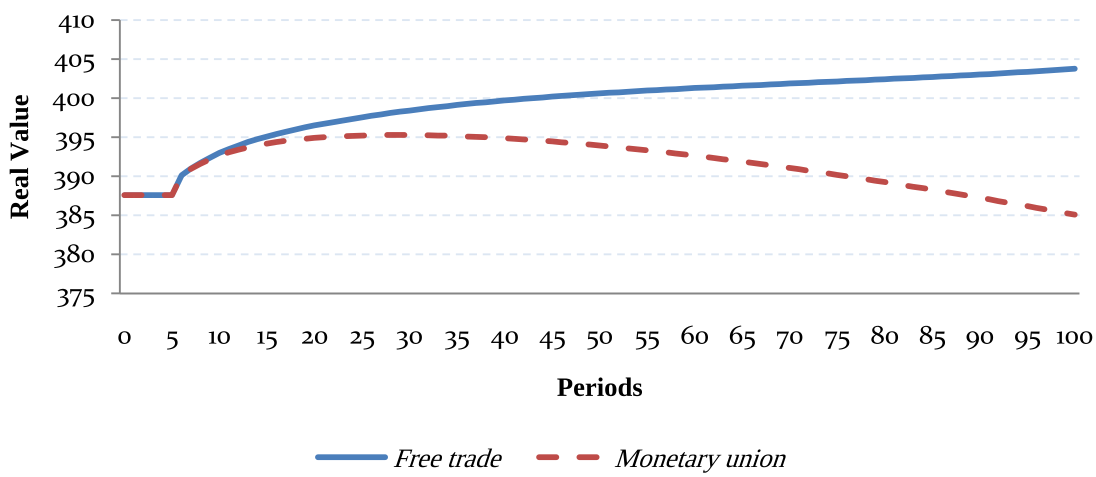
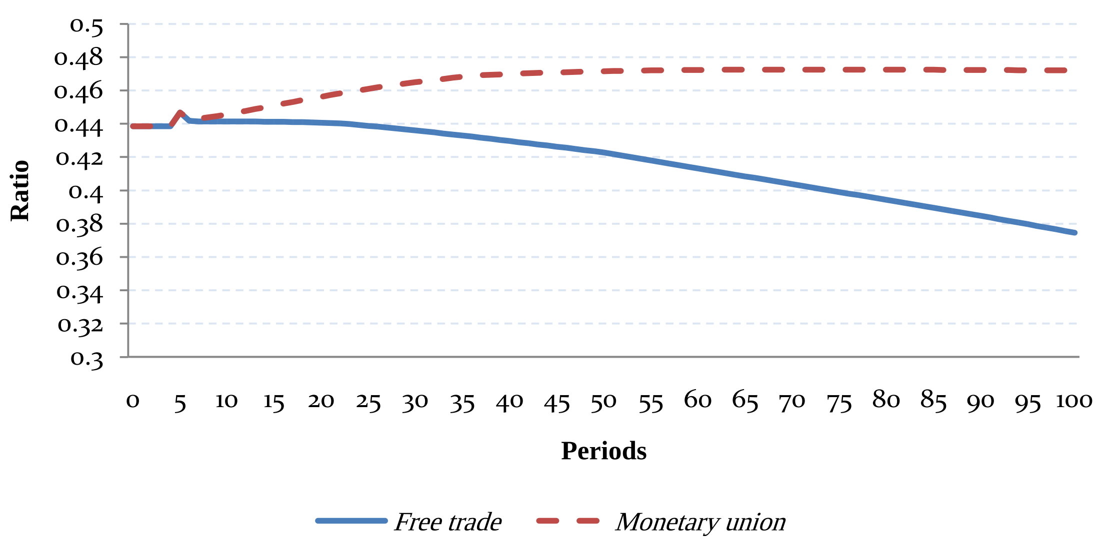
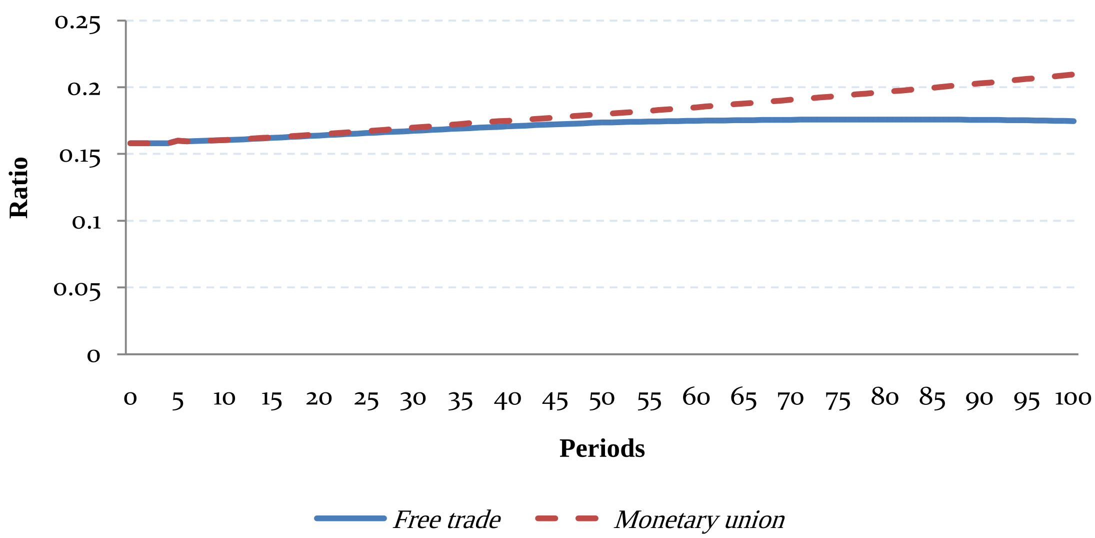


Figure 4.15: *Index of financial integration in the first country in the cases of free trade and monetary union*



Figures 4.15 and 4.16 show Lane and Milesi-Ferretti's index of financial integration for both countries in the cases of free trade and monetary union. As shown in figure 4.15, the first country become more financially integrated in the case of monetary union compared with the case of free trade only, while figure 4.16 shows that the second country is more financially integrated in the case of free trade only compared with the case of monetary union.

Figure 4.16: *Index of financial integration in the second country in the cases of free trade and monetary union*



4.3 CONCLUSION

The goal of this chapter is to produce a stock flow consistent model to study financial integration, as measured by a volume-based measure of international financial integration. The contribution of this chapter is to build a relatively detailed models that can explain much about financial integration between countries, as it can explore several policies, and agreements, which can be taken in order to enhance financial integration, and thus to contribute both to the emerging literature on stock-flow consistent modeling, as well as the current debate on the costs and benefits of ever-closer financial and economic integration amongst the world's economies.

This chapter shows that freeing trade by eliminating trade barriers initially leads to higher levels of output, income and wealth, and its components for both countries. Converging asset prices or rates of return on these assets do lead to a significant change in output, income, and wealth, but this converging trend does change the households' portfolio allocation and converge the demand for these assets.

Monetary union, considered as an advanced level of financial integration between countries, is also modeled. In this model, monetary union affects the real side of the economy. The effect of monetary union in both real and financial sides of the economy can be more with the existing of the proper fiscal or monetary policy accompanied the process of monetary union between countries. Thus, each agreement aimed at promoting financial integration between countries should be parallel with fiscal and monetary policies that would stimulate economic growth, income, wealth, and asset prices convergence. Relating this finding back to the European Union's current problems, a more developed system of automatic fiscal stabilizers (or a fiscal algorithm or rule set) would be beneficial to reduce the effect of asymmetric shocks to individual countries.

The volume measure of financial integration used in Lane and Milesi-Ferretti (2001a and 2007a) does not reflect the effect of converging asset prices on the process of financial integration between countries. This measure can be an appropriate measure in cases such as a certain agreement or in cases of fiscal policies, but it does not reflect the picture in cases such as converging asset prices or returns. In these cases, if one wishes to explore the effect of assets prices or returns convergence, it is better to look at the convergence of the demand for foreign assets, as documented above. This model may also be calibrated with real world data to assist policy formation.

Several other points and extensions on the model can be taken in order to explore financial integration more widely such as assuming that households can also purchase foreign equities, firms can also demand loans from foreign banks. One can explore financial integration between developing and developed countries. Financial integration may also be explored in the case of fixed exchange rate, in order to see the effect of financial integration on foreign bills acquired by the central bank.

4.4 APPENDIX 4.A: MODEL EQUATIONS

Production sector equations:

$$Y^1 = C^1 + G^1 + I^1 + X^1 - IM^1 \quad (4.1)$$

$$Y^2 = C^2 + G^2 + I^2 + X^2 - IM^2 \quad (4.2)$$

$$s^1 = c^1 + g^1 + i^1 + x^1 \quad (4.3)$$

$$s^2 = c^2 + g^2 + i^2 + x^2 \quad (4.4)$$

$$y^1 = s^1 - im^1 \quad (4.5)$$

$$y^2 = s^2 - im^2 \quad (4.6)$$

$$k^1 = k^1_{-1} + i^1 - \delta^1_k . k^1_{-1} \quad (4.7)$$

$$k^2 = k^2_{-1} + i^2 - \delta^2_k . k^2_{-1} \quad (4.8)$$

$$i^1 = \gamma^1_k . (k^{T1} - k^1_{-1}) + \delta^1_k . k^1_{-1} \quad (4.9)$$

$$i^2 = \gamma^2_k . (k^{T2} - k^2_{-1}) + \delta^2_k . k^2_{-1} \quad (4.10)$$

$$k^{T1} = \frac{y^1}{u^1} \quad (4.11)$$

$$k^{T2} = \frac{y^2}{u^2} \quad (4.12)$$

$$u^1 = \frac{y^1}{k^1_{-1}} \quad (4.13)$$

$$u^2 = \frac{y^2}{k^2_{-1}} \quad (4.14)$$

$$P^1_s = \frac{(1 + \varphi^1).(WB^1 + IM^1 + T^1_{im})}{s^1} \quad (4.15)$$

$$P^2_s = \frac{(1 + \varphi^2).(WB^2 + IM^2 + T^2_{im})}{s^2} \quad (4.16)$$

$$P^1_{ds} = \frac{(S^1 - X^1)}{(s^1 - x^1)} \quad (4.17)$$

$$P^2_{ds} = \frac{(S^2 - X^2)}{(s^2 - x^2)} \quad (4.18)$$

$$P_y^1 = \frac{Y^1}{y^1} \tag{4.19}$$

$$P_y^2 = \frac{Y^2}{y^2} \tag{4.20}$$

$$WB^1 = W^1.N^1 \tag{4.21}$$

$$WB^2 = W^2.N^2 \tag{4.22}$$

$$N^1 = \frac{y^1}{Pr^1} \tag{4.23}$$

$$N^2 = \frac{y^2}{Pr^2} \tag{4.24}$$

$$N_{fe}^1 = N^1 \tag{4.25}$$

$$N_{fe}^2 = N^2 \tag{4.26}$$

$$\pi^1 = \frac{\Delta P_s^1}{P_s^1} \tag{4.27}$$

$$\pi^2 = \frac{\Delta P_s^2}{P_s^2} \tag{4.28}$$

$$K^1 = k^1.P_{ds}^1 \tag{4.29}$$

$$K^2 = k^2.P_{ds}^2 \tag{4.30}$$

$$I^1 = i^1.P_{ds}^1 \tag{4.31}$$

$$I^2 = i^2.P_{ds}^2 \tag{4.32}$$

$$F_f^1 = S^1 - IM^1 - T_f^1 - WB^1 - r_{l-1}^1.L_{f\,d-1}^1 - \delta_k^1.k_{-1}^1 \tag{4.33}$$

$$F_f^2 = S^2 - IM^2 - T_f^2 - WB^2 - r_{l-1}^2.L_{f\,d-1}^2 - \delta_k^2.k_{-1}^2 \tag{4.34}$$

$$\Delta L_{f\,d}^1 = I^1 - \delta_k^1.K_{-1}^1 - \Delta e_s^1.P_e^1 \tag{4.35}$$

$$\Delta L_{f\,d}^2 = I^2 - \delta_k^2.K_{-1}^2 - \Delta e_s^2.P_e^2 \tag{4.36}$$

$$T_f^1 = T_s^1 + T_{im}^1 \tag{4.37}$$

$$T_f^2 = T_s^2 + T_{im}^2 \tag{4.38}$$

$$e_s^1 = e_d^1 \tag{4.39}$$

$$e_s^2 = e_d^2 \tag{4.40}$$

$$\omega^{T1} = \left(\frac{W^1}{P_s^1}\right)^T = \Omega_0^1 + \Omega_1^1 . Pr^1 + \Omega_2^1\left(\frac{N^1}{N_{fe}^1}\right) \tag{4.41}$$

$$W^1 = W_{-1}^1 . \left(1 + \Omega_3^1 . \left(\omega_{-1}^{T1} - \left(\frac{W_{-1}^1}{P_{s-1}^1}\right)\right)\right) \tag{4.42}$$

$$\omega^{T2} = \left(\frac{W^2}{P_s^2}\right)^T = \Omega_0^2 + \Omega_1^2 . Pr^2 + \Omega_2^2\left(\frac{N^2}{N_{fe}^2}\right) \tag{4.43}$$

$$W^2 = W_{-1}^2 . \left(1 + \Omega_3^2 . \left(\omega_{-1}^{T2} - \left(\frac{W_{-1}^2}{P_{s-1}^2}\right)\right)\right) \tag{4.44}$$

<u>Trade equations:</u>

$$\boldsymbol{P_m^1} = \upsilon_0^1 + \upsilon_1^1 . \boldsymbol{E_1} + \upsilon_2^1 . \boldsymbol{P_y^1} + \upsilon_3^1 . \boldsymbol{P_y^2} \tag{4.45}$$

$$P_m^2 = P_x^1 . E_1 \tag{4.46}$$

$$\boldsymbol{P_x^1} = \nu_0^1 + \nu_1^1 . \boldsymbol{E_1} + \nu_2^1 . \boldsymbol{P_y^1} + \nu_3^1 . \boldsymbol{P_y^2} \tag{4.47}$$

$$P_x^2 = P_m^1 . E_1 \tag{4.48}$$

$$E_1 = \frac{B_{h\ 1\ s}^2}{B_{h\ 1\ d}^2} \tag{4.49}$$

$$\boldsymbol{im^1} = \mu_0 - \mu_1 . \left(\boldsymbol{P_{m-1}^1} - \boldsymbol{P_{y-1}^1}\right) + \mu_2 . \boldsymbol{y^1} \tag{4.50}$$

$$\boldsymbol{x^1} = \varepsilon_0 - \varepsilon_1 . \left(\boldsymbol{P_{m-1}^2} - \boldsymbol{P_{y-1}^2}\right) + \varepsilon_2 . \boldsymbol{y^2} \tag{4.51}$$

$$im^2 = x^1 \tag{4.52}$$

$$x^2 = im^1 \tag{4.53}$$

$$CAB^1 = X^1 - IM^1 + r_{b-1}^2 . B_{h\ 1\ d-1}^2 + r_{b-1}^2 . B_{cb\ 1\ d-1}^2 - r_{b-1}^1 . B_{h\ 2\ s-1}^1 \tag{4.54}$$

$$CAB^2 = X^2 - IM^2 + r_{b-1}^1 . B_{h\ 2\ d-1}^1 - r_{b-1}^2 . B_{h\ 1\ s-1}^2 - r_{b-1}^2 . B_{cb\ 1\ s-1}^2 \tag{4.55}$$

$$KAB^1 = \Delta B_{h\ 2\ s}^1 - \Delta B_{h\ 1\ d}^2 - \Delta B_{cb\ 1\ d}^2 \tag{4.56}$$

$$KAB^2 = \Delta B_{h\ 1\ s}^2 + \Delta B_{cb\ 1\ s}^2 - \Delta B_{h\ 2\ d}^1 \tag{4.57}$$

Households sector equations:

$$YP^1 = WB^1 + F^1 + r^1_{m-1}.M^1_{d-1} + r^1_{b-1}.B^1_{h\,1\,d-1} + r^2_{b-1}.B^2_{h\,1\,d-1} \tag{4.58}$$

$$YP^2 = WB^2 + F^2 + r^2_{m-1}.M^2_{d-1} + r^2_{b-1}.B^2_{h\,2\,d-1} + r^1_{b-1}.B^1_{h\,2\,d-1} \tag{4.59}$$

$$YD^1 = YP^1 - T^1_h + CG^1 = (1-\theta^1).YP^1 + CG^1 \tag{4.60}$$

$$YD^2 = YP^2 - T^2_h + CG^2 = (1-\theta^2).YP^2 + CG^2 \tag{4.61}$$

$$CG^1 = \Delta\left(\frac{1}{E_1}\right).B^2_{h\,1\,s-1} + \Delta(P^1_e).e^1_{d-1} \tag{4.62}$$

$$CG^2 = \Delta(E_1).B^1_{h\,2\,s-1} + \Delta(P^2_e).e^2_{d-1} \tag{4.63}$$

$$\Delta V^1 = YD^1 - C^1 \tag{4.64}$$

$$\Delta V^2 = YD^2 - C^2 \tag{4.65}$$

$$c^1 = \alpha^1_1.yd^{e1} + \alpha^1_2.v^1_{-1} \tag{4.66}$$

$$c^2 = \alpha^2_1.yd^{e2} + \alpha^2_2.v^2_{-1} \tag{4.67}$$

$$yd^1 = \frac{YD^1}{P^1_{ds}} - \pi^1.\frac{V^1_{-1}}{P^1_{ds}} \tag{4.68}$$

$$yd^2 = \frac{YD^2}{P^2_{ds}} - \pi^2.\frac{V^2_{-1}}{P^2_{ds}} \tag{4.69}$$

$$yd^{e1} = \beta^1.yd^1_{-1} + (1-\beta^1).yd^{e1}_{-1} \tag{4.70}$$

$$yd^{e2} = \beta^2.yd^2_{-1} + (1-\beta^2).yd^{e2}_{-1} \tag{4.71}$$

$$C^1 = c^1.P^1_{ds} \tag{4.72}$$

$$C^2 = c^2.P^2_{ds} \tag{4.73}$$

$$v^1 = \frac{V^1}{P^1_{ds}} \tag{4.74}$$

$$v^2 = \frac{V^2}{P^2_{ds}} \tag{4.75}$$

$$F^1 = F^1_f + F^1_b \tag{4.76}$$

$$F^2 = F^2_f + F^2_b \tag{4.77}$$

$$H_{h\ d}^{1} = \lambda_c^1 . C^1 \tag{4.78}$$

$$H_{h\ d}^{2} = \lambda_c^2 . C^2 \tag{4.79}$$

$$V_{nc}^1 = V^1 - H_{h\ d}^1 \tag{4.80}$$

$$V_{nc}^2 = V^2 - H_{h\ d}^2 \tag{4.81}$$

$$\frac{M_d^1}{V_{nc}^1} = \lambda_{10}^1 + \lambda_{11}^1 . r_m^1 + \lambda_{12}^1 . r_b^1 + \lambda_{13}^1 . \left(r_b^2 + d\left(\frac{1}{E_1}\right) \right) + \lambda_{14}^1 . r_k^1 \tag{4.85'}$$

$$\frac{B_{h\ 1\ d}^1}{V_{nc}^1} = \lambda_{20}^1 + \lambda_{21}^1 . r_m^1 + \lambda_{22}^1 . r_b^1 + \lambda_{23}^1 . \left(r_b^2 + d\left(\frac{1}{E_1}\right) \right) + \lambda_{24}^1 . r_k^1 \tag{4.82}$$

$$\frac{B_{h\ 1\ d}^2}{V_{nc}^1} = \lambda_{30}^1 + \lambda_{31}^1 . r_m^1 + \lambda_{32}^1 . r_b^1 + \lambda_{33}^1 . \left(r_b^2 + d\left(\frac{1}{E_1}\right) \right) + \lambda_{34}^1 . r_k^1 \tag{4.83}$$

$$\frac{e_d^1 . P_e^1}{V_{nc}^1} = \lambda_{50}^1 + \lambda_{51}^1 . r_m^1 + \lambda_{52}^1 . r_b^1 + \lambda_{53}^1 . \left(r_b^2 + d\left(\frac{1}{E_1}\right) \right) + \lambda_{54}^1 . r_k^1 \tag{4.84}$$

$$M_d^1 = V_{nc}^1 - B_{h\ 1\ d}^1 - B_{h\ 1\ d}^2 - e_d^1 . P_e^1 \tag{4.85}$$

$$\frac{M_d^2}{V_{nc}^2} = \lambda_{10}^2 + \lambda_{11}^2 . r_m^2 + \lambda_{12}^2 . \left(r_b^1 + d(E_1) \right) + \lambda_{13}^2 . r_b^2 + \lambda_{14}^2 . r_k^2 \tag{4.89'}$$

$$\frac{B_{h\ 2\ d}^1}{V_{nc}^2} = \lambda_{20}^2 + \lambda_{21}^2 . r_m^2 + \lambda_{22}^2 . \left(r_b^1 + d(E_1) \right) + \lambda_{23}^2 . r_b^2 + \lambda_{24}^2 . r_k^2 \tag{4.86}$$

$$\frac{B_{h\ 2\ d}^2}{V_{nc}^2} = \lambda_{30}^2 + \lambda_{31}^2 . r_m^2 + \lambda_{32}^2 . \left(r_b^1 + d(E_1) \right) + \lambda_{33}^2 . r_b^2 + \lambda_{34}^2 . r_k^2 \tag{4.87}$$

$$\frac{e_d^2 . P_e^2}{V_{nc}^2} = \lambda_{50}^2 + \lambda_{51}^2 . r_m^2 + \lambda_{52}^2 . \left(r_b^1 + d(E_1) \right) + \lambda_{53}^2 . r_b^2 + \lambda_{54}^2 . r_k^2 \tag{4.88}$$

$$M_d^2 = V_{nc}^2 - B_{h\ 2\ d}^1 - B_{h\ 2\ d}^2 - e_d^2 . P_e^2 \tag{4.89}$$

Government equations:

$$G^1 = g^1 . P_{ds}^1 \tag{4.90}$$

$$G^2 = g^2 . P_{ds}^2 \tag{4.91}$$

$$T_h^1 = \theta^1 . YP^1 \tag{4.92}$$

$$T_h^2 = \theta^2 . YP^2 \tag{4.93}$$

$$T_s^1 = \tau_s^1 . S^1 \tag{4.94}$$

$$T_s^2 = \tau_s^2 . S^2 \tag{4.95}$$

$$T_{im}^1 = \tau_{im}^1 . IM^1 \tag{4.96}$$

$$T_{im}^2 = \tau_{im}^2 . IM^2 \tag{4.97}$$

$$T^1 = T_h^1 + T_f^1 \quad (4.98)$$

$$T^2 = T_h^2 + T_f^2 \quad (4.99)$$

$$PSBR^1 = G^1 + r_{b-1}^1.B_{s-1}^1 - (T^1 + F_{cb}^1) \quad (4.100)$$

$$PSBR^2 = G^2 + r_{b-1}^2.B_{s-1}^2 - (T^2 + F_{cb}^2) \quad (4.101)$$

$$\Delta(B_s^1) = PSBR^1 \quad (4.102)$$

$$\Delta(B_s^2) = PSBR^2 \quad (4.103)$$

$$B_{h\,1\,s}^1 = B_{h\,1\,d}^1 \quad (4.104)$$

$$B_{h\,2\,s}^2 = B_{h\,2\,d}^2 \quad (4.105)$$

$$B_{b\,s}^1 = B_{b\,d}^1 \quad (4.106)$$

$$B_{b\,s}^2 = B_{b\,d}^2 \quad (4.107)$$

$$B_{h\,2\,s}^1 = B_{h\,2\,d}^1.\frac{1}{E_1} \quad (4.108)$$

$$B_{h\,1\,s}^2 = constant \quad (4.109)$$

$$B_{cb\,1\,s}^2 = constant \quad (4.110)$$

$$B_{cb\,1\,s}^1 = B_s^1 - B_{h\,1\,s}^1 - B_{b\,s}^1 - B_{h\,2\,s}^1 \quad (4.111)$$

$$B_{cb\,2\,s}^2 = B_s^2 - B_{h\,2\,s}^2 - B_{b\,s}^2 - B_{h\,1\,s}^2 - B_{cb\,1\,s}^2 \quad (4.112)$$

Central bank equations:

$$H_s^1 = \Delta B_{cb\,1\,d}^1 + \Delta B_{cb\,1\,d}^2 \quad (4.113)$$

$$H_s^2 = \Delta B_{cb\,2\,d}^2 \quad (4.114)$$

$$H_{b\,s}^1 = H_s^1 - H_{h\,d}^1 \quad (4.115)$$

$$H_{b\,s}^2 = H_s^2 - H_{h\,d}^2 \quad (4.116)$$

$$B_{cb\,1\,d}^1 = B_{cb\,1\,s}^1 \quad (4.117)$$

$$B_{cb\,2\,d}^2 = B_{cb\,2\,s}^2 \quad (4.118)$$

$$B^2_{cb\ 1\ d} = B^2_{cb\ 1\ s}.\frac{1}{E_1} \tag{4.119}$$

$$F^1_{cb} = r^1_{b-1}.B^1_{cb\ 1\ d-1} + r^2_{b-1}.B^2_{cb\ 1\ d-1} \tag{4.120}$$

$$F^2_{cb} = r^2_{b-1}.B^2_{cb\ 2\ d-1} \tag{4.121}$$

Private banks equations:

$$F^1_b = r^1_{l-1}.L^1_{f\ s-1} + r^1_{b-1}.B^1_{b\ 1\ d-1} - r^1_{m-1}.M^1_{s-1} \tag{4.122}$$

$$F^2_b = r^2_{l-1}.L^2_{f\ s-1} + r^2_{b-1}.B^2_{b\ 2\ d-1} - r^2_{m-1}.M^2_{s-1} \tag{4.123}$$

$$L^1_{f\ s} = L^1_{f\ d} \tag{4.124}$$

$$L^2_{f\ s} = L^2_{f\ d} \tag{4.125}$$

$$M^1_s = M^1_d \tag{4.126}$$

$$M^2_s = M^2_d \tag{4.127}$$

$$H^1_{b\ d} = \rho^1.M^1_s \tag{4.128}$$

$$H^2_{b\ d} = \rho^2.M^2_s \tag{4.129}$$

$$B^1_{b\ d} = M^1_s - H^1_{b\ d} - L^1_{f\ s} \tag{4.130}$$

$$B^2_{b\ d} = M^2_s - H^2_{b\ d} - L^2_{f\ s} \tag{4.131}$$

$$BLR^1 = \frac{B^1_{b\ d}}{M^1_s} \tag{4.132}$$

$$BLR^2 = \frac{B^2_{b\ d}}{M^2_s} \tag{4.133}$$

$$BPM^1 = \frac{F^1_b + F^1_{b-1}}{(M^1_{s-1} + M^1_{s-2})} \tag{4.134}$$

$$BPM^2 = \frac{F^2_b + F^2_{b-1}}{(M^2_{s-1} + M^2_{s-2})} \tag{4.135}$$

$$r^1_m = r^1_{m-1} + \Delta r^1_m + \xi^1_b.\Delta r^1_b \tag{4.136}$$

$$\Delta r^1_m = \xi^1_m(z^1_1 - z^1_2) \tag{4.137}$$

$$z^1_1 = 1 \qquad iff\ \ BLR^1 < bot^1 \tag{4.138}$$

$$z_2^1 = 1 \quad iff \;\; BLR^1 > top^1 \tag{4.139}$$

$$r_m^2 = r_{m-1}^2 + \Delta r_m^2 + \xi_b^2 . \Delta r_b^2 \tag{4.140}$$

$$\Delta r_m^2 = \xi_m^2 (z_1^2 - z_2^2) \tag{4.141}$$

$$z_1^2 = 1 \quad iff \;\; BLR^2 < bot^2 \tag{4.142}$$

$$z_2^3 = 1 \quad iff \;\; BLR^3 > top^3 \tag{4.143}$$

$$r_l^1 = r_{l-1}^1 + \Delta r_l^1 + \Delta r_b^1 \tag{4.144}$$

$$\Delta r_l^1 = \xi_l^1 (z_3^1 - z_4^1) \tag{4.145}$$

$$z_3^1 = 1 \quad iff \;\; BPM^1 < botpm^1 \tag{4.146}$$

$$z_4^1 = 1 \quad iff \;\; BPM^1 > toppm^1 \tag{4.147}$$

$$r_l^2 = r_{l-1}^2 + \Delta r_l^2 + \Delta r_b^2 \tag{4.148}$$

$$\Delta r_l^2 = \xi_l^2 (z_3^2 - z_4^2) \tag{4.149}$$

$$z_3^2 = 1 \quad iff \;\; BPM^2 < botpm^2 \tag{4.150}$$

$$z_4^3 = 1 \quad iff \;\; BPM^3 > toppm^3 \tag{4.151}$$

4.5 APPENDIX 4.B: MODEL CODES

Before defining the variables, the following notations must take into consideration:

1- The subscript *b* refers bank.
2- The subscript *cb* refers central bank.
3- The subscript *d* refers to demand.
4- The superscript *e* refers expected value or volume.
5- The subscript *f* = firms.
6- The subscript *h* = households.
7- The superscript or subscript *j* = 1 for country one and 2 for country two.
8- The subscript *l* refers loans.
9- The subscript *m* refers deposits.
10- The superscript *T* refers target value or volume.
11- The superscript *z* = 1 for country one and 2 for country 2, such that z ≠ j.

B	Government security (treasury bills) e.g. $B^{j}_{h\,z\,d}$ is country z households demand for country j treasury bills
BLR^j	Bank liquidity ratio
BPM^j	Bank profit margin
C^j	Nominal consumption
c^j	Real consumption
CAB	Capital account balance
CG	Capital gains
e^j	Number of equities
E_1	Exchange rate, how much units of the second country currency per one unit of the first country currency.
F^j_b	Bank profits
F^j_{cb}	Central bank profits

F^j_f	Firms profits
G^j	Nominal government expenditure
g^j	Real government expenditure
H^j_s	High powered money supplied by the central bank
H^j_b	Vault cash
H^j_h	Households cash money
I^j	Nominal investment
i^j	Real investment
K^j	Nominal fixed capital
k^j	Real fixed capital
KAB^j	Capital account balance
L^j_f	Firms loans
M^j	Bank deposits
N^j	Number of employees
N^j_{fe}	Number of employees in a full employment level
$\omega^{T\,j}$	Real wages
p^j_{ds}	Domestic sales prices
p^j_e	Equity price
p^j_{im}	Import prices
p^j_s	Sales prices
p^j_x	Export prices
p^j_y	GDP deflator
φ^j	Price mark-up
π^j	Price inflation
pr^j	Workers' productivity

$PSBR^j$	Public sector borrowing requirement
r^j_b	Treasury bills interest rate
r^j_k	Rate of return on equities
r^j_l	Loans interest rate
$r^{i\,j}_m$	Deposits interest rate
S^j	Nominal sales
s^j	Real sales
T^j	Taxes
T^j_f	Firms taxes (sales tax)
T^j_h	Households taxes (income tax)
T^j_{im}	Import taxes
u^j	Capacity utilization
V^j	Nominal wealth
V^j_{nc}	Wealth net of cash
v^j	Real wealth
W^j	Wage rate
WB^j	Wage bill
Y^j	Nominal output or GDP
y^j	Real GDP
YD^j	Nominal disposable income
yd^j	Real disposable income
yd^{ej}	Expected real disposable income
YP^j	Value of personal income

4.6 APPENDIX 4.C: PARAMETERS VALUES

Parameter	Value	Parameter	Value	Parameter	Value
α^1_1	0.7	λ^1_{34}	-0.5	τ^1_s	0.1304
α^2_1	0.7	λ^2_{34}	-0.5	τ^2_s	0.1304
α^1_2	0.09	λ^1_{40}	0.3167	θ^1	0.2
α^2_2	0.09	λ^2_{40}	0.2840	θ^2	0.2
β^1_1	0.5	λ^1_{41}	-0.5	ξ^1_b	0.9
β^1_2	0.5	λ^2_{41}	-0.5	ξ^2_b	0.9
β^2_1	0.5	λ^1_{42}	-0.5	ξ^1_l	0.0001
β^2_2	0.5	λ^2_{42}	-0.5	ξ^2_l	0.0001
δ^1_k	0.1	λ^1_{43}	-0.5	ξ^1_m	0.0001
δ^2_k	0.1	λ^2_{43}	-0.5	ξ^2_m	0.0001
ε_0	-1.281601	λ^1_{44}	1.5	υ_0	0.0
ε_1	1.0	λ^2_{44}	1.5	υ_1	0.5
ε_2	0.7	λ^1_c	0.1	υ_2	0.5
λ^1_{20}	0.2029	λ^2_c	0.1	υ_3	0.5
λ^2_{20}	0.0564	μ_0	-0.5707	ω_0	0.0
λ^1_{21}	-0.5	μ_1	1.0	ω_1	0.5
λ^2_{21}	-0.5	μ_{02}	0.7	ω_2	0.5
λ^1_{22}	1.5	Ω^1_0	-2.3844	ω_3	0.5
λ^2_{22}	1.5	Ω^2_0	-2.3843		
λ^1_{23}	-0.5	Ω^1_1	1.0		
λ^2_{23}	-0.5	Ω^2_1	1.0		
λ^1_{24}	-0.5	Ω^1_2	2.0		
λ^2_{24}	-0.5	Ω^2_2	2.0		
λ^1_{30}	0.0916	Ω^1_3	0.5		
λ^2_{30}	0.2599	Ω^2_3	0.5		
λ^1_{31}	-0.5	φ^1	0.3054		
λ^2_{31}	-0.5	φ^2	0.3523		
λ^1_{32}	-0.5	ρ^1	0.12		
λ^2_{32}	-0.5	ρ^2	0.12		
λ^1_{33}	1.5	τ^1_{im}	0.1071		
λ^2_{33}	1.5	τ^2_{im}	0.1071		

4.7 APPENDIX 4.D: EXOGENOUS VARIABLE VALUES

Variable	Value	Variable	Value
$B^2_{cb\,1\,s}$	7.6464	pr^1	1.384
$B^2_{h\,1\,s}$	28.6740	pr^2	1.384
bot^1	0.780	r^1_b	0.030
bot^2	0.780	r^2_b	0.030
$botpm^1$	0.004	r^1_k	0.056
$botpm^2$	0.004	r^2_k	0.078
g^1	39.886	top^1	0.900
g^2	103.697	top^2	0.900
p^1_e	1.000	$toppm^1$	0.011
p^2_e	1.000	$toppm^1$	0.011

Chapter 5

CREDIT CRUNCH CONTAGION AND EFFECTS

5.1 INTRODUCTION

A credit crunch, also known as a `credit squeeze' or `credit crisis', refers to a sudden shortage of funds for lending resulting in a decline in loan lending. This decline is assumed to be independent of a rise in official interest rates (see for example Ben Bernanke *et al* 1991 and Borensztein and Lee 2002). There are several proposed reasons for a credit crunch:

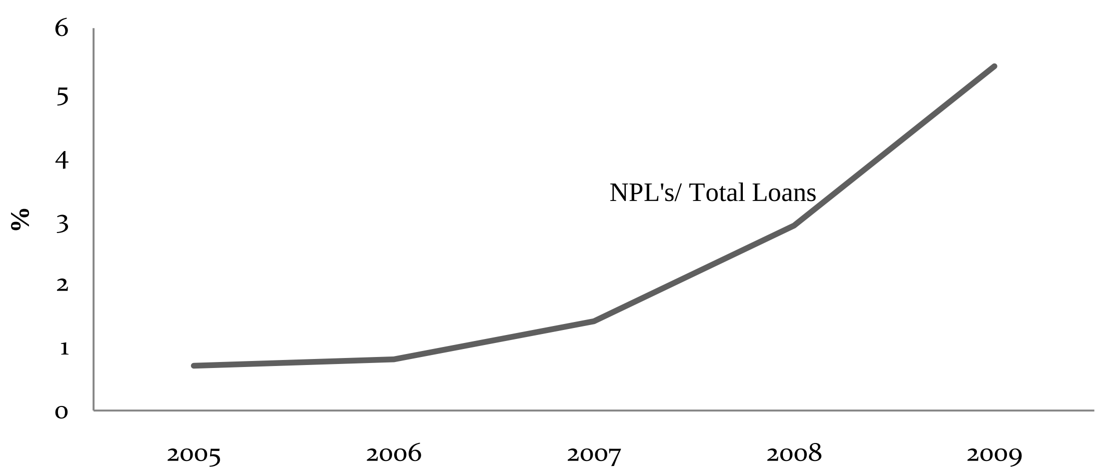
1- An anticipated decline in the value of collateral;
2- An exogenous change in monetary conditions, such as a central bank suddenly and unexpectedly raising reserve requirements or imposing new restrictions on lending activities;
3- The central government imposing direct credit controls on the banking system; or
4- An increase in risk regarding the solvency in the banking system.

The recent credit crunch was driven by a sharp increase in default in subprime mortgages in US, with the result of this shortage of funds spreading to the rest of the world. Increases in bad debts led to a decline in the banks' reserves, and also the increases in the costs of interbank lending resulted in a decline in loans supplied to consumers. This decline may have led to, or contributed to, a fall in the demand for houses and their prices, and also to a fall in bank profits margins and a decline in the share value of banks.

The inability of banks to meet their short run liabilities led to failures of those banks and as a consequence to bankruptcy. In the recent financial crisis several banks in the US, Europe and in the rest of the world failed or were acquired such as Lehman Brothers and Bear Stearns in the US, Northern Rock and the Bradford and Bingley in the UK.

Figure 5.1 shows non-performing loans (NPLs) as a share of total loans in the US in the period 2005-2009. The figure shows that NPLs increased from below 1.0% in 2006 to around 5.4% in 2009 as a share of total loans. As long as house prices increased, when a household could not pay back its mortgage the bank would acquire the collateral (the house), which had gone up in value, so that the bank would still make a profit. But when the price of houses dropped, the inability of a home owner to pay back their mortgage implied that the bank acquired a house with a lower value, and was making a loss.

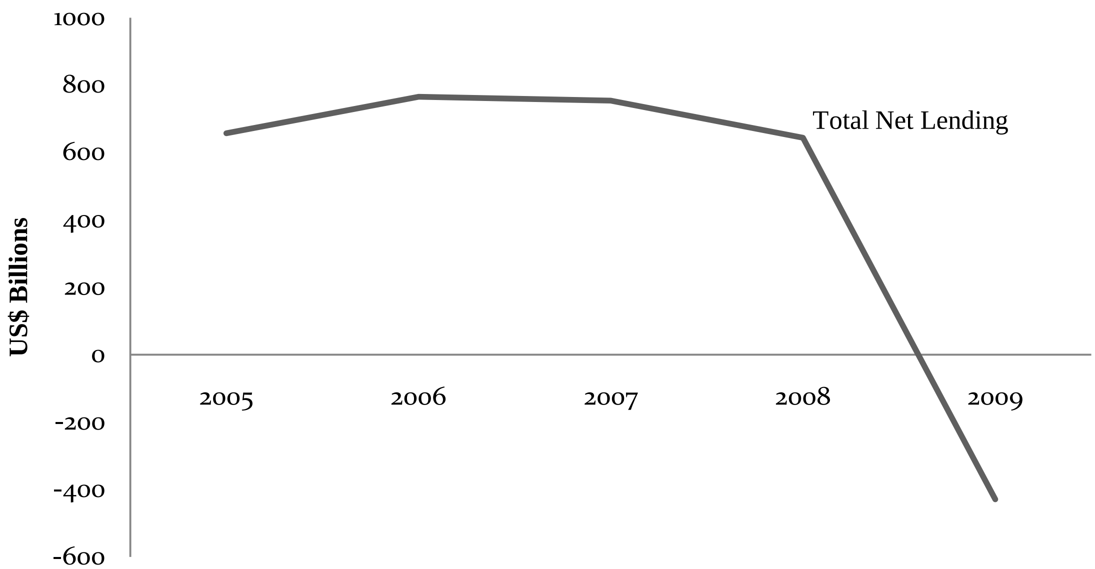
Figure 5.1: *Non-performing loans to total loans in US 2005-2009.*



Source: IMF, World financial stability report, April 2010.

Figure 5.2 shows total net lending in the US commercial banks in the period 2005-2009. As it is shown in the figure, net lending dropped slightly in 2008 compared with 2007 but sharply in 2009 compared with 2008.

Figure 5.2: *Total net lending in the US commercial banks 2005-2009.*



Source: Board of Governance of the Federal Reserve System, US 2010.

The aim of this chapter is to describe credit crunch crises, their contagion effects, and analyze those effects on income distribution and the business cycle using a stock-flow consistent monetary model for two economies. A credit crunch is assumed to spread within the banking system in the country and also spread to banks in other countries that have connections with the infected banks. Stock flow consistent models can best describe the whole picture of the event and the process of contagion.

Several studies discuss the issue of credit crunch. Ben Bernanke *et al* (1991) define credit crunch as a leftward shift in the supply curve of bank loans, holding constant real interest rates and quality of bank borrowers. They aver that slow growth in lending could be a result of weak demand for credit, weak supply, or both. Regarding the supply side of credit, Bernanke *et al* argue that a shortage of banks' equity capital is the most important factor reducing the supply of loans.

Ben Bernanke *et al* (1991) refer to two factors which may help understanding the slow-down in bank lending. First is the unavailability of funds. In order to lend banks must have sufficient funds in the form of each bank's capital or its managed liabilities. The second factor is the upward trend in the securitization of bank loans; banks regularly initiate loans with the intention of selling all or part of it to other investors. Loans securitized in this manner do not appear on the banks' balance sheet and thus would not be counted as part of bank loans.

Ben Bernanke *et al* claim that cutting back bank lending directly affects bank-dependent borrowers like small businesses, and indirectly affects the macroeconomy. Reducing credit to firms will force them to shed workers and delay or cancel some investment, and thus reducing output in the short- and long-runs. An exogenous decline in lending will either cut off bank-dependent borrowers entirely or force them to employ more costly forms of credit. In either case, the net return on investment falls, and, as a consequence, the demand for investment falls.

Borensztein and Lee (2002) analyze the financial crisis and credit crunch in Korea in the late 1990s, and found that the allocation of credit had an important effect on real output. Results suggest that the credit crunch may have been the outcome of the structural changes in the financial sector, rather than of a general monetary contraction. This suggests that a monetary expansion will do little to eliminate the problem. They claim that weaknesses in the financial institutions and corporate borrowers may explain much of the credit contraction that happened in Korea in the late 1990s.

Furman and Stiglitz (1998) claim that a credit crunch will exacerbate an economic downturn. Liquidity constraints imposed by weakening the financial system with stringently enforced capital adequacy standards make it difficult for firms to find outside financing, and the low level of profits associated with the economic downturn make it difficult to expand investment.

Ding et al (1998), writing about the credit crunch in East Asia in 1997, find that credit crunch negatively affected East Asian economies, particularly small sized banks and enterprises. They claim that reliance on tight monetary policy may be counter-productive to restore market confidence on those economies.

Gai and Kapadia (2010) claim that the collapse of the interbank loans market has been a central feature of the recent global financial crisis. Because banks are afraid about their liquidity position, they become hoarders and stop lending to other banks. Gai and Kapadia claim that highly connected banks, or banks with high interbank loans, should be considered the instruments of the credit crunch contagion.

Gui and Kapadia suggest policy measures to target the key institutions or "super-spreaders". These policies mainly focus on liquidity, "systemic liquidity requirements may contribute significantly towards financial stability". Other policies are suggested, like "promoting greater liquidity self-insurance and more diversified funding by banks in the future". Results point toward prudential regulations to provide a disincentive for banks to increase their liquidity risk in proportion to the marginal contribution of any bank to overall systemic risk.

Whalen (2008) describes the US credit crunch in 2007 as a "Minsky moment". Before July 2007, banks were able to lend to the buyout firms—buyout market is just one dimension of the credit crunch—because they were able to resell these loans to other investors. But in July 2007, "the market of new and existing buyout loans shrank rapidly". This is because, as Jubak (2007) writes, investors discovered in late July that they could not sell their loans at any price, and loans they were holding were losing much of their value. Another dimension of credit crunch is the "commercial papers", which are promises to pay that wide range of companies issue to acquire short term funding. As in the market for buyouts, the commercial paper market was "freezing up" by the end of August 2007.

Another dimension is hedge funds, they were borrowing money to invest in mortgages, but when it appeared that large numbers of homeowners could not repay their mortgage obligations, hedge funds found themselves sitting on huge losses. For example, in June 2007 two hedge funds run by Bear Stearns were wiped out, for a total loss of $20 billion (Foley 2007).

Whalen (2008) identifies some key elements which may have led to a Minsky moment of credit crunch. The start was with the housing boom which began around 2000, with lenders enticing less creditworthy home buyers into the market with exotic mortgages such as "interest-only" loans and "option adjustable rate" mortgages (known also as option ARMs). These types of loans start with low payments by the home-owners, but later these payments increase. Another key element in the creation of a Minsky moment in the US was unregulated mortgages brokers. Those brokers just care about their commission, so they were pushing option ARMs hard because they were highly profitable for banks, thus brokers' commissions were also high as Whalen states.

Another key element that led to a Minsky moment of credit crunch is the securitization of mortgages. This means that banks were bundling dozens of mortgages and selling them to investment funds, such as hedge funds, as they were considered to be pros in managing risk. Whalen (2008: 102) argues that "*The mortgage bundles, financial derivatives (such as futures and options trading), and other investment tools widely used by these investments funds involve a lot more Keynesian uncertainty than probabilistic risk*".

According to Mizen (2008), a number of factors provided the base for the credit crunch in the US in 2007. First, there was a period of economic stability with very low long-term interest rates supported by global saving gluts flowing from emerging and oil-exporting economies. The second factor is the financial innovations like mortgage-backed securities (MBSs) and third, banks introduced more complex, higher leverage products with weaker underlying assets based on subprime mortgages.

The fourth factor is the fall in house prices in the US which was unanticipated and when that house prices did fall the default in loans increased mainly in the subprime sector which provide a trigger for the crisis. This crisis spread to other markets like assets and money markets. Widespread loan default led to several bank failures, which then spurred a reaction in the markets for short-term paper as banks withdrew from lending in money markets.

The rest of the chapter is organized as follows: following the introduction, section 2 contains the main model features are presented, after that, matrices and equations are constructed, and finally model run and simulations are presented. Section 3 concludes.

5.2 THE MODEL

This chapter contribution is describing credit crunch using the stock flow consistent approach in lines of Godley and Lavoie (2007). The model deployed in this chapter describes two steady state—almost identical—economies with five sectors in each economy: households, firms (non-financial sector), government, central bank, and private banks. Each sector is assumed to acquire assets (+) and have liabilities (-). The main contribution of this model is that the private bank sector in both economies is composed of two representative banks. The reason behind this assumption is to see the contagion of credit crunch from one bank in a specific country to the other banks in the domestic country and to foreign banks connected through interbank loans.

This model assumes that a credit crunch happens due to a decline in the supply of loans to the other sectors in the economy, as well as in the supply of interbank loans. The demand for loans and interbank loans is assumed to follow supply, in other words, the demand for loans is supply-constrained.

5.2.1 MODEL MATRICES

Table 5.1 provides the balance sheet of the model. The model contains five sectors. The households sector is assumed to acquire high powered money ($+H^{j}_{h\,d}$), where j = 1 for country one and 2 for country two, money deposits ($+M^{i\,j}_{d}$) in both domestic banks, where i = I for bank *I* and II for bank *II*, local ($+B^{j}_{h\,j\,d}$) and foreign ($+B^{z}_{h\,j\,d}$) government securities (e.g. treasury bills), where z = 1, 2 and $z \neq j$, and banks equities ($+OF^{i\,j}$). Households are assumed to take loans from their domestic banks ($-L^{i\,j}_{h\,d}$). The sum of all households' assets and liabilities gives the wealth of households (V^{j}).

Table 5.1: *Balance Sheets Matrix in both economies*

	Country 1						Ex. Rate	Country 2						Sum
	Households	Firms	Gov.	C. Bank	Banks			Households	Firms	Gov.	C. Bank	Banks		
					I	II						I	II	
Fixed Capital		$+K^1$					E_1		$+K^2$					ΣK
High Powered Money	$+H^1_{h\,d}$			$-H^1_s$	$+H^{I\,1}_{b\,d}$	$+H^{II\,2}_{b\,d}$		$+H^2_{h\,d}$			$-H^2_s$	$+H^{I\,2}_{b\,d}$	$+H^{II\,2}_{b\,d}$	0
Households Loans	$-L^{I\,1}_{h\,d}$				$+L^{I\,1}_{h\,s}$			$-L^{I\,2}_{h\,d}$				$+L^{I\,2}_{h\,s}$		0
	$-L^{II\,1}_{h\,d}$					$+L^{II\,1}_{h\,s}$		$-L^{II\,2}_{h\,d}$					$+L^{II\,2}_{h\,s}$	0
Firm Loans		$-L^{I\,1}_{f\,d}$			$+L^{I\,1}_{f\,s}$				$-L^{I\,2}_{f\,d}$			$+L^{I\,2}_{f\,s}$		0
		$-L^{II\,1}_{f\,d}$				$+L^{II\,1}_{f\,s}$			$-L^{II\,2}_{f\,d}$				$+L^{II\,2}_{f\,s}$	0
Interbank Loans					$-L^{II\,1}_{b\,I\,1\,d}$	$+L^{II\,1}_{b\,I\,1\,s}$						$-L^{II\,2}_{b\,I\,2\,d}$	$+L^{II\,2}_{b\,I\,2\,s}$	0
Intrabank loans					$+L^{I\,1}_{b\,I\,2\,s}$	$-L^{II\,2}_{b\,II\,1\,d}$	E_1					$-L^{I\,1}_{b\,I\,2\,d}$	$+L^{II\,2}_{b\,II\,1\,s}$	0
Deposits	$+M^{I\,1}_d$				$-M^{I\,1}_s$			$+M^{I\,2}_d$				$-M^{I\,2}_s$		0
	$+M^{II\,1}_d$					$-M^{II\,1}_s$		$+M^{II\,2}_d$					$-M^{II\,2}_s$	0
Bills^1	$+B^1_{h\,1\,d}$		$-B^1_s$	$+B^1_{cb\,1\,d}$	$+B^{I\,1}_{b\,d}$	$+B^{II\,1}_{b\,d}$	E_1	$+B^1_{h\,2\,d}$			$+B^1_{cb\,2\,d}$			0
Bills^2	$+B^2_{h\,1\,d}$			$+B^2_{cb\,1\,d}$			E_1	$+B^2_{h\,2\,d}$		$-B^2_s$	$+B^2_{cb\,2\,d}$	$+B^{I\,2}_{b\,d}$	$+B^{II\,2}_{b\,d}$	0
Bank Capital	$+OF^{I\,1}$				$-OF^{I\,1}$			$+OF^{I\,2}$				$-OF^{I\,2}$		0
	$+OF^{II\,1}$					$-OF^{II\,1}$		$+OF^{II\,2}$					$-OF^{II\,2}$	0
Balance	$-V^1$	$-NW^1_f$	$-NW^1_g$				E_1	$-V^2$	$-NW^2_f$	$-NW^2_g$				ΣK
Sum	**0**	**0**	**0**	**0**	**0**	**0**		**0**	**0**	**0**	**0**	**0**	**0**	**0**

Firms are assumed to own tangible assets—fixed capital ($+K^j$). Firms take loans from both domestic banks ($-L^{ij}{}_{fd}$). The sum of these assets and liabilities gives the net worth of firms ($NW^j{}_f$).

The government in each country has to finance any deficit by selling securities, in this model treasury bills ($-B^j{}_s$) are considered as a proxy of government securities. Both governments in this model are assumed to sell treasury bills to other sectors in the local economy and to the households and the central bank of the other country, these securities considered to be the net worth of the government ($NW^j{}_g$). The two countries' central banks are assumed to acquire government securities from the domestic government ($+B^j{}_{cb\,j\,d}$) and the foreign government ($+B^z{}_{cb\,j\,d}$). Central banks are assumed to supply high powered money ($+H^j{}_s$) to households and to private banks domestically.

Private banks in both countries are assumed to hold vault cash ($+H^{i\,j}{}_{b\,d}$), acquire local government securities ($+B^{ij}{}_{b\,d}$), supply loans to domestic households ($+L^{i\,j}{}_{h\,s}$) and to firms ($+L^{ij}{}_{fs}$). Banks accept households money deposits ($-M^{ij}{}_s$) and supply equities to households, these equities are considered to be banks' capital ($-OF^{ij}$).

Private banks in this model are assumed to demand and supply interbank loans between each other locally and outside. Bank *I* in country one creates a demand for interbank loans from country one *II* bank ($-L^{II\,1}{}_{b\,I\,1\,d}$) and supplies interbank loans to the second country *I* bank ($+L^{I\,1}{}_{b\,I\,2\,s}$). Bank *II* in country one is assumed to create a demand for interbank loans from country two *II* bank ($-L^{II\,2}{}_{b\,II\,1\,d}$) and supply interbank loans to bank *I* in the first country ($+L^{II\,1}{}_{b\,I\,1\,s}$). Second country *I* bank is assumed to demand interbank loans from first country *I* bank ($-L^{I\,1}{}_{b\,II\,1\,d}$) and from second country *II* bank ($-L^{II\,2}{}_{b\,II\,1\,d}$). Bank *II* in the second country is assumed to supply loans to the first country *II* bank ($+L^{II\,2}{}_{b\,II\,1\,s}$) and to the second country *I* bank ($+L^{II\,2}{}_{b\,I\,2\,s}$).

Table 5.2 is the revaluation matrix, which contains two components, fixed capital and bank capital. Banks accumulate own funds and these funds belong to the owners of the banks (households), and thus they are treated as a liability of banks. From the standpoint of the bank owners, the own funds accumulated by banks are treated as capital gain. These gains are considered to be part of the households' wealth from a Haig-Simon point of view and as implemented in Godley and Lavoie (2007), because if the bank gets liquidated, the bank owners would be left with the own funds of the bank. The value of the firm's fixed capital revaluated automatically from price inflation.

Table 5.2: *Revaluation Matrix in both economies*

	Country 1				Country 2				Sum
	Households	Firms	Banks I	Banks II	Households	Firms	Banks I	Banks II	
Fixed Capital		$+\Delta p^1.k^1_{-1}$				$+\Delta p^1.k^1_{-1}$			$\Delta p^1.k^1_{-1}.E_1$ $+\Delta p^2.k^2_{-1}$
Bank Capital	$+\Delta OF^{I\,1}$		$-\Delta OF^{I\,1}$		$+\Delta OF^{I\,2}$		$-\Delta OF^{I\,2}$		0
	$+\Delta\ OF^{II\,1}$			$-\Delta\ OF^{II\,1}$	$+\Delta\ OF^{II\,2}$			$-\Delta OF^{II\,2}$	0

Table 5.3 describes values of transactions and flows within and between economic sectors in both economies in a given period of time. Variables with (+) sign describes the *sources* of funds and variables with (-) sign describes the *uses* of funds. Each row and column in the transactions flows matrix must sum to zero. Starting from the firms sectors, firms have two accounts: current and capital accounts. On the current account column, firms produce consumption goods and services to households ($+C^j_s$) and to government ($+G^j_s$) and provide net investment to its capital account ($+I^j$).

Firms pay taxes on sales to the government ($-T^j_f$), wages to households ($-WB^j$), interest on loans provided by the domestic banks ($-r^{i\,j}_{l-1}.L^{i\,j}_{f\,d-1}$), and keep part of their funds to cover for the depreciation in the fixed capital ($-\delta^j_k.K^j$), the depreciation allowances go to the firm's capital account. The difference between sources and uses of funds in the firm's current account is its profits ($-F^j_f$), which are transferred to households as they are considered to be the owners of firms.

Another source of funds besides the depreciation allowance, which appears in the capital account of firms are new loans. These sources of funds are used to cover new investments, which appears in the capital account of firms.

Households in this model are assumed to earn wages form firms; profits transferred to them form the firms sector, dividends from the banking sector ($+FD^{ij}_b$), interest on their deposits ($+r^{ij}_{m-1}.M^{ij}_{d-1}$), interest on their holdings of domestic ($+r^j_{b-1}.B^j_{h\,j\,d-1}$) and foreign ($+r^z_{b-1}.B^z_{h\,j\,d-1}$) government securities—in this model, treasury bills are taken as a proxy of the government securities.

Households use these sources of funds to pay for their consumption to firms, income taxes to the government ($-T^j_h$). In this model it is assumed that households have some loan defaults, or non-performing loans, and they are considered to form 5.0% of their stock of loans. What households will pay is the interest on performing loans ($-r^{ij}_{l-1}\,(L^{ij}_{h\,d-1}-NPL^{ij}_{-1})$).

After deducting income tax and interest on loans from all sources of funds including capital gains or losses we get disposable income of the households sector and after subtracting consumption from the disposable income we have the change in households' wealth level or households' savings in that particular period of time. Change in wealth comes from the change in stocks of all their assets and liabilities.

Table 5.3: *Transactions Flows Matrix in both economies*

Country 1	**Households**	**Firms**		**Gov.**	**Central Banks**	**Banks**				**Ex. Rate**
						I		**II**		
		Current	**Capital**			**Current**	**Capital**	**Current**	**Capital**	
Consumption	$-C^1_d$	$+C^1_s$								
Gov. Expen.		$+G^1_s$		$-G^1_d$						
Investment		$+I^1$	$-I^1$							
Depreciation		$-\delta^1_k.\ K^1$	$+\delta^1_k.\ K^1$							
Taxes	$-T^1_h$	$-T^1_f$		$+T^1$						
Wages	$+WB^1$	$-WB^1$								
Entreprene-urial Profits	$+F^1_f$	$-F^1_f$								
Bank Profits	$+FD^{1\,I}_b$					$-F^{I\,1}_b$	$+FU^{I\,1}_b$			
	$+FD^{1\,II}_b$							$-F^{II\,1}_b$	$+FU^{II\,1}_b$	
CB Profit				$+F^1_{cb}$	$-F^1_{cb}$					
Interest on										
Household Loans	$-r^{I\,1}_{l-1}.\ L^{I\,1}_{h\,d-1}$					$+r^{I\,1}_{l-1}.\ L^{I\,1}_{h\,s-1}$				
	$-r^{II\,1}_{l-1}.\ L^{II\,1}_{h\,d-1}$							$+r^{II\,1}_{l-1}.\ L^{II\,1}_{h\,s-1}$		
Households default loans	$+r^{I\,1}_{l-1}.\ NPL^{I\,1}_{-1}$					$-r^{I\,1}_{l-1}.\ NPL^{I\,1}_{-1}$				
	$+r^{II\,1}_{l-1}.\ NPL^{II\,1}_{-1}$							$-r^{II\,1}_{l-1}.\ NPL^{II\,1}_{-1}$		
Firm Loans		$-r^{I\,1}_{l-1}.L^{I\,1}_{f\,d-1}$				$+r^{I\,1}_{l-1}.\ L^{I\,1}_{f\,s-1}$				
		$-r^{II\,1}_{l-1}.L^{II\,1}_{f\,d-1}$						$+r^{II\,1}_{l-1}.\ L^{II\,1}_{f\,s-1}$		
Interbank						$-r^{II\,1}_{lb-1}.$		$+r^{II\,1}_{lb-1}.$		

Loans						$L^{II\,1}_{b\,I\,1\,d-1}$		$L^{II\,1}_{b\,I\,1\,s-1}$		
Intrabank Loans						$+r^{I\,1}_{lb-1}\cdot L^{I\,1}_{b\,I\,2\,s-1}$		$-r^{2\,II}_{lb-1}\cdot L^{2\,II}_{b\,II\,1\,d-1}$		E_1
Deposits	$+r^{I\,1}_{m-1}.M^{I\,1}_{d-1}$ $+r^{II\,1}_{m-1}.M^{II\,1}_{d-1}$					$-r^{I\,1}_{m-1}\cdot M^{I\,1}_{s-1}$		$-r^{II\,1}_{m-1}.M^{II\,1}_{s-1}$		
Bills[1]	$+r^{1}_{b-1}.\ B^{1}_{h\,1\,d-1}$			$-r^{1}_{b}.B^{1}_{s-1}$	$+r^{1}_{b-1}.\ B^{1}_{cb\,1\,d-1}$	$+r^{1}_{b-1}\cdot B^{I\,1}_{b\,d-1}$		$+r^{1}_{b-1}\cdot B^{II\,1}_{b\,d-1}$		E_1
Bills[2]	$+r^{2}_{b-1}.\ B^{2}_{h\,1\,d-1}$				$+r^{2}_{b-1}.\ B^{2}_{cb\,1\,d-1}$					E_1
Δ in the stocks of										
Household Loans	$+\Delta L^{I\,1}_{h\,d}$ $+\Delta L^{II\,1}_{h\,d}$						$-\Delta L^{I\,1}_{h\,s}$		$-\Delta L^{II\,1}_{h\,s}$	
Firm Loans			$+\Delta L^{I\,1}_{f\,d}$ $+\Delta L^{II\,1}_{f\,d}$				$-\Delta L^{I\,1}_{f\,s}$		$-\Delta L^{1\,II}_{f\,s}$	
Interbank Loans							$+\Delta L^{II\,1}_{b\,I\,1\,d}$		$-\Delta L^{II\,1}_{b\,I\,1\,s}$	
Intrabank Loans							$-\Delta L^{I\,1}_{b\,I\,2\,s}$		$+\Delta L^{II\,1}_{b\,II\,2\,d}$	
HPM	$-\Delta H^{1}_{h\,d}$				$+\Delta H^{1}_{s}$		$-\Delta H^{I\,1}_{b\,d}$		$-\Delta H^{II\,1}_{b\,d}$	
Deposits	$-\Delta M^{I\,1}_{d}$ $-\Delta M^{II\,1}_{d}$						$+\Delta M^{I\,1}_{d}$		$+\Delta M^{II\,1}_{d}$	
Bills[1]	$-\Delta B^{1}_{h\,1\,d}$			$+\Delta B^{1}_{s}$	$-\Delta B^{1}_{cb\,1\,d}$		$-\Delta B^{I\,1}_{b\,d}$		$-\Delta B^{I\,1}_{b\,d}$	E_1
Bills[2]	$-\Delta B^{2}_{h\,1\,d}$				$-\Delta B^{2}_{cb\,1\,d}$					E_1
Default Loans	$+NPL^{I\,1}$ $+NPL^{II\,1}$						$-NPL^{I\,1}$		$-NPL^{II\,1}$	
Σ	0	0	0	0	0	0	0	0	0	

Table 5.3: *Transactions Flows Matrix in both economies (Continued)*

Country 2	**Households**	**Firms**		**Gov.**	**Central Banks**	**Banks**				**Sum**
						I		**II**		
		Current	**Capital**			**Current**	**Capital**	**Current**	**Capital**	
Consumption	$-C^2_d$	$+C^2_s$								0
Gov. Expen.		$+G^2_s$		$-G^2_d$						0
Investment		$+I^2$	$-I^2$							0
Depreciation		$-\delta^2_k.\ K^2$	$+\delta^2_k.\ K^2$							
Taxes	$-T^2_h$	$-T^2_f$		$+T^2$						0
Wages	$+WB^2$	$-WB^1$								0
Entreprene-urial Profits	$+F^2_f$	$-F^2_f$								0
Bank Profits	$+FD^{I\,2}_b$					$-F^{I\,2}_b$	$+FU^{I\,2}_b$			0
	$+FD^{II\,2}_b$							$-F^{II\,2}_b$	$+FU^{II\,2}_b$	0
CB Profit				$+F^2_{cb}$	$-F^2_{cb}$					0
Interest on										
Household Loans	$-r^{I\,2}_{l-1}.\ L^{I\,2}_{h\,d-1}$					$+r^{I\,2}_{l-1}.\ L^{I\,2}_{h\,s-1}$				0
	$-r^{II\,2}_{l-1}\ L^{II\,2}_{h\,d-1}$							$+r^{II\,2}_{l-1}.\ L^{II\,2}_{h\,s-1}$		0
Households default loans	$+r^{I\,2}_{l-1}.\ NPL^{I\,2}_{-1}$					$-r^{I\,2}_{l-1}.\ NPL^{I\,2}_{-1}$				0
	$+r^{II\,2}_{l-1}.\ NPL^{II\,2}_{-1}$							$-r^{II\,2}_{l-1}.\ NPL^{II\,2}_{-1}$		0
Firm Loans		$-r^{I\,2}_{l-1}.\ L^{I\,2}_{f\,d-1}$				$+r^{I\,2}_{l-1}.\ L^{I\,2}_{f\,s-1}$				0
		$-r^{II\,2}_{l-1}.\ L^{II\,2}_{f\,d-1}$						$+r^{II\,2}_{l-1}.\ L^{II\,2}_{f\,s-1}$		0
Interbank						$-r^{II\,2}_{lb-1}.$		$+r^{II\,2}_{lb-1}.$		0

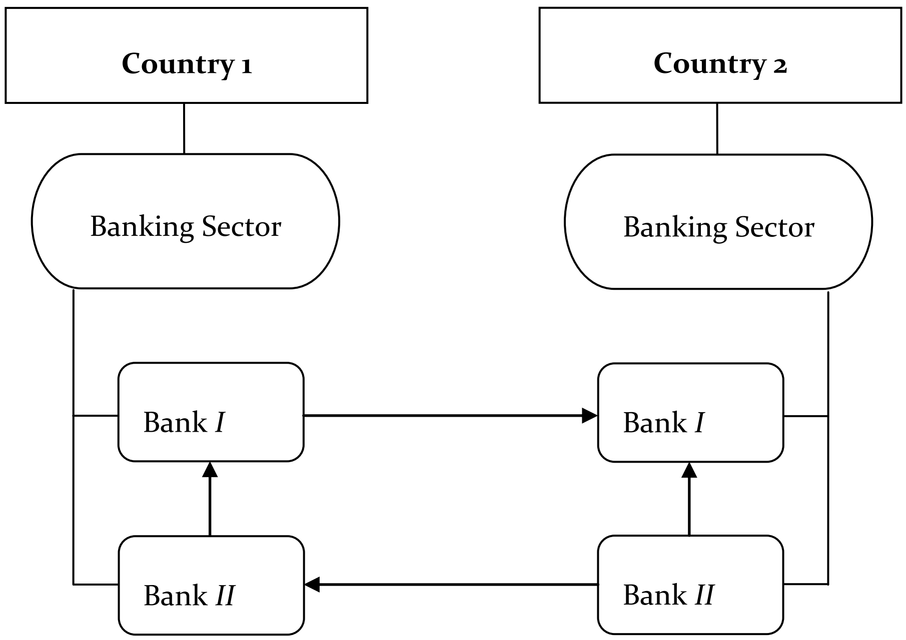
Loans						$L^{II\,2}_{b\,I\,2\,d-1}$		$L^{II\,2}_{b\,I\,2\,s-1}$		
Intrabank Loans						$-r^{I\,1}_{lb-1}\cdot L^{I\,1}_{b\,I\,2\,d-1}$		$+r^{II\,2}_{lb-1}\cdot L^{II\,2}_{b\,II\,1\,s-1}$		0
Deposits	$+r^{I\,2}_{m-1}\cdot M^{I\,2}_{d-1}$					$-r^{I\,2}_{m-1}\cdot M^{I\,2}_{s-1}$				0
	$+r^{II\,2}_{m-1}\cdot M^{II\,2}_{d-1}$							$-r^{II\,2}_{m-1}\cdot M^{II\,2}_{s-1}$		0
Bills[1]	$+r^{1}_{b-1}\cdot B^{1}_{h\,2\,d-1}$				$+r^{1}_{b-1}\cdot B^{1}_{cb\,2\,d-1}$					0
Bills[2]	$+r^{2}_{b-1}\cdot B^{2}_{h\,2\,d-1}$			$-r^{2}_{b}\cdot B^{2}_{s-1}$	$+r^{2}_{b-1}\cdot B^{2}_{cb\,2\,d-1}$	$+r^{2}_{b-1}\cdot B^{I\,2}_{b\,d-1}$		$+r^{2}_{b-1}\cdot B^{II\,2}_{b\,d-1}$		0
Δ in the stocks of										0
Household Loans	$+\Delta L^{I\,2}_{h\,d}$						$-\Delta L^{I\,2}_{h\,s}$			0
	$+\Delta L^{II\,2}_{h\,d}$								$-\Delta L^{II\,2}_{h\,s}$	0
Firm Loans			$+\Delta L^{I\,2}_{f\,d}$				$-\Delta L^{I\,2}_{f\,s}$			0
			$+\Delta L^{II\,2}_{f\,d}$						$-\Delta L^{2\,II}_{f\,s}$	0
Interbank Loans							$+\Delta L^{II\,2}_{b\,I\,2\,d}$		$-\Delta L^{II\,2}_{b\,I\,2\,s}$	0
Intrabank Loans							$+\Delta L^{I\,1}_{b\,I\,2\,d}$		$-\Delta L^{II\,2}_{b\,II\,1\,s}$	0
HPM	$-\Delta H^{2}_{h\,d}$				$+\Delta H^{1}_{s}$		$-\Delta H^{I\,1}_{b\,d}$		$-\Delta H^{II\,2}_{b\,d}$	0
Deposits	$-\Delta M^{I\,2}_{d}$						$+\Delta M^{I\,2}_{d}$			0
	$-\Delta M^{II\,2}_{d}$								$+\Delta M^{II\,2}_{d}$	0
Bills[1]	$-\Delta B^{1}_{h\,2\,d}$				$-\Delta B^{1}_{cb\,2\,d}$					0
Bills[2]	$-\Delta B^{2}_{h\,2\,d}$			$+\Delta B^{2}_{s}$	$-\Delta B^{2}_{cb\,2\,d}$		$-\Delta B^{I\,2}_{b\,d}$		$-\Delta B^{II\,2}_{b\,d}$	0
Default Loans	$+NPL^{I\,2}$						$-NPL^{I\,2}$			0
	$+NPL^{II\,2}$								$-NPL^{II\,2}$	0
Σ	0	0	0	0	0	0	0	0	0	0

The government receives taxes ($+T^{i}$) from firms and households and central bank's profits ($+F^{j}_{cb}$) and it pays interests on treasury bills supplied to the other sectors locally and to the other country ($-r^{j}_{b-1}.B^{j}_{s}$). The sum of these components determines the public sector borrowing requirements (*PSBR*). Governments of both countries are assumed to cover their *PSBR* by issuing new treasury bills ($+\Delta B^{j}_{s}$).

Each Central bank receives interests on their holdings of treasury bills from the domestic government ($+r^{j}_{b-1}.B^{j}_{cb\ j\ d-1}$) and from the other country's government ($+r^{z}_{b-1}.B^{z}_{cb\ j\ d-1}$). The sum of these interests is the central bank's profits, and they are transferred completely to the government as shown in the central bank column. Central bank is assumed to cover new flows (domestic and foreign bills) by issuing high powered money ($-\Delta H^{j}_{s}$) to households and to private banks.

Private banks, in the current account column, receive interests on loans to households and firms, interests on their holdings of treasury bills ($+r^{j}_{b-1}.B^{i\,j}_{b\ d-1}$), and pay interests to households on money deposits. As it is assumed in this model, households have some default in their loans, and thus banks receive interest just on performing loans ($+r^{i\,j}_{l-1}\,(L^{i\,j}_{h\ d-1}-NPL^{i\,j}_{-1})$).

The main contribution of this model is introducing the interbank loans market. Private banks are assumed to take and give interbank loans. The following diagram shows the interbank loans market in both countries. The diagram shows that bank *I* of the first country takes interbank loans from bank *II* of the same country and supplies interbank loans to bank *I* of the second country and bank *II* also take interbank loans from bank *II* of the second country. Bank *I* of the second country is a net debtor in this market and take interbank loans from bank *II* of the same country, and thus Bank *II* of the second country is a net creditor in this market. Interbank loans market in this model tries to give all possible interactions between banks locally and internationally in an attempt to reflect the real world.



Banks have to pay interests on demanded interbank loans and receive interests on their supplied interbank loans. Bank *I* in country one receive interest on interbank loans supplied to bank *I* of the second country ($+r^{I\,1}_{lb-1}.L^{I\,1}_{b\,I\,2\,s-1}$) and pay interests on its demand from bank *II* of country one ($-r^{II\,1}_{lb-1}.L^{II\,1}_{b\,I\,1\,d-1}$). Bank *II* in country one receives interests from bank *I* of the same country ($+r^{II\,1}_{lb-1}.L^{II\,1}_{b\,I\,1\,s-1}$) and pays interests to bank *II* of the second country ($-r^{II\,2}_{lb-1}.L^{II\,2}_{b\,II\,1\,d-1}$). Regarding the second country, bank *I* pays interests on interbank loans to country one bank *I* ($-r^{I\,1}_{lb-1}.L^{I\,1}_{b\,I\,2\,d-1}$) and to country two bank *II* ($-r^{II\,2}_{lb-1}.L^{II\,2}_{b\,I\,2\,d-1}$). Bank *II* of the second country receives interests on interbank loans supplied to the first country bank *II* ($+r^{II\,2}_{lb-1}.L^{II\,2}_{b\,II\,1\,s-1}$) and to the second country bank *I* ($+r^{II\,2}_{lb-1}.L^{II\,2}_{b\,I\,2\,s-1}$).

The difference between the ingoing interests and outgoing interests equals to the bank profits ($-F^{ij}_{b}$). Part of these profits goes to households as dividends and the rest goes as returned earnings ($+FU^{ij}_{b}$) to the capital accounts of banks.

Banks' capital account contains the change in banks' assets and liabilities, which gives the new flows of bank own funds or bank equities, returned earnings, and the value of non-performing loans.

5.2.2 MODEL EQUATIONS

This subsection outlines the behavior and motivation of each sector in both economies. The main model equations are going to be described in this subsection. All model equations are in appendix 5.A.

Production firms have to take a complex and interdependent set of decisions regarding pricing, investment, employment, and finance. Firms' real/ nominal output in this model is equal to their real/ nominal sales. The following equation is the real output in each country which is the sum of households' consumption (c^j), government expenditure (g^j), and investment (i^j).

$$y^j = s^j = c^j + g^j + i^j$$

The pricing decision is a constant mark-up of the unit cost, which in turn is equal to wages (WB^j) paid per each unit of sales. Investment decision of firms is given by the accounting identity of the capital account of firms.

$$P^j = \left(1 + \tau_s^j\right) * \left(1 + \varphi^j\right) . UC^j$$

$$UC^{j} = \frac{WB^{j}}{s^{j}}$$

The level of investment in a specific period depends upon the flows of loans and the value of fixed capital depreciation (see equations 5.19 and 5.20 in appendix 5.A). The employment decision depends upon volume of sales and workers productivity. In this model, as mentioned above, firms demand for loans is equal to banks' supply of loans to these firms.

$$I^{j} = \Delta L_{f\,d}^{I\,j} + \Delta L_{f\,d}^{II\,j} + \delta_{k}^{j}.K_{-1}^{j}$$

Households' personal income (YP^{j}) is the sum of wages, profits, and interests on their acquired financial assets, see equations 5.33 and 5.34 in appendix 5.A. Disposable income (YD^{j}) is equal to the personal income less income tax and interests on loans plus the interests on *NPL*, value of *NPL*, and capital gains (CG^{j}).

$$YP^{j} = WB^{j} + F_{f}^{j} + FD_{b}^{j} + r_{m-1}^{Ij}.M_{d-1}^{Ij} + r_{m-1}^{IIj}.M_{d-1}^{IIj} + r_{b-1}^{j}.B_{h\,j\,d-1}^{j} + r_{b-1}^{z}.B_{h\,j\,d-1}^{z}$$

$$YD^{j} = YP^{j} - T_{h}^{j} - r_{l-1}^{Ij}.L_{h\,d-1}^{Ij} - r_{l-1}^{IIj}.L_{h\,d-1}^{IIj} + r_{l-1}^{Ij}.NPL_{-1}^{Ij} + r_{l-1}^{IIj}.NPL_{-1}^{IIj} + NPL_{-1}^{Ij} + NPL_{-1}^{IIj} + CG^{j}$$

In this model households in both countries are assumed to be divided into three groups. The three groups are assumed to share the total country disposable income. The first group is assumed to receive 50 percent of the total country disposable income. This group is assumed to consume part of their share of disposable income and other part out of their previous level of wealth. The following equation shows the consumption function of the first group of households:

$$c1^{j} = \alpha_{0}^{j} + sh1^{j}.\alpha_{1}^{j}.yd^{ej} + \alpha_{2}^{j}.v_{-1}^{j}$$

where $sh1^j$ is the first group share of the total country disposable income and assumed to be constant all the time.

The second group is assumed to consume all their share of the total country disposable income plus the new loans they demand from banks.

$$c2^j = sh2^j . yd^{ej} + nl^j$$

The third group is those households who default in their loans and assumed to consume just their share of the total country disposable income, see the following equation.

$$c3^j = sh3^j . yd^{ej}$$

The shares of the second and the third group are assumed to vary over time. In this model it is assumed that when a household default in their loan they move from the second group to the third group, and thus the share of the third group increases when loan defaults increases and vice versa. The following are the equations of the second and third share of the total country disposable income:

$$sh2^j = 1 - sh1^j - sh3^j$$

$$sh3^j = sh3^j_{-1} + \eta^j . \Delta\left(\frac{\sum_{i=I}^{II} NPL^{i\,j}}{\sum_{i=I}^{II} L^{i\,j}_{h\,d}}\right)$$

where η^j is a constant transforms the second term of the write hand side of the equation into percentages. This equation stats that when total non-performing loans in a country out of total loans demand increases the share of the third group increases and on the same time the share of the second group decreases by the same percentages.

Total households' consumption is the sum of the three groups' consumption.

$$c^j = c1^j + c2^j + c3^j$$

Households are assumed to manage their portfolios based on Tobin portfolio decision. Demand for financial assets as a share of financial market assets wealth (V^j_{fma}) depends upon the rate of return on those assets, see equations 5.73 – 5.80 in appendix 5.A. V^j_{fma} equals to the value of total wealth minus stocks of cash money, loans, and flows of bank equities. Cash money is assumed to be a potion of households' consumption; households demand for loans is equal to the supply of loans to households, and flows of bank equities is determined by the difference between bank returned earnings and *NPLs*.

The government of each country is assumed to pay for its expenditure and transfers (interests on treasury bills supplied for domestic and foreign markets) and collects taxes from firms and households in addition to the profits of its central bank. The following equation describes *PSBR* in each country. Flows of treasury bills supplied depend upon the value of *PSBR*.

$$PSBR^j = G^j + r^j_{b-1}.B^j_{s-1} - \left(T^j + F^j_{cb}\right)$$

$$\Delta\left(B^j_s\right) = PSBR^j$$

Both governments sell treasury bills to domestic and foreign households, to domestic banks, and to the foreign central bank. The rest are assumed to be sold to the domestic central bank as described in the following equation, and thus central banks clear the market of treasury bills in both countries. Given this assumption, central banks in this model are not entirely independent from their governments.

$$B^j_{cb\,s} = B^j_s - B^j_{h\,j\,s} - B^{Ij}_{b\,s} - B^{IIj}_{b\,s} - B^j_{h\,z\,s} - B^j_{cb\,z\,s}$$

Regarding central banks in both countries, they are assumed to supply high powered money (*HPM*) to households and banks on demand. Central banks demand for domestic treasury bills depend upon their capital account position. In other words, change in domestic treasury bills demand depends upon the flows of *HPM* and foreign treasury bills. Central bank profits are equal to the interests on their acquired treasury bills.

The main assumption about private banks is that they are assumed to supply loans to households and firms based on their liquidity. Banks supply loans in the interbank markets based on their liquidity and the debtor bank liquidity. Equations 5.217 – 5.228 in appendix 5.A show loans supply functions. These equations state that banks are able to supply more loans if their liquidity ratio is above a target ratio set by the central bank and they provide less loans if it is lower than the target liquidity ratio. Regarding the interbank markets, banks supply more loans to other banks if their liquidity ratio is above the target one and the other bank has a positive change in its liquidity ratio.

Banks acquire vault cash as a portion of money deposits; see equations 5.133 – 5.136 in appendix 5.A. The change in banks' own funds or existing equities is equal to the returned earnings after subtracting *NPL* as shown in equations 5.151 – 5.154 in appendix 5.A.

Banks' demand for treasury bills is an accounting identity determined in the balance sheet of each bank, see equations 5.231 – 5.234 in appendix 5.A.

The redundant, or the hidden, equation in this model is that the central bank in each country supplies vault cash to banks *II* on demand.

$$H_{b\,s}^{II\,j} = H_{b\,d}^{II\,j}$$

The above equation can be derived from equation 5.124 or 5.127.

5.2.3 MODEL SIMULATIONS

The baseline scenario assumes that both economies are in a steady state condition, i.e. all stocks and flows are constant if all exogenous variables are held constant. If all stocks and flows are constant then as a consequence *PSBR* equals zero then:

$$G^j + r^j_{b-1}.B^{j*}_{s-1} - \left(T^j + F^{j*}_{cb}\right) = 0$$

$$G^j + r^j_{b-1}.B^{j*}_{s-1} - F^{j*}_{cb} = T^j$$

$$= T^j_h + T^j_f$$

$$= \theta^j.YP^{j*} + \tau^j_s.S^{j*}$$

but $$y^{j*} = p^{j*}s^{j*}$$

then $$y^{j*} = \frac{p^{j*}.g^j + r^j_{b-1}.B^{j*}_{s-1} - F^{j*}_{cb} - \theta^j.YP^{j*}}{\tau^j_s.p^{j*}}$$

From the above equations, the value of steady state real output depends upon real government expenditure, government debt servicing, tax rates, and endogenous variables. To know what exactly is going on in the model, we need to use simulations.

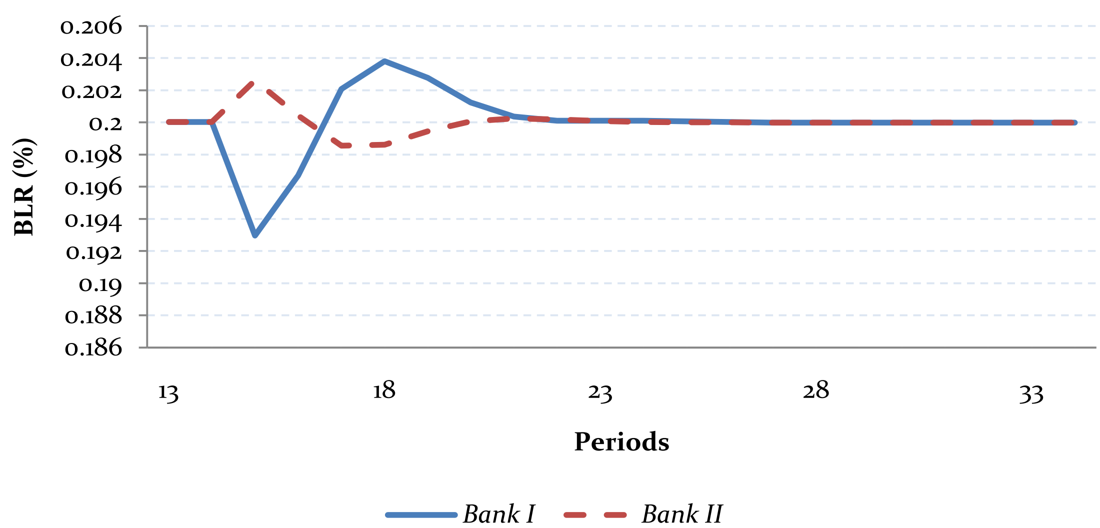
The first scenario (Temporary increase in NPL)

The first scenario assumes a onetime increase in the households' non-performing loans they take from bank *I* in the first country. In the baseline scenario it is assumed that the ratio of households default loans forms 5.0% of the total loans stock. In the first scenario this ratio is assumed to increase in period 15 to reach 10.0% of total households' loans from bank *I* of the first country.

Credit crunch contagion:

An increase in non-performing loans leads to an immediate decline in bank *I* income receipts which will affect negatively the bank's own funds as described in equations 5.151 – 5.154. The decline in bank *I* own funds affects negatively the bank's demand for government treasury bills, see equations 5.231 – 5.234. As a consequence, bank *I* liquidity declines, which affects its capability to supply loans to households, firms, and in the interbank loans market. Figures 5.3 and 5.4 show the evolution of banks *I* and *II* of the first and the second country liquidity ratio after the increase in the first country bank *I NPL*.

Figure 5.3: *Evolution of bank liquidity ratio in country one*



In the interbank loans market, the decline in bank *I* liquidity ratio forces the bank to decline the supply of interbank loans to the second country bank *I*. Bank *II* in the first country starts to be afraid about bank *I* solvency, which may affect its capability in fulfilling its short and long terms liabilities and thus bank *II* may be affected due to that. As a consequence, bank *II* of the first country decreases its interbank loans supply to bank *I*.

Figure 5.4: *Evolution of bank liquidity ratio in country two*

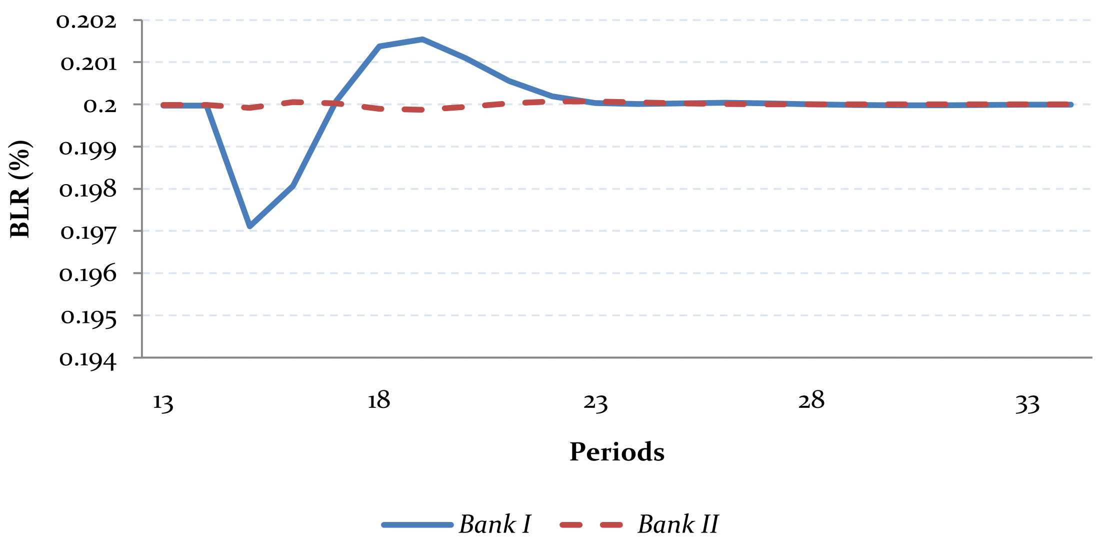


Figure 5.5 shows the evolution of the first country bank *I* supply of loans to bank *I* of the second country (solid line) and the evolution of the first country bank *II* supply of loans to bank *I* in the same country (dash line).

Figure 5.6 shows the interbank loans supply in the second country after the increase in bank *I NPL* of the first country. The solid line shows the evolution of interbank loans supply of bank *II* of the second country to bank *II* of the first country. The dash line shows the evolution of interbank loans supply of bank *II* of the second country to bank *I* of the same country.

Figure 5.5: *Evolution of interbank loans supply in the first country*

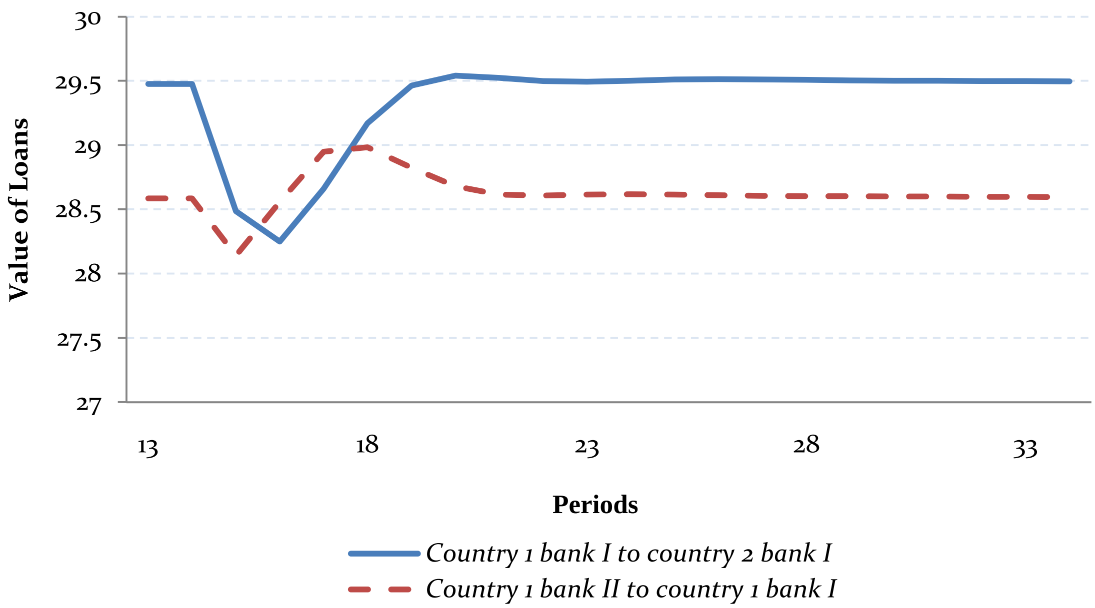
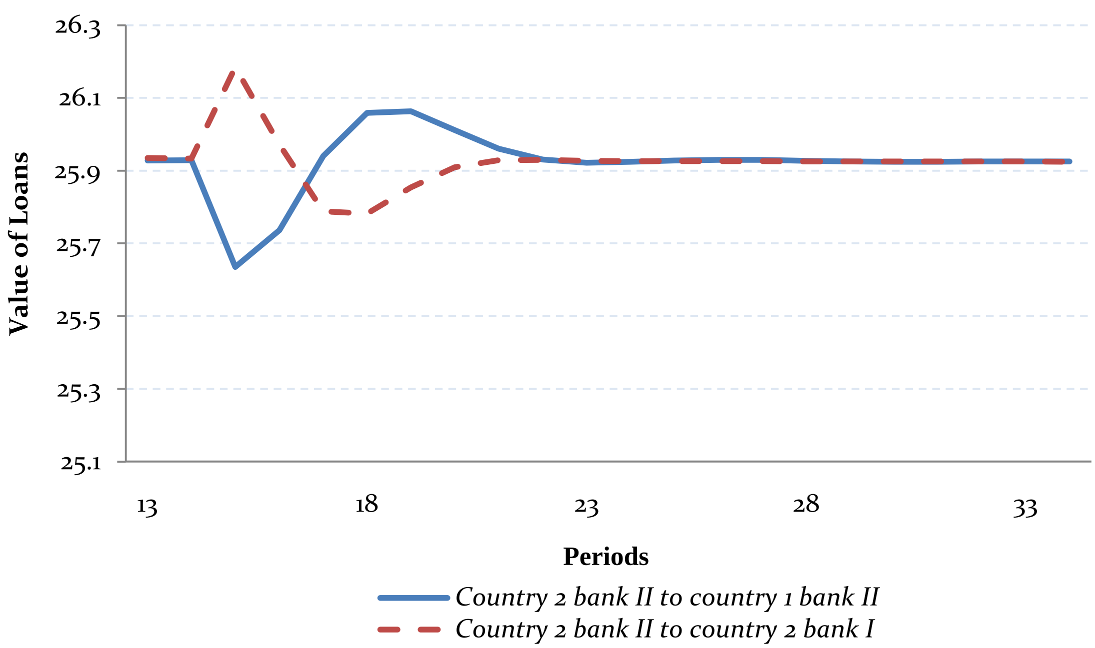


Figure 5.6: *Evolution of interbank loans supply in the second country*



As shown in the figure, loans supply of bank *II* of the second country to bank *I* of the first country declines due to the decline in the second country bank *I* liquidity ratio. The second country bank *I* liquidity ratio declines due to the decline in the received interbank loans from the first country bank *I*. As a consequence bank *II* in the second country decreases interbank loans supply to the second country bank *I*.

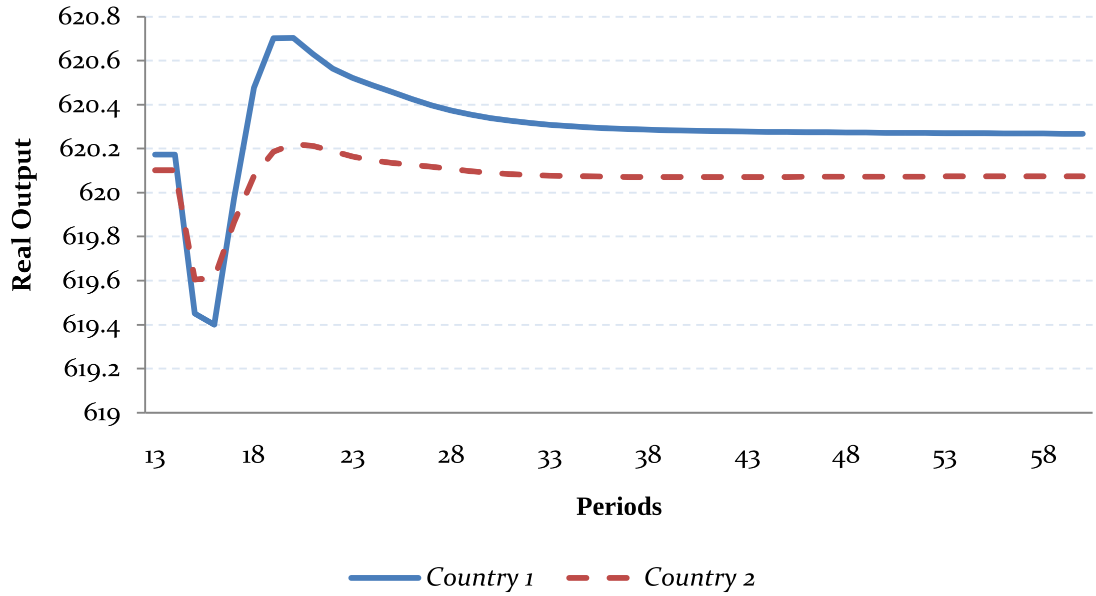
After that bank *II* of the first country decreases interbank loans supply to bank *I* in the same country, its liquidity ratio increases and due to that interbank loans supply to it by the second country bank *II* increases as shown in figure 5.6.

Banks in this model aim to keep their liquidity at a target level set by the central bank. And to keep the target level of liquidity, banks change their loans supply levels or policies. When the bank liquidity ratio falls below the target one, banks decrease loans supply (credit crunch) and when it rises above the target, banks lend more (credit expansion). In this scenario, decreasing loans supply will lead to an increase in bank liquidity and reach levels above the target one and with the increase in bank liquidity, they start to lend more. After a certain period bank liquidity starts to decline again and thus lending. This process will continue until banks find their liquidity ratio equal to the target liquidity ratio. A credit crunch will affect the domestic economy as well as the foreign economy through interbank markets in both countries.

Credit crunch effect on the real economy:

Figure 5.7 shows the evolution of real output in both countries. It shows that the real output declines in both countries immediately after the increase in *NPL* of the first country bank *I* by households.

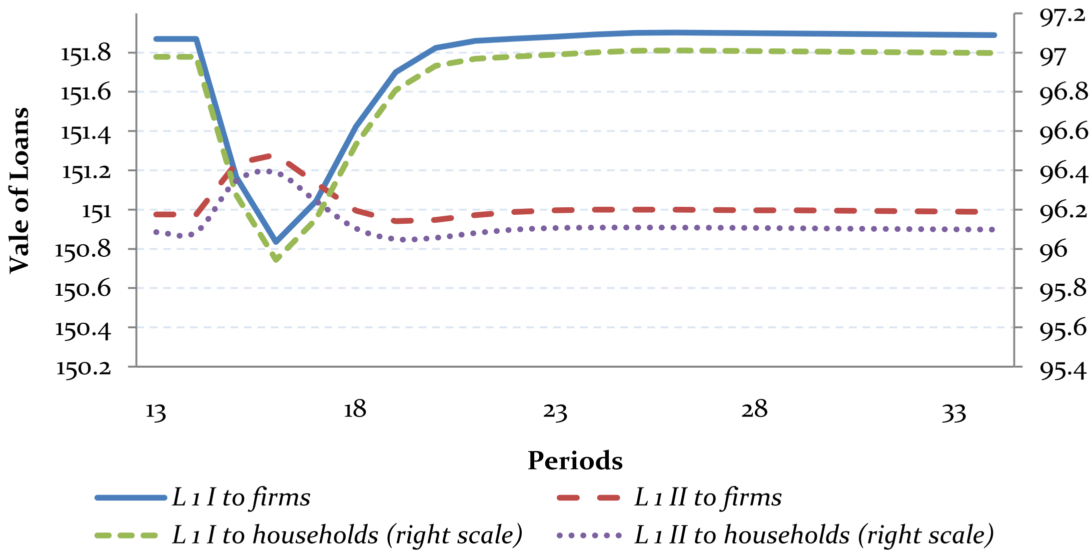
Figure 5.7: *Evolution of real output in both countries*



There are two channels through which a credit crunch affects the real economy in both countries. The first is through firms' investments and the second is through households' consumption. The decline in bank *I* of the first country liquidity leads to a decline in its lending to households and firms. The increase in bank *II* liquidity of the same country leads to an increase in its lending to firms and households.

Figure 5.8 shows the evolution of loans supplied by banks *I* and *II* to firms and households in the first country. The solid line is the supply of loans to firms by bank *I*, dash line is the supply of loans to firms by bank *II*, square dots line is the supply of loans to households by bank *I*, and the round dots line is the supply of loans to households by bank *II*.

Figure 5.8: *Evolution of loans supply in country one*



Figures 5.9 and 5.10 show the evolution of loans supplied by banks *I* and *II* in the second country to firms and to households. These figures show that loans supply movement follows bank liquidity movement in both countries.

Figure 5.9: *Evolution of loans supply to firms in the second country*

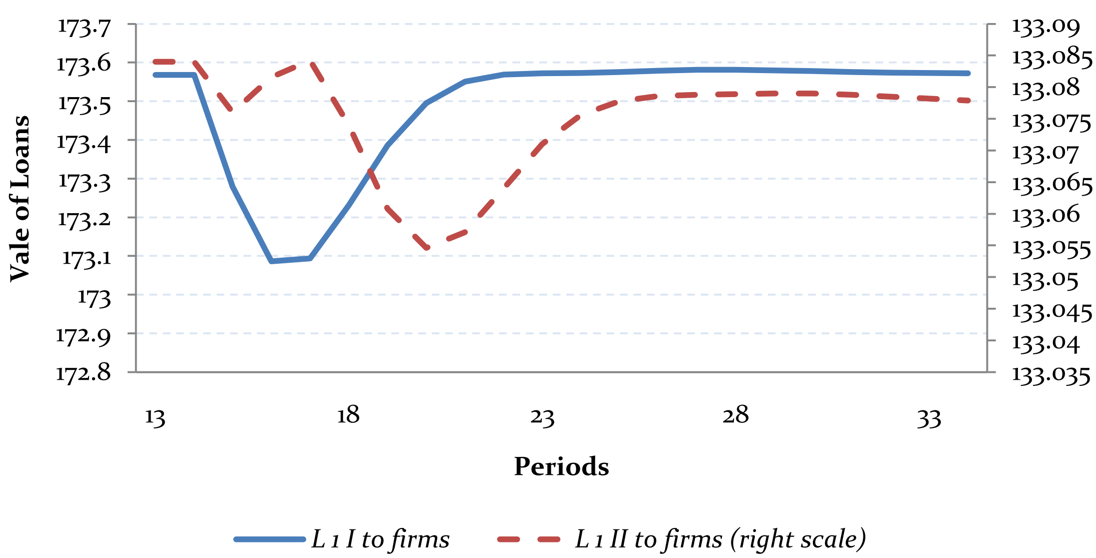
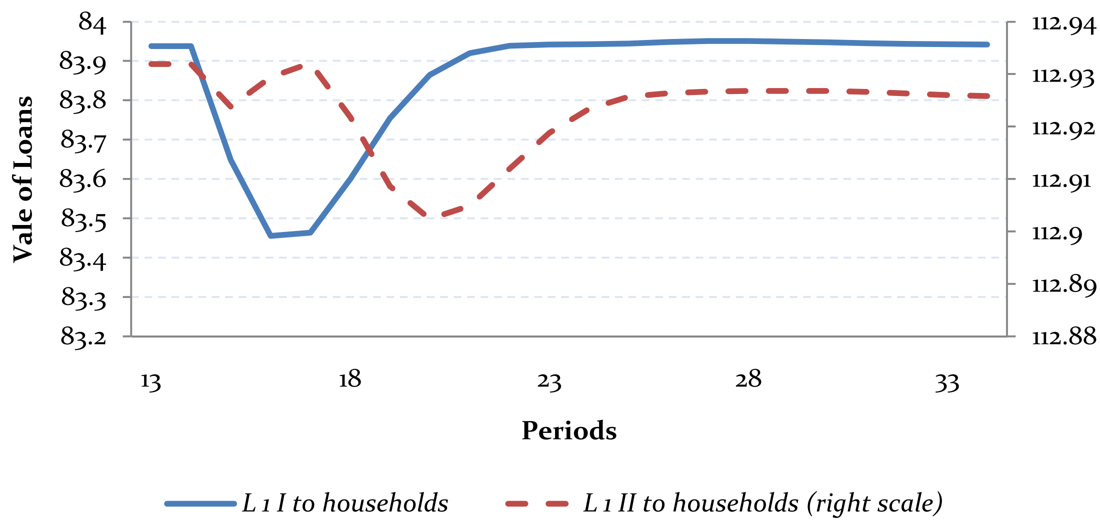
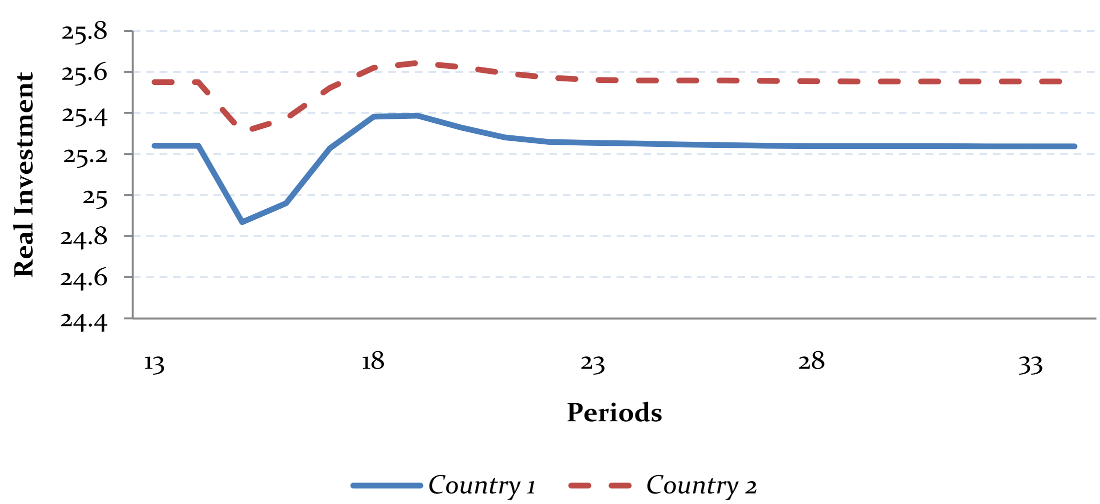


Figure 5.10: *Evolution of loans supply to households in the second country*



By equations 5.19 and 5.20, investment depends upon the flows of bank loans to firms, and thus credit crunch will affect investment negatively which leads to a decline in the real output. Figure 5.11 shows the evolution of real investment in both countries after a one period increase in the first country bank *I NPL*.

Figure 5.11: *Evolution of real investment in both countries*

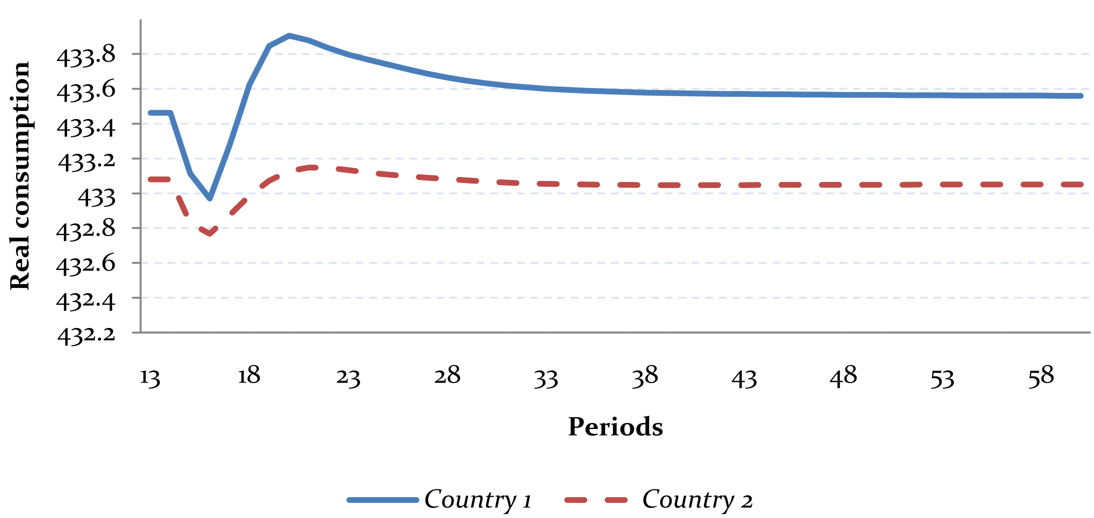


The other channel that affects real output is the households' consumption. There are two effects on households' consumption, one is direct and the other is indirect. The direct effect can be explained by equations 5.43 and 5.50 in appendix 5.A. In this model group 2 households are assumed to ask for loans to cover part of their consumption as shown in the equations. When loans to households decline, there consumption will decline too, and thus real output.

The indirect effect comes from disposable income. When loans supply to firms decline investment declines and also consumption—through the direct effect. This leads to a decline in firms' sales, which leads to a decline in wages and profits and thus disposable income. Disposable income decline due to the decline in capital gains—banks' own funds—and increase due to the increase in *NPL*, but these two elements will cancel each other, see equations 5.35 – 5.38.

Figure 5.12 shows the evolution of real households' consumption in both countries after a one period increase in the first country bank *I NPL*.

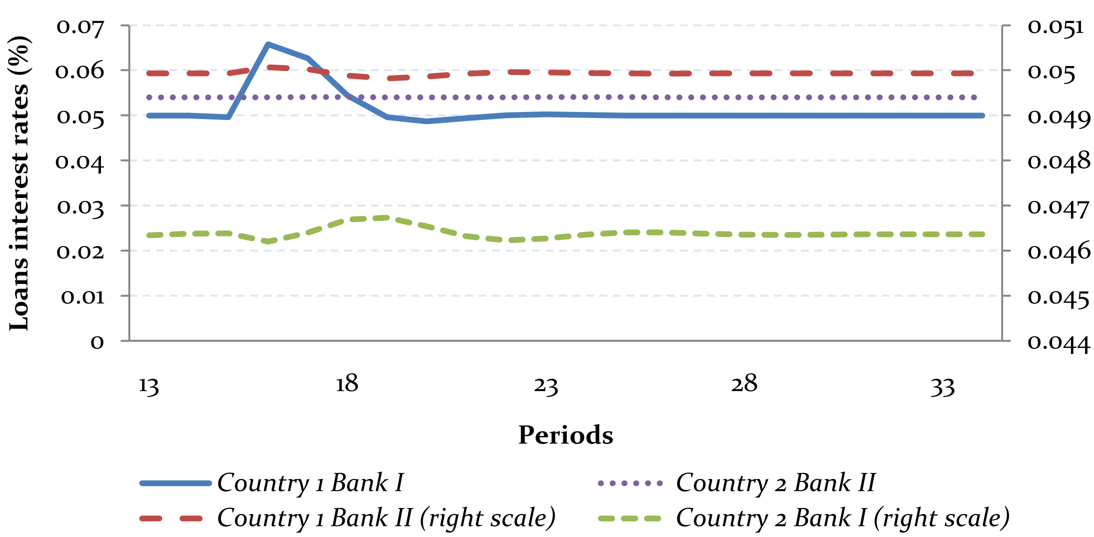
Figure 5.12: *Evolution of real households' consumption in both countries*



These declines in investment, consumption, and output in both continues continue for several periods then they start to increase again and reach higher levels than the steady state levels following banks' behavior in lending but later it starts to decline again towards the steady state levels before the shock. When there is a credit crunch there is a decline in the economy and when there is a credit expansion there is an expansion in the economy.

Regarding the interest rates in the interbank markets and on loans to firms and to households, they evolve depending on target bank profits, interest on assets, and stocks of loans supplied, see equations 5.155 – 5.158. When *NPL* increases, own funds declines, so bank liquidity, and thus stocks of loans supplied, which leads to a decline in bank profits. For banks to keep their profits close to the target one, they find themselves in need to increase the interest rates on loans supplied. Figure 5.13 shows the evolution of interest rates on loans to households and to firms in both countries after a one time increase in the first country bank *I NPL*.

Figure 5.13: *Evolution of loans interest rates in both countries*



As shown in the figure, bank *I* in the first country increases loans interest rates much more compared with the other banks due to the losses that come from the increase in *NPL* beside the change in the stock of loans supplied. The other bank response is mainly due to the change in the stock of loans supplied to the interbank markets and to households and firms. Interest rates on interbank loans follow the same pattern of the interest rates on loans to households and firms; see equations 5.211 – 5.213.

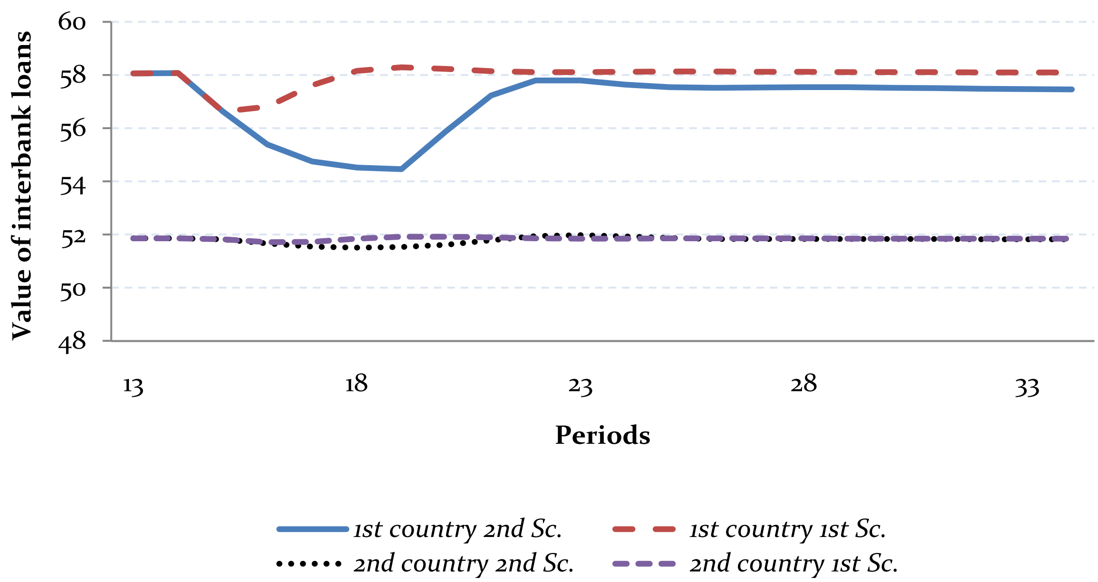
The second scenario (Several periods increase in NPL)

The second scenario assumes an *increase* in households' *NPL* they take from bank *I* for 5 periods starting from period 15. The reason behind this scenario is to see the effect of a several time increase in *NPL* on the economy, which may allow us to generalize the results. The ratio of *NPL* as a share of total households demand for loans will increase from 5.0% to 10.0%.

Figure 5.14 shows the evolution of interbank loans supply in both countries after the increase in *NPL* of bank *I* in the first country (second scenario) compared with an increase in the *NPL* for one time only (first scenario).

In this figure, one should note that the interbank loan supply is summed for both banks in the country not for a specific bank as in figures 5.5 and 5.6 above. As shown in the figure, the effect of a more than one time increase in NPL is more than a onetime increase. The shock has a more negative effect on interbank loans supply in the second scenario compared with the first scenario in both countries. Thus interbank lending takes more time to return to its previous levels before the shock in the second scenario compared with the first scenario.

Figure 5.14: *Evolution of interbank loans supply in both countries*



Figures 5.15 and 5.16 show the effect of an increase in the *NPL* of bank *I* of the first country on loans supply to firms and households in both countries in both scenarios. This increase in *NPL* in the second scenario has a more negative effect on loans supply compared with the first scenario in both countries as the case in the interbank lending market.

When *NPLs* increase in bank *I* for more than one period bank *I* starts facing losses on its own funds which affects its liquidity and become below the target level set by the central bank. This forces bank *I* to decrease loans supply in the interbank market, to households, and to firms to treasure back its liquidity to be equal to the target one. The continuation of the higher levels of *NPLs* forces bank *I* to continue decreasing loans supply until its liquidity return back to the target level. As discussed in the first scenario, bank *I* credit crunch will spread to the other domestic and foreign banks.

Figure 5.15: *Evolution of loans supply to firms in both countries*

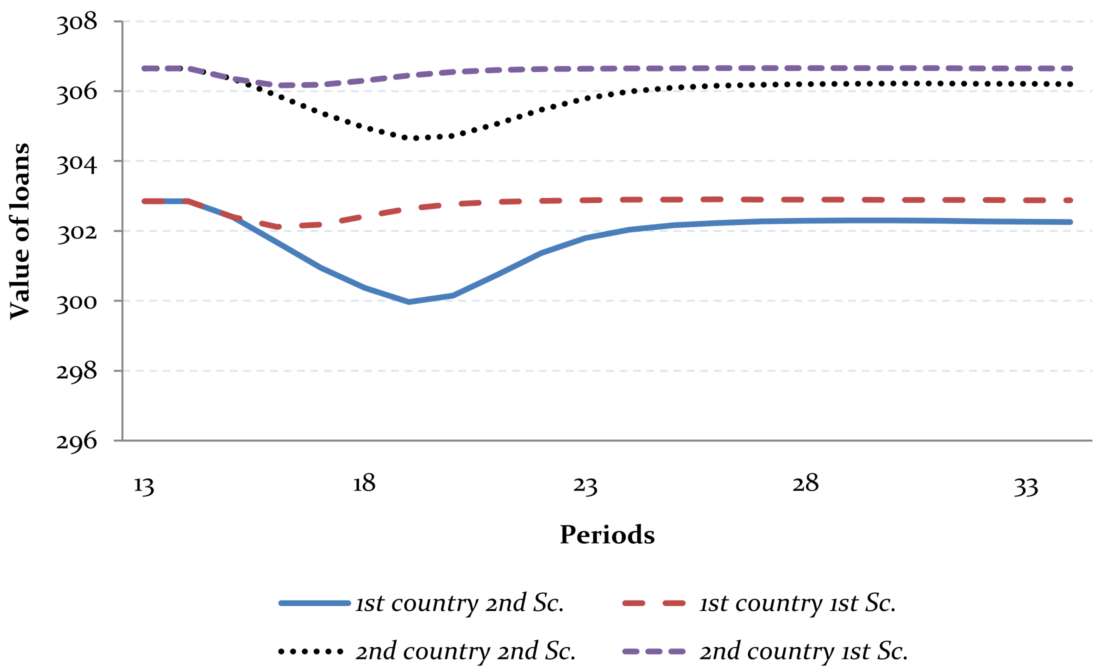


Figure 5.16: *Evolution of loans supply to households in both countries*

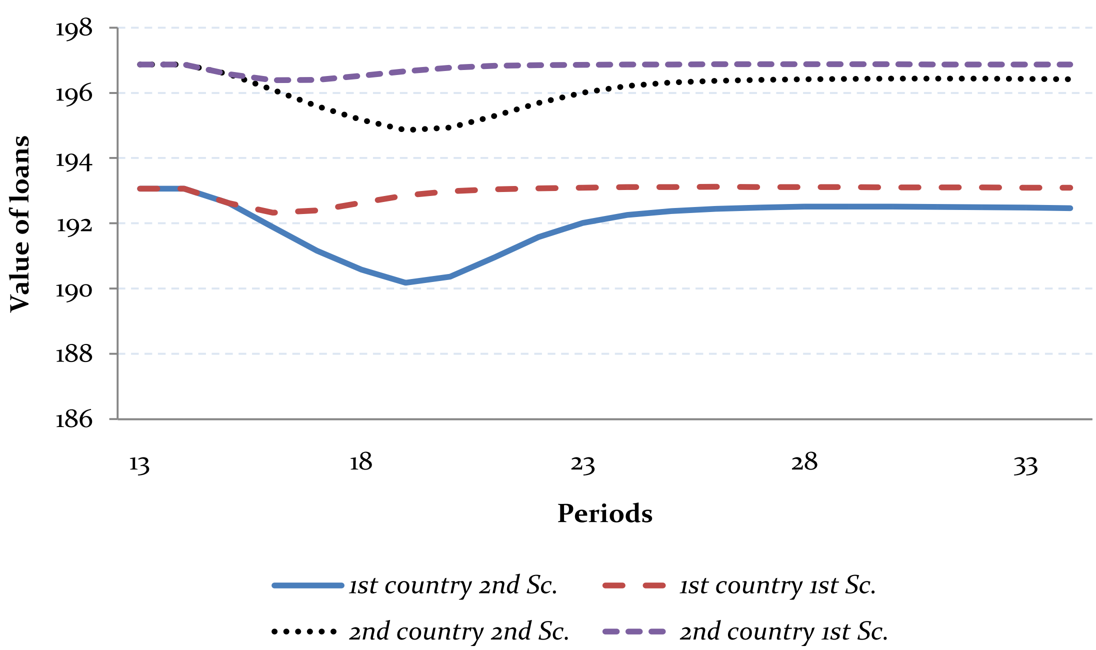


Figure 5.17 shows the real output in both countries in both scenarios. As shown in the figure, the credit crunch in both countries has bigger effects on real output in the second scenario compared with the first scenario. The evolution of real output follows the evolution of banking behavior in lending both in the interbank lending market and in the domestic market.

Figure 5.17: *Evolution of real output in the first country*[10]

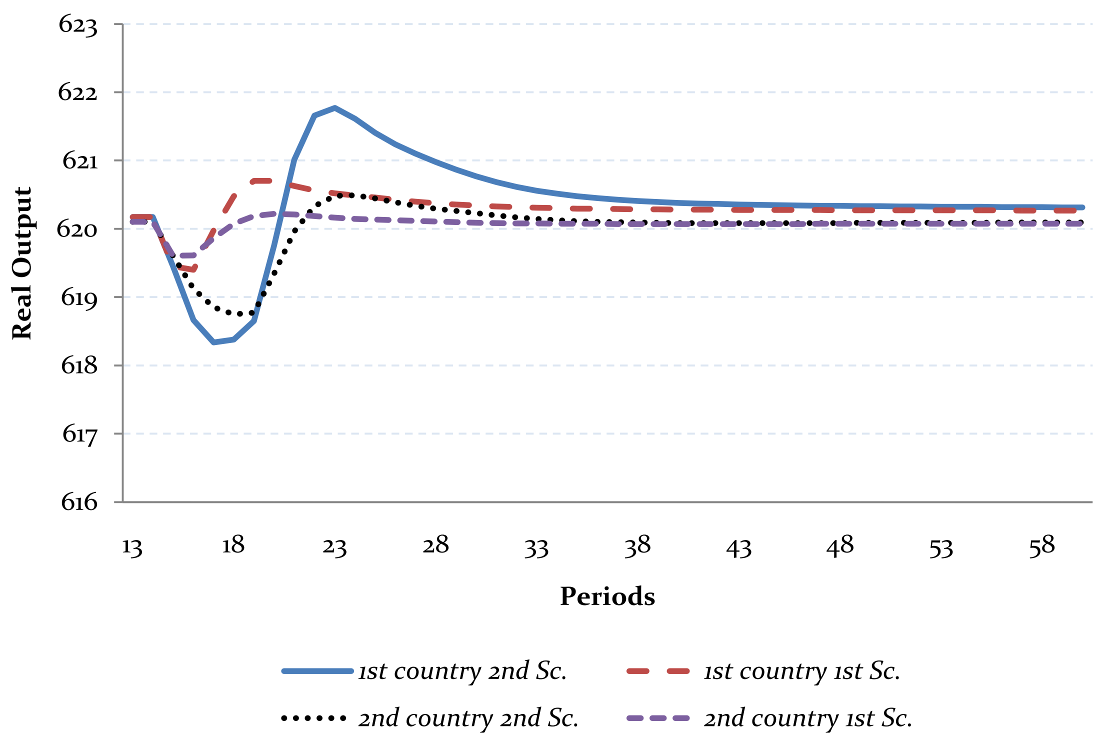


Figure 5.18 shows the evolution of real households' consumption and real disposable income in the first country in the case of the second scenario compared with the first scenario. As shown in the figure, real consumption and real disposable income are affected in the second scenario more than in the first scenario. A credit

[10] One should note that due to the different scale between figure 5.7 and 5.17 real output in both countries looks identical in figure 5.17 and not in figure 5.7 while real output in the first country is slightly higher.

crunch in the first country spreads to the other country, which will have a negative effect on households' real consumption and on real disposable income. Figure 5.19 shows the evolution of real households' consumption and real disposable income in the second country in both scenarios.

Figure 5.18: *Evolution of real consumption and real disposable income in the first country*

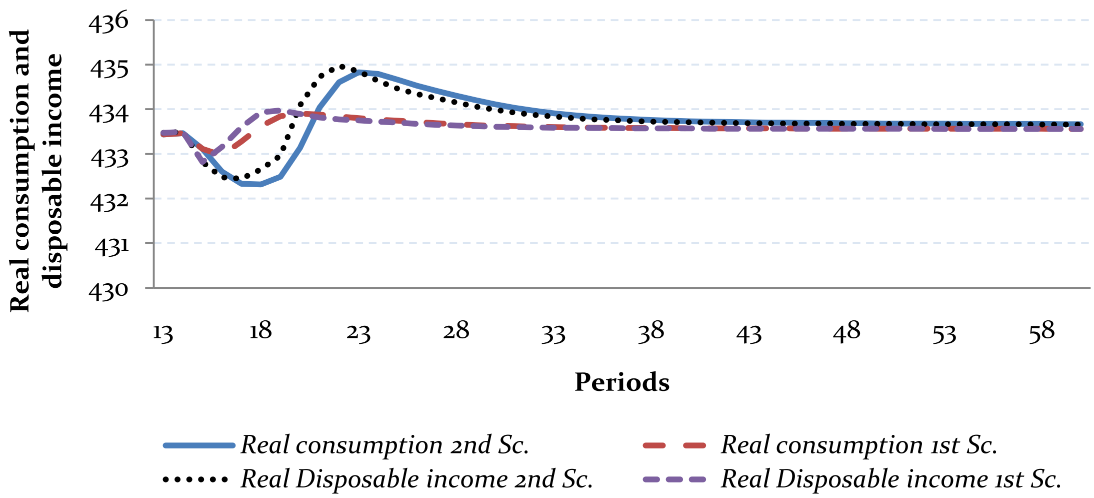
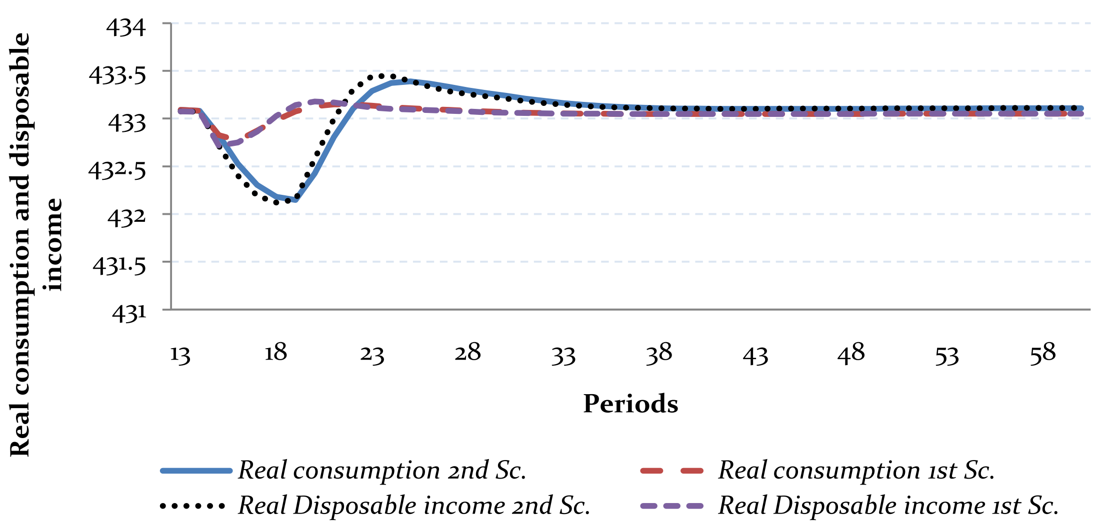


Figure 5.19: *Evolution of real consumption and real disposable income in the second country*



5.3 CONCLUSION

This chapter describes the contagion effects of a credit crunch, and its effects in a two steady state open economies in a stock flow consistent monetary model. The model deployed in this chapter assumes that a credit crunch happens due to a decline in the supply of credit only, with demand for credit following supply. To see the credit crunch contagion, the model is built in such a way to have two types of banks in each country. These banks supply interbank loans to each other in the domestic and foreign markets. This chapter, also, explores the effect of a credit crunch on output, investment, consumption, income, and the other main economic variables in both countries.

A credit crunch is assumed to happen due to an increase in households' non-performing loans of the first country that they demand from bank *I* of the same country.

The model simulations show conclusively that credit crunches spread between connected banks either locally or globally. Another result is that highly connected banks are affected more than the less connected banks by credit crunch. In further work, it should be possible to quantify the optimal level of connectivity between private banks.

The decline in loans supplied leads to a direct decline in investment of firms and in households' consumption through the decline in new loans they demand to cover their investment regarding firms and consumption regarding households.

The indirect effect on the real economy comes from disposable income. Disposable income contains the interests that households do not pay on their non-performing loans. This leads to an increase in disposable income. But the decline in investment leads to a decline in firms' profits and wages, and thus leads to a decline in disposable income.

Banks are assumed to supply loans based on their liquidity compared to a target level set by the central bank. Any decline in bank liquidity ratios below the target level forces banks to diminish their loans, and thus banks change their loans supply decision to keep their liquidity close to the target one. When banks decrease their supply of loans their liquidity becomes better-off and they start to increase their lending. Due to this mechanism, the main economic and financial variables continue to in a cyclical movement until they return to their previous level before the shock.

Results of the second scenario show that when the credit crunch continues the negative effect on the economy is bigger and it takes more time for the economy to return back to previous levels before the shock.

Several steps can be taken in the future to make this model closer to the reality, like introducing two types of households, one owning firms and banks, and the others working in those firms and demanding loans. Another step is to introduce more kinds of financial paper that banks purchase and trade among themselves locally and globally. Another step is by introducing demand forces for loans whether in the interbank market or in the households and firms sectors. Finally, one can go further in this model to explore the effect of a credit crunch on financial integration and globalization.

5.4 APPENDIX 5.A: MODEL EQUATIONS

Production firms equations

$$y^1 = s^1 = c^1 + g^1 + i^1 \tag{5.1}$$

$$y^2 = s^2 = c^2 + g^2 + i^2 \tag{5.2}$$

$$k^1 = k^1_{-1} + (i^1 - \delta^1_k . k^1_{-1}) \tag{5.3}$$

$$k^2 = k^2_{-1} + (i^2 - \delta^2_k . k^2_{-1}) \tag{5.4}$$

$$P^1 = (1 + \tau^1_s) * (1 + \varphi^1) . UC^1 \tag{5.5}$$

$$P^2 = (1 + \tau^2_s) * (1 + \varphi^2) . UC^2 \tag{5.6}$$

$$WB^1 = W^1 . N^1 \tag{5.7}$$

$$WB^2 = W^2 . N^2 \tag{5.8}$$

$$N^1 = \frac{s^1}{Pr^1} \tag{5.9}$$

$$N^2 = \frac{s^2}{Pr^2} \tag{5.10}$$

$$UC^1 = \frac{WB^1}{s^1} \tag{5.11}$$

$$UC^2 = \frac{WB^2}{s^2} \tag{5.12}$$

$$\pi^1 = \frac{\Delta P^1}{P^1_{-1}} \tag{5.13}$$

$$\pi^2 = \frac{\Delta P^2}{P^2_{-1}} \tag{5.14}$$

$$Y^1 = S^1 = s^1.P^1 \tag{5.15}$$

$$Y^2 = S^2 = s^2.P^2 \tag{5.16}$$

$$K^1 = k^1\,.p^1 \tag{5.17}$$

$$K^2 = k^2\,.p^2 \tag{5.18}$$

$$I^1 = \Delta L_{f\,d}^{I\,1} + \Delta L_{f\,d}^{II\,1} + \delta_k^1.K_{-1}^1 \tag{5.19}$$

$$I^2 = \Delta L_{f\,d}^{I\,2} + \Delta L_{f\,d}^{II\,2} + \delta_k^2.K_{-1}^2 \tag{5.20}$$

$$i^1 = \frac{I^1}{p^1} \tag{5.21}$$

$$i^2 = \frac{I^2}{p^2} \tag{5.22}$$

$$L_{f\,d}^{I1} = L_{f\,s}^{I1} \tag{5.23}$$

$$L_{f\,d}^{II1} = L_{f\,s}^{II1} \tag{5.24}$$

$$L_{f\,d}^{I2} = L_{f\,s}^{I2} \tag{5.25}$$

$$L_{f\,d}^{II2} = L_{f\,s}^{II2} \tag{5.26}$$

$$F_f^1 = S^1 - T_f^1 - WB^1 - r_{l-1}^{I1}.L_{f\,d-1}^{I1} - r_{l-1}^{II1}.L_{f\,d-1}^{II1} - \delta_k^1.K_{-1}^1 \tag{5.27}$$

$$F_f^2 = S^2 - T_f^2 - WB^2 - r_{l-1}^{I2}.L_{f\,d-1}^{I2} - r_{l-1}^{II2}.L_{f\,d-1}^{II2} - \delta_k^2.K_{-1}^2 \tag{5.28}$$

$$\omega^{T1} = \left(\frac{W^1}{P_s^1}\right)^T = \Omega_0^1 + \Omega_1^1.Pr^1 + \Omega_2^1\left(\frac{N^1}{N_{fe}^1}\right) \tag{5.29}$$

$$W^1 = W_{-1}^1.\left(1 + \Omega_3^1.\left(\omega_{-1}^{T1} - \left(\frac{W_{-1}^1}{P_{s-1}^1}\right)\right)\right) \tag{5.30}$$

$$\omega^{T2} = \left(\frac{W^2}{P_s^2}\right)^T = \Omega_0^2 + \Omega_1^2.Pr^2 + \Omega_2^2\left(\frac{N^2}{N_{fe}^2}\right) \quad (5.31)$$

$$W^2 = W_{-1}^2.\left(1 + \Omega_3^2.\left(\omega_{-1}^{T2} - \left(\frac{W_{-1}^2}{P_{s-1}^2}\right)\right)\right) \quad (5.32)$$

Households equations

$$YP^1 = WB^1 + F_f^1 + FD_b^1 + r_{m-1}^{I1}.M_{d-1}^{I1} + r_{m-1}^{II1}.M_{d-1}^{II1} + r_{b-1}^1.B_{h\,1\,d-1}^1 + r_{b-1}^2.B_{h\,1\,d-1}^2 \quad (5.33)$$

$$YP^2 = WB^2 + F_f^2 + FD_b^2 + r_{m-1}^{I2}.M_{d-1}^{I2} + r_{m-1}^{II2}.M_{d-1}^{II2} + r_{b-1}^2.B_{h\,2\,d-1}^2 + r_{b-1}^1.B_{h\,2\,d-1}^1 \quad (5.34)$$

$$YD^1 = YP^1 - T_h^1 - r_{l-1}^{I1}.L_{h\,d-1}^{I1} - r_{l-1}^{II1}.L_{h\,d-1}^{II1} + r_{l-1}^{I1}.NPL_{-1}^{I1} + r_{l-1}^{II1}.NPL_{-1}^{II1} + NPL_{-1}^{I1} + NPL_{-1}^{II1} + CG^1 \quad (5.35)$$

$$YD^2 = YP^2 - T_h^2 - r_{l-1}^{I2}.L_{h\,d-1}^{I2} - r_{l-1}^{II2}.L_{h\,d-1}^{II2} + r_{l-1}^{I2}.NPL_{-1}^{I2} + r_{l-1}^{II2}.NPL_{-1}^{II\,2} + NPL_{-1}^{I\,2} + NPL_{-1}^{II\,2} + CG^2 \quad (5.36)$$

$$CG^1 = \Delta\left(\frac{1}{E_1}\right).B_{h\,1\,s-1}^2 + \Delta e_b^{I1} + \Delta e_b^{II1} \quad (5.37)$$

$$CG^2 = \Delta(E_1).B_{h\,2\,s-1}^1 + \Delta e_b^{I2} + \Delta e_b^{II2} \quad (5.38)$$

$$yd^1 = \frac{YD^1}{P^1}.\pi^1\frac{V_{-1}^1}{P^1} \quad (5.39)$$

$$yd^2 = \frac{YD^2}{P^2}.\pi^2\frac{V_{-1}^2}{P^2} \quad (5.40)$$

$$c^1 = c1^1 + c2^1 + c3^1 \quad (5.41)$$

$$c1^1 = \alpha_0^1 + sh1^1.\alpha_1^1.yd^{e1} + \alpha_2^1.v_{-1}^1 \quad (5.42)$$

$$c2^1 = sh2^1.yd^{e1} + nl^1 \quad (5.43)$$

$$c3^1 = sh3^1.yd^{e1} \quad (5.44)$$

$$sh1^1 = constant \quad (5.45)$$

$$sh2^1 = 1 - sh1^1 - sh3^1 \quad (5.46)$$

$$sh3^1 = sh3^1_{-1} + \eta^1.\Delta\left(\frac{\sum_{i=I}^{II} NPL^{i\ 1}}{\sum_{i=I}^{II} L_{h\ d}^{i\ 1}}\right) \quad (5.47)$$

$$c^2 = c1^2 + c2^2 + c3^2 \quad (5.48)$$

$$c1^2 = \alpha_0^2 + sh1^2.\alpha_1^2.yd^{e2} + \alpha_2^2.v_{-1}^2 \quad (5.49)$$

$$c2^2 = sh2^2.yd^{e2} + nl^2 \quad (5.50)$$

$$c3^2 = sh3^2.yd^{e2} \quad (5.51)$$

$$sh1^2 = constant \quad (5.52)$$

$$sh2^2 = 1 - sh1^1 - sh3^1 \quad (5.53)$$

$$sh3^2 = sh3^2_{-1} + \eta^2.\Delta\left(\frac{\sum_{i=I}^{II} NPL^{i\ 2}}{\sum_{i=I}^{II} L_{h\ d}^{i\ 2}}\right) \quad (5.54)$$

$$yd^{e1} = \varepsilon^1.yd^1_{-1} + (1-\varepsilon^1).yd^{e1}_{-1} \quad (5.55)$$

$$yd^{e2} = \varepsilon^2.yd^2_{-1} + (1-\varepsilon^2).yd^{e2}_{-1} \quad (5.56)$$

$$\Delta V^1 = YD^1 - C^1 \quad (5.57)$$

$$\Delta V^2 = YD^2 - C^2 \quad (5.58)$$

$$NL^1 = \Delta L_{h\ d}^{I\ 1} + \Delta L_{h\ d}^{II\ 1} \quad (5.59)$$

$$NL^2 = \Delta L_{h\ d}^{I\ 2} + \Delta L_{h\ d}^{II\ 2} \quad (5.60)$$

$$nl^1 = \frac{NL^1}{p^1} \tag{5.61}$$

$$nl^2 = \frac{NL^2}{p^2} \tag{5.63}$$

$$C^1 = c^1.P^1 \tag{5.64}$$

$$C^2 = c^2.P^2 \tag{5.66}$$

$$v^1 = \frac{V^1}{P^1} \tag{5.67}$$

$$v^2 = \frac{V^2}{P^2} \tag{5.68}$$

$$H^1_{h\,d} = \lambda^1_c.C^1 \tag{5.69}$$

$$H^2_{h\,d} = \lambda^2_c.C^2 \tag{5.70}$$

$$V^1_{fma} = V^1 - H^1_{h\,d} - L^{I1}_{h\,d} - L^{II1}_{h\,d} - OF^{I1} - OF^{II1} \tag{5.71}$$

$$V^2_{fma} = V^2 - H^2_{h\,d} - L^{I2}_{h\,d} - L^{II2}_{h\,d} - OF^{I2} - OF^{II2} \tag{5.72}$$

$$\frac{M^{I1}_d}{V^1_{fma}} = \lambda^1_{10} + \lambda^1_{11}.r^{I1}_m + \lambda^1_{12}.r^{II1}_m + \lambda^1_{13}.r^1_b + \lambda^1_{14}.\left(r^2_b + d(E_1)\right) \tag{5.73}$$

$$\frac{M^{II1}_d}{V^1_{fma}} = \lambda^1_{20} + \lambda^1_{21}.r^{I1}_m + \lambda^1_{22}.r^{II1}_m + \lambda^1_{23}.r^1_b + \lambda^1_{24}.\left(r^2_b + d(E_1)\right) \tag{5.74}$$

$$\frac{B^1_{h\,1\,d}}{V^1_{fma}} = \lambda^1_{30} + \lambda^1_{31}.r^{I1}_m + \lambda^1_{32}.r^{II1}_m + \lambda^1_{33}.r^1_b + \lambda^1_{34}.\left(r^2_b + d(E_1)\right) \tag{5.75}$$

$$\frac{B^2_{h\,1\,d}}{V^1_{fma}} = \lambda^1_{40} + \lambda^1_{41}.r^{I1}_m + \lambda^1_{42}.r^{II1}_m + \lambda^1_{43}.r^1_b + \lambda^1_{44}.\left(r^2_b + d(E_1)\right) \tag{5.79'}$$

$$\frac{M^{I2}_d}{V^2_{fma}} = \lambda^2_{10} + \lambda^2_{11}.r^{I2}_m + \lambda^2_{12}.r^{II2}_m + \lambda^2_{13}.\left(r^2_b + d\left(\frac{1}{E_1}\right)\right) + \lambda^2_{14}.r^2_b \tag{5.76}$$

$$\frac{M_d^{II2}}{V_{fma}^2} = \lambda_{20}^2 + \lambda_{21}^2 . r_m^{I2} + \lambda_{22}^2 . r_m^{II2} + \lambda_{23}^2 . \left(r_b^2 + d\left(\frac{1}{E_1}\right) \right) + \lambda_{24}^2 . r_b^2 \tag{5.77}$$

$$\frac{B_{h\ 2\ d}^1}{V_{fma}^2} = \lambda_{30}^2 + \lambda_{31}^2 . r_m^{I2} + \lambda_{32}^2 . r_m^{II2} + \lambda_{33}^2 . \left(r_b^2 + d\left(\frac{1}{E_1}\right) \right) + \lambda_{34}^2 . r_b^2 \tag{5.80'}$$

$$\frac{B_{h\ 2\ d}^2}{V_{fma}^2} = \lambda_{40}^2 + \lambda_{41}^2 . r_m^{I2} + \lambda_{42}^2 . r_m^{II2} + \lambda_{43}^2 . \left(r_b^2 + d\left(\frac{1}{E_1}\right) \right) + \lambda_{44}^2 . r_b^2 \tag{5.78}$$

$$B_{h\ 1\ d}^2 = V_{fma}^1 - M_d^{I1} - M_d^{II1} - B_{h\ 1\ d}^1 \tag{5.79}$$

$$B_{h\ 2\ d}^1 = V_{fma}^2 - M_d^{I2} - M_d^{II2} - B_{h\ 2\ d}^2 \tag{5.80}$$

$$NPL^{I1} = npl^{I1} . L_{h\ d-1}^{I1} \tag{5.81}$$

$$NPL^{II1} = npl^{II1} . L_{h\ d-1}^{II1} \tag{5.82}$$

$$NPL^{I2} = npl^{I2} . L_{h\ d-1}^{I2} \tag{5.83}$$

$$NPL^{II2} = npl^{II2} . L_{h\ d-1}^{II2} \tag{5.84}$$

$$L_{h\ d}^{I1} = L_{h\ s}^{I1} \tag{5.85}$$

$$L_{h\ d}^{II1} = L_{h\ s}^{II1} \tag{5.86}$$

$$L_{h\ d}^{I2} = L_{h\ s}^{I2} \tag{5.87}$$

$$L_{h\ d}^{II2} = L_{h\ s}^{II2} \tag{5.88}$$

$$npl^{I1e} = \varepsilon_{bh}^{I1} . npl_{-1}^{I1e} + (1 - \varepsilon_{bh}^{I1}) . npl_{-1}^{I1} \tag{5.89}$$

$$npl^{II1e} = \varepsilon_{bh}^{II1} . npl_{-1}^{II1e} + (1 - \varepsilon_{bh}^{II1}) . npl_{-1}^{II1} \tag{5.90}$$

$$npl^{I2e} = \varepsilon_{bh}^{I2} . npl_{-1}^{I2e} + (1 - \varepsilon_{bh}^{I2}) . npl_{-1}^{I2} \tag{5.91}$$

$$npl^{II2e} = \varepsilon_{bh}^{II2}.npl_{-1}^{II2e} + (1 - \varepsilon_{bh}^{II2}).npl_{-1}^{II2} \tag{5.92}$$

<u>Government equations</u>

$$G^1 = g^1.P^1 \tag{5.93}$$

$$G^2 = g^2.P^2 \tag{5.94}$$

$$T_f^1 = \tau_s^1.S^1 \tag{5.95}$$

$$T_f^2 = \tau_s^2.S^2 \tag{5.96}$$

$$T_h^1 = \theta^1.YP^1 \tag{5.97}$$

$$T_h^2 = \theta^2.YP^2 \tag{5.98}$$

$$T^1 = T_f^1 + T_h^1 \tag{5.99}$$

$$T^2 = T_f^2 + T_h^2 \tag{5.100}$$

$$B_{h\,1\,s}^1 = B_{h\,1\,d}^1 \tag{5.101}$$

$$B_{h\,2\,s}^2 = B_{h\,2\,d}^2 \tag{5.102}$$

$$B_{h\,2\,s}^1 = B_{h\,2\,d}^1.E_1 \tag{5.103}$$

$$B_{h\,1\,s}^2 = B_{h\,1\,d}^2.\frac{1}{E_1} \tag{5.104}$$

$$B_{b\,s}^{II\,1} = B_{b\,d}^{II\,1} \tag{5.105}$$

$$B_{b\ s}^{I\ 1} = B_{b\ d}^{I\ 1} \tag{5.106}$$

$$B_{b\ s}^{I\ 2} = B_{b\ d}^{I\ 2} \tag{5.107}$$

$$B_{b\ s}^{II\ 2} = B_{b\ d}^{II\ 2} \tag{5.108}$$

$$B_{cb\ 1\ s}^{1} = B_{s}^{1} - B_{h\ 1\ s}^{1} - B_{b\ s}^{I\ 1} - B_{b\ s}^{II1} - B_{h\ 2\ s}^{1} - B_{cb\ 2\ s}^{1} \tag{5.109}$$

$$B_{cb\ 2\ s}^{2} = B_{s}^{2} - B_{h\ 2\ s}^{2} - B_{b\ s}^{I\ 2} - B_{b\ s}^{II2} - B_{h\ 1\ s}^{2} - B_{cb\ 1\ s}^{2} \tag{5.110}$$

$$B_{cb\ 2\ d}^{1} = constant \tag{5.111}$$

$$B_{cb\ 2\ s}^{1} = B_{cb\ 2\ d}^{1}.E_1 \tag{5.112}$$

$$B_{cb\ 1\ d}^{2} = constant \tag{5.113}$$

$$B_{cb\ 1\ s}^{2} = B_{cb\ 1\ d}^{2}.\frac{1}{E_1} \tag{5.114}$$

$$PSBR^1 = G^1 + r_{b-1}^1.B_{s-1}^1 - (T^1 + F_{cb}^1) \tag{5.115}$$

$$\Delta(B_s^1) = PSBR^1 \tag{5.116}$$

$$PSBR^2 = G^2 + r_{b-1}^2.B_{s-1}^2 - (T^2 + F_{cb}^2) \tag{5.117}$$

$$\Delta(B_s^2) = PSBR^2 \tag{5.118}$$

Central bank equations

$$\Delta H_s^1 = \Delta B_{cb\ 1\ d}^{1} + \Delta B_{cb\ 1\ d}^{2} + \Delta R^1 \tag{5.119}$$

$$\Delta H_s^2 = \Delta B_{cb\ 2\ d}^{2} + \Delta B_{cb\ 2\ d}^{1} + \Delta R^2 \tag{5.120}$$

$$F_{cb}^{1} = r_{b-1}^{1}.B_{cb\ 1\ d-1}^{1} + r_{b-1}^{2}.B_{cb\ 1\ d-1}^{2} \tag{5.121}$$

$$F_{cb}^{2} = r_{b-1}^{1}.B_{cb\ 2\ d-1}^{1} + r_{b-1}^{2}.B_{cb\ 2\ d-1}^{2} \tag{5.122}$$

$$H_{b\ s}^{I1} = H_{b\ d}^{I1} \tag{5.123}$$

$$H_{b\ s}^{II1} = H_{s}^{1} - H_{h\ s}^{1} - H_{b\ s}^{I1} \tag{5.124}$$

$$H_{h\ s}^{1} = H_{h\ d}^{1} \tag{5.125}$$

$$H_{b\ s}^{I2} = H_{b\ d}^{I2} \tag{5.126}$$

$$H_{b\ s}^{II2} = H_{s}^{2} - H_{h\ s}^{2} - H_{b\ s}^{I2} \tag{5.127}$$

$$H_{h\ s}^{2} = H_{h\ d}^{2} \tag{5.128}$$

$$\Delta B_{cb\ 1\ d}^{1} = \Delta B_{cb\ 1\ s}^{1} \tag{5.129}$$

$$\Delta B_{cb\ 2\ d}^{2} = \Delta B_{cb\ 2\ s}^{2} \tag{5.130}$$

$$E_{1} = constant \tag{5.131}$$

$$B_{cb\ 1\ d}^{2} = constant \tag{5.132}$$

Private banks equations

$$H_{b\ d}^{I1} = \rho^{I1}.M_{s}^{I1} \tag{5.133}$$

$$H_{b\ d}^{II1} = \rho^{II1}.M_{s}^{II1} \tag{5.134}$$

$$H_{b\,d}^{I2} = \rho^{I2}.M_s^{I2} \tag{5.135}$$

$$H_{b\,d}^{II2} = \rho^{II2}.M_s^{II2} \tag{5.136}$$

$$M_s^{I1} = M_d^{I1} \tag{5.137}$$

$$M_s^{II1} = M_d^{II1} \tag{5.138}$$

$$M_s^{I2} = M_d^{I2} \tag{5.139}$$

$$M_s^{II2} = M_d^{II2} \tag{5.140}$$

$$F_b^{I1} = r_{l-1}^{I1}.\left(L_{h\,s-1}^{I1} + L_{f\,s-1}^{I1}\right) + r_{b-1}^{1}.B_{b\,d-1}^{I1} - r_{l-1}^{I1}.(NPL_{-1}^{I1}) - r_{lb-1}^{II1}.L_{b\,I\,1\,d-1}^{II1} + r_{lb-1}^{I1}.L_{b\,I\,2\,s-1}^{I1} - r_{m-1}^{I1}.M_{s-1}^{I1} \tag{5.141}$$

$$F_b^{II1} = r_{l-1}^{II1}.\left(L_{h\,s-1}^{II1} + L_{f\,s-1}^{II1}\right) + r_{b-1}^{1}.B_{b\,d-1}^{II1} - r_{l-1}^{II1}.(NPL_{-1}^{II1}) + r_{lb-1}^{II1}.L_{b\,I\,1\,s-1}^{II1} - r_{lb-1}^{II2}.L_{b\,II\,1\,d-1}^{II2} - r_{m-1}^{II1}.M_{s-1}^{II1} \tag{5.142}$$

$$F_b^{I2} = r_{l-1}^{I2}.\left(L_{h\,s-1}^{I2} + L_{f\,s-1}^{I2}\right) + r_{b-1}^{2}.B_{b\,d-1}^{I2} r_{l-1}^{I2}.(NPL_{-1}^{I2}) - r_{lb-1}^{II2}.L_{b\,I\,2\,d-1}^{II2} - r_{lb-1}^{I1}.L_{b\,I\,2\,d-1}^{I1} - r_{m-1}^{I2}.M_{s-1}^{I2} \tag{5.143}$$

$$F_b^{II2} = r_{l-1}^{II2}.\left(L_{h\,s-1}^{II2} + L_{f\,s-1}^{II2}\right) + r_{b-1}^{2}.B_{b\,d-1}^{II2} - r_{l-1}^{II2}.(NPL_{-1}^{II2}) + r_{lb-1}^{II2}.L_{b\,I\,2\,s-1}^{II2} + r_{lb-1}^{II2}.L_{b\,II\,1\,s-1}^{II2} - r_{m-1}^{II2}.M_{s-1}^{II2} \tag{5.144}$$

$$FD_b^{I1} = \lambda_b^{I1}.F_{b-1}^{I1} \tag{5.145}$$

$$FD_b^{II1} = \lambda_b^{II1}.F_{b-1}^{II1} \tag{5.146}$$

$$FD_b^{I2} = \lambda_b^{I2}.F_{b-1}^{I2} \tag{5.147}$$

$$FD_b^{II2} = \lambda_b^{II2}.F_{b-1}^{II2} \tag{5.148}$$

$$FD_b^{1} = FD_b^{I1} + FD_b^{II1} \tag{5.149}$$

$$FD_b^{2} = FD_b^{I2} + FD_b^{II2} \tag{5.150}$$

$$\Delta OF_b^{I1} = FU_b^{I1} - NPL^{I1} \tag{5.151}$$

$$\Delta OF_b^{II1} = FU_b^{II1} - NPL^{II1} \tag{5.152}$$

$$\Delta OF_b^{I2} = FU_b^{I2} - NPL^{I2} \tag{5.153}$$

$$\Delta OF_b^{II2} = FU_b^{II2} - NPL^{II2} \tag{5.154}$$

$$r_l^{I1} = r_m^{I1} + add_1^{I1} \tag{5.155}$$

$$r_l^{II1} = r_m^{II1} + add_1^{II1} \tag{5.156}$$

$$r_l^{I2} = r_m^{I2} + add_1^{I2} \tag{5.157}$$

$$r_l^{II2} = r_m^{II2} + add_1^{II2} \tag{5.158}$$

$$FU_b^{I1} = F_b^{I1} - FD_b^{I1} \tag{5.159}$$

$$FU_b^{II1} = F_b^{II1} - FD_b^{II1} \tag{5.160}$$

$$FU_b^{I2} = F_b^{I2} - FD_b^{I2} \tag{5.161}$$

$$FU_b^{II2} = F_b^{II2} - FD_b^{II2} \tag{5.162}$$

$$add_1^{I1} = \frac{\{F_b^{I1T} - r_{b-1}^{1}.B_{b\,d-1}^{I1} + r_{lb-1}^{II1}.L_{b\,I\,1\,d-1}^{II1} - r_{lb-1}^{I1}.L_{b\,I\,2\,s-1}^{I1} + r_{m-1}^{I1}.(M_{s-1}^{I1} - A^{I1})\}}{A^{I1}} \tag{5.163}$$

$$add_1^{II1} = \frac{\{F_b^{II1T} - r_{b-1}^{1}.B_{b\,d-1}^{II1} + r_{lb-1}^{II2}.L_{b\,II\,1\,d-1}^{II2} - r_{lb-1}^{II1}.L_{b\,I\,1\,s-1}^{II1} + r_{m-1}^{II1}.(M_{s-1}^{II1} - A^{II1})\}}{A^{II1}} \tag{5.164}$$

$$A^{I1} = L_{f\,d-1}^{I1} + \left(1 - npl^{I1e}\right).L_{h\,d-1}^{I1} \tag{5.165}$$

$$A^{II1} = L_{f\,d-1}^{II1} + \left(1 - npl^{II1e}\right).L_{h\,d-1}^{II1} \tag{5.166}$$

$$add_1^{I2} = \frac{\{F_b^{I2T} - r_{b-1}^2 . B_{b\ d-1}^{I2} + r_{lb-1}^{II2} . L_{b\ I\ 2\ d-1}^{II2} + r_{lb-1}^{I1} . L_{b\ I\ 2\ d-1}^{I1} + r_{m-1}^{I2} . (M_{s-1}^{I2} - A^{I2})\}}{A^{I2}} \tag{5.167}$$

$$add_1^{II2} = \frac{\{F_b^{II2T} - r_{b-1}^2 . B_{b\ d-1}^{II2} - r_{lb-1}^{II2} . L_{b\ II\ 2\ s-1}^{II2} - r_{lb-1}^{II2} . L_{b\ II\ 1\ s-1}^{II2} + r_{m-1}^{II2} . (M_{s-1}^{II2} - A^{II2})\}}{A^{II2}} \tag{5.168}$$

$$A^{I2} = L_{f\ d-1}^{I2} + \left(1 - npl^{I2e}\right) . L_{h\ d-1}^{I2} \tag{5.169}$$

$$A^{II2} = L_{f\ d-1}^{II2} + \left(1 - npl^{II2e}\right) . L_{h\ d-1}^{II2} \tag{5.170}$$

$$F_b^{I1T} = FD_b^{I1} + FU_b^{I1T} \tag{5.171}$$

$$F_b^{II1T} = FD_b^{II1} + FU_b^{II1T} \tag{5.172}$$

$$F_b^{I2T} = FD_b^{I2} + FU_b^{I2T} \tag{5.173}$$

$$F_b^{II2T} = FD_b^{II2} + FU_b^{II2T} \tag{5.174}$$

$$FU_b^{I1T} = OF_b^{I1e} - OF_{b-1}^{I1} + npl^{I1e} . L_{h\ s-1}^{I1} \tag{5.175}$$

$$FU_b^{II1T} = OF_b^{II1e} - OF_{b-1}^{II1} + npl^{II1e} . L_{h\ s-1}^{II1} \tag{5.176}$$

$$FU_b^{I2T} = OF_b^{I2e} - OF_{b-1}^{I2} + npl^{I2e} . L_{h\ s-1}^{I2} \tag{5.177}$$

$$FU_b^{II2T} = OF_b^{II2e} - OF_{b-1}^{II2} + npl^{II2e} . L_{h\ s-1}^{II2} \tag{5.178}$$

$$OF_b^{I1e} = (1 - \beta_b^{I1}) . OF_{b-1}^{I1} + \beta_b^{I1} . OF_{b-1}^{I1e} \tag{5.179}$$

$$OF_b^{II1e} = (1 - \beta_b^{II1}) . OF_{b-1}^{II1} + \beta_b^{II1} . OF_{b-1}^{II1e} \tag{5.180}$$

$$OF_b^{I2e} = (1 - \beta_b^{I2}) . OF_{b-1}^{I2} + \beta_b^{I2} . OF_{b-1}^{I2e} \tag{5.181}$$

$$OF_b^{II2e} = (1 - \beta_b^{II2}) . OF_{b-1}^{II2} + \beta_b^{II2} . OF_{b-1}^{II2e} \tag{5.182}$$

$$OF_b^{I1T} = NCAR^{I1}.(L_{f\,s-1}^{I1} + L_{h\,s-1}^{I1}) \quad (5.183)$$

$$OF_b^{II1T} = NCAR^{II1}.(L_{f\,s-1}^{II1} + L_{h\,s-1}^{II1}) \quad (5.184)$$

$$CAR^{I1} = \frac{OF_b^{I1}}{L_{f\,s}^{I1} + L_{h\,s}^{I1} + L_{b\,I\,2\,s}^{I1}} \quad (5.185)$$

$$CAR^{II1} = \frac{OF_b^{II1}}{L_{f\,s}^{II1} + L_{h\,s}^{II1} + L_{b\,I\,1\,s}^{II1}} \quad (5.186)$$

$$CAR^{I2} = \frac{OF_b^{I2}}{L_{f\,s}^{I2} + L_{h\,s}^{I2}} \quad (5.187)$$

$$CAR^{II1} = \frac{OF_b^{II2}}{L_{f\,s}^{II2} + L_{h\,s}^{II2} + L_{b\,I\,2\,s}^{II2} + L_{b\,II\,1\,s}^{II2}} \quad (5.188)$$

$$BLR^{I1} = \frac{B_{b\,d}^{I1}}{M_s^{I1}} \quad (5.189)$$

$$BLR^{II1} = \frac{B_{b\,d}^{II1}}{M_s^{II1}} \quad (5.190)$$

$$BLR^{I2} = \frac{B_{b\,d}^{I2}}{M_s^{I2}} \quad (5.191)$$

$$BLR^{II2} = \frac{B_{b\,d}^{II2}}{M_s^{II2}} \quad (5.192)$$

$$L_{b\,I\,2\,s}^{I1} = L_{b\,I\,2\,d}^{I1}.E_1 \quad (5.193)$$

$$L_{b\,II\,1\,s}^{II2} = L_{b\,II\,1\,d}^{II2}.1/E_1 \quad (5.194)$$

$$r_m^{I1} = r_{m-1}^{I1} + \Delta r_m^{I1} + \xi_b^{I1}.\Delta r_b^{I1} \quad (5.195)$$

$$\Delta r_m^{I1} = \xi_m^{I1}(z_1^{I1} - z_2^{I1}) \quad (5.196)$$

$$z_1^{I1} = 1 \quad iff \;\; BLR^{I1} < bot^{I1} \tag{5.197}$$

$$z_2^{I1} = 1 \quad iff \;\; BLR^{I1} > top^{I1} \tag{5.198}$$

$$r_m^{II1} = r_{m-1}^{II1} + \Delta r_m^{II1} + \xi_b^{II1}.\Delta r_b^{II1} \tag{5.199}$$

$$\Delta r_m^{II1} = \xi_m^{II1}(z_1^{II1} - z_2^{II1}) \tag{5.200}$$

$$z_1^{II1} = 1 \quad iff \;\; BLR^{II1} < bot^{II1} \tag{5.201}$$

$$z_2^{II1} = 1 \quad iff \;\; BLR^{II1} > top^{II1} \tag{5.202}$$

$$r_m^{I2} = r_{m-1}^{I2} + \Delta r_m^{I2} + \xi_b^{I2}.\Delta r_b^{I2} \tag{5.203}$$

$$\Delta r_m^{I2} = \xi_m^{I2}(z_1^{I2} - z_2^{I2}) \tag{5.204}$$

$$z_1^{I2} = 1 \quad iff \;\; BLR^{I2} < bot^{I2} \tag{5.205}$$

$$z_2^{I2} = 1 \quad iff \;\; BLR^{I2} > top^{I2} \tag{5.206}$$

$$r_m^{II2} = r_{m-1}^{II2} + \Delta r_m^{II2} + \xi_b^{II2}.\Delta r_b^{II2} \tag{5.207}$$

$$\Delta r_m^{II2} = \xi_m^{II2}(z_1^{II2} - z_2^{II2}) \tag{5.208}$$

$$z_1^{II2} = 1 \quad iff \;\; BLR^{II2} < bot^{II2} \tag{5.209}$$

$$z_2^{II2} = 1 \quad iff \;\; BLR^{II2} > top^{II2} \tag{5.210}$$

$$r_{lb}^{I1} = r_m^{I1} + add_2^{I1} \tag{5.211}$$

$$r_{lb}^{II1} = r_m^{II1} + add_2^{II1} \tag{5.212}$$

$$r_{lb}^{II2} = r_m^{II2} + add_2^{II2} \tag{5.213}$$

$$add_2^{I1} = \chi_b^{I1}.add_1^{I1} \tag{5.214}$$

$$add_2^{II1} = \chi_b^{II1}.add_1^{II1} \tag{5.215}$$

$$add_2^{II2} = \chi_b^{II2}.add_1^{II2} \tag{5.216}$$

$$L_{f\,s}^{I1} = L_{f\,s-1}^{I1} + \xi_f^{I1}.(BLR^{I1} - BLR^{I1T}) \tag{5.217}$$

$$L_{f\,s}^{II1} = L_{f\,s-1}^{II1} + \xi_f^{II1}.(BLR^{II1} - BLR^{II1T}) \tag{5.218}$$

$$L_{f\,s}^{I2} = L_{f\,s-1}^{I2} + \xi_f^{I2}.(BLR^{I2} - BLR^{I2T}) \tag{5.219}$$

$$L_{f\,s}^{II2} = L_{f\,s-1}^{II2} + \xi_f^{II2}.(BLR^{II2} - BLR^{II2T}) \tag{5.220}$$

$$L_{h\,s}^{I1} = L_{h\,s-1}^{I1} + \xi_h^{I1}.(BLR^{I1} - BLR^{I1T}) \tag{5.221}$$

$$L_{h\,s}^{II1} = L_{h\,s-1}^{II1} + \xi_h^{II1}.(BLR^{II1} - BLR^{II1T}) \tag{5.222}$$

$$L_{h\,s}^{I2} = L_{h\,s-1}^{I2} + \xi_h^{I2}.(BLR^{I2} - BLR^{I2T}) \tag{5.223}$$

$$L_{h\,s}^{II2} = L_{h\,s-1}^{II2} + \xi_h^{II2}.(BLR^{II2} - BLR^{II2T}) \tag{5.224}$$

$$L_{b\,I\,2\,s}^{I1} = L_{b\,I\,2\,s-1}^{I1} + \zeta_{b1}^{I1}.(BLR^{I1} - BLR^{I1T}) + \zeta_{b2}^{I1}.\Delta BLR^{I2} \tag{5.225}$$

$$L_{b\,I\,1\,s}^{II1} = L_{b\,I\,1\,s-1}^{II1} + \zeta_{b1}^{II1}.(BLR^{II1} - BLR^{II1T}) + \zeta_{b2}^{II1}.\Delta BLR^{I1} \tag{5.226}$$

$$L_{b\,I\,2\,s}^{II2} = L_{b\,I\,2\,s-1}^{II2} + \zeta_b^{II2}.(BLR^{II2} - BLR^{II2T}) + \zeta_{b2}^{II2}.\Delta BLR^{I2} \tag{5.227}$$

$$L_{b\,II\,1\,s}^{II2} = L_{b\,II\,1\,s-1}^{II2} + \zeta_{b1}^{II2}.(BLR^{II2} - BLR^{II2T}) + \zeta_{b2}^{II1}.\Delta BLR^{II1} \tag{5.228}$$

$$L_{b\ I\ 1\ d}^{II1} = L_{b\ I\ 1\ s}^{II1} \tag{5.229}$$

$$L_{b\ I\ 2\ d}^{II2} = L_{b\ I\ 2\ s}^{II2} \tag{5.230}$$

$$B_{b\ d}^{I1} = M_s^{I1} + L_{b\ I\ 1\ d}^{II1} - L_{b\ I\ 2\ s}^{I1} - H_{b\ d}^{I1} - L_{h\ d}^{I1} - L_{f\ d}^{I1} + OF_b^{I1} \tag{5.231}$$

$$B_{b\ d}^{II1} = M_s^{II1} + L_{b\ II\ 1\ d}^{II2} - L_{b\ I\ 1\ s}^{II1} - H_{b\ d}^{II1} - L_{h\ d}^{II1} - L_{f\ d}^{II1} + OF_b^{II1} \tag{5.232}$$

$$B_{b\ d}^{I2} = M_s^{I2} + L_{b\ I\ 2\ d}^{I1} + L_{b\ I\ 2\ d}^{II2} - H_{b\ d}^{I2} - L_{h\ d}^{I2} - L_{f\ d}^{I2} + OF_b^{I2} \tag{5.233}$$

$$B_{b\ d}^{II2} = M_s^{II2} - L_{b\ I\ 2\ s}^{II2} - L_{b\ II\ 1\ s}^{II2} - H_{b\ d}^{II2} - L_{h\ d}^{II2} - L_{f\ d}^{II2} + OF_b^{II2} \tag{5.234}$$

5.5 APPENDIX 5.B: MODEL CODES

Before defining the variables, the following notations must take into consideration:

1- The subscript *b* refers bank.

2- The subscript *cb* refers central bank.

3- The subscript *d* refers to demand.

4- The superscript *e* refers expected value or volume.

5- The subscript *f* = firms.

6- The subscript *h* = households.

7- The superscript or subscript *i* = *I* for bank I and *II* for bank II.

8- The superscript or subscript *j* = 1 for country one and 2 for country two.

9- The subscript *l* refers loans.

10- The subscript *lb* refers to interbank loans.

11- The subscript *m* refers deposits.

12- The superscript *T* refers target value or volume.

12- The superscript *z* = 1 for country one and 2 for country 2, such that z ≠ j.

B	Government security (treasury bills)
BLR	Bank liquidity ratio
C^j	Nominal consumption
c^j	Real consumption
CAR	Capital adequacy ratio
CG	Capital gains
E_1	Exchange rate, how much units of the first country currency per one unit of the first country currency.
$F^{i\,j}{}_b$	Bank profits
$F^{i\,j\,T}{}_b$	Target bank profits
$F^j{}_{cb}$	Central bank profits

F^j_f	Firms profits
FD_b	Bank dividends
$FU^{i\,j}_b$	Bank returned earnings
$FU^{i\,j\,T}_b$	Target bank returned earnings
G^j	Nominal government expenditure
g^j	Real government expenditure
H^j_s	High powered money supplied by the central bank
$H^{i\,j}_b$	Vault cash
H^j_h	Households cash money
I^j	Nominal investment
i^j	Real investment
K^j	Nominal fixed capital
k^j	Real fixed capital
$L^{i\,j}_{b\,i\,j\,d}$	Bank *i* in country *j* demand for Interbank loans from bank *i* in country *j*
$L^{i\,z}_{b\,i\,j\,d}$	Bank *i* in country *j* demand for Interbank loans from bank *i* in country *z*
$L^{i\,z}_{b\,i\,j\,s}$	Bank *i* in country *z* supply of Interbank loans to bank *i* in country *j*
$L^{i\,j}_f$	Firms loans
$L^{i\,j}_h$	Households loans
$M^{i\,j}$	Bank deposits
N^j	Number of employees
N^j_{fe}	Number of employees in a full employment level
$NCAR^{i\,j}$	Normal capital adequacy ratio
NL^j	Value of new loans
nl^j	Real value of new loans
$NPL^{i\,j}$	Value of non-performing loans
$npl^{i\,j}$	Ratio of NPL as a share of total loans demand

$npl^{i\,j\,e}$	Expected ratio of NPL as a share of total loans demand
$OF^{i\,j}{}_{b}$	Own funds of banks (bank capital)
$OF^{i\,j\,e}{}_{b}$	Expected own funds of banks
$OF^{i\,j\,T}{}_{b}$	Target own funds of banks
$\omega^{T\,j}$	Real wages
p^{j}	Price index
φ^{j}	Price mark-up
π^{j}	Price inflation
pr^{j}	Workers' productivity
$PSBR^{j}$	Public sector borrowing requirement
$r^{j}{}_{b}$	Treasury bills interest rate
$r^{i\,j}{}_{l}$	Loans interest rate
$r^{i\,j}{}_{lb}$	Interbank loans interest rate
$r^{i\,j}{}_{m}$	Deposits interest rate
S^{j}	Nominal sales
s^{j}	Real sales
T^{j}	Taxes
$T^{j}{}_{f}$	Firms taxes (sales tax)
$T^{j}{}_{h}$	Households taxes (income tax)
UC^{j}	Unit cost
V^{j}	Nominal wealth
$V^{j}{}_{fma}$	Financial market asset wealth
v^{j}	Real wealth
W^{j}	Wage rate
WB^{j}	Wage bill

Y^j	Nominal output or GDP
y^j	Real GDP
YD^j	Nominal disposable income
yd^j	Real disposable income
$yd^{j\,e}$	Expected real disposable income
YP^j	Value of personal income

5.6 APPENDIX 5.C: PARAMETERS VALUES

Parameter	Value	Parameter	Value	Parameter	Value
α^1_0	32.5	λ^1_{30}	0.369586	ξ^{I1}_h	100
α^2_0	32.5	λ^1_{31}	-0.5	ξ^{I2}_h	100
α^1_1	0.6	λ^1_{32}	-0.5	ξ^{II1}_h	100
α^2_1	0.6	λ^1_{33}	1.5	ξ^{II2}_h	100
α^1_2	0.05	λ^1_{34}	-0.5	ξ^{I1}_m	0.0001
α^2_2	0.05	λ^2_{40}	0.369586	ξ^{I2}_m	0.0001
β^{I1}_b	0.1	λ^2_{41}	-0.5	ξ^{II1}_m	0.0001
β^{I2}_b	0.5	λ^2_{42}	-0.5	ξ^{II2}_m	0.0001
β^{II1}_b	0.1	λ^2_{43}	-0.5	ζ^{I1}_{b1}	100
β^{II2}_b	0.5	λ^2_{44}	1.5	ζ^{II1}_{b1}	100
χ^{I1}	0.233333	λ^{I1}_b	0.339056	ζ^{II2}_{b1}	100
χ^{I2}	0.233333	λ^{II1}_b	0.339056	ζ^{I1}_{b2}	100
χ^{II1}	0.233333	λ^1_c	0.1	ζ^{II1}_{b2}	100
χ^{II2}	0.233333	λ^2_c	0.1	ζ^{II2}_{b2}	100
δ^1_k	0.1	Ω^1_0	0.129333		
δ^2_k	0.1	Ω^2_0	0.129333		
ε^1	0.5	Ω^1_1	0.4		
ε^2	0.5	Ω^2_1	0.4		
η^1	1.3	Ω^1_2	0.2		
η^2	1.1	Ω^2_2	0.2		
λ^1_{10}	0.237439	Ω^1_3	0.01		
λ^2_{10}	0.190951	Ω^2_3	0.01		
λ^1_{11}	1.5	φ^1	0.26		
λ^2_{11}	1.5	φ^2	0.26		
λ^1_{12}	-0.5	ρ^{I1}	0.1		
λ^2_{12}	-0.5	ρ^{I2}	0.1		
λ^1_{13}	-0.5	ρ^{II1}	0.1		
λ^2_{13}	-0.5	ρ^{II2}	0.1		
λ^1_{14}	-0.5	τ^1_s	0.2		
λ^2_{14}	-0.5	τ^2_s	0.2		
λ^1_{20}	0.237439	θ^1	0.15		
λ^2_{20}	0.283927	θ^2	0.15		
λ^1_{21}	-0.5	ξ^{I1}_b	0.0005		
λ^2_{21}	-0.5	ξ^{I2}_b	0.0005		
λ^1_{22}	1.5	ξ^{II1}_b	0.0005		
λ^2_{22}	1.5	ξ^{II2}_b	0.0005		
λ^1_{23}	-0.5	ξ^{I1}_f	100		
λ^2_{23}	-0.5	ξ^{I2}_f	100		
λ^1_{24}	-0.5	ξ^{II1}_f	100		
λ^2_{24}	-0.5	ξ^{II2}_f	100		

5.7 APPENDIX 5.D: EXOGENOUS VARIABLES VALUES

Variable	Value	Variable	Value	Variable	Value
$B^{2}_{cb\,1\,d}$	35.10	N^{1}_{fe}	492.22	R^{1}	0.00
$B^{1}_{cb\,2\,d}$	35.10	N^{1}_{fe}	492.22	R^{2}	0.00
$BLR^{I\,T\,1}$	0.20	$NCAR^{I\,1}$	0.08	r^{1}_{b}	0.03
$BLR^{II\,T\,1}$	0.20	$NCAR^{II\,1}$	0.08	r^{2}_{b}	0.03
$BLR^{I\,T\,2}$	0.20	$NCAR^{I\,2}$	0.08	$Sh1^{1}$	0.50
$BLR^{II\,T\,2}$	0.20	$NCAR^{II\,2}$	0.08	$Sh1^{2}$	0.50
$bot^{I\,1}$	0.18	$npl^{I\,1}_{h}$	0.05	$top^{I\,1}$	0.22
$bot^{II\,1}$	0.18	$npl^{II\,1}_{h}$	0.05	$top^{II\,1}$	0.22
$bot^{I\,2}$	0.18	$npl^{I\,2}_{h}$	0.05	$top^{I\,2}$	0.22
$bot^{II\,2}$	0.18	$npl^{II\,2}_{h}$	0.05	$top^{II\,2}$	0.22
g^{1}	161.47	Pr^{1}	1.26		
g^{2}	161.47	Pr^{2}	1.26		

Chapter 6

GENERAL CONCLUSION AND FUTURE WORK

6.1 GENERAL CONCLUSION

This thesis provides a tractable accounting scheme, starting from economic theory, and implied macro models are derived, emphasizing the dynamic interaction between price formation and (functional) income distribution along traditional Keynes and Kalecki lines, resulting in aggregate dynamics that could be recognized as business cycles.

Chapter 2 of my thesis provides a literature review on the stock-flow consistent approach and its applications. This chapter starts with the definition of monetary economics, the different paradigms in the field of monetary economics, and the differences among these paradigms. After that I introduce the stock flow consistent approach, its definition, roots, and features.

C*hapter 3* describes the impact of house price variations on income distribution and the business cycle using a stock flow consistent model. This chapter builds on the work done by Zezza (2007) and (2008).

The model explains a part of the recent financial crisis by modeling the house price bubble, which is considered as one of the main contributors of the recent financial crisis. The model shows that the increase in expected house prices leads to an increase in most macroeconomic variables, such as output, consumption, investment, and disposable income, but several periods after the incidence of the shock, a fall in output and in households' wealth and income happens.

Due to the assumption that the shock stays only for several periods, the effect of this shock is not going to continue in the long-run, but it will have an effect in the short- and medium-runs. To eliminate the negative effects of this shock, an intervention by the government and/ or the central bank is needed to recover the economy to levels before the shock. This chapter conducts three simulation experiments (scenarios) in addition to the baseline scenario, which assumes a steady state in the economy.

The first scenario assumes an increase in the expected house prices in the economy, the second assumes an increase in pure government expenditure as a fiscal policy, and the third assumes that the central bank implements a monetary policy by decreasing interest rates on advances supplied to private banks. These scenarios are analyzed to determine what will happen to the economy after the decline. One can try another scenario that assumes both fiscal and monetary policies implemented to see the effect on the economy. It can be easily predicted that both fiscal and monetary policies can help the economy better than each policy alone.

The model shows that the economy experiences a boom at the beginning after the increase in house prices. This boom has a positive effect on the economy, wealth, and the distribution of income, but after some periods the economy starts to decline. This chapter proposes that an increase in asset prices (real or financial) will have a positive effect on the economy in the short-run, but a negative effect in the medium- and long-runs if the problem (or the shock) continues. This chapter shows that fiscal and monetary policies are important in stimulating the economy, but more specific policies regarding housing and credit markets are also needed to help the economy and prevent such shocks from happening in the future.

The goal of *chapter 4* is to produce a stock flow consistent model to study financial integration, as measured by a volume-based measure of international financial integration. The contribution of this chapter is to build a relatively detailed model that can explain much about financial integration between countries, as it can explore several policies, and agreements, which can be taken in order to enhance financial integration, and thus to contribute both to the emerging literature on stock-flow consistent modeling, as well as the current debate on the costs and benefits of ever-closer financial and economic integration amongst the world's economies.

This chapter shows that freeing trade by eliminating trade barriers leads to higher levels of output, income and wealth, and its components for both countries. Converging asset prices or rates of return on these assets do lead to a significant change in output, income, and wealth, but this converging trend does change the households' portfolio allocation and converge the demand for these assets.

In this model, monetary union affects the real side of the economy. The effect of monetary union in both real and financial sides of the economy can be more with the existing of the proper fiscal and/ or monetary policy accompanied the process of monetary union between countries. Thus, each agreement aimed at promoting financial integration between countries should be paralleled with fiscal and monetary policies that would stimulate economic growth, income, wealth, and asset prices convergence. Relating this finding back to the European Union's current problems, a more developed system of automatic fiscal stabilizers (or a fiscal algorithm or rule set) would be beneficial to reduce the effect of asymmetric shocks to individual countries.

The volume measure of financial integration used in Lane and Milesi-Ferretti (2001a and 2007a) does not reflect the effect of converging asset prices on the process of financial integration between countries. This measure can be an appropriate measure in cases such as a certain agreement or in cases of fiscal policies, but it does not reflect the picture in cases such as converging asset prices or returns. In these cases, if one wishes to explore the effect of assets prices or returns convergence, it is better to look at the convergence of the demand for foreign assets, as documented above. This model may also be calibrated with real world data to assist policy formation.

Chapter 5 describes credit crunch contagion and its effects in a two country stock flow consistent monetary model. The model deployed in this chapter assumes that a credit crunch happens due to a decline in the supply of credit only, and the demand for credit follows the supply of it. To see the credit crunch contagion, the model is built in such a way to have two types of banks in each country. These banks supply interbank loans to each other in the domestic and foreign markets. This chapter, also, explores the effect of credit crunch on output, investment, consumption, income, and other main economic indicators in both countries.

The credit crunch is assumed to happen due to an increase in households' non-performing loans in the first country, which they demand from bank *I* of the same country.

Results of the model simulations show conclusively that the credit crunch spreads between connected banks either locally or globally. Another result is that highly connected banks are affected more than the less connected banks by the credit crunch. In further work, it should be possible to quantify the optimal level of connectivity between private banks. Given this, one can conclude that the more the country is open or economically or financially integrated the more it is vulnerable to external shocks.

The decline in loans supplied leads to a direct decline in investment of firms and in households' consumption through the decline in new loans they demand to cover their investment regarding firms and consumption regarding households.

The indirect effect on the real economy comes from disposable income. Disposable income contains the interests that households do not pay on their non-performing loans. This leads to an increase in disposable income. But the decline in investment leads to a decline in firms' profits and wages, and thus leads to a decline in disposable income.

Banks are assumed to supply loans based on their liquidity compared to a target level set by the central bank. Any decline in bank liquidity ratios below the target level forces banks to decrease their loans supply to keep their liquidity close to the target level. When banks decrease the supply of loans their liquidity becomes better-off and they start to increase their lending. Due to this mechanism, the main economic and financial variables continue in a cyclical movement until they return to their previous level before the shock.

A jump in households' non-performing loans leads to the same cyclical movement as a onetime increase in the non-performing loans in the short-run. But in the long run, due to the positive effect of non-performing loans on disposable income, which compensate for the negative effect of the credit crunch on disposable income, country one ends up with a slightly higher level of output, consumption, investment, and other variables. In the second country, there is no assumption of an increase in non-performing loans, and thus there is no positive effect on disposable income. As a consequence, in the long-run, the main economic variables end up at slightly lower levels.

Relaxing the assumption that interests of non-performing loans affect positively the disposable income, the credit crunch will have a negative effect on the economy in the long-run, but the effect is oscillatory in the short-run.

6.2 FUTURE WORK

Stock-flow consistent monetary models presented in this thesis can provide the benchmark for deep analyses of the evolving local and global economies, in which different phenomena can be described and analyzed using comprehensive macrodynamic models that can describe the interaction within and between all economic sectors in the country. Stock flow consistent models gather both stocks and flows, which is not the case in other models. The stock flow consistent models implemented in this thesis provide a theoretical proof for what is happening these days regarding the recent financial crisis.

Regarding *chapter 3*, several steps can be taken to expand the model to better reflect the real world. One could expand this model for an open economy, and/ or includes two classes of households. Another dimension is to see the effects of the shock on a more complex financial sector than presented here or one can check the effect of an increase in households' debt burdens due to the increase in house prices and mortgages, which is not modeled in this chapter.

Regarding c*hapter 4*, other points and extensions on the model can be taken in order to explore financial integration more widely such as assuming that households can also purchase foreign equities; firms can also demand loans from foreign banks. One can explore financial integration between developing and developed countries. Financial integration may also be explored in the case of fixed exchange rates and we could see the effect of financial integration on countries foreign reserves (foreign bills in this model).

Several steps can be taken in the future to make the model of *chapter 5* closer to reality like, introducing two types of households, one owning firms and banks, and the other working in those sectors and demanding loans. Another step is to introduce more kinds of financial papers that banks purchase and trade among themselves locally and globally. Another step would introduce demand forces for loans whether in the interbank market or in the households and firms sectors. Finally, one can go further in this model to explore the effect of the credit crunch on financial integration and globalization.

My work will proceed in two connected directions: the first is to simulate stock flow consistent models using real data, which I think can be a better option for economic policy designed for a specific country. The other direction is to apply stock flow consistency for a more complex set of financial assets. Modern financial systems need more complex stock flow consistent models.

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