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STOCK-FLOW CONSISTENT MODELS: EVOLUTION, METHODOLOGICAL ISSUES, AND FISCAL POLICY APPLICATIONS

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Dissertação submetida ao Programa de Pós-Graduação em Economia da Faculdade de Ciências Econômicas da UFRGS, como requisito parcial para obtenção do título de Mestre em Economia

Orientador: Prof. Dr. Marcelo Milan

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RESUMO

A presente dissertação tem por objetivo discutir diferentes aspectos de um método de modelagem econômica conhecido por Modelos Stock-Flow Consistent (SFC). Essa classe de modelos tem como principais características a presença de matrizes que representam os balanços patrimoniais dos setores modelados, bem como os fluxos de transações e de fundos financeiros. A primeira etapa do trabalho consiste em analisar as origens dos modelos SFC, apresentando os trabalhos que precederam as primeiras formulações. Em seguida, é feito um survey completo da literatura SFC corrente. Essas duas etapas são realizadas através de uma revisão bibliográfica de artigos, working papers, teses e dissertações. A terceira etapa do trabalho consiste em discutir aspectos metodológicos da modelagem SFC, em especial a modelagem de equações comportamentais de expectativas. Por fim, um modelo SFC é elaborado com o objetivo de analisar o comportamento de uma economia sob quatro regimes fiscais diferentes: (i) balanço equilibrado; (ii) meta de gastos do governo como proporção do PIB; (iii) meta de déficit do governo como proporção do PIB; (iv) meta de dívida pública como proporção do PIB. O comportamento em estado estacionário desses regimes é analisado, bem como sua resiliência a choques. Entre as conclusões, percebeu-se que o segundo regime apresenta a maior taxa de crescimento no steady state, além de ser mais resiliente a choques negativos.

Palavras-chave: Economia Pós-Keynesiana. Modelos de consistência entre estoques e fluxos. Política fiscal.

ABSTRACT

The general goal of this dissertation is to discuss different dimensions of a class of Post-Keynesian models known as Stock-Flow Consistent Models. The main features of these models are: (i) the presence of balance sheets matrices of the sectors to be modeled, guaranteeing the consistency in the economic stocks; (ii) the flow of funds matrix, that records the real and financial transactions of the economy. The first step of the work is to analyze the origins of the SFC models, presenting the works that preceded the first elaborations. Next to it, the current SFC literature is surveyed. These two steps are accomplished by means of a survey of the literature in academic journals, working papers, dissertations and thesis. The third step of the work is a discussion of methodological issues such as the role of expectations in the behavioral functions for consumption. Finally, the fourth step consists of elaborating a SFC model in order to analyze four fiscal policy regimes: (i) balanced budget, (ii) a target for government's expenditures , (iii) a target for government deficit, and (iv) a target for government debt. The steady state behavior of each regime is analyzed, as well as its resilience to adverse shocks. The second regime is the one with the higher steady state growth rate and also is the more resilient to negative shocks.

Key words: Post Keynesian economics. Stock-flow consistent models. Fiscal policy.

SUMMARY

1 INTRODUCTION

The current state of mainstream macroeconomic theory is in disarray. Its failure to predict the 2008 financial crisis gave rise to many criticisms, even among mainstream authors themselves. Solow (2010), in a statement to the Congressional Committee on Science and Technology, makes that failure clear:

> Here we are, still near the bottom of a deep and prolonged recession, with the immediate future uncertain, desperately short of jobs, and the approach to macroeconomics that dominates serious thinking, certainly in our elite universities and in many central banks and other influential policy circles, seems to have absolutely nothing to say about the problem. Not only does it offer no guidance or insight, it really seems to have nothing useful to say (SOLOW, 2010, p. 1).

The Dynamic Stochastic General Equilibrium (DSGE) model, the current dominant method of mainstream macro, received harsh criticisms as well. Romer (2016) argues that "For more than three decades, macroeconomics has gone backwards." (p. 1), and "[…] macroeconomists started invoking imaginary driving forces to explain fluctuations." (p. 15) and also that "[…] they seemed to forget things that had been discovered about the identification problem" (p. 15). Blanchard (2016, p. 1) claims that he sees "[…] the current DSGE models as seriously flawed" and criticizes their simplifying assumptions, their estimation method, their normative implications and their bad appeal as a communication device.[1]

The natural alternative to mainstream failures is the heterodox school[2]. The methodology that will be explored in this dissertation, the Stock-Flow Consistent (SFC) method, has many potentials regarding the heterodox school. Lavoie (2008) puts it clearly:

> [Models with] stock-flow consistency with simple adjustment reaction functions, often linking stock-flow targets, can play an essential role in heterodox macroeconomics, as it provides a potential for common ground for all heterodox schools, just like the maximizing representative agent seems to be the standard of mainstream economics. LAVOIE (2008, p. 332-333).

The main feature of the Stock-flow Consistent (SFC) method is, as its own name suggests, a consistent modeling of economic stocks and flows. There are two basic matrices in every SFC model, one describing the balance sheets of the sectors modeled (accounting for

1 A review of these critiques is provided by Keen (2017).

2 Dequech (2007) provides a discussion about the concepts of mainstream, orthodoxy, and heterodoxy. He claims that the heterodox school can be defined negatively, in opposition to the orthodoxy, or positively. But, in this latter case, he argues that "when applying this positive concept historically, the result may be an empty set" (DEQUECH, 2007, p. 301).

the stocks) and another dealing with the real and financial transactions (accounting for the flows). And advantage of such action is that "[…]there are no black holes: every flow comes from somewhere and goes somewhere" (GODLEY, 1996, p. 7). According to Santos (2002, p.1), SFC models are "[…] crucial for sound macroeconomic reasoning in general and, therefore, its widespread adoption would increase both the transparency and the logical coherence of most macro models."

Lavoie and Godley (2001-2002) reinforces the message:

> In our methodology, we can justify every point by reference to a precise system of relationships. If others disagree, they can be challenged to say precisely what simplification or parameter is inappropriate. Every relationship can be changed, and one can find out whether the change makes any difference to the results. This method ought to be helpful to resolve some controversial issues (LAVOIE; GODLEY, 2001-2002, p. 308).

The SFC methodology presents many other potentials. One is its capacity to predict crisis. Bezemer (2010) and Galbraith (2012) argue that the 2008 financial crash was predicted by authors that used models based on a rigorous accounting, whereas models that rely upon notions of general equilibrium did not. SFC models are used not just in the academy, but also by central banks, like the Bank of England (see Burgess et al., 2016) and by financial institutions, such as Goldman Sachs (see Hatzius and Stehn, 2012).

The relevance of SFC models turned out to give them some attention in newspapers and also in the blogosphere. Schlefer (2013), on a New York Times column, provides a biography of Wynne Godley, acknowledging that he was able to predict the financial crisis thanks to his modeling approach. Krugman (2013) minimizes Godley's achievements, claiming that his model resembles the old-fashioned "hydraulic Keynesianism" of the 1950s, which was surpassed by the New Keynesian models due to failures to predict the 1970s stagflation. He ends the text claiming that "[…] it is kind of funny to see a revival of old-fashioned macro hailed, at least by some, as the key to a reconstruction of the field".

Smith (2016) also criticizes the SFC models, and the heterodox approach in general. He complains that the current mainstream macro models were unable to predict the financial crisis, but argues that "[…] heterodox economics hasn't really produced a replacement for mainstream macro". He also claims that "[…] heterodox models didn't "predict" the crisis in the sense of an actual quantitative forecast". Regarding the SFC models, he rises many criticisms. He argues that "they have so many parameters that existing macroeconomic data has essentially no hope of identifying them all. This also tends to make them very vulnerable to so-called overfitting […]". He also claims that "[…] they don't take human behavior into

account". Keen (2016) and Michell (2016a) provide responses to Smith's criticisms. The first author points out that SFC models are in fact better suited for macroeconomic data compared to DSGE models, since they theorize about measurable stocks and flows. The second author points that the issue at stake is the correct assumptions to be taken in a macro model, and that SFC, due to its Post-Keynesian roots, provides better assumptions.

Wren-Lewis (2016) also raises his criticisms against SFC models. The focus of his discussion is the Bank of England paper (BURGHESS et al., 2016). He claims that SFC models has "minimal behavioral content". Michell (2016b) retorts, claiming that SFC models do have behavioral content, rooted in the Post-Keynesian tradition, although arguing that "[…] theoretical justifications for the behavioral specifications and the connections to previous literature could have been spelled out more clearly" by Burgess et al (2016).

The general goal of this dissertation is to discuss different dimensions of the SFC method of analysis. It has the specific goals of:

a) presenting the major features of the method and analyzing the origins of the SFC models, presenting the works that preceded the first elaborations;
b) surveying the current SFC literature;
c) discussing methodological issues such as the role of expectations in the behavioral functions for consumption;
d) elaborating a SFC model in order to analyze four fiscal policy regimes: balanced budget, a target for government's expenditures, a target for government deficit, and a target for government debt.

The methodology adopted for carrying out the research has two steps. The first step is to survey the literature in academic journals, working papers, theses, and dissertations for chapters 1 and 2. The second step, employed in the third chapter, is to simulate an economic environment by means of a complete SFC model. The model will be developed along the SFC lines, using the Eviews software.

Thus, this dissertation has four chapters besides this introduction. The second chapter develops the literature review of both the precursors of and the current SFC literature. The third chapter deals with a methodological issue regarding the modeling of expectations in the consumption function. The fourth chapter is the construction of the SFC model of fiscal policy regimes. It is a theme of great importance today, especially in Brazil, that has recently approved an austerity plan that freezes the government budget for the next 20 years, allowing

it evolve only in tandem with inflation[3]. Such a measure goes against recent empirical findings of the positive impact of fiscal policy and fiscal multipliers, such as Blanchard and Leigh (2013), Borsi (2016) and Klein (2016). Finally, the fifth chapter concludes.

3 The Washington Post called it the “mother of all austerity plans”. (SIMS, 2016).

2 SFC MODELS: BASIC FEATURES AND LITERATURE REVIEW

In this chapter, we provide a review of the SFC approach. The first section offers a discussion about the basic features common to all SFC model. The second section is a literature review focused on the origins of the approach. The third section discusses the more recent SFC modelling. The last section concludes.

2.1 SFC MODELS: THE BASICS

In this section, we introduce two SFC models developed in Godley and Lavoie (2007a), in order to provide a basic understanding of the mechanisms behind them. The first modeling step in the SFC method is to make explicit the sectoral accounting interrelationships, which are described by means of two matrices: The Balance Sheet Matrix, which deals with assets and liabilities of all the sectors of the economy (representing therefore the stocks), and the Transactions-Flow Matrix, that records all the monetary transactions in an economy (representing therefore the flows).

The complexity of these matrices depends on the intentions of the researcher. Let us start with a very simple one, based on the second chapter of Godley and Lavoie (2007a). The first model is a rather simplified case of a closed economy without government. There are two kinds of assets: Tangible capital and money deposits. Table 1 presents the respective macroeconomic balance sheet.

Table 1 – Balance sheet of a simple economy

	Households	**Firms**	**Banks**	**Σ**
Money deposits	$+ M_h$	$+ M_f$	- M	0
Tangible Capital		+ K		+K
Loans		$- L_f$	$+ L_f$	0
Balance (net worth)	$- NW_h$	$- NW_f$	0	- K
Σ	0	0	0	0

Source: elaborated by the author.

Several points regarding the matrix must be emphasized here. First, the choice of sectors for the model is an important decision, representing the underlying simplifications and assumptions. A second aspect considers the signals of the matrix's entries. A positive sign indicates an asset, whereas a negative one represents a liability. Households for example have only one asset: Money deposits (M_h). The entire value appears on the liability side of the

balance sheet as their net worth (NW_h). Firms have two assets, money deposits (M_f) and tangible capital (K), and two liabilities, loans (L_f) and their respective net worth (NW_f). Banks' assets are loans (L_f), and liabilities are in the form of deposits (M), with zero net worth. A third point concerns the sum of the columns and rows. The columns have to sum up to zero, because the accounting rules ascertain that the assets must have the same value as the liabilities. Liabilities have to sum to zero as well, except for the row dealing with tangible capital. Rows dealing with financial assets and liabilities must sum to zero, because they are "claims of someone against someone else" (GODLEY; LAVOIE, 2007a, p. 32), leading to the need for mutual compensation. The tangible capital, in contrast, appears just once, in the entry of its owner.

Table 2 represents the transactions-flow matrix of the model, including the circuit of money. In this case, the respective signs have a different meaning. A positive sign means that the entry is a source of funds, whereas a negative sign represents a use of funds. Households have only one source of funds, their wages (WB), and two possible kinds of expenditures, consumption (C) and increases in money deposits (ΔM_h). Firms have two columns, representing current and capital transactions, in order to account for investments (I), which means that an intra-firm sector purchase needs to be identifiable within the matrix, as well as any resources necessary for additional funding of investment in excess of profits (ΔL_f)[1].

Table 2 – Transactions-flow matrix of a simple model

		Firms		**Banks**	
	Households	Current	Capital	Capital	**Σ**
Consumption	- C	+ C			0
Investment		+ I	- I		0
Wages	+ WB	-WB			0
Δ Loans			$+ \Delta L_f$	- ΔL	0
Δ Deposits	$- \Delta M_h$		$- \Delta M_f$	+ ΔM	0
Σ	0	0	0	0	0

Source: elaborated by the author.

As above, every column must sum up to zero in this case. The reason lies in the fact that every purchase from one sector is a sale from another. In the case of non-commercial transaction, the sum must be zero because a payment from one sector is a receipt to another. In the latter case, the columns show the budget constraint of each sector. It must sum to zero, because every fund either represents purchases of goods or an increases in assets.

1 On the household column, this difference was disregarded. For the sake of coherence, it would have to have a "capital" column too, showing the increases (or decreases) in money deposits.

It is important to note that, so far, no behavioral aspects were considered

> beyond what is implied by logical constraints (e.g. that every buyer must have a seller) or by the functions that have been allocated to the various sectors (e.g. that firms are responsible for all production, banks for making all loans) or by the conventional structure and significance of asset portfolios (e.g. that money is accepted as a means of payment) (GODLEY; LAVOIE, 2007a, p. 42).

One feature of the transaction-flow matrix is the principle of quadruple entry. Every purchase implies at least two operations: a negative one as a use of funds, and a counterpart representing an income source (for example, the "wages" entry in the table 2), or a reduction in an asset (or increase in a liability, as in the case of a loan for a firm). Also, because every transaction involves two sectors, there must be at least four entries in the matrix to account for every transaction.

Table 3 – The first step in a quadruple-entry example

		Firms		**Banks**	
	Households	Current	Capital	Capital	**Σ**
Consumption					0
Investment					0
Wages					0
Δ Loans			$+ \Delta L_f$ ←	$- \Delta L$	0
			↓	↑	
Δ Deposits			$- \Delta M_f$ →	$+ \Delta M$	0
Σ	0	0	0	0	0

Source: elaborated by the author

Table 4 – The second step in a quadruple-entry example

		Firms		**Banks**	
	Households	Current	Capital	Capital	**Σ**
Consumption					0
Investment					
		+ I	← - I		0
		↓			
Wages	+WB ←	-WB			0
Δ Loans	↓		$+ \Delta L_f$	$- \Delta L$	0
Δ Deposits	$- \Delta M_h$			$+ \Delta M$	0
Σ	0	0	0	0	0

Source: elaborated by the author

An example can clarify these aspects. Assume that banks grant loans to firms (–ΔL on matrix 3). Firms receive resources (+ ΔLf) and deposit them (–ΔMf), which represents a use of funds by firms and a source of funds to banks. The second step is the use of the resources by firms, presented on table 4. Firms withdraw their deposits (ΔLf entry) and use the resource to acquire new investment goods. The production process involves wage payments (–WB) to households in the form of income (+WB), who then deposit them (-ΔMh).

The balance sheets and the transactions-flow matrices of the SFC models can be modified according to different assumptions, for example, the inclusion or omission of other sectors. Some sectors can be simplified away and other sectors can be introduced, like the LP model of Godley and Lavoie (2007a, chapter 5), which subtracts private banks and adds the government and the central bank. Tables 5 and 6 show, respectively, the balance sheet and the transaction-flow matrix for this case.

Table 5 – Balance sheet of Model LP

	Households	**Firms**	**Government**	**Central Bank**	Σ
Money	+ H			- H	0
Bills	+ B_h		- B	+ B_{cb}	0
Bonds	+ BL.p_{bl}		- BL.p_{bl}		0
Balance (net worth)	- V		+ V		0
Σ	0	0	0	0	0

Source: Godley and Lavoie (2007a), p. 137.

There are four sectors in this economic model: Households, firms, the government, and the central bank. Households have three kinds of assets: Money (H), bills (Bh) and bonds (BL); and one liability, their net worth (V). The government's liabilities are bills and bonds, and the asset is its net worth. The central bank bills are its assets, and the high-powered money H is its liability.

The transactions-flow matrix includes specific entries for Central Bank profits and interest payments. It must be noted that the very configuration of the matrix tells a lot about the underlying assumptions. In the first place, the split of companies' account into current and capital is eliminated. This reflects the assumption that firms do not invest in tangible capital. Second, the row "Central Bank profits" is introduced to deal with the assumption that all the Central Bank profits are transferred to the government. The last row deals with "capital gains". This fact raises some questions, since capital gains obtained by price changes are not transactions, but increase the wealth of the sectors, that is, they modify their balance sheet.

Table 6 – Transactions-flow matrix of Model LP

				Central Bank		
	Households	**Firms**	**Government**	Current	Capital	Σ
Consumption	- C	+ C				0
Government expenditures		+ G	- G			0
Income = GDP	+ Y	- Y				0
Interest payments on bills	+ $r_{b-1}.B_{h-1}$		- $r_{b-1}.B_{-1}$	+ $r_{b-1}.B_{cb-1}$		0
Interest payments on bonds	+ BL_{-1}		- BL_{-1}			0
Central Bank profits			+ $r_{b-1}.B_{cb-1}$	- $r_{b-1}.B_{cb-1}$		0
Taxes	- T		+ T			0
Change in Money	- ΔH				+ ΔH	0
Change in bills	- ΔB_h		+ ΔB_h		+ ΔB_{cb}	0
Change in bonds	- $\Delta BL.p_{bl}$		+ $\Delta BL.p_{bl}$			0
Σ	0	0	0	0	0	0
Memo: capital gains	- $\Delta p_{bl}.BL_{-1}$		+ $\Delta p_{bl}.BL_{-1}$			0

Source: Godley and Lavoie (2007a), p. 139.

Capital gains are accounted for as follows. One entry is indicated in the row 'Change in bonds' and the counterpart in 'memo: capital gains'. This result can be demonstrated by the Ostergaard diagram below (figure 1), and also algebraically. The large rectangle in the Ostergaard diagram represents the end-of-period value of an asset. Bonds are used in this example, but any other asset can be subject to price changes. The small rectangle represents the value of bonds at the end of the previous period. The changes are given by their respective differences: One comes from the new acquisitions of bonds, the other from price variations that alter the value of the previously held bonds.

The algebraic proof given by Godley and Lavoie is as follows. The difference between the new and the former value of the stock of bonds is, by definition, equal to $(p_{bl}BL - p_{bl-1}BL_{-1})$, which leads to equation 1:

$$\begin{aligned}(p_{bl-1} + \Delta p_{bl}).(BL_{-1} + \Delta BL) - (p_{bl-1}BL_{-1}) \\ = (p_{bl-1}BL_{-1}) + (\Delta p_{bl})BL_{-1} + (p_{bl-1}\Delta BL) + (\Delta p_{bl}\Delta BL) \\ - (p_{bl-1}BL_{-1})\end{aligned} \quad (1)$$

Note that the first and the last parenthesis in the right-hand side of the equation cancel out. Therefore:

$$(p_{bl-1}\Delta BL) + (\Delta p_{bl}\Delta BL) + (\Delta p_{bl})BL_{-1} = (p_{bl-1} + \Delta p_{bl})\Delta BL + (\Delta p_{bl})BL_{-1} \quad (2)$$

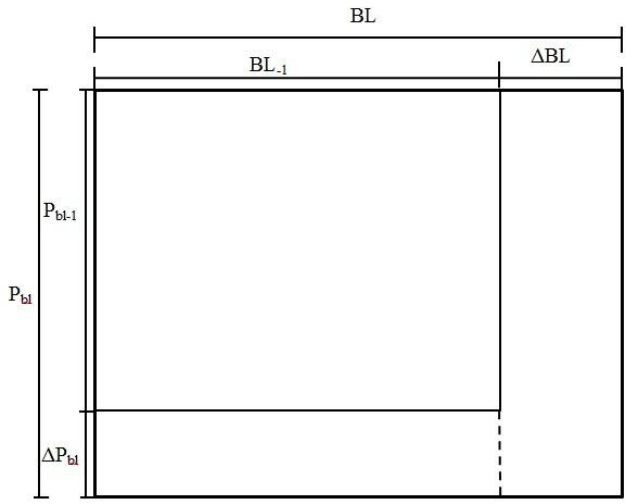
This boils down to:

$$(\Delta BL)p_{bl} + (\Delta p_{bl})BL_{-1} \quad (3)$$

The first term represents the changes in bonds and the second term is the value of the row 'memo: capital gains'.

The complexity of the SFC models can be further increased, with the addition of more sectors and assets/liabilities. Each asset adds at least two rows to the transactions-flow matrix, one for the interest payments (or distributed profits, in the case of equity) and another for the new asset. New sectors add at least one column to the matrix. If it is important to differentiate between current and capital transactions, the respective sector adds two columns to the matrix. For the case of an open economy model, a duplication of the columns in order to represent the other country is a common practice. In this case, the rows sum to zero after exchange rate adjustments.

Figure 1 – Ostergaard diagram



Source: Godley and Lavoie (2007a), p. 135.

So far, we have not dealt with the sector-specific behaviors, that is, the supply and demand equations, and the numeric solutions to an SFC model. The behavioral equations vary widely among models, according to the theoretical background and to the research emphasis. For example, an investment function can include expected sales, or capacity utilization, or both. The behavior of a sector, banks for example, can vary from a simple deposit taker and loan supplier to the complexities of credit rationing and mark-up procedure in the interest rates charged.

SFC models are usually solved by the identification of a steady-state and the introduction of an exogenous shock variable. This approach of making simulations has the shortcoming of providing only local equilibrium. A global equilibrium can be found analytically. However, it is not a common procedure, since the models are usually very large

(with more than fifty equations) and may involve non-linearities. A full SFC model for evaluating fiscal policy regimes is developed in chapter 3.

Next section presents the evolution of the SFC approach in order to highlight the most important issues discussed in this tradition over the years.

2.2 SFC MODELS: INTELLECTUAL HISTORY

In this section, we discuss the intellectual origins of the SFC Models. In particular, we emphasize the role played by two research groups: the Yale school and the Cambridge Economic Policy Group (CEPG).

2.2.1 Early discussions[2]

Some basic features of the SFC method, such as the study of balance sheet interrelations between sectors, and the budget constraint that they face, have a long history in the economic thought. Kinsella (2011) argues that William Petty's Verbum Sapienti book, written in 1664, "[…] presents a balance sheet approach to the study of national income and expenditure" (p. 3). Bezemer (2010) claims that the "circular flow" view of the monetary economy, which "[…] was present in classical thought from the start" (p. 679), is the starting point of the SFC approach. Francois Quesnay's Tableau Economique adopted that method, as well as Adam Smith's Wealth of Nations and Jean Baptiste Say's Treatise on Political Economy. Karl Marx identified the "profit puzzle" with a circular-flow view of the economy. Schumpeter's Theory of Economic Development is based on the context of a circular flow of traded goods.

By the end of the 1960's and beginning of the 1970's, some authors had worked on the consistency between stocks and flows related to the government's budget balance. Ott and Ott (1965) criticize fiscal policy models for their lack of considerations about the government budget impacts. According to them, government deficits (surpluses) increase (reduce) the wealth of the private sector, consequently altering consumption and the aggregate demand. They argue that the standard conclusions of the fiscal and monetary policy models are wrong, because they do not take these effects into account. Using a simple model, they show that the equilibrium of the economy is given by the level of income that balances the government

[2] One early discussion that can be considered a precursor of SFC literature is the Monetary Circuit Theory. This school, however, will not be discussed in this thesis. See Graziani, Arena and Salvadori (2004) for a review of this topic.

budget[3] . One implication of this conclusion is that changes in the autonomous investment, in the consumption function or in the mix by which the government deficit is financed (money or bonds) does not change the equilibrium income. However, monetary policy can affect the time that the economy needs to reach a new equilibrium after a shock. Moreover, it can alter the equilibrium interest rate.

Oates (1966) points to some implicit assumptions of Ott and Ott (1965) and its implications. The first assumption is that the private sector does not expect a future increase in taxes after a government's bond emission[4] . If the opposite happens, the conclusions would not hold anymore. The second assumption is that the economy is closed to foreign trade and capital movements. An extension of the model to an open economy is then presented. The new equilibrium can be either a balanced government budget or a twin-deficit situation (where both the budget and the balance of payments are in deficit).

Christ (1967) explores the interdependencies of fiscal and monetary policies. He develops a model that takes the government budget restriction into account, defined as the combination of the instruments used to finance the government spending, such as taxes, monetary emission and bonds. Several simulations are run with different values attached to each instrument, all of them guaranteeing a balanced budget. The maximum impact in the GDP occurs when the government spending is financed only with monetary emission. The minimum impact occurs when only taxes are used. Christ (1968) shows that, if the government has N policy variables (be they either fiscal, such as spending and taxes, or monetary, such as emission of money), it can choose the value of only N – 1 variables. The Nth variable is endogenous, its value being given by the others.

Blinder and Solow (1973) points out that the previous authors have neglected an important aspect of the government budget: the interest payments on bonds. They incorporate this feature in an IS-LM framework by introducing the interest payments as an outflow from government budget and an inflow into households' income. They show that the neglect of interest payments results in a lower steady state multiplier. Infante and Stein (1976) explore some implications of the previous model. They show that the conditions that guarantee the model' stability imply negative fiscal multipliers; if the multiplier is positive, the system will be unstable. They also show that, in the long run, a rise in the money supply generates lower prices, a result that is called an "anti-quantity theory" of money.

3 The authors develop an equation that is almost identical to the fiscal stance presented by Godley and Cripps (1983) discussed below.

4 His explanation of this point resembles the Ricardian Equivalence proposed by Barro (1974).

2.2.2 Yale

There is consensus in the literature in pointing to the work of Brainard and Tobin (1968) as the seminal work of a whole generation of models. The authors explain their objective in a quote that makes clear its importance for the future SFC models:

> In this paper we argue for the importance of explicit recognition of the essential interdependencies of markets in theoretical and empirical specifications of financial models. Failure to respect some elementary interrelationships – for example, those enforced by balance-sheet identities – can result in inadvertent but serious errors of econometric inference and of policy (BRAINARD; TOBIN, 1968, p. 99).

The authors, then, construct their model (usually called Pitfalls Model), that consists of multiple assets and interest rates. The portfolio allocation is given by a series of equations where the demand for one asset depends on its rate of return and also on the rates of return of all other assets. This happens because, given the wealth, the effect of a change in one interest rate added over the whole portfolio must be zero; that is, increases in the holdings of one asset are made at the expenses of the others assets' holdings. After establishing the base model, the authors set an adjustment mechanism to deal with portfolio disequilibrium, which occurs when the quantity actually held of one asset is different from its desired quantity. The adjustments are made gradually, that is, they are not completed in one single period. Tobin (1969) follows the same core idea, presenting three models of increased complexity. The first model is composed of two sectors, the private and the government, and has only two assets, cash and tangible capital. The second model introduces government bonds, and the third adds the banking sector.

The work of Brainard and Tobin (1968) gave rise to a series of debates, all of them published in the American Economic Review. There can be identified two threads in the debate. The first starts with Ladenson (1971). This author affirms that the main feature of the Pitfalls Model is the restrictions imposed on the coefficients of the portfolio equations. The mains restriction is that the coefficients of a given variable, when summed over all the equations, must be zero. The author claims that this restriction was presented without any formal derivation. His objective is, thus, to present such formal derivation. Clinton (1973) criticizes both Ladenson (1971) and Brainard and Tobin (1968), arguing that their treatment of portfolio equations were only special cases of a more general one proposed by him. Ladenson (1973) is a rejoinder, in which the author assumes some errors, but points to the fact that the three previous works are special cases of an even more general case, presented in his

article. Smith (1975) pinpoints some cases of linear dependency in the previous works and proposes solutions.

The second thread of debates that the work of Brainard and Tobin (1968) inspired starts with Purvis (1978). This author criticizes the Pitfalls Model for its separation of consuming and saving decisions. His objective is, therefore, to offer an extension of the model in which these decisions are integrated. However, Smith (1978) shows formally that the model with integrated decisions is a linear transformation of the model with separate decisions, what renders both approaches equivalent. Moreover, the author criticizes the usefulness of an integrated approach, since there are variables which are relevant to the consumption-saving decision but that are irrelevant to the portfolio decisions beyond its impact in the level of wealth. This last point, yet, is not formally presented by the author. Owen (1981) makes such formalization.

Meyer (1975) combines the Government Financing Constraint of Christ (1968) and the portfolio modeling of Brainard and Tobin (1968) in order to analyze the crowding-out effect of an expansionary fiscal policy. He argues that the combination of the two mentioned approaches makes clearer the influence of a deficit financed with bond emission on the interest rate, which is due to the private sector portfolio allocation. Every dollar increase in government bonds increases wealth by a dollar, but wealth owners wish to diversify their portfolios. Thus, the only way the government can induce wealth owners to hold all the wealth increase in the form of bonds is by means of a higher interest rate.

Tobin (1980) discusses several questions about macroeconomic theory. His main objective is to present a critical assessment of the monetarist and new classical schools. In the last chapter of the book, he presents a simple model, similar to the Pitfalls, and discusses several closures[5] to it, altering the variables that are endogenous and exogenous. According to the author, the main conclusions of the IS-LM model are maintained, with the advantage of a more accurate treatment of the financial market. Minsky (1981) offers a critical revision of Tobin's book. According to him, "[…] there are valid and useful insights in Tobin's analysis. The pervasive flaw in Tobin's work is his continued faith in the validity of the IS-LM formulation" (p. 208). The focus of Minsky's criticism is the last chapter of the book. He argues that there are two price levels in the model, one for output and another for financial

5 We follow Taylor (1991, p.41) in the usage of the term "closure": "Formally, prescribing a closure boils down to stating which variables are endogenous or exogenous in an equation system largely based upon macroeconomic accounting identities, and figuring out how they influence one another."

assets, but points out that they were not properly analyzed by Tobin. If they were so, the IS-LM conclusions would not hold.

In his Sveriges Riskbank Prize in Economics Lecture, Tobin (1982) emphasizes the principal features of his framework, which is still present in SFC models. These are: precision regarding time; tracking of stocks; several assets and rates of return; modeling of financial and monetary policy operations; and Walras' Law and adding-up constraints.

There is an extensive empirical literature related to models in the Pitfalls tradition. The main reference is Backus el al. (1980). These authors establish a simple theoretical model that is subjected to an empirical test over the USA data. Concerning the results, the authors comment:

> Unconstrained OLS estimates testify to the difficulty of obtaining significant and/or sensible coefficient estimates in models of this type. Fewer than half of the short-run rate responses and approximately half of the adjustment coefficients are significant, and there are a larger number of estimates quantitatively, if not significantly, far from the priors. Many are of the "wrong" sign, and some significantly so (BACKUS et al., 1980, p., 283).

2.2.3 New Cambridge

The CEPG was founded by Wynne Godley in 1970, when he moved from the British Treasury to Cambridge University (MATA, 2012). One of the main projects of the CEPG was to issue a yearly forecast of the British economy. These forecasts, however, did not present a formal model or a discussion about the estimation method. This, added to the criticisms made by New Cambridge authors upon other estimations from CEPG, gave rise to responses and additional critiques. The bulk of the debates were related to some CEPG hypotheses, such as the aggregation of households and firms into a Private Expenditure Function and the assumption of a constant wealth to income ratio and the implied relationship between the government budget and the balance of payments.

Bispham (1975) was one of the first to give a response to criticisms raised by the CEPG to the conventional forecasting method of that time, in special the predictions made by the National Institute of Economic and Social Research. Bispham concentrates his critiques of the CEPG model on two fronts: the theoretical level and the empirical. In the first one, he argues against the supposition that the private sector has a stable wealth to income ratio, which implies that budget deficits are matched by balance of payments' deficits. He points out that the budget deficit is partly endogenous, and also that the causation can go both from the government budget to the balance of payments and vice versa. Still on the theoretical side, he

criticizes the private expenditure function for its lack of theoretical background. On the empirical side, the author emphasizes the forecasting failures of the CEPG model in 1974. He points to a possible defense of the CEPG model upon the fact that the value of stocks (an argument in CEPG estimation's function) had increased almost unpredictably. But he also argues that the mistakes of the conventional models in the early 1970s can be blamed on an unpredictable variable too, viz. the oil prices. In conclusion, he points out that the CEPG model gives no better alternative to the conventional models and, because of its lack of theoretical background, should be put aside.

Higgins (1976) also criticizes the CEPG conclusions, especially the ones related to the constant wealth to income ratio and the implied relationship between the government budget and the balance of payments. The author identifies some variables that can undermine the CEPG position, such as changes in prices and movements in the capital account. In conclusion, he argues that "[…] the valid service the New [Cambridge] School has done is to remind policy makers of the reasons why attempts to increase domestic activity and employment may be frustrated by the balance of payments effects" (p. 205).

Rowan (1976) attempts to formalize his interpretation of the New Cambridge ideas. The author emphasizes throughout the text the word "interpretation", because the absence, at the time, of a formal presentation of the CEPG model forced him to rely on a number of different publications, not completely compatible, produced by the New Cambridge authors. He coins the terms "Godley's Law" and "Godley's Rule", the first one related to the empirical finding that the private sector's net acquisition of financial assets is constant, and the latter related to the implied equality between government's budget and balance of payment results.

Vines (1976) also formalizes the CEPG views, arguing that "The theoretical basis for the assertions of the New [Cambridge] School is not well known, since this debate has been mainly conducted in the pages of *The Times*" (p. 207). He argues that the New Cambridge assertion that the financial balance of the private sector is stable conflicts with the conventional Keynesian view. The argument is that the belief that investment determines savings is not compatible with the CEPG view, since, to the former, investments are driven by the entrepreneurs' animal spirits, and savings adjust to it through changes in the level of the economic activity. To the CEPG, "[…] both corporations and individuals are supposed either to adjust their investment plans in the face of changed income, or to alter the proportion of this new income which they save" (p. 227). Dixon (1982-83) makes similar arguments. According to him, the New Cambridge School promotes a rejection of Keynes' views,

because the assumption that the private sector's financial balance is stable goes against the Keynes' belief that the private investment is the major source of economic instability.

Rowan (1976) and Vines (1976) complaints were solved in the same year by Cripps and Godley (1976), who provide the first formal presentation of the CEPG model. According to the authors, their model "[…] lies squarely within the postwar tradition of Keynesian model building […]" (p. 335). They present formally the main assumptions of the New Cambridge School – that is, the Private Expenditure Function, the constant wealth to income ratio, and the implied relationship between the government budget and the balance of payments – and discuss some policy matters. They argue that, if the intention of the policymakers is to improve the terms of trade, the best option is to raise import tariffs, because it is less inflationary than an exchange rate devaluation.

In 1978, the Carnegie-Rochester Conference Series on Public Policy organized a publication discussing the economic problems of Great Britain. Fetherston and Godley (1978) dealt with the issues using the CEPG model. According to the authors, "the explicit hypothesis associated with the term 'New Cambridge' is that virtually all the disposable income of the private sector as a whole will be spent on goods and services with a fairly short lag" (p. 34). Their model can be presented in the following simplified way[6]. Be ΔSFA the change in the stock of financial assets, ΔY_d the change in disposable income and (1 – α) the marginal propensity to save, we get:

$$\Delta SFA = (1 - \alpha)\Delta Y_d \tag{4}$$

Using the national accounts, we get:

$$Y \equiv P + G + X - M \tag{5}$$

Where P is the private sector purchases, G is the government spending, X is the exports, and M represents the imports. The equation above can be rewritten in the following way:

$$(G - T) + (X - M) \equiv (Y - T - P) \equiv \Delta SFA \tag{6}$$

Where T are taxes. Substituting (6) in (4) gives:

$$\frac{G - T}{\Delta Y_d} + \frac{X - M}{\Delta Y_d} = (1 - \alpha) \tag{7}$$

Equation 7 can be interpreted in many ways. One of them, as Russel and Wakeman (1978) argue, is that expansionist fiscal policy pursued by the government causes a deterioration of the balance of payments, supposing that the private marginal propensity to save is kept constant. Another interpretation, given by Fetherston and Godley (1978), is that,

6 We follow Russel and Wakeman (1978) in this simplification.

keeping the balance of payments constant, increases in the private marginal propensity to save generate higher public deficits.

The Fetherston and Godley (1978) paper raised many comments. Blinder (1978) criticizes throughout them, from the notation utilized to the theoretical suppositions, such as the absence of the law of one price when discussing the external trade. Frenkel (1978) criticizes their definition of the long term, especially the supposition that there is a margin of excess capacity that allows the supply to adjust to demand. Hall (1978) argues against their defense of import quotas. According to him, this prescription is based on two unrealistic hypotheses: that the quotas do not change the imports' prices and that the domestic prices are not affected by the real output expansion.

In the early 1980s, there was another debate concerning the New Cambridge hypotheses. Chrystal (1981) argues that the supposed stable behavioral relationship given by the Private Expenditure Function is not behavioral at all, because it is derived from the national accounts and is stable only when there is no disequilibrium in the budget and/or in the balance of payments. According to him, in the 1950s and 1960s, no such disequilibrium happened, which explains the New Cambridge supposition. In the 1970s, however, the disequilibrium appeared, destabilizing the supposed behavioral relationship. Anyadike-Danes (1983) pinpoints an error in the econometric estimations provided by the last author. Chrystal (1983) admits his error, but argues that his other criticisms, such as the issue that the Private Expenditure Function is an identity, without behavioral content, is valid.

The seminal work of the New Cambridge School is Godley and Cripps (1983). This book provides a series of models with consistency between the budget restraints of the sectors and of the economy as a whole. About this, the authors affirm:

> 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; CRIPPS, 1983, p. 18).

Moreover, the models have just a few behavioral variables, the majority being stock/flow norms. About this, they say:

> The smaller the number of behavioral variables which govern how the system *must* function in the view of the logical constraints, the more powerful will be our theory as a model for organizing and interpreting data (GODLEY; CRIPPS, 1983, p. 18).

A simple model capable of illustrating these aspects is the one presented in chapter 5 of the book. It is a closed economy without government, where the only financial asset is the households' deposits kept in commercial banks. This latter sector uses its resources to lend money to the firms sector, which needs loans to finance its inventories. Formally:

$$Y \equiv FE + \Delta I \tag{8}$$

Where Y is the national product (income), FE is final expenditures, and ΔI is the inventories change. This can be rewritten as:

$$FE \equiv Y - \Delta FA \tag{9}$$

Where ΔFA is the change in financial assets holdings.

On banks' balance sheet, we have that their assets (loans, called LI) are equal to their liabilities (which are households' deposits); assuming that the loans have always the same value of the inventories, we get:

$$FA = LI = I \tag{10}$$

A simple assumption for the accumulation of inventories is made, making it dependent on a proportion of the flow of sales of the last period:

$$I = \gamma FE_{t-1} \tag{11}$$

Another simple assumption regards the households' financial assets accumulation, assuming that it is a constant proportion of the income:

$$FA^* = \alpha Y \tag{12}$$

Where FA* is the desired stock of financial assets. The difference between the actual and the desired level is closed gradually:

$$\Delta FA = \phi(FA^* - FA_{t-1}) \tag{13}$$

Substituting (12) and (13) in (9), we get:

$$FE = (1 - \alpha\phi)Y + \phi FA_{t-1} \tag{14}$$

Substituting (14) in (8) and solving for Y gives:

$$Y = \frac{(\Delta I + \phi FA_{t-1})}{\alpha\phi} \tag{15}$$

Considering as the steady state the point where the stock changes are null, equation (15) can be reduced to:

$$Y = \frac{FA}{\alpha} \tag{16}$$

It is possible to see the importance of the stock/flow norms, since income determination depends on such norm (α). The other two behavioral variables are the adjustment term (ϕ) of actual and desired levels of financial holdings and the proportion of the stock of inventories to the flow of sales (γ).

In chapter 6, the authors introduce the government, reaching one of the main conclusions of the book. Taken YG as the government income, its budget will be balanced when G = YG. The government income is composed of taxes, that are a θ proportion of the national income. Thus, the budget will be balanced when G = θY. A steady state where all the stocks are constant is given by:

$$Y = \frac{G}{\theta} \tag{17}$$

Which is called the fiscal stance. The introduction of the external sector provides another important conclusion. The steady state of an open economy is therefore given by:

$$YG - G = X - M = 0 \tag{18}$$

Rearranging:

Considering the imports as a proportion μ of the income and solving for Y gives:

$$Y = \frac{G + X}{\theta + \mu} \tag{19}$$

Which is the combination of the fiscal stance with the trade performance ratio (X/μ). This equation leads the authors to the conclusion that:

> In the long run, fiscal policy can only be used to sustain growth of real income and output in an open economy provided that foreign trade performance so permits. This is the most important practical conclusion of our book (GODLEY; CRIPPS, 1983, p. 283).

Finally, it is worth inserting a quote that expresses the spirit of Godley and Cripps (1983) work and supplies connections with the actual SFC literature:

> We do not ask the reader to believe that the way economies work can be discovered by deductive reasoning. We take the contrary view. The evolution of whole economies, like their political systems, is a highly contingent historical process. We do not believe that it is possible to establish precise behavioral relationships comparable with the natural laws of physical sciences by techniques of statistical inference. Few laws of economics will hold good across decades or between countries. On the other hand, we must exploit logic so far as we possibly can. Every purchase implies a sale; every money flow comes from somewhere and goes somewhere; only certain configurations of transactions are mutually compatible. The aim here is to show how logic can help to organize information in a way that enables us to learn as much from it as possible (GODLEY; CRIPPS, 1983, p. 44).

Coutts, Godley and Gugdin (1985) describe the consistent accounting of stocks and flows in nominal and in real terms. They show that real income must be defined to include changes in the values of financial assets and of liabilities due to inflation. They also examine the conditions that guarantee that no real changes take place with rising prices. These conditions are, first, that companies must increase their bank loans in line with inflation to

compensate the changes in the value of inventories; and, second, that the nominal interest rate on government bonds must increase to maintain the private sector real income. The government must increase its nominal borrowing to compensate for this rise.

More recently, some authors have turned their attention to the New Cambridge School and their hypotheses. Shaikh (2012) stresses the work of Ruggles and Ruggles (1992), who argue that households use their savings to finance durable goods purchases, and that firms use their retained earnings to purchase new plant and equipment. Shaikh (2012) argues that, these authors and the New Cambridge School, both reason in terms of flows and stocks, since, for Ruggles and Ruggles (1992), a flow of savings have a stock purpose (capital accumulation). Martin (2012) constructs a historical database for the UK economy and runs several econometric exercises. His results help to justify the New Cambridge method of aggregating the households and the firms in a consolidated private sector[7], but reject the hypothesis of a constant long run norm of wealth to disposable income.

In the early 1980s, the CEPG funding was cut off. Godley remained in Cambridge until his retirement in 1993, and then went on to the Levy Economics Institute of Bard College (PAPADIMITRIOU, 2012). There, he started to develop what today is the SFC method. This transition period is treated in the next section.

2.2.4 The Transition period

Godley and Zezza (1992) calibrate a model using Danish data. Some features of the recent SFC models are present. This can be seen in the first paragraph of the paper, where the authors affirm that their model includes, "[…] right from the start, a representation of stock (or balance sheet) variables which were consistently interrelated with flow variables" (GODLEY; ZEZZA, 1992, p. 140). It is also evident in their method of medium run simulation, in which they found a steady state of the model and then gave a shock to it, just like in the more recent SFC literature.

Godley (1993) argues that "[…] anti-neoclassical Keynesian economists, among whom I number Sylos Labini and Kaldor, notwithstanding their penetrating and suggestive insights, have not succeeded in creating an alternative paradigm" (p. 43). Godley's aim in his paper is to sketch an alternative macroeconomic theory, which he calls a "real stock-flow monetary model" (p. 43). He argues in favor of the accounting consistency, but do not show

7 This is done by empirical findings that the private sector surplus has "broad constancy of mean" (p. 88) and by the formal evidence of stationarity.

any accounting matrix. Some of the main features of his model, as pointed out by Godley himself (p. 58), are the evolution of the model through real time and the demonstration that the function of pricing is to distribute income.

Later, Godley (1996) presents a flow of funds matrix with four sectors (households, firms, government, and banks) and then sets the behavioral equations. On another work, Godley (1997) displays, for the first time, both the flow of funds and the balance sheet matrices. Four simulations are carried out: an increase in the level of inventories, an increase in government expenditures, the introduction of random expectations, and an increase in the interest rate. In Godley (1999a), he keeps analyzing the four sectors mentioned above. He finds that, after an increase in the interest rate on government's bonds, the income and consumption initially falls, but then recovers to a higher steady-state level. This happens because the increase in interest rates generates a higher income flow to the households.

Godley (1999b) extends the previous models to an open-economy setting. The model has two countries that, together, comprise a closed economy. Three different closures are provided, with increasing complexity: the first one has a fixed exchange rate and no international capital flows; the second introduces capital flows; the last one introduces the floating exchange rate.

One application of the above works is Godley (1999c), in which he analyzes the U.S. economy based on the three-balance approach. The starting point is the GDP identity:

$$GDP = C + I + G + B \tag{20}$$

Where C is consumption, I is investment, G is government expenditures, and B is the balance of trade. Next, the net transfers from sector i to sector j, T_{ij}, are computed. The sectors are households (H), business (B), government (G) and the rest of the world (W):

$$\begin{aligned} GDP - T_{hg} - T_{bg} + T_{wh} + T_{wb} \\ = C + I + \left(G - T_{hg} - T_{bg} + T_{gw}\right) + \left(B + T_{wh} + T_{wb} - T_{gw}\right) \end{aligned} \tag{21}$$

Note that the term in the first bracket in equation (22) is the definition of government deficit (GD). Note also that the term in the second bracket is the balance of payments of the current account (BP). Taking these two simplifications into account and defining Y_h as personal income and Y_b as business gross profits, we get:

$$\left(Y_h + T_{bh} + T_{wh} - T_{hg}\right) + \left(Y_b - T_{bg} - T_{bh}\right) = C + I + GD + BP \tag{22}$$

Now, the first bracket shows the personal disposable income (YD_h) and the second gives us the undistributed profits (Π). Splitting investment into residential investment (I_r) and nonresidential investment (I_k), and rearranging the terms, we get:

$$(YD_h - C - I_r) + (\Pi - I_k) = GD + BP \tag{23}$$

Note that $YD_h - C = S_h$ is households saving. So:

$$(S_h - I_r) + (\Pi - I_k) = GD + BP \quad (24)$$

This equation can be further simplified. The left hand side can be treated as the private sector saving minus the private sector investment. Formally:

$$\left(S_p - I\right) = GD + BP \quad (25)$$

This equation reveals that the private sector surplus is equal to the government deficit plus the current account surplus. Godley (1999c) points out that, at the time he was writing, the U.S. had an increasing private sector deficit, government surplus and external deficits. Based on this, he proposes seven unsustainable processes that were occurring in the North-American economy:

> (1) the fall in private saving into ever deeper negative territory, (2) the rise in the flow of net lending to the private sector, (3) the rise in the growth rate of the real money stock, (4) the rise in asset prices at a rate that far exceeds the growth of profits (or of GDP), (5) the rise in the budget surplus, (6) the rise in the current account deficit, (7) the increase in the United States' net foreign indebtedness relative to GDP (p. 2).

Similar discussions can be found in Eatwell and Taylor (1999), Godley and McCarthy (1998), Santos (2004), Godley and Izurieta (2004) and Godley et al. (2007). For a review of Godley's strategic analyzes, see Bibow (2012).

2.2.5 Related literature

Some authors outside the Yale and New Cambridge schools also worked with the interrelation between stocks and flows. Davis (1987a) gives a brief survey of stocks and flows modeling, such as the aggregation of investment to generate the stock of capital; equity emissions; wealth effects on consumption; and stocks of financial assets. He then analyzes empirical models of various British research groups, the CEPG among them, in order to evaluate their treatment of the issues mentioned above. His conclusion is that, "in general [...], the UK macro-economic models do not fully model either physical or financial asset stocks, or their effect in the economy" (DAVIS, 1987a, p. 128).

Davis (1987b) elaborates an empirical model based on the British data in order to study the interrelations between stocks and flows. From his results, the author affirms that

> We can conclude that the model suggests that stocks of assets, in particular the capital stock and financial assets, should have a central place in an explanation of the behavior of the British economy, notably of physical investment, inventory

> investment, consumption, employment and developments in financial markets (DAVIS, 1987b, p. 285).

Finally, Patterson and Stephenson (1988) derive formally the conditions for the consistency between stocks and flows variables. They also develop a simple model based on a balance sheet and on a flow of funds matrix.

2.3 THE CURRENT SFC LITERATURE: MAIN THEMES AND ISSUES

In order to organize the extensive literature, we divided the SFC works into five categories. This is not intended to be a perfect division: some articles can be classified under more than one label, and it is possible that the best place for a work could be a different category than the one chosen here. The classification has the sole proposal of organizing the more than one hundred works.

In the first category, the main concern is with fiscal policy. The second one deals with open-economy models and related topics, such as financial integration and global imbalances. The third section is focused on the financial side of the economy, and the reviewed works deal with financialisation, shadow banking, financial fragility, etc. The fourth section is devoted to theoretical issues, with subjects ranging from criticisms to the mainstream to the Monetary Circuit Theory. Finally, the fifth section is focused on methodological issues.

2.3.1 Fiscal Policy[8]

Fifteen works are comprised in this category. Fiscal policy, however, is not the only concern of the models presented here. Some of them also deal with monetary policy (LE HERON, 2008; 2012), criticizes the mainstream views (RICHARDSON, 2015) or deals with open-economy issues (GREENWOOD-NIMMO, 2014).

Godley and Lavoie (2007c) show the effectiveness of fiscal policy in reaching employment and inflation targets, providing a counterpoint to the New Consensus and its focus on monetary policy. The authors reach two conclusions that also go against the New Consensus View. The first one is that an economy "[…] with a real rate of interest net of taxes that exceeds the real growth rate will not necessarily generate explosive interest flows, even if the government makes no discretionary attempt to achieve primary budget surpluses"

8 A STF model for fiscal policy is proposed in chapter 3. Our main references are Godley and Lavoie (2007, cp. 11), Dafermos (2012) Le Heron (2012b), and Pedrosa and Silva (2016).

(GODLEY; LAVOIE, 2007c, p. 99). The second is that "[…] it cannot be assumed that a debtor country requires a trade surplus if interest payments on debt are not to explode" (GODLEY; LAVOIE, 2007c, p. 99).

The above model is extended by Martin (2008). This author explores formally three scenarios: one where the fiscal policy is active, whereas the monetary policy is passive; the second with a passive fiscal policy and an active monetary policy; the third one where the monetary policy is active and the fiscal policy is adjusted in order to stabilize the government debt. The result is that the first case generates stable results provided that the private sector behavior does not change; the second case is unstable, whereas the third is stable.

Pucci and Tinel (2010) follow these last two works. In their model, they disaggregate the households in two groups (low income, that spend all what they earn; and high income, that can save), and introduce a progressive taxation system. They analyze three fiscal policy regimes: first, automatic stabilizers, in which the government spending is used to reach full employment; second, autonomous government spending, insufficient to reach full employment; and last, the "Maastricht" case, in which the government spending is used to reach a desired level of the debt/GNP ratio. In all these cases, the government spending has a strong effect on GNP growth, but none on the debt/GDP ratio. Tax cuts, by their turn, have little effect on economic growth, but reduce the debt/GDP ratio. The authors conclude that "[…] in all cases, the debt/GDP ratio is an increasing function of the national income going to saving households; […] an increasing debt/GDP ratio can be interpreted as an expression of the rise in income inequality in the society" (PUCCI; TINEL, 2010, p. 18).

Le Heron (2008) constructs a model with the objective to reconcile the liquidity preference theory, which implies an endogenous interest rate, with the endogenous money supply view, which implies an exogenous interest rate. This reconciliation is done by introducing bank's liquidity preference. The author also introduces the borrower's and lender's risks from the Minskyan approach and the amortization of circulating capital. The model is then subjected to a contractionary monetary policy, analyzed in three different cases: neutral fiscal policy; weak counter-cyclical fiscal policy; strong counter-cyclical fiscal policy. Only under the last case the growth rate of national income returns to the previous steady-state level, a result not achieved by the other scenarios.

Le Heron (2012a) uses the previous model to analyze a fall in the state of confidence of the economy in conjunction with two policy mixes: monetary policy following a Taylor rule and public expenditures growing at the same rate as the national income; and monetary

policy focused only on inflation and a balanced budget. Under the first mix, the fall in the growth rate is less sharp and the recovery is more stable when compared to the second mix.

Le Heron (2012b) studies the question of the neutrality of fiscal policy. He argues that, from a post-keynesian perspective, "[…] neutrality must be understood in terms of general economic policy and not at the level of one policy" (LE HERON, 2012b, p. 284), so he analyzes both the fiscal and the monetary policy. The author constructs six closures to his model, each one corresponding to a "view" about the neutrality of monetary policy: independent central bank; fiscal deficit targeting rule; fiscal debt targeting rule; Wynne Godley's proposal, corresponding to the fiscal stance adequate to the steady state; Ricardian equivalence; and the treasury view. The system is then subject to two kinds of monetary policy shocks: a zero interest rate policy and a temporary higher interest rate. The Godley's proposal is the only one that is neutral in the sense that it "[…] corresponds nor to acceleration, neither to slowdown in growth" (LE HERON, 2012b, p. 284).

Le Heron (2014) uses the same model structure of the previous works, splitting the households between workers and capitalists, maintaining the remaining of the model untouched. He analyzes again a decrease in the state of confidence of the private agents, and then studies two alternative policy scenarios: a redistributive policy composed of reduction in taxes paid by the workers and an increase in the ones paid by the capitalists, and a reduction of wages. The author concludes that the former is a better way to get out of the crisis.

Chatelain (2009) explores the nexus between profits, investment, unemployment, and capacity utilization. Four regimes are considered, which are combinations of the demand driver (wage-led or profit-led) and the financial constraints on investment (with or without credit rationing). Then, the economy is subjected to a demand shock. The fiscal policy gives a faster recovery when compared to monetary policy.

Arestis and Sawyer (2012) use the Levy Institute model to analyze fiscal policy dynamic multipliers. They study increases in government purchases accompanied by three different types of finance: borrowing, taxes, and printing money. The first one has the higher GDP multiplier.

Kinsella and Aliti (2012) calibrate a model using Irish data. They show that a fiscal austerity shock leads to a reduction in economic activity, due to an increase in households wealth caused by precautionary savings and to a reduction in governments' liabilities.

Lobo and Oreiro (2012) elaborate a model that mimics some features of the Brazilian financial system. The most important one is the treatment of two kinds of government bonds: the LFTs and LTN. The first one is a post-fixed bond, whose interest rate is the same as the

target rate of the Central Bank. The second one is a pre-fixed bond with a higher interest rate. Some problems arise from this configuration, since one interest rate is used for two different objectives: the management of the public debt by the treasury and the financial system management by the monetary authority. The objective of the authors is to simulate the extinction of the LFTs. In the short run, the effect is more stable growth and a reduction in the inflation rate, but these results are reverted in the long run. A combination of policies with the extinction of the LFTs is then simulated. Three scenarios are analyzed: restrictive fiscal policy, restrictive monetary policy, and an income policy destined to restrict the households claims for higher wages. The last one is the most successful in controlling the inflation.

Ryoo and Skott (2013) examine an economy where the government uses the fiscal policy to maintain full employment, considering four instruments: government consumption, corporate income tax, wage income tax, and household property income tax. They find that adjustments in tax rates and public debt are required to maintain the full employment if the financial behavior of households and firms change. Moreover, the stability of the steady-growth solution for public debt depends on household's behavior and on the fiscal instrument utilized.

Greenwood-Nimmo (2014) is an extension of the model presented in chapter 12 of Godley and Lavoie (2007a). The author introduces two innovations, in order to analyze stabilization policies. The first one is the introduction of inflationary forces arising from a conflicting claims mechanism. The second one is an endogenous marginal propensity to consume out of disposable income and wealth, acting now as negative functions of the real interest rate. These two forces are the motivation for the existence of stabilization policies. Five closures of the model are developed: baseline case with no stabilization policy; inflation targeting pursued autonomously by each country; leader-follower interest rate setting; autonomous inflation targeting with counter-cyclical fiscal policy; and leader-follower interest rate setting with counter-cyclical fiscal policy. These five closures are subject to three shocks: a steep decrease in exports from country B; an increase in real wage pressures in country B; and an expansionary tax cut in country A. In terms of stabilization, the mixed approaches are better than the use of monetary policy alone.

Richardson (2015) tries to understand the common sense that there is "too much government debt". He first points out to some inconsistencies in mainstream works that advocate a crowding out effect of the government deficit, such as the absence of a surplus unit in the system that matches the deficit of the government. He then explores the claim that debt

must be repaid, pointing to some liabilities that have no maturity dates, such as base money and private equity.

Pedrosa and Silva (2015) explore the effects of private financial decisions on public deficit and debt, incorporating Minsky's lender's and borrower's risk theory, and Fisherian debt deflation. They find that a reduction in private spending decreases the private economic activity, reducing government tax revenues and inflation. They also conclude that "[…] the higher the interest rate sensitiveness to current economic activity, the greater the deflationary trend and, as a consequence, the bigger the increase in public debt ratio" (PEDROSA; SILVA, 2015, p. 20).

2.3.2 Open Economy Models

The models in this subsection deals with a range of issues that vary from methodological issues in the open-economy SFC modeling to the study of global imbalances. Another recurrent theme is financial integration, in models whose main concern is the European Union. As pointed above, our classification is not a perfect one, since some open-economy models, such as Greenwood-Nimmo (2014), were placed under another label. When this happens, we will avoid repetition.

Godley and Lavoie (2003) elaborate an extension of Godley (1999b), by modeling two economies, called "Japan" and "USA". They find that a positive shock in "Japan's" exports leads to a higher output, and current account budgetary surpluses. The central bank of "Japan" keeps its money stock constant, while altering its bonds holdings, increasing the "North-American" ones and reducing the "Japanese" bonds. Godley and Lavoie (2004) set a two-country model that together comprises the whole world. The simulations are compared with standard Mundell-Fleming results. In the case of flexible exchange rates, they find that both the fiscal and monetary policies are effective in their model. In the case of fixed exchange rates, the conclusion is that the current account surpluses can be indefinitely kept without a rise in the money supply, which is the expected result in the Mundell-Fleming model. Godley and Lavoie (2005-2006) present a simplified version of Godley and Lavoie (2003), using a fixed exchange rate regime to show how the sterilization, or compensation thesis, occurs endogenously. This happens when the current account surpluses, and the consequent increase in international reserves, do not cause increases in the monetary base, because the central bank reduces its bonds holdings.

Zhao (2006) elaborates a three-country model. The hypothetical economies are labeled China, USA, and Europe. The exchange rate between China and USA is fixed, whereas the others are floating. The simulations show that a shock in one country affects all three economies. For example, when the Chinese propensity to import North-American goods is increased, the immediate impact is a commercial deficit in China and a surplus in the USA. As the US income increases, it will demand more European bonds, impacting the exchange rate between the dollar and the euro. Lavoie and Zhao (2010) extend the previous model to simulate the impact of a diversification of Chinese foreign reserves from dollars to euros. In a first experiment, the diversification is done in one step, resulting in an appreciation of the euro against both the dollar and the RMB, the USA and China economies both improve their trade account and GDP. In a second experiment, the diversification is gradual. In this case, the appreciation of the euro is stronger. An interesting feature of the model is that it presents path dependence, since the "[…] transition path towards the diversification target influences its long-run equilibrium" (LAVOIE; ZHAO, 2010, p. 588).

Godley and Lavoie (2007b) also elaborate a three-country model intended to represent the USA and two Euro zone countries. They show that an increase in the propensity to import of one Euro zone country is followed by a higher government bonds emission, which will be acquired by the European Central Bank. This situation cannot last long if the central bank decides to stop the acquisitions. The authors consider two alternatives to this case. The first one is to make the interest rate endogenous, which will result in an explosive dynamics. The second alternative is to use fiscal policy as the adjusting variable, contracting the economic activity and bringing the economy back to a stable equilibrium. This exercise led the authors to the conclusion that there are two alternatives to the Euro zone: one is that the surplus countries run expansionary fiscal policies; the other is that European Union achieves more power to spend in order to distribute the fiscal resources between the surplus and deficit zones.

Lavoie and Daigle (2011) develop a model to study the effects of exchange rate expectations, along the lines of behavioral finance. They introduce two kinds of agents, the "conventionalists" and the chartists. The former base their expectation about the exchange rate on a conventional value of this rate, believing that the economy will move towards this value. The latter expects the latest change in the exchange rate to be repeated in the next period. The authors find that, the more chartists are in the economy, the more unstable it becomes.

The next seven papers deal with financial integration. Izurieta (2003) explores a dollarized economy which faces a negative shock on its exports. The two options left for the country have negative consequences. The first one is to maintain the fiscal stance, thus increasing the public deficit. This is accompanied by a trade deficit (it is a twin deficit situation). The debt service rises, and the government is obliged to raise the interest rates to make its bonds more attractive, leading to an unstable scenario. The second option is to reduce government spending in order to balance the budget. The current account became balanced too, but the economy enters into a recession. In conclusion, the author states that "If none of these is a sensible option, neither is dollarization" (IZURIETA , 2003, p. 160).

Khalil and Kinsella (2010) develop a model of two countries in order to study the different phases of economic integration. The economies start from an autarky situation, and then they open up to foreign trade. A second scenario is the settlement of free trade agreements, which is done in two ways: the elimination of import taxes and the equalization of interest rate on treasury bills. The third scenario is a monetary union. The results show that opening up for the trade in goods and assets have a positive effect on GDP, as well as the elimination of the import taxes. The equalization of interests' rates has effects only in the households' portfolio allocation. The monetary union has no significant effect on the real side of the economies.

Duwicquet and Mazier (2010) construct an open-economy model in order to analyze a monetary union and the stabilization effects of different levels of financial integration. They develop four closures: central bank financing current account imbalances; inclusion of foreign assets and intra-zone credit, with a lower households' propensity to hold equities; with a higher households' propensity to hold equities; and intra-zone credits and Treasury bills, but excluding equities and bonds. The system is subject to three kinds of shocks: an increase in the import propensity; a decrease in consumption; and a decrease in capital accumulation, all of them imposed on only one country. The authors conclude that "[…] intrazone credit seems to have no specific stabilization effects. Models with or without foreign financing inside the monetary union give the same results" (DUWICQUET; MAZIER, 2010, p. 362). They also conclude that "[…] the holding of foreign assets has a stabilizing role […]" (DUWICQUET; MAZIER, 2010, p. 362), since the holding of equities guarantees a flow of earnings even when the home economy is decreasing.

Duwicquet and Mazier (2012) use the same model to study credit rationing in a monetary union. Several scenarios are analyzed, such as credit rationing by banks to all the regions or just one of them, rationing credit to private sector or to the government. The

economy is subject to a loss of competitiveness, which is analyzed in a range of different levels of financial integration. In general, the higher the financial integration, the more stable are the responses to the shock.

Duwicquet, Mazier and Saadaoui (2013) use the very same model, now to analyze the exchange rate misalignments that occur in the Euro zone due to the economic heterogeneity of the countries. They introduce a federal budget in the model, with taxes collected from and transfers made to the countries in the monetary union. Five scenarios are analyzed, ranging from the absence of the federal budget to a strong fiscal transfer when the economy faces negative shocks. The authors conclude that these fiscal transfers have a stabilizing role.

Kinsella and Khalil (2012) analyze an investment shock followed by a debt deflation in a two country model, where one of the economies is supposed to be small. The shock is simulated in a monetary union and in a floating exchange rate regime. The contractionary effects are worst in the former.

Mazier and Valdecantos (2013) elaborate a four-country model, consisting of Spain (representing southern Europe countries), Germany (representing northern countries), the USA, and the rest of the world. They examine different scenarios to cope with exchange rate misalignments, such as the possible introduction of two Euros (one to the south and other to the north) or Germany leaving the Euro zone.

Finally, the next two works deal with global imbalances. Mazier and Aliti (2012) use a three-country model to analyze world economic imbalances, defined by them as the large US current account deficits, the Asian surpluses, and the intra-European imbalances. They run several closures, with different assumptions regarding the Chinese yuan exchange rate. A floating dollar-yuan exchange rate is capable of reducing the world imbalances, though this is an unrealistic outcome. A managed exchange rate, with the Chinese central bank intervening to reach a target of foreign reserves or of current account surplus, yield almost the same stabilizing effect as a floating exchange rate.

Valdecantos and Zezza (2015) construct a model to analyze global imbalances in the International Monetary System (IMS), the most important of them being the imbalance in the US external accounts: the country experiences trade deficits, but the dollar does not depreciate, because of foreign investors' demand. Their model has four "countries" (USA, China, the Euro zone, and the Rest of the World) and is subject to three different closures: the US dollar as the international currency, an increase in the importance of the SDR, and the introduction of the Bancor, along the lines proposed by Keynes over the Bretton Woods Conference. Only the last one eliminates the imbalances of the system.

2.3.3 Financial Sector

The models considered here share the concern to properly treat the financial sector. The contexts where this happens, however, are varied. Some of them deal explicitly with Minskyan ideas. Others tackle financialisation issues. The modeling of housing markets appears too, and with it the discussion of income inequality, bubbles, and crises.

Santos (2005) provides a critical discussion of the formal Minskyan literature (FML). He remarks that, due to the lack of a complete systematization, the FML models incur in hidden hypotheses that can lead to unintended consequences. For example, the assumption that the supply of bank loans depends only on the interest rate has the hidden hypotheses that (i) the stock/flow, stock/stock and flow/flow ratios (such as the reserves to loans ratio, the loans to profits ratio, etc.) can vary widely without altering banks behavior; or (ii) that the parameters assume values that impede these ratios to vary widely. The author concludes that the FML works deal with the financial markets in a less rigorous manner than the SFC ones.

Tymoigne (2006) also provides a formalization of Minskyan ideas. His model is constructed to enable the absence of cycles: given the other exogenous variables, a change in the state of expectations leads the economy to a permanent expansion (called optimistic state of expectations) or to a permanent recession (called pessimistic state of expectations). The only possible modification is given by a new expectation shock. The author analyzes shocks in the financing costs and in the maturity of debts in each state of expectations. The results lead the author to the conclusion that the best policy for central banks is not the administration of interest rate, but the creation of financial instruments that enables a better equalization of maturity terms in financial markets.

Ryoo (2010) analyzes long waves and short cycles in a financial fragility context. The former are given by the interaction between firms' debt dynamics (where financial fragility arises endogenously) and households' portfolio decisions. The short cycles are given by the dynamics of the effective demand and the labor market.

Bellofiore and Passarella (2010) analyze Minskyan insights through the lens of the circuit theory, asset inflation, and consumer credit. With these inputs and the help of a SFC accounting framework, they conclude that "the hypothesis of growing leverage ratio cannot ground a general theory of business cycle, describing rather the particular case of a debt-financed investment-led boom" (p. 6). The accounting framework shows the interdependence of the sectors, thus making clear that the leverage ratio of firms depends, among other things, on the decisions of households (their portfolio choice alters the price of equities) and banks

(the interest rates that they charge on loans). With asset inflation, firms will replace bank borrowing with equity issues, reducing its leverage ratio. The same asset inflation makes households able to get more credit, since their collateral increases, fueling the economy with more consumption. In the end, the banking sector has changed its focus from investment financing to households consumption credit.

Passarella (2012) extends the previous model and shows that the degree of fragility of firms' balance sheets is reduced with an increase in the autonomous consumption of households and/or with rising equity prices. According to the author, this helps explaining the current crisis, since in the "early post-2003 upswing, as well as during the boom of the 1990s, the counter-tendencies to an increase in the leverage ratio for the non-financial business sector have been stronger than the tendency to an increase in that ratio" (p. 581). The counter-tendencies are precisely the increase in households' consumption and the inflation in assets prices.

Carvezasi (2013) explores the "missing macro link" in Minsky's Financial Instability Hypothesis (FIH). This missing link is based on a critique raised by Lavoie and Seccareccia (2001), whose core claim is that the investment expenditures of firms are a source of income for the ones producing capital goods. Hence, the overall level of indebtedness of the firms remains unchanged, since the debt of some became the income of others. Minsky's argument is that, the higher the level of investment, the more firms will need external finance. Therefore, more investment generates more debt. Using SFC accounting, Carvezasi shows that "debt-financed investments do not lead to a worsening in the financial position of the firm sector only assuming that firms do not distribute profits or, if they do, that households have a saving propensity equal to zero" (p. 21-22).

Ryoo (2013) analyzes the interactions between banks' and firms' profitability and financial instability, in a model with long waves given by Minsky's financial instability hypothesis (FIH) and short waves given by Harrodian business cycles. There are self-reinforcing mechanisms between firms' indebtedness and banks' leverage, since the former increases the latter, which increases banks' profitability, leading to further credit expansions. When the debt burden gets so high that it reduces the aggregate demand, the cycle goes the other way around, with a reduction in indebtedness decreasing banks' leverage and profitability.

Nikolaidi (2014a) focuses on the desired margins of safety of firms and banks in order to analyze the relationship between leverage and investment. She finds that the two variables

can move both in the same and in the opposite direction, without the need for a regime switch from a debt-burdened to a debt-led one.

The next five papers deals with financialisation. Lavoie (2008) uses the model presented in chapter 11 of Godley and Lavoie (2007a) to analyze the impact of changes in variables related to financialisation. Regarding the behavior of firms, two parameters are submitted to shocks: an increase in the target proportion of investment to be financed by internal funds and an increase in the proportion of profits distributed as dividends. The parameters of households are changed as well. In the first place, there is an increase in the desire to hold equities, which is compensated by two alternative ways: by a reduction in the money deposits and by a reduction in the holdings of government bonds. Lastly, an increase in the ratio of new loans to personal income is studied. An interesting feature of all the simulations is the interdependence of all the sectors. For example, in the case of the increase in the distributed dividends, the liquidity ratio and the capital adequacy ratio of banks are modified, which results in changes in the deposit and lending rates.

Skott and Ryoo (2008) analyze financialisation considering a number of alternative assumptions. The consumption function can be a function of distributed income and capital gains; alternatively, the portfolio composition can be inserted in the function. The accumulation function can assume two specifications: a Harrodian one, in which the coveted excess capital capacity is where firms want it to be, and the accumulation will be increased or decreased based on deviations from this desired level; or it can be Kaleckian, where the capacity utilization becomes endogenous, and the profit share is treated as exogenous. The labor market receives two specifications as well: it can be a mature economy that is labor-constrained; or it can be a dual economy, with unlimited supplies of labor. They conclude that the

> […] qualitative effects of 'financialisation' are insensitive to the precise specification of household saving behavior but depend critically on the labor market assumptions (labor-constrained versus dual) and the specification of the investment function (Harrodian versus Kaleckian) (SKOTT; RYOO, 2008, p. 827).

Clévenot, Guy and Mazier (2009) elaborate a simple SFC model to analyze financialisation issues, with a special focus on the balance sheet of firms, which can finance their investment with retained profits, equity issues, and loans. They explore two different closures, one where the loans are the residual component of the balance sheet, and another where the equity issues play this role. Lastly, they estimate both closures using data from France over the period 1978-2007. They find that equity issuing responds positively to the

real rate of interest, to the economic rate of profit, to the equity relative price and to the level of indebtedness, and responds negatively to the rate of return for equities. The loan demand responds positively to the rate of accumulation and to the rate of return on equities, and negatively to the real interest rate and to the economic rate of profit.

Van Treeck (2009) explores one feature of financialisation: the increase in shareholder orientation. The households in his model are split into two categories, workers and rentiers, and just the latter ones save. The author conducts two experiments: a reduction in the proportion of new equity issues and an increase in the dividend payout ratio[9]. The simulations are run for different scenarios, where the parameters related to wealth and debt effects on investment and consumption range from low to high values. Lastly, the author simplifies some equations of the model to explore an analytical solution.

Le Heron (2010) tries to understand why some European countries have suffered negative impacts from the subprime crisis without any specific reason, such as absence of a bubble in housing markets, banks with low levels of engagement in the US speculative markets, and no wealth effects on households. His hypothesis is that one of the main channels of diffusion of the crisis is the "confidence channel", which is defined following the psychological laws put forth by Keynes: the marginal efficiency of capital (which affects entrepreneurs), the marginal propensity to consume (affecting the households) and the liquidity preference (generalized by the author to affect the banking sector). The confidence parameters are calibrated using French data, and the model "perfectly simulates the reality of the French production crisis" (LE HERON, 2010, p. 376).

Now we turn to works that model the housing market and/or deal with income inequality and its consequences to housing and financial markets. Zezza (2008) develops a model that integrates the discussion of income inequality and housing bubbles. In his model, the households are split between "capitalists" – who receives wages, distributed profits, interest income from bank deposits and government bills, and rents – and "other households" – whose only incomes are wages and interest on bank deposits. The consumption function of the latter has an "imitation effect", in the sense that they plan their consumption in relation to the standard of living of the "capitalists". The capitalists demand new homes based on portfolio management, whereas the "other households" demand new homes based on the

9 The same experiments are conducted in Lavoie (2008), but the results are not directly comparable due to the differences in the specification of the model. In Lavoie's work, the households were not split, and there is a central bank, which does not appear in Van Treeck's model.

growth of population and income. A bubble can arise in the housing market if the expectations of price increases are higher than actual price increases.

Fontana and Godin (2013) model an economy where commercial banks convert mortgage loans into tradable securities (securitization). Their assumed financial system includes commercial banks and two kinds of investment banks. Moreover, households are split up between workers and capitalists, as is common in models of the housing market.

Nikolaidi (2014b) develops a more complex model, in which households are split into three groups: one that takes out mortgages from commercial banks to finance their purchase of houses, another one that takes only consumer loans, and a group of investor households. The economy consists of institutional investors and SPVs (Special Purpose Vehicles) underwriters. The author finds that a rise in securitization practices, combined with a declining wage-income share (two stylized facts of the recent crisis), increase the instability of the system.

Beckta (2015) introduces a markup in the housing pricing by the firm sector. This markup is augmented when the realized inventories-to-sales ratio lies below the targeted ratio, and reduced in the opposite case. Higher housing prices increase their returns, which induces a higher demand for houses by households. The construction of houses grows until a reversion in the tendencies in inventories-to-sales ratio happens, and then markup, prices, and demand decrease.

Two important questions that appear in the above papers are the rising inequality and the emulation effects of consumption, in the sense that households form their desired consumption level *vis à vis* its social reference group, which generally is upward-looking. Belabed, Theobald and van Treeck (2013) develop a three-country model to analyze these effects and the impact of rising inequality on the current account. The values of the parameters are calibrated to correspond to data from the USA, Germany, and China. An innovative feature of the model is the split of the households sector into deciles, making it possible the study of the emulation effect. They find that a rise in income inequality generates debt-financed consumption, which in turn results in current account deficits.

Dafermos and Papatheodorou (2015) model the links between functional and personal income distribution. The households in their model are split into five categories: low-skilled and high-skilled workers that can be employed or unemployed and entrepreneur-owners. They find that a rise in low-skilled workers' wage share reduces inequality, whereas a rise in the dividend payout ratio of firms causes the opposite outcome.

Jackson and Victor (2016) explore the hypothesis that lower growth rates tend to rise inequality, a point made recently by Piketty in his Capital in the 21st Century best-selling book. The authors show that, under certain conditions, the hypothesis holds true, but "[…] that there is absolutely no inevitability at all that a declining growth rate leads to explosive (or even increasing) levels of inequality" (JACKSON; VICTOR, 2016, p. 215). In the model, inequality depends positively on the elasticity of the substitution between labor and capital, and negatively on the workers' savings rate and on the retained profit ratio of the firms.

Lainá (2015) analyzes an economy with a full-reserve banking system. He finds that money creation through government spending leads to a temporary increase in GDP and to a permanent reduction in consolidated government debt.

Desiderio and Chen (2012) formulate a simple model in order to develop a "pure theory of debt" (p. 12). Their system is made up of interconnected agents that produce and sell to each other. In a first experiment, no debt is allowed, and they conclude that the equilibrium value of personal wealth for a given agent is an increasing function of the propensity to consume of his/her trade partners and a decreasing function of his/her own propensity to consume. The debt is introduced in the model only by the emission of securities, since there are no commercial banks and the stock of money is supposed to be fixed. They conclude that the effect of the introduction of debt is a redistribution of wealth in favor of the lenders. If the marginal propensity to spend of borrowers is larger than that of lenders, then the income is reduced.

Lastly, there are two papers that attempt to model the shadow banking system. Pilkington (2008) is a first attempt to insert the shadow banking system into a SFC model. His effort is preliminary, since he only presents the accounting framework, without introducing behavioral equations or generating experiments. Fischer and Bernardo (2014) model the political economy behind shadow banking. One interesting feature of their model is the influence that the business sector exerts upon the government. The higher the workers' clout, the higher the business pressure to government scales back its spending.

2.3.4 Theoretical Issues

A large number of works deal with theoretical issues, ranging from critiques of the mainstream to Schumpeterian creative destruction.

Godley and Shaikh (2002) explore the standard neoclassical model, with four markets (labor, commodities, bonds, and money), firms that maximize profits, households that

maximize utility, workers' remuneration determined by marginal productivity, and firms distributing all their profits to households. This last assumption is crucial to the argument, since there is only one financial instrument that can enable this distribution: bonds. The flow of interest payments of these bonds is not, however, necessarily equal to the profits. The authors solve this problem by distinguishing between households' income (wages and interest payments) and value added (wages and profits). It seems to be a simple distinction, but it has severe consequences. The most striking one is the dichotomy between real and nominal variables, which no longer applies. The mechanism behind the paradox is the following: a change in the price level changes the real value of the bonds, and hence modifies the real interest payments. Since these payments form part of the households' income, the modification induces a change in consumption. The conclusion is that, if stocks and flows are consistently modeled in a standard neoclassical model, nominal changes (price level) affect real variables (consumption).

Taylor (2004b) criticizes open-economy portfolio balance models, as well as the Mundell-Fleming approach. According to him, both models consist of three independent equations which determine three variables: the domestic and foreign interest rates and the exchange rate. However, if the accounting is right, in the sense that "economic actors satisfy standard balance sheet and portfolio allocation restrictions" (TAYLOR, 2004b, p. 205), there will be only two independent equations, because the determination of the exchange rate is beyond the models' reach. The implication of this flaw is twofold: first, the dichotomy between fixed reserves/floating rate and floating reserves/fixed rate does not apply; second, econometric models based on these models are bound to fail. The author proposes an alternative that corrects these problems, based on a two-country IS-LM model, constructed along the lines of SFC models.

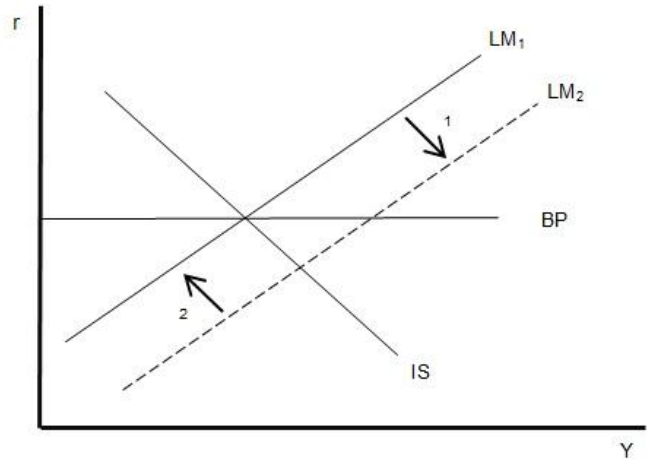
Bezemer (2010), in explaining the financial crisis and the fact that, seemingly, "nobody saw this coming", argues in favor of the so called "accounting approach" to economic analysis, which has been used, among others, by the Levy Economics Institute, Dean Baker, Michael Hudson, Steve Keen, etc. The common feature of the models of these analysts is the use of flow-of-funds concepts and the modeling of the financial sector, features absent of the mainstream DSGE models.

Bezemer (2011) discusses the claim that the complex systems theory, and Agent-Based Modeling (ABM) in particular, is a good substitute for the DSGE models. The author arguments that ABM is a method, and the problem with DSGE is theoretical, since "the failure of DSGE-style macroeconomics was a failure to meaningfully include finance in its

models, not just a failure to model heterogeneous interacting agents" (BEZEMER, 2011, p. 2). Using a simple SFC model, he shows that complex behavioral features, such as nonlinearities and sudden transitions, arise endogenously from the economy's financial structure, without the need to use microfoundations.

Santos and Silva (2010) use the three-balances approach to criticize some conclusions reached by the Mundell-Fleming textbook model. A standard conclusion of the Mundell-Fleming model is that, with fixed exchange rates and perfect capital mobility, monetary policy is inefficient, in the sense that the economy will return to its initial income and interest rate levels, represented in Figure 2 below. The expansionary monetary policy shifts the LM curve from LM1 to LM2. This causes a decline in the interest rate, which is followed by a capital flight from the economy. The resulting deficit in the balance of payments is matched by a reduction in the foreign reserves of the central bank. The result is a reduction of the monetary base, causing the LM curve to return to its initial position. Thus, monetary policy is deemed inefficient. The only change occurs in the Central Bank portfolio, where foreign reserves are replaced by domestic money[10].

Figure 2 – Monetary policy in a Mundell-Fleming model with fixed exchange rates and perfect capital mobility



Source: elaborated by the author

However, a closer look at the financial balances of the other sectors shows that this is not the only effect of the monetary expansion. The monetary expansion leads to a temporary increase in production and income (when LM1 shifts to LM2). This higher income generates higher imports, which reduces the foreign trade balance. And, since government expenditures

[10] This discussion is developed more fully in Kappes and Milan (2016).

are kept constant, the increase in income elevates the taxes receipt, which reduces the government deficit.

Looking at equation (25), it is possible to see that the decrease in GD and in BP must be matched by a reduction in the financial balance of either households or firms, or both. It is worth noticing that it is reasonable to suppose that the households' income have increased, whereas it is also reasonable to assume that the lower interest rate increases firms' investment. Thus, the decrease in GD and BP and the increase in households' financial balances are matched by a reduction in the firms' financial balances. As Santos and Silva (2010) argue, "the explanation for the fall in firms' financial balance is pretty simple: the decrease in trade balance reduces firms' profits" (p. 13).

It is natural to ask if these outcomes have any implication to the model. The answer is yes. Households' asset holdings have increased, government debt has been reduced, the international investment position has worsened, and firms' indebtedness increased. In the words of Santos and Silva (2010):

> Those changes in stocks of financial assets and liabilities will implicate changes in internal and international interest flows in the next short run, changing the configuration of the system. Therefore, each short period carries in itself the seeds of the next (and inevitably different) short period (SANTOS; SILVA, 2010, p. 14).

Another recurrent theoretical theme in the SFC literature is the Monetary Circuit Theory (MCT). Lavoie (2003) illustrates the MCT of Augusto Graziani with the help of the accounting matrices of the SFC approach. Godley (2004) elaborates a simple model in order to show the similarities of the SFC approach and Graziani's work. Accoce and Mouakil (2007) point out that the MCT has three limitations: lack of formalism, a basic analysis of the banking system, and the omission of stocks. They claim that the SFC approach can overcome these problems, thus providing a powerful tool for the MCT.

Zezza (2012) shows that the profit paradox, common in the MCT, disappears when the bankers' interest receipts are treated consistently, being a source of demand either for goods or for financial assets. Passarella (2014) aims to update the MCT in order to deal with financialisation. According to him, the usual view of the theory that the money enters the system through banks' loans to firms does not hold the facts anymore, since it is a stylized fact that firms became a surplus sector, whereas the households are those who take loans. By means of an SFC approach, the author elaborates an updated monetary circuit.

Sawyer and Passarella (2015) develop a "stock-flow coherent rereading of the TMC" (p. 7) in order to deal with financialisation. The salient features of their model are a split of

the financial sector into commercial banks and other financial institutions, and the securitization of the loans granted to households, which are traded in the financial market. Botta, Carvezasi and Tori (2015) use the SFC method and the MCT to analyze the shadow banking system and the assets that belong to it, such as REPOs (Repurchase Agreements), ABSs (Asset-Backed Securities), CMOs (Collateralized Mortgage Obligations) and CDSs (Credit Default Swaps).

Now we turn our attention to works that deal with a multitude of other theoretical aspects. Lavoie and Godley (2001-2002) elaborate a Kaleckian growth model of a closed economy without government. The authors present a long discussion about investment functions, and opt for one in which investment depends on four variables: the cash flow/capital ratio, the interest/capital ratio, Tobin's q, and the rate of capacity utilization. In the simulations, the authors find two stable regimes: one in which the investment function is less sensible to Tobin's q than to the capacity utilization, called normal regime, and another one in which the opposite happens, called puzzling regime. It receives its denomination because it presents counter-intuitive results when subjected to some shocks, like, for example, the fact that the accumulation ratio became higher after an increase in the interest rate.

Zezza and Santos (2004) extend the model discussed in Lavoie and Godley (2001-2002) by adding a government sector and a central bank. They find that "[…] some of their major results, such as the validity of the paradox of savings, and the endogeneity of money, were shown to hold under a larger set of possible model parameters" (p. 205). Zezza and Santos (2006) analyze the relationships between the distribution of income and growth. The paradoxes of thrift and costs hold in their model. Increases in the lending rate and in the distributed profits have mixed effects, "[…] and ultimately depend on the choice of parameters for the investment function" (ZEZZA; SANTOS, 2006, p. 118).

Santos (2006) argues that "[…] the SFC approach can be seen as a natural 'outcome' of the path taken by Keynesian macroeconomic thought in the 1960s and 1970s" (p. 542). He sets an accounting structure and makes four different closures, representing the views of Paul Davidson, Wynne Godley, Hyman Minsky, and James Tobin.

Kim (2006) presents a Kaleckian model of two productive sectors (consumption and investment goods). Among the distinct features of his model are: the determination of profits and wage shares depends on the bargaining power of capitalists and workers, as well as on the sales expectation and inflation; the technical progress depends on the growth rate (the Kaldor-Verdoorn law) and on the wages (that is, the technical progress is sensible to income distribution).

Le Heron and Mouakil (2008) affirm that the Kaldorian concept of endogenous money is widely accepted among post-keynesians for his description of the functioning of central banks. The Kaldorians adopt the same view when they theorize about private banks, implying that they are "accommodationists", in the sense that they set the interest rate on loans, apply a mark-up to it, and then provides loans to all creditworthy borrowers. The objective of the authors is to maintain the Kaldorian view of the functioning of central banks while opening the black box of the private banks along Minskyan lines, generalizing the Keynes's theory of liquidity preference to private banks. They also use the Minskyan concepts of borrower's and lender's risk, and model the banks' portfolio decision along Tobinesque lines.

Pérez-Caldentey (2009) develops an SFC model following the tradition of balance-of-payments constrained growth, and applies it to the Caribbean Community. The model is able to explain the main stylized facts of the region, such as stagnant growth rates, and widening current account and fiscal deficits.

Dallery and Van Treeck (2011) enter the debate about the capacity utilization rate. They argue that the equality between actual and standard rates of utilization may not necessarily be reached, because different groups inside and outside the firms have different objectives. Two kinds of conflict within the firms are modeled: one between managers' growth target and shareholders profitability target; and another involving capitalists and workers in the income's distribution between profits and wages. They find two possible regimes for the model: one called 'Fordism' and another called 'financialisation'. The regime that will prevail depend on which social class is dominant. In the former, managers and workers were the leading groups, whereas the shareholders dominate in the latter.

Silva and Santos (2011) explore the connections between the SFC approach and Keynes' views exposed in the General Theory and in the Tract on Monetary Reform. They also argue that "SFC models are useful tools to economists (especially post-Keynesians) who are not convinced by neoclassical (or classical) parables about the long run and, at the same time, do not accept to limit themselves to short-period analyses" (SILVA; SANTOS, 2011, p. 121).

Dafermos (2012) integrates the liquidity preference and perceived uncertainty into the decisions of households, firms, and banks. In the case of households, the liquidity preference is expressed on their portfolio choice. In the case of firms, it is expressed on their willingness to invest in capital stock, and on the holdings of high-powered money. Finally, banks express their liquidity preference with credit rationing. A rise in the perceived risk reduces the loans

demanded by households and firms, reducing consumption and investment, and thus output and employment.

Caiani, Godin and Lucarelli (2014) explore the insights of Schumpeter's creative destruction hypothesis. The model starts from a stationary steady state composed by four sectors: consumption goods producers, traditional capital goods producers, households, and banks. The latter provide the loans necessary to innovators enter the system. Their entrance causes an increase in the traditional capital goods, which increases the profits of its producers. However, in the subsequent periods, the innovative capital goods enter in the market, reducing the price level and leading to the bankruptcy of the traditional capital goods producers.

Van Suntum (2014) develops a model to compare the theories of interest rate determination of Böhm-Bawerk and Keynes. His model has a lot of mainstream features, such as the presence of overlapping generations and representative individuals that maximize a utility function.

Jackson and Victor (2015) explore the claim that capitalism has an inherent "growth imperative" caused by the charging of interest on debt, an assertion commonly found in the de-growth literature. They develop a model that is differentiated for a stationary steady state, thus contradicting the growth imperative hypothesis. Simulations using the model demonstrate that it is possible to move from a growth path to a stationary state without a collapse of the system.

Some authors have used the SFC approach to analyze Ecological Economics issues. Godin (2013) compares an Employment of Last Resort (ELR) policy with a simple increase in government spending. The ELR policy is directed to jobs that save energy. The model consists of workers, capitalists, government, banks, and firms that produce capital goods, consumption goods, and energy. The GDP increases more in the simple fiscal policy, but the ELR scheme guarantees a higher worker's income and a lower energy consumption.

Dafermos, Galanis and Nikolaidi (2014) develop an Ecological Stock-Flow-Fund (ESFF) model, which is a unification of the SFC method with physical stocks and flows analyses from the field of Ecological Economics, respecting the accounting principles and the laws of thermodynamics. Their accounting system is composed by four matrices: the physical input-output fund matrix; the physical stock matrix; the transactions flow matrix; and the balance sheet matrix. An interesting feature of the model is the presence of natural resources, greenhouse gas emissions, green investment, and the modeling of intermediate outputs, such as energy.

Naqvi (2015) seeks to solve the trilemma of achieving high growth, reduced inequality, and environmental sustainability. Therefore, he models an economy composed by capitalists, workers, and firms that use energy as an input and generate greenhouse gases as a byproduct. Five policy scenarios are evaluated: lower consumption; introduction of a capital stock damage function; carbon taxes; higher shares of renewable energy; and technological shocks to productivity. The latter policy is the only one that can solve the trilemma.

Lastly, we review the works that use the three-balances approach. Zezza (2009) shows that five of the seven unsustainable processes outlined by Godley (1999c) were still at work in the 2000s. The processes that stopped are the rise in the growth rate of the money stock and the rise in the budget surplus. The author, then, explores formally the Levy Institute macroeconometric model, stressing its connections with the New Cambridge Hypothesis. Lastly, he points to research groups that use the methodology of the three financial balances put forth by the Levy Institute.

Brecht et al (2012) apply the three-balances approach to the Eurozone's Stability Programmes that followed the crisis. They found that the programmes are based on unrealistic hypotheses about the Eurozone current account balance and the intra-zone balances.

2.3.5 Methodological Issues[11]

Lastly, there are authors that deal with methodological issues. The questions here range from parameters estimation to microfoundations, with a special look at the agent-based modeling technique.

Godley and Lavoie (2007a) is a textbook of SFC, discussing from the history of this approach to modeling issues. It starts with very simple models, displaying three sectors and only one asset, as in chapter 3, and gradually evolves to more complex models, such as the one of chapter 11, with five sectors and six assets[12].

Godin, Aliti and Kinsella (2012) develop a method to estimate the flows and the parameters of an SFC model. For n flow variables, m stock variables, p parameters and k constrains on these parameters, the method is composed of three steps: (i) given a model that shows consistency between stocks and flows, (ii) "Obtain the n flows as a function of the p − k unknown parameters and the m observed stock values by solving analytically the model" (p.

11 In chapter two, we will develop a methodological analysis regarding the modeling of expectations in SFC models.

12 An early presentation of their chapter 10 can be found in Lavoie and Godley (2006). Taylor (2008) is a review of the book.

4) and (iii) for a given variable X, minimize the absolute value between observed X and predicted X. The problem, then, is one of global minimization in p – k dimensions.

Michell and Toporowski (2012) show that different speculative financial positions can arise on the same balance sheet structures due to intra-sectoral assets purchases. Kakarot-Handtke (2012) argues that SFC models should free themselves from "ill-founded notions like GDP and other artifacts of the equilibrium approach" (p. 2). He formally demonstrates that the implicit notion in the GDP accounting that valued output equals factor income does not hold, and claims that more rigorous accounting proofs should be considered in the development of the model.

Álvarez and Ehnts (2015) introduce graph theory as a method in order to visualizing different "closures" of an SFC model, "closure" here defined as before as the choice of which variables are to be set as dependent and which ones as independent. One advantage of this method is that all the possible closures of a model can be explicitly represented. Another one is that a regime change, in the sense that some dependent variables turn independent and vice-versa, can be modeled.

Lysandrou (2015) argues that a useful microfoundation for SFC is Marx's concept of Commodity as developed in Capital. Caiani et al. (2016) combine the SFC approach with agent-based modeling. They develop a benchmark model that is "simple and flexible" and "can be easily employed, adapted, and changed" (p. 380). The authors also propose a methodology to calibrate the initial stock and flow variables. Finally, they compare their results with some stylized facts.

Lastly, there are some works that integrate the SFC approach with the agent-based modeling technique. Kinsella, Greiff and Nell (2010) develop an Agent-Based Stock-Flow Consistent (AB-SFC) model with education and technological change. The workers/households have innate abilities which can increase with learning by doing and spillover effects, and invest in education. Firms can invest to increase productive capacity or in innovations, which the former considered riskless, and the latter risky. Banks provide loans for workers to invest in education and firms invest in innovation. The local interactions of decentralized agents give rise, endogenously, to inequality.

Seppecher (2012) elaborates a simple model with households, firms, and one bank. He finds a long-run stability in the wage and profit shares, and then conducts some experiments in the labor market. When the flexibility of wages is increased, the wages decrease, the demand declines, and the economy goes into recession. Alternatively, when a minimum wage is introduced, the recession stops and the economy start to recover.

2.4 CONCLUDING REMARKS

This chapter provided an extensive discussion of the SFC approach. It started with a conceptual discussion intended to provide the reader an elementary knowledge about the basic structure of the SFC models. Next, it discussed the origins of the approach. The economic thinking about stocks and flows is not a new issue: it can be found in the writings of classical economists such as William Petty and Adam Smith. Neither the modeling of stock/flows relations is an innovation of SFC authors solely, since some authors have worked on these issues in the 1960s. The current innovative feature is the comprehensive modeling of the stocks and flows between all sectors and the economy as a whole.

Two schools laid the roots for the current SFC approach: the Yale school, led by James Tobin, and the New Cambridge School, led by Wynne Godley. The second section of this chapter presented the main works of each school, as well as the transition period of the 1990s in which the two schools have disappeared and the method was carried on almost exclusively at the Levy Institute. The third section provided a revision of the current SFC models and themes. The potential of the method to tackle different aspects of the economic thought is evidenced by the range of topics studied.

3 A METHODOLOGICAL ISSUE: MODELING HOUSEHOLD ADAPTIVE EXPECTATIONS IN STOCK-FLOW CONSISTENT MODELS

As shown in the previous chapter, SFC models are made up of a matrix with the economy' stocks, a second matrix presenting the transaction flows, and finally many behavioral equations used to simulate how the economy evolves after a few shocks. Most of the time, these equations are modeled in an ad hoc manner. For instance, in the behavioral equations for households, it is necessary to specify how expectations regarding future income flows are formed in the consumption function. As also presented in the previous chapter, there is a SFC literature addressing methological problems associated with the approach. This chapter addresses a methodological issue regarding how expectations are modeled in the behavioral equations. Many SFC models (e. g. Zezza, 2008; Le Heron, 2011; Caiani et al., 2016; Burguess et al., 2016) assume an adaptive expectations form, avoiding, albeit not always consciously, the hyperrationality problem and other disadvantages associated with the rational expectation hypothesis (SCHUMAN, 1997). Nonetheless, there is no single accepted rule or guideline for modeling adaptive expectations in the consumption functions of the SFC models. In the behavioral equations there are many different formulations, sometimes with only slightly modifications.

At first, this should not cause many meaningful problems, since it is only the expectational element of the consumption function in a universe containing tens of or dozens equations. That is, different specifications regarding expected income could apparently lead at most to slightly discrepant results, not to distinct structural dynamics. Yet, as it is shown below, the macroeconomic implications of only seemingly different specifications are substantially large. At the same time, the expectation specifications analyzed are not robust to the importance of the forecasting errors, based on such modeling exercises, for the very process of expectations formation.

In this chapter, we address the issue of expectations considering a few standard formulations of the role of expected income in the consumption patterns of households. Therefore, the aim of this chapter is to show how different specifications of adaptive expectations in the consumption functions can lead to significantly discrepant

macroeconomic dynamics in the simulations, with major consequences to the evolution of both stocks and flows. Moreover, there is a formulation that appears to be invariant to the importance of the forecasting errors based on such expectations specifications in most of the settings considered, being the model recommended for specifying expectations in SFC models.

The chapter is organized as follows. In the next section, we analyze different formulations for expectations in consumption functions and discuss the question regarding how to model expectations in the SFC models. The third section shows the numerical calculations based on different specifications, pointing out the discrepancies derived and how the results based on these specifications diverge depending upon the importance of the forecasting error term in the expectational rule. It also presents criteria for selecting among the different expectations formation rules. The final section concludes.

3.1 MODELING EXPECTATIONS IN SFC MODELS

There is no agreement in the SFC modeling literature regarding a wide number of issues involved in the specification of behavioral equations. For example, it is common to define the households' consumption function as dependent on the personal disposable income. Some authors use its current value (e. g. Godley and Lavoie, 2005-6; Duwicquet and Mazier, 2010), others use its lagged value (e. g. Dafermos, 2012), whereas some other authors use its expected value (e. g. Fontana and Godin, 2013; Zezza, 2008; Caiani et al., 2016; Le Heron and Mouakil, 2008). The use of expectations in the consumption reaction function is what concern this chapter. Usually, the expectation function is of the adaptive type, with a forecasting error term included. Its specification, however, varies considerably, both in terms of the error term and of the weight of this error in the expectation adjustment process. Hereby three models of adaptive expectations function are considered, and it is shown that their different specifications have consequences for the long-run system dynamics.

The following equation is used by Caiani et al. (2016) [16]:

16 This model is an Agent-Based one. The validity of a comparison between equations that describe an aggregate behavior and one that describes the behavior of a single agent can be questioned.

$$x_t^e = x_{t-1}^e + \varepsilon(x_{t-1} - x_{t-1}^e) \quad (26)$$

Where x is any variable of interest. The superscript e represents expected values, and the subscripts are the time periods.

Another specification for adaptive expectations is used by Zezza (2008), Fontana and Godin (2013), and Burgess et al. (2016). It should be noted that the latter is a paper elaborated for the Bank of England, posing the question about the consequences for monetary policy of different SFC specifications:

$$x_t^e = x_{t-1} + \varepsilon(x_{t-1}^e - x_{t-1}) \quad (27)$$

A third specification is employed by Le Heron and Mouakil (2008), Le Heron (2011), among others:

$$x_t^e = x_{t-1} + \varepsilon(x_{t-1} - x_{t-1}^e) \quad (28)$$

It should be noticed that the differences between the equations are tenuous. The first term in equation (26) is the expected value of the variable in the last period, whereas the other two equations use the actual lagged value. Inside the parentheses, the forecasting error or adjustment term, the difference lies in the order of the variables: equations (26) and (28) subtracts the expected value from the actual lagged value, while equation (27) does the opposite. These differences may seem harmless, but they give rise to a cumulative process of errors that, in a SFC model, might affect the steady state values reached after a stock in the system. A simulation was carried out to show these differences.

3.2 SIMULATING THE MACROECONOMIC IMPACTS OF DIFFERENT SPECIFICATIONS

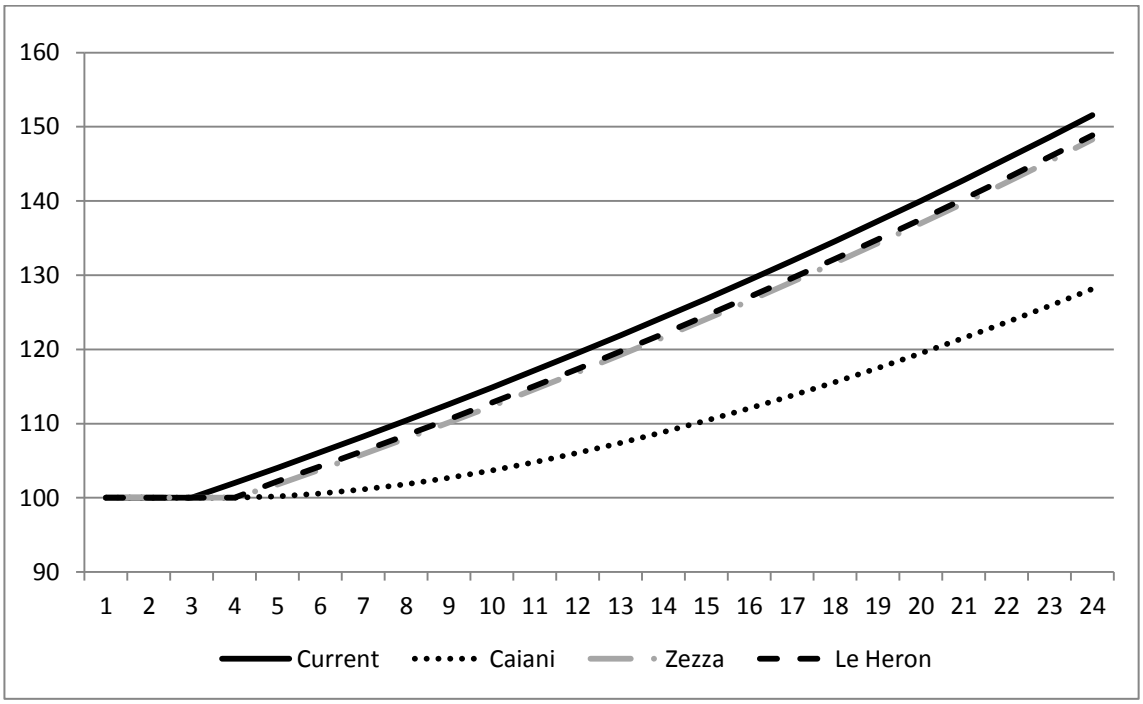
In this section, the results of a simple simulation are presented in order to show the impact of the differences between the expectation specifications and the importance of the value of the parameter ε. The methodology includes the construction of an artificial variable whose starting value is 100 and that grows 2 percent each period for a total of 24 periods. This artificial variable is represented by the solid black line in the following figures (labeled current). Next, we plot the results obtained by the insertion of the artificial values into the three expectations specifications. The study then compares

Nevertheless, the authors affirm that "all agents share the same simple adaptive scheme to compute expectations" (CAIANI et al., 2016, p. 383), which, in our opinion, validates the comparison.

the results for different ε values. The values chosen for the parameter ε are the ones utilized by the authors of the following papers: In Le Heron (2011) the parameter is 0.1. For Caiani et al. (2016) it is 0.25. For Godley and Lavoie (2007, chapter 11) it is 0.5. Finally, for Zezza (2008) the value is 0.75. We also analyze the value 0.9 to show a situation in which the forecasting error is heavily important for expectations formation.

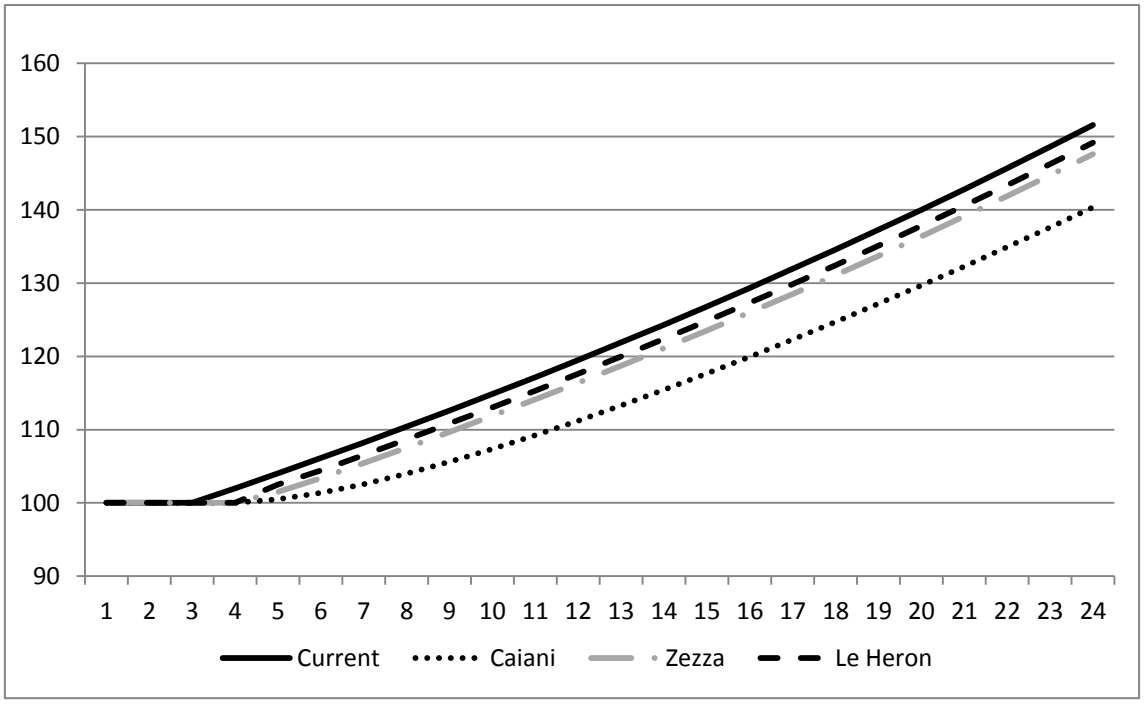
The results suggest that both the specification and the weight of the forecasting error (parameter ε) matter. For smaller weights, Caiani et al.'s model provides increasingly divergent results, but all specifications underestimate the correct values. That is, Caiani et al.'s A-B model is dependent on forecasting errors not being very important in the dynamic adjustment of expectations. As the error term becomes more important, Caiani et al.'s model provides a better fit, whereas Zezza's becomes increasingly less accurate. The more robust specification is Le Heron's.

Figure 3 – Discrepancies in Expected Values using Different Specifications (ε = 0.1)



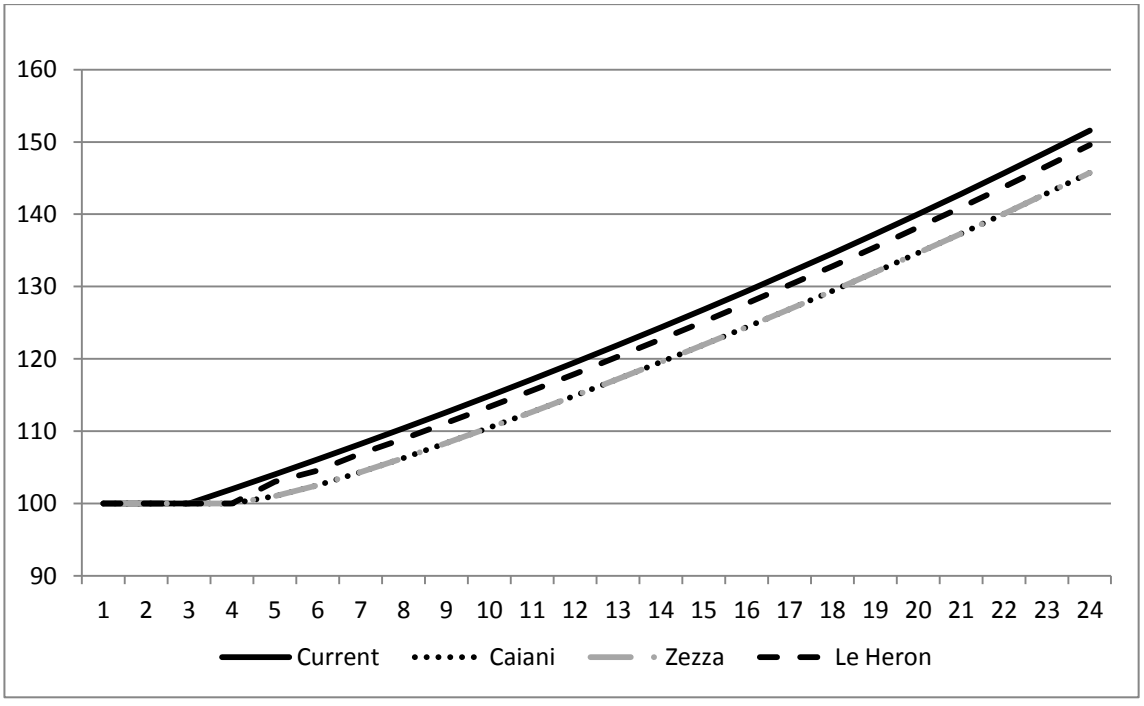
Source: Elaborated by the author.

Figure 4 – Discrepancies in Expected Values using Different Specifications (ε = 0.25)



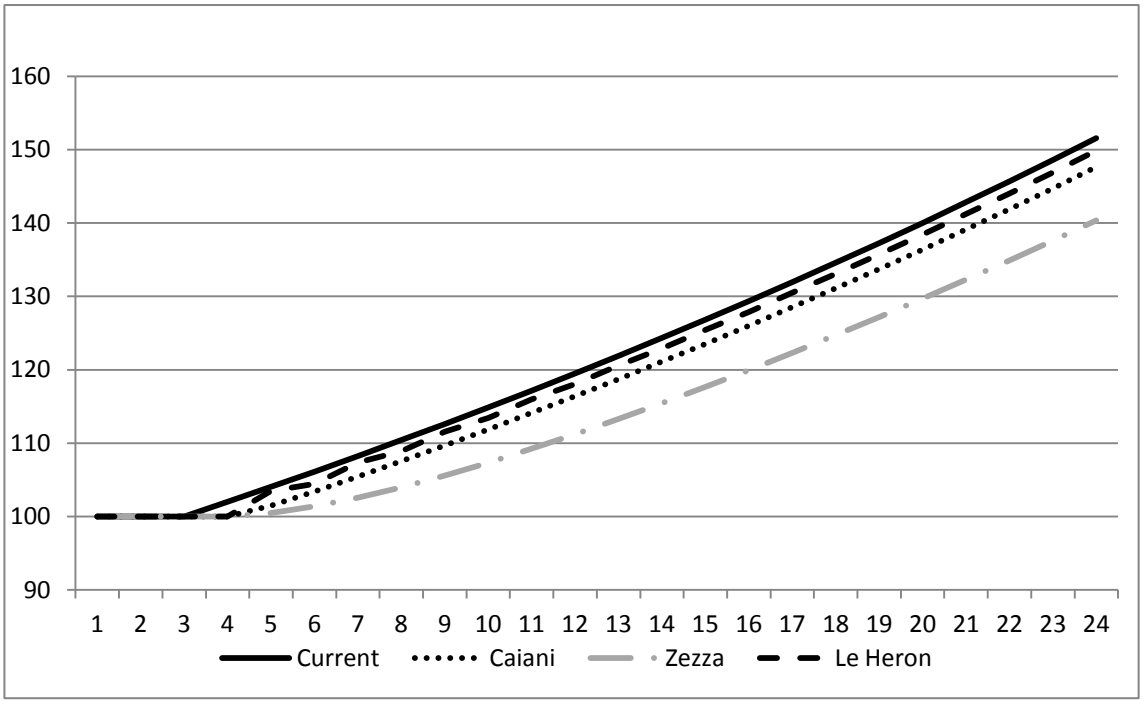
Source: Elaborated by the author.

Figure 5 – Discrepancies in Expected Values using Different Specifications (ε = 0.5)



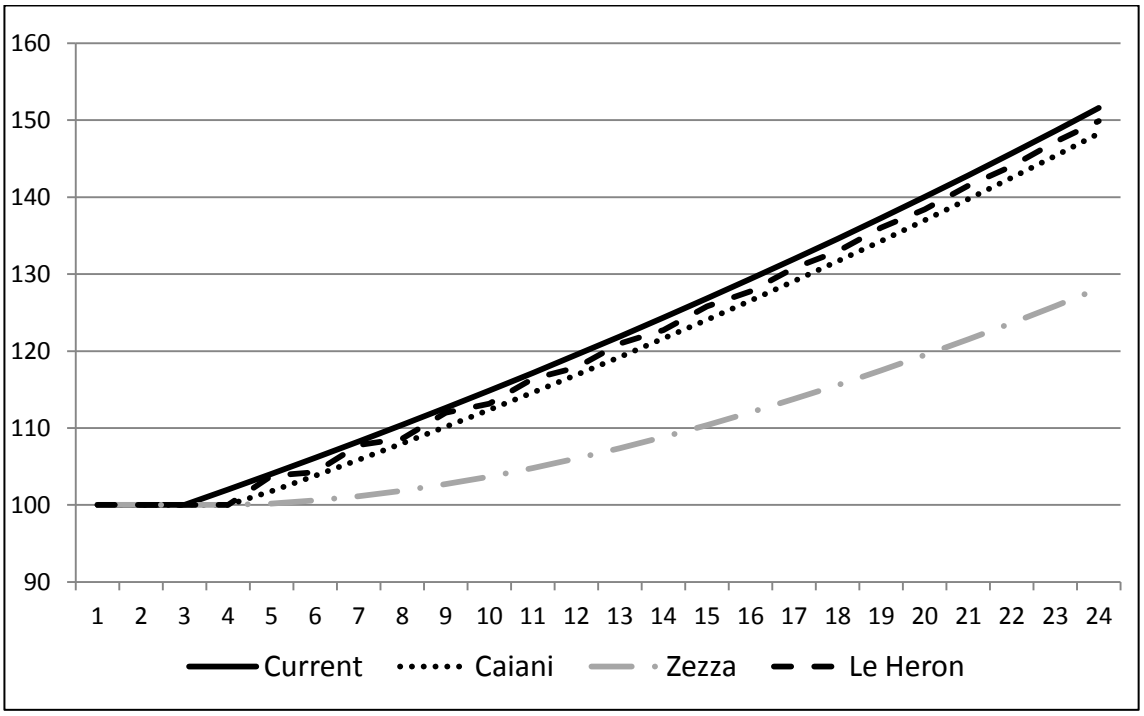
Source: Elaborated by the author.

Figure 6 – Discrepancies in Expected Values using Different Specifications (ε = 0.75)



Source: Elaborated by the author.

Figure 7 – Discrepancies in Expected Values using Different Specifications (ε = 0.9)



Source: Elaborated by the author.

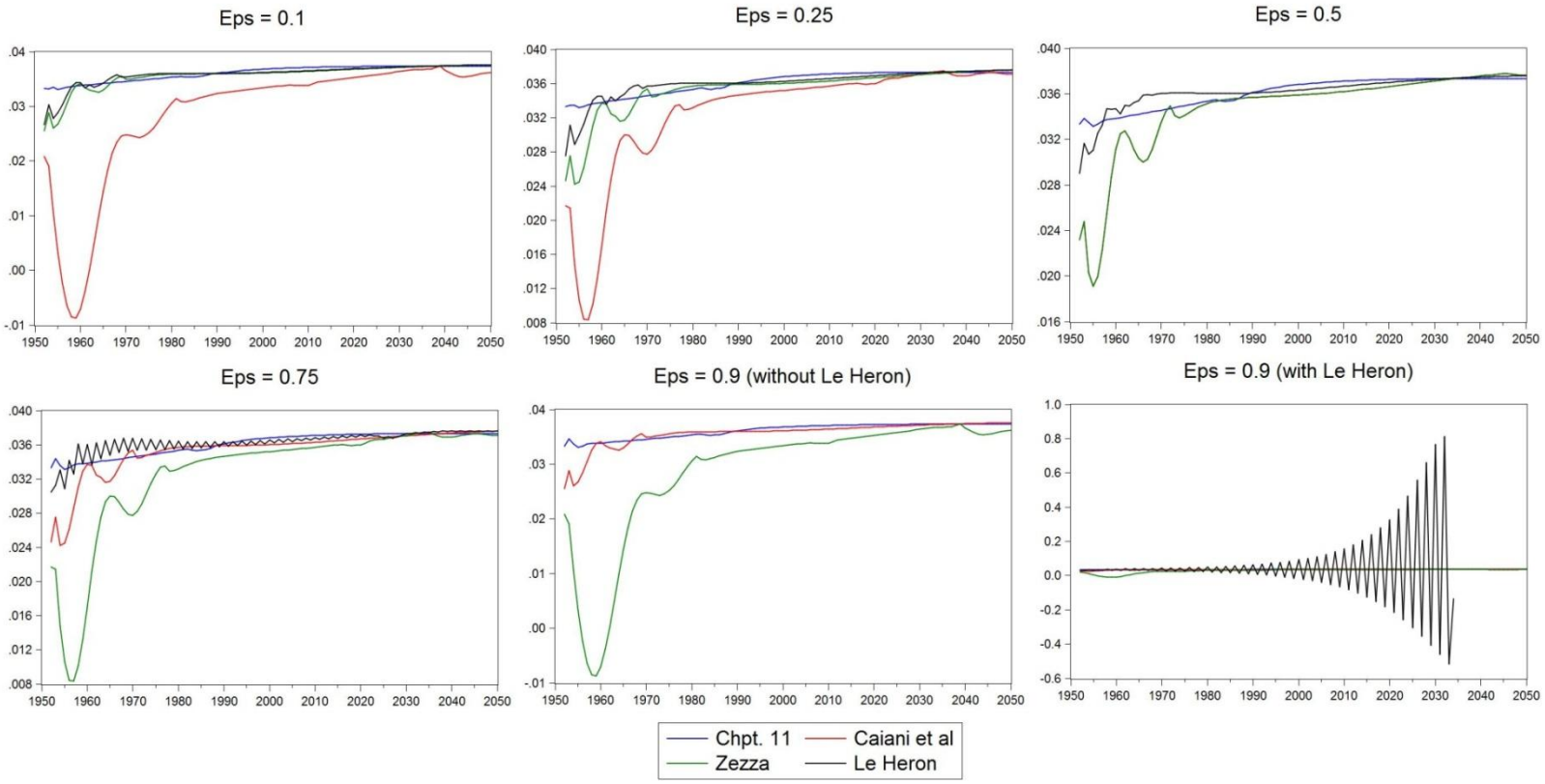
3.3 EXPECTATIONS, CONSUMPTION AND ECONOMIC DYNAMICS

The above three formulations for expectations generate different forecasts based on the artificial data employed, with the formulation developed by Le Heron being the more robust and accurate. One question that could be raised is: how do these differences affect the systemic properties of the economy? In order to measure the macroeconomic consequences of those formulations discrepancies, the expectations are included in the model labeled GROWTH, built by Godley and Lavoie (2007, chap. 11). This approach allows one to analyze the impacts of different modeling strategies in a large SFC model[17]. Thus, equation 11.54 in Godley and Lavoie's model, representing expected real regular disposable income of households, is replaced by equations (26), (27) and (28) above. The benchmark model (labeled chpt. 11) is kept to highlight the differences, without any value judgments comparing the benchmark with the other specifications. The goal of the exercise is to show how the specifications fare in a complete SFC model that differs from each one of the models employed by the authors. It is therefore possible to analyze the steady state ratios of the model and see how different expectational functions give room to different long-run results. The analysis is carried out with the ε (labeled eps on the panels below) values used in the previous exercise.

The steady-state, long-run real annual output growth converges to about 3.6% for all different settings and for all models. But the short and medium term dynamics diverge a lot (figure 8). For low values of ε, Caiani et al.'s again provide more unstable dynamics compared to the Godley and Lavoie baseline model. For higher values, Zezza' specification renders more instability. For ε = 0.5, Caiani et al.'s and Zezza's overlap. In the previous exercise, the formulation made by Le Heron was usually more robust. However, for the highest value of ε tested, his model presents an explosive behavior and stops running before the end of the simulation period. Thus, the macroeconomic consequences of different expectations specifications are not trivial.

17 The Eviews software codes for all the chapters of Godley and Lavoie (2007) book had been made generously available by Gennaro Zezza at <http://gennaro.zezza.it/software/eviews/gl2006.php>

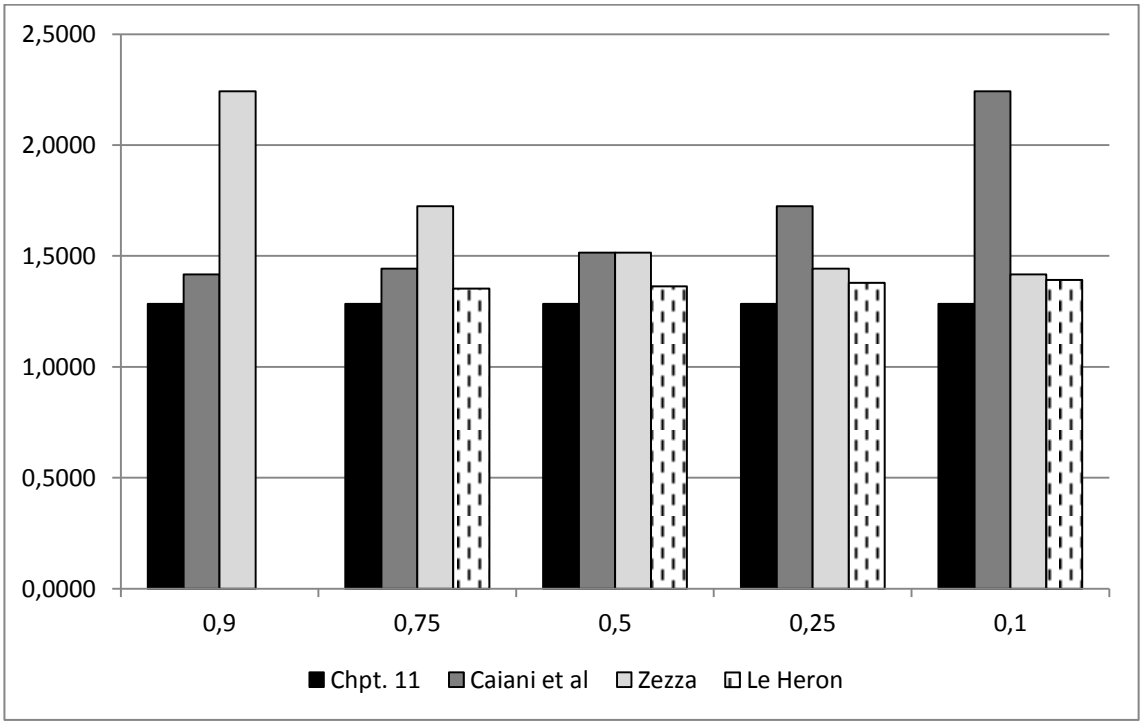
Figure 8 – Real Output Growth Using Different Specification for Expected Income and Forecasting Error Weights



Source: Elaborated by the author.

The different output dynamics affect some important relationships in the steady state, whereas others, like the output-capital ratio, is model- and weight-invariant. Just to mention a few important ratios, the household total wealth to corporate stock ratio is very different depending upon the expectation formation rule modeled. For Caiani et al.'s, the ratio increases with the forecasting error weight, whereas Zezza's diminishes (figure 9 below). But all three remain above the benchmark, with Le Heron's model providing the closest values. The same is true for the ratio of government debt (bills and bonds) to corporate capital stock (figure 10).

Figure 9 – Steady-State Household Wealth to Corporate Capital Stock Ratio

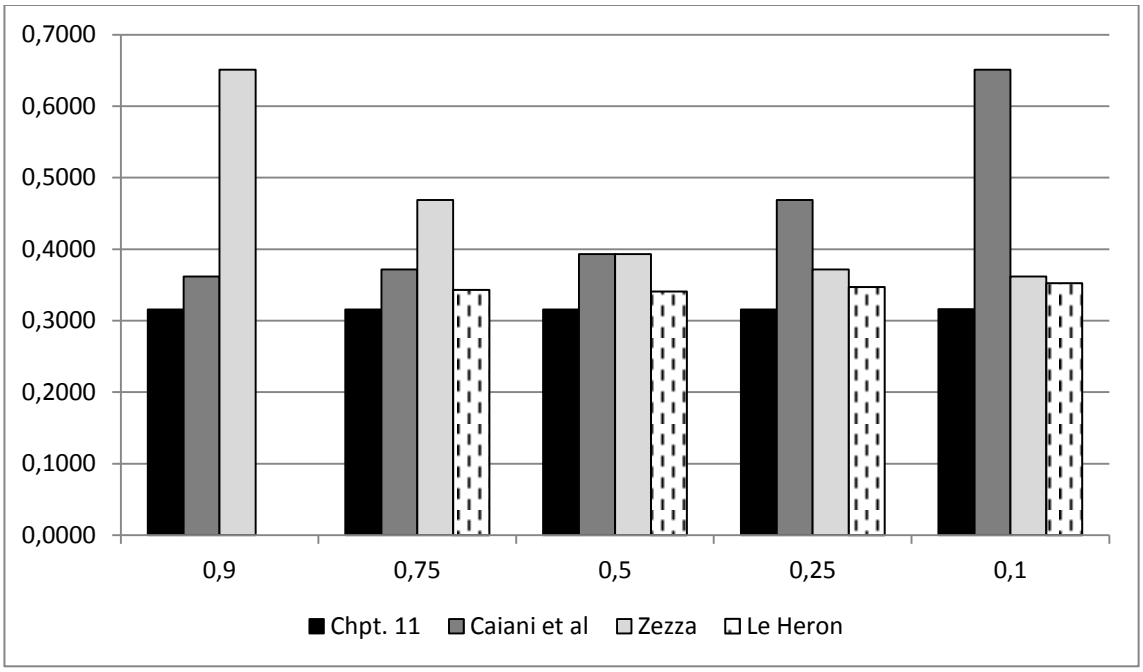


Source: Elaborated by the author.
Note: (numbers below the columns represent the ε).

These results have important implications for the steady-state composition of household balance sheet. Assets and liabilities change according to the expectations specification and the weight of forecasting errors. Figure 11 below presents the results for the lowest value of ε (and changing the value of this parameter affects the composition of balance sheet). The households' assets considered were Own Funds (banks' capital), Equities, Government Bills, Government Bonds, Money or Bank Deposits and High Powered Money or Cash. On the liability side, there are bank Loans. Thus, for a low weight of forecasting errors, the baseline model GROWTH generates more loans and deposits, and Caiani et al.

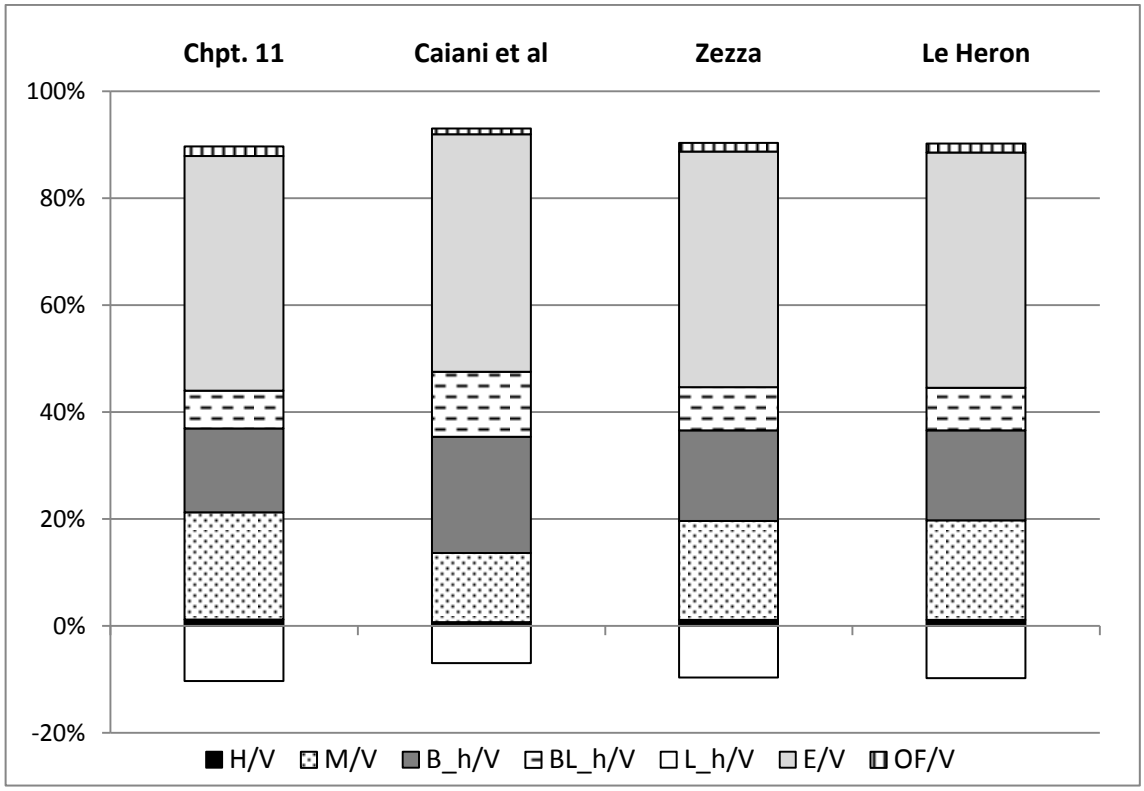
show a shrunk balance sheet with less liabilities and equities, but households accumulate relatively more Government Bills. Therefore, minor changes in expectations specification seem to generate non-trivial results regarding the accumulation of wealth by the different sectors in the economy. This affects the financing of economic activity and has important consequences for decision-making at the state and private sectors.

Figure 10 – Government debt relative to corporate capital stock



Source: Elaborated by the author.
Note: (numbers below the columns represent the ε).

Figure 11 – Steady-State Household Balance Sheet Composition for Different Expectations Specifications (ε = 0.1)



Source: Elaborated by the author.

3.4 CONCLUSION

This chapter showed that an apparently slight modification in the entire structure of SFC models can have important macroeconomic implications, raising important methodological issues. Different specifications for the expected income in the household consumption function affects how the expectations adjust to previous errors. These cumulative differences have important consequences for the ability of researchers to model expectation formations. The specification used by Le Heron (2011) yielded the more accurate results. More important, the different specifications have non-trivial effects on the economy trajectory. It was shown that output growth converges to the same steady-state rate when a system of equations has different specifications for expectations. However, the short-term and medium-term dynamics are quite different. Again, Le Heron (2011) specification offered a path that was close to the baseline used for comparison.

On the other hand, the weight of the forecasting error in the expectation formula also biases the simulation results. In this regard, when expectational errors are more important, Le Heron's formulation creates dynamic issues for the system, with an explosive behavior. And

here the solution is not so clear cut, since deciding about how important errors are in the expectations involves a lot of subjective and even philosophical questions. Finally, the apparently minor differences in expectations equations affect the composition of households' balance sheets. Since SFC models assume double-entry bookkeeping throughout, the changes in the composition of the balance sheets of the household sector will affect the corporate, banking, and government sectors. These relative changes in assets and liabilities might affect the financing and funding of economic activity. Again, Le Heron (2011) approach generated results closer to the baseline when expectational errors are not extremely important.

Of course, the long-run output trend did not change, and so an important flow was resilient to changes in specifications and different weights for forecasting errors. And modifications in the composition of balance sheets were not jaw-dropping by any means. This is probably because the baseline model GROWTH system dynamics may not rely only on expectations to generate completely distinct trajectories. Yet the exercise draws attention to the fact that the same problem may be associated with the specifications for other behavioral equations in the system, not only the ones addressing how expectations are formed. And given the large number of behavioral equations in a typical SFC model, the problem may turn out to be more serious than could be suggested by the exercises done in this paper. This means that, besides sensitivity and robusteness tests, additional methodological research is necessary to develop more robust SFC models regarding how important variables and parameters should be modeled.

4 FISCAL POLICY REGIMES IN A SFC MODEL

The aim of the present chapter is to analyze different fiscal policy regimes and their responses to adverse shocks in a SFC model. Our main inspirations are Godley and Lavoie (2007, cp. 11), Dafermos (2012) Le Heron (2012b), and Pedrosa and Silva (2016). The chapter is organized as follows: the first section sets up the accounting framework, discusses the behavioral equations, elaborates the Directed Acyclic Graph (DAG) of the model, and develops some analytical considerations. The second section analyzes the evolution of the economy under four different fiscal regimes: government expenditures as a fixed proportion of GDP; government deficit as a fixed proportion of GDP; government debt as a fixed proportion of GDP; and a balanced budget. The third section compares the responses of these fiscal regimes to adverse shocks. The fourth section analyzes the consequences of fiscal regime changes. The last section provides the concluding remarks.

4.1 THE MODEL

In this section, the model will be discussed in its many aspects, starting from the accounting framework and going over the behavioral equations, Directed Acyclic Graph, and analytical considerations.

4.1.1 The accounting framework

Our model is made up of five sectors: households, firms, commercial banks, a central bank, and the government. The sectoral balance sheets are presented on table 7. Many simplifying assumptions are made: households do not take loans and also do not hold cash; firms also do not hold cash and do not accumulate inventories; and commercial banks do not issue equities.

Table 8 represents the transactions-flow matrix of our fictional economy. The upper part represents current sales and purchases of goods and services and factors' payments. The middle part records the flows of financial payments. The lower part represents the changes in the stocks held by each sector.

More simplifying assumptions can be inferred from this second table. One of them is that banks' profits are completely distributed to households. The same happens between the central bank and the government.

The equations that make this accounting structure up evolve through time are discussed in the next subsection.

Table 7 – Balance sheet

	Households	**Firms**	**Banks**	**Government**	**Central bank**	**Σ**
Deposits	+ D		- D			0
Tangible Capital		+ K				+ K
Equities	+ e	- e				0
Treasury bills	+ B_h		+ B_b	- B	+ B_{cb}	0
High-powered money			+ H_b		- H	0
CB advances			- A		+ A	0
Loans		- L	+ L			0
Balance	- V	- Vf	0	- B	0	- K
Σ	0	0	0	0	0	0

Source: Elaborated by the author.

Table 8 – Transactions flow

			Firms				**Central bank**		
		Households	Current	Capital	**Banks**	**Government**	Current	Capital	Σ
Consumption		- C	+ C						0
Government expenditures			+ G			- G			0
Investment			+ I	- I					0
Taxes		- T				+ T			0
Wages		+ WB	- WB						0
Firms' profits		+ FD_f	- F_f	+ FU_f					0
Banks' profits		+ Fb			- Fb				0
Central bank's profits						+ Fcb	- Fcb		0
Interest on	Deposits	+ $r_{d-1}.D_{-1}$			- $r_{d-1}.D_{-1}$				0
	Loans		- $r_{l-1}.L_{-1}$		+ $r_{l-1}.L_{-1}$				0
	CB advances				- $r_{A-1}.A_{-1}$		+ $r_{A-1}.A_{-1}$		0
	Treasury bills	+ $r_{b-1}.B_{h-1}$			+ $r_{b-1}.B_{b-1}$	- $r_{b-1}.B_{-1}$	+ $r_{b-1}.B_{cb-1}$		0
Change in the stocks of	Deposits	- ΔD			+ ΔD				0
	Loans			+ ΔL	- ΔL				0
	High-powered money				- ΔH_b			+ ΔH	0
	Treasury bills	- $\Delta B_h.p_B$			- $\Delta B_b.p_B$	+ $\Delta B.p_B$		- $\Delta B_{cb}.p_B$	0
	CB advances				+ ΔA			- ΔA	0
	Equities	- $\Delta e.p_e$		+ $\Delta e.p_e$					0
Σ		0	0	0	0	0	0	0	0

Source: Elaborated by the author.

4.1.2 The behavioral equations

In this subsection, it will be discussed the behavioral equations of all the macroeconomic sectors of the model.

4.1.2.1 Equations for Households

The first equation of the household sector is the definition of personal income:

$$YP = WB + FD_f + F_b + r_{d-1}D_{-1} + r_{b-1}B_{h_{-1}} \quad (29)$$

Where YP is personal income, WB is wage bill, FD_f is distributed profits of firms, F_b represents the profits of banks, which we assume to be totally distributed to its owners, r_d is the interest rate paid on deposits, D is the stock of deposits, r_b is the interest rate paid on government bonds, and B_h are the bonds held by households.

The personal income is subject to taxation. The income left from taxation is the regular disposable income, YD_r:

$$YD_r = YP - T \quad (30)$$

$$T = \theta . YP \quad (31)$$

In addition to the regular sources of income, households also gain purchasing power by capital gains realized in financial markets. The summation of the regular disposable income with the capital gains gives the Haigh-Simons disposable income:

$$YD_{hs} = YD_r + CG \quad (32)$$

$$CG = \Delta p_e e_{d-1} \quad (33)$$

The stock of wealth of households is the wealth of the previous period, plus the difference between Haigh-Simons disposable income and consumption:

$$V = V_{-1} + YD_{hs} - C \quad (34)$$

The consumption level depends on the lagged regular disposable income and on the lagged stock of wealth.

$$C = \alpha_1 YD_{r-1} + \alpha_2 V_{-1} \quad (35)$$

The wealth of households is allocated between government bonds, firms' equities and banking deposits. We simplify the portfolio choice, assuming that the households want to hold a fixed proportion of bonds and equities, according to its Perceived Degree of Uncertainty (PDU). Banking deposits are a residual.

$$B_h = (h_{10} + h_{11}.PDU).V_{-1} \quad (36)$$

$$e_d = (h_{20} - h_{21}.PDU).V_{-1} \quad (37)$$

$$D = V - B_h - e_d \quad (38)$$

The PDU is employed by Dafermos (2012) in his discussion about the linkages between liquidity preference, uncertainty, and recession. We utilize this variable in almost all the equations of his model: households' portfolio choice, firms' investment decision, and banks' credit rationing and excess reserves holdings. The correspondence, though, is not a perfect one, since our model is simpler than the one proposed by Dafermos (2012). As it happens with this author's model, we assume that PDU is the same for all sectors.

In SFC models, households' portfolio choice is usually done along Tobinesque lines. Here, though, we avoid the complications that arise from this approach, following instead a simpler modeling, similar to the one presented in Santos and Zezza (2008) and Pedrosa and Silva (2016).

4.1.2.2 Equations for Commercial Banks

The first equation here follows directly from the accounting framework: banks' profits are composed of the interest rate charged on loans (r_l) multiplied by the stock of loans plus the interest receipts from its holdings of government bonds (B_b), minus the interest paid on deposits and on central bank advances (A).

$$F_b = r_{l-1}L_{-1} + r_{b-1}B_{b-1} - r_{d-1}D_{-1} - r_{A-1}A_{-1} \quad (39)$$

The new loans given to firms are subject to a credit rationing, which depends on the PDU, on the leverage ratio of firms (L/K) and on the basic interest rate. The stock of loans at the end of the period (L) is the previous period stock minus repayments (rep), plus the new loans given in the current period. This formulation is based on Dafermos (2012) and Le Heron and Mouakil (2008).

$$CR = \rho_1 PDU + \rho_2(L_{-1}/K_{-1}) + \rho_3 r_b \quad (40)$$

$$NL = L_D(1 - CR) \quad (41)$$

$$L = (1 - rep)L_{-1} + NL \quad (42)$$

Banks' holdings of high powered money are composed of reserve requirements upon deposits (μ) and excess reserves, η. The amount of excess reserves depends positively on the PDU and negatively on the base interest rate, which represents the opportunity cost of holding excess reserves:

$$H_b = (\mu + \eta).D \tag{43}$$

$$\eta = \eta_0 + \eta_1 PDU - \eta_2 r_b \tag{44}$$

We distinguish between two cases regarding the demand for government bonds and central bank advances. If deposits net of required reserves are higher than loans, banks will use these extra resources to acquire government bonds and advances will be equal to excess reserves. But if loans are higher than deposits net of required reserves, no government bonds are held and central bank advances are demanded to fill the gap.

$$B_{bn} = D - \mu.D - L \tag{45}$$

$$B_b = \begin{cases} B_{bn}, & B_{bn} \geq 0 \\ 0, & B_{bn} < 0 \end{cases} \tag{46}$$

$$A = \begin{cases} \eta.D, & B_{bn} \geq 0 \\ H_b + L - D, & B_{bn} < 0 \end{cases} \tag{47}$$

Discussing the first case above, Dafermos (2012), who uses the same approach, argues that

> the amount of excess reserves represents the cash not lent by banks in a surplus position to their counterparties in a deficit position. Thus, a specific amount of excess reserves translates into an equivalent amount of advances, which the banks in a deficit position are forced to get from the central bank (DAFERMOS, 2012, p. 766).

Finally, the interest rate on loans is simply a mark-up m_l upon the basic interest rate, whereas the interest rate paid on deposits is the basic interest rate minus a spread m_d.

$$r_l = r_b + m_l \tag{48}$$

$$r_d = r_b - m_d \tag{49}$$

4.1.2.3 Equations for Firms

We start our discussion of firms' equations from their costs, which are very simplified in our model. The wage bill of the economy is the wage times the number of employed workers. We assume that wages grow with labor productivity, and that the number of employed workers is the output Y divided by the labor productivity.

$$WB = N.W \tag{50}$$

$$W = W_{-1}(1 + g_{pr}) \tag{51}$$

$$N = y/pr \tag{52}$$

$$pr = pr_{-1}(1 + g_{pr}) \tag{53}$$

The productivity of labor grows at an exogenous rate g_{pr}. In the calibration process, we assume that this ratio is 1,85%. According to Cavalcante and De Negri (2014, p. 149), this was the Brazilian labor productivity growth rate between 2001 and 2011.

We assume that the production of firms is sold out each period, and is distributed between households' consumption, firms' investment (*I*), and government purchases (*G*). Subtracting the wage costs and the interest on loans from output, it gives us the definition of firms' profits. A proportion s_f of them is retained by the firm, and the rest of it is distributed to households.

$$Y = C + I + G \tag{54}$$

$$F_f = Y - WB - r_{l-1}L_{-1} \tag{55}$$

$$FU_f = s_f F_f \tag{56}$$

$$FD_f = F_f - FU_f \tag{57}$$

The desired investment (i_d) depends on the lagged capacity utilization, on the undistributed profits normalized by the nominal capital stock, on the interest rate on loans[1], and on a parameter β_0 which represents the "animal spirits" of the entrepreneurs.

This last parameter depends on a constant χ_0 and on the PDU. The rate of capacity utilization is defined as the ratio between output (*Y*) and potential output-capital ratio (*v*) times the stock of capital (*K*).

$$i_d = \left(\beta_0 + \beta_1 u_{-1} + \beta_2 \left(\frac{FU_f}{K_{-1}}\right) - \beta_3 r_l\right).K_{-1} \tag{58}$$

$$\beta_0 = \chi_0 - \chi_1.PDU \tag{59}$$

$$K = K_{-1} + I \tag{60}$$

$$u = \frac{Y}{v.K_{-1}} \tag{61}$$

Investment can be financed by loans, retained profits, and issuance of equities. We treat the demand for loans as the residual of the financing decisions, and it is subject to the above described credit rationing from banks. The realized investment is thus influenced by the amount of loans that the firms actually receive.

$$L_D = I_d - FU_f - p_e\Delta e + rep.L_{-1} \tag{62}$$

$$I = \Delta L + FU_f + p_e\Delta e \tag{63}$$

1 This equation is based on Lavoie and Godley (2001-2002). The only difference is that we simplified away the influence of Tobin q.

Following Santos and Zezza (2008, p. 454) and Pedrosa and Silva (2016, p. 7), we assume that firms keep a fixed proportion x between equities and the stock of capital. Equities' price is given by the interaction of demand and supply.

$$e = x.k_{-1} \tag{64}$$

$$p_e = \frac{e_d}{e} \tag{65}$$

4.1.2.4 Equations for Central Bank

The Central Bank makes profits, F_{cb}, which are completely distributed to the government. They are composed of the interest receipts upon the advances given to the commercial banks and the earnings from governments' bonds held.

$$F_{cb} = r_{A-1}A_{-1} + r_{b-1}B_{cb-1} \tag{66}$$

We assume, for simplicity, that the interest rate on central bank advances (r_A) is the same as the interest on governments' bonds.

$$r_A = r_b \tag{67}$$

All the high-powered money demanded by commercial banks is supplied.

$$H = H_b \tag{68}$$

We assume that the central bank is the residual purchaser of government bonds[2].

$$B_{cb} = B - B_h - B_b \tag{69}$$

The stock of bonds is the stock of the previous period plus the fiscal result of the government (*DG*).

$$B = DG + B_{-1} \tag{70}$$

The redundant equation, implied by all the others, is the one that guarantees the closure of central bank's balance:

$$H = A + p_b B_{cb} \tag{71}$$

4.1.2.5 Equations for Government[3]

Our intention is to analyze the dynamics that arise from different fiscal policy regimes. We study four cases, drawing heavily on Le Heron (2012b). In the first regime, the

2 Thus, the central bank can run out of government's bonds if the other sectors purchase all the supply. In this case. We can assume that monetary policy is conducted via interests on reserves, rather than by open market operations.

3 There is a growing literature about fiscal multipliers. However, it goes beyond the scope of the present work to deal with fiscal multipliers in SFC models. See Borsi (2016) and Mittnik and Semmler (2012) for good discussions about this subject.

government seeks to maintain a fixed proportion of spending relative to GDP, that is, a fixed proportion of G/Y.

$$G = \sigma_1 Y_{-1} \tag{72}$$

$$DG = G + (r_{b-1} B_{-1}) - T - F_{cb} \tag{73}$$

The second case is one in which the government has a target proportion for deficit. In this case, we have:

$$G = DG - (r_{b-1} B_{-1}) + T + F_{cb} \tag{74}$$

$$DG = \sigma_2 Y_{-1} \tag{75}$$

In the third case, the fixed proportion is related to the debt (target debt, B^T):

$$G = DG - (r_{b-1} B_{-1}) + T + F_{cb} \tag{76}$$

$$DG = \Delta B \tag{77}$$

$$\Delta B = B^T - B_{-1} \tag{78}$$

$$B^T = \sigma_3 Y_{-1} \tag{79}$$

Finally, the last case is the one where the budget is balanced:

$$G = T + F_{cb} - r_{b-1} B_{-1} \tag{80}$$

$$\Delta B = 0 \tag{81}$$

Simulating different fiscal policy regimes in a SFC model is not a novel exercise. Le Heron (2012b) carried out a similar operation, comparing six different regimes. The targets for the deficit and for the debt, as well as the balanced budget, were analyzed by him. Our regime of a fixed proportion of spending relative to GPD is innovative when compared to this author. Pedrosa and Silva (2016) also compared fiscal regimes, none of them similar to ours. They considered first government expenditures as a constant fraction of the capital stock; then government expenditures varying according to deviations of capacity utilization from its long-term trend; and, lastly, an austerity case, where expenditures decrease if the lagged public debt increased.

It is important to note that our model is a very simple one: it ignores inflation, utilizes a very straightforward portfolio choice, and simplifies the wage bargaining process. Another drawback of our model is that the economy is closed. Moreover, households do not take loans, firms do not hold cash and do not accumulate inventories, all of them being unrealistic assumptions[4]. Also, there are no supply side constraints.

4 See Benati and Lubik (2014) for an empirical discussion of inventories. Denis and Silbikov (2009) discuss firms' cash holdings. See Mian, Sufi, and Verner (2015) for household debt.

4.1.3 The model in a Directed Acyclic Graph

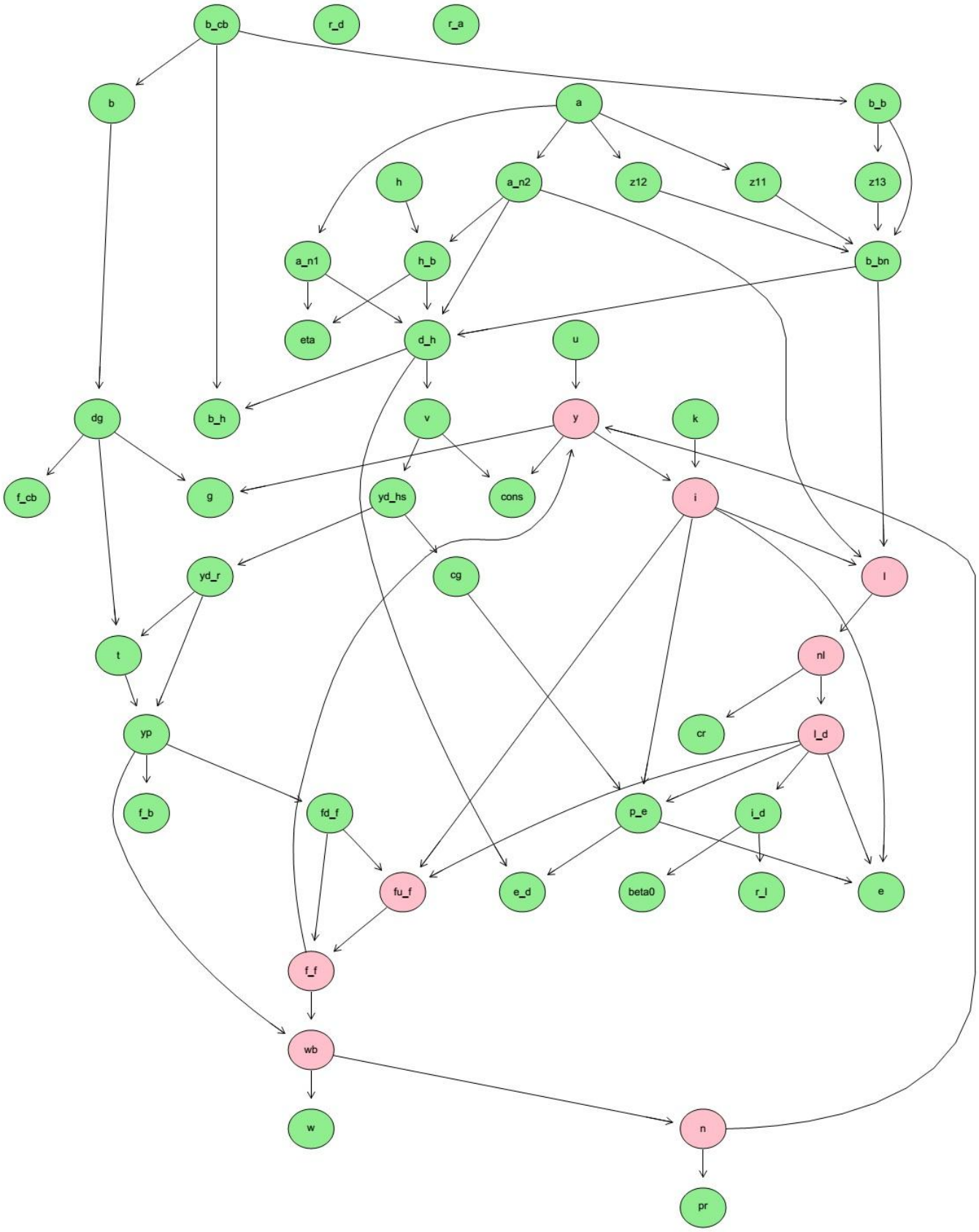
A Directed Acyclic Graph is graphical representation of a system of variables consisting of nodes (variables) and edges (links among variables), constructed in such a way that it is impossible to start from any node *x* and follow a sequence of edges that goes back to *x* again. Fennell et al. (2015) prove that any SFC model can be represented in a DAG, and also provide an algorithm that plots the DAG of any SFC model[5].

The first step to build a DAG is to plot the Directed Graph, a representation of a model where all the nodes (variables) and edges (links among variables) are plotted. However, it is possible that the model presents a cycle, that is, it is possible to start from any node *x* and to go back to it following a sequence of edges. The elements that make that loop possible can be mapped by a Strongly Connected Component (SCC). If the SCC component is contracted into a single node, called *metanode*, then the Directed Graph becomes a DAG.

Figure 12 below shows the Directed Graph of our model. The arrows point to the variables that influence the node from where they depart. For example, the node *Y* in the center of the figure has arrows pointing to *G*, *cons*, and *I*, nodes that represent government expenditures, households' consumption, and firms' investment. The pink nodes are the ones that form a SCC. They are shown separately on figure 13. Figure 14 represents de DAG of our model, where the pink node *Y* is in fact a *metanode* that comprises the whole SCC.

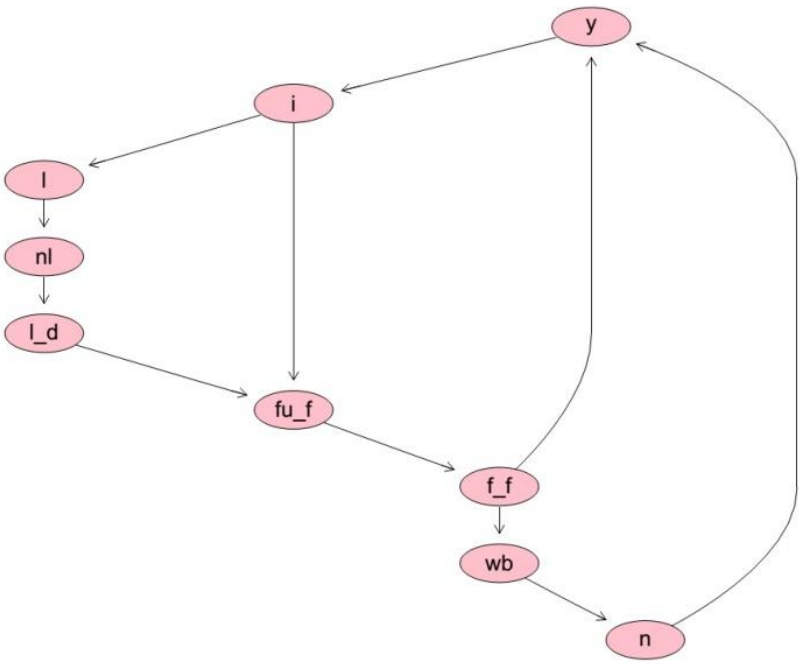
5 The source codes of the algorithm, as well as a tutorial to run it on software R, can be found in https://github.com/S120/PKSFC.

Figure 12 – Directed Graph



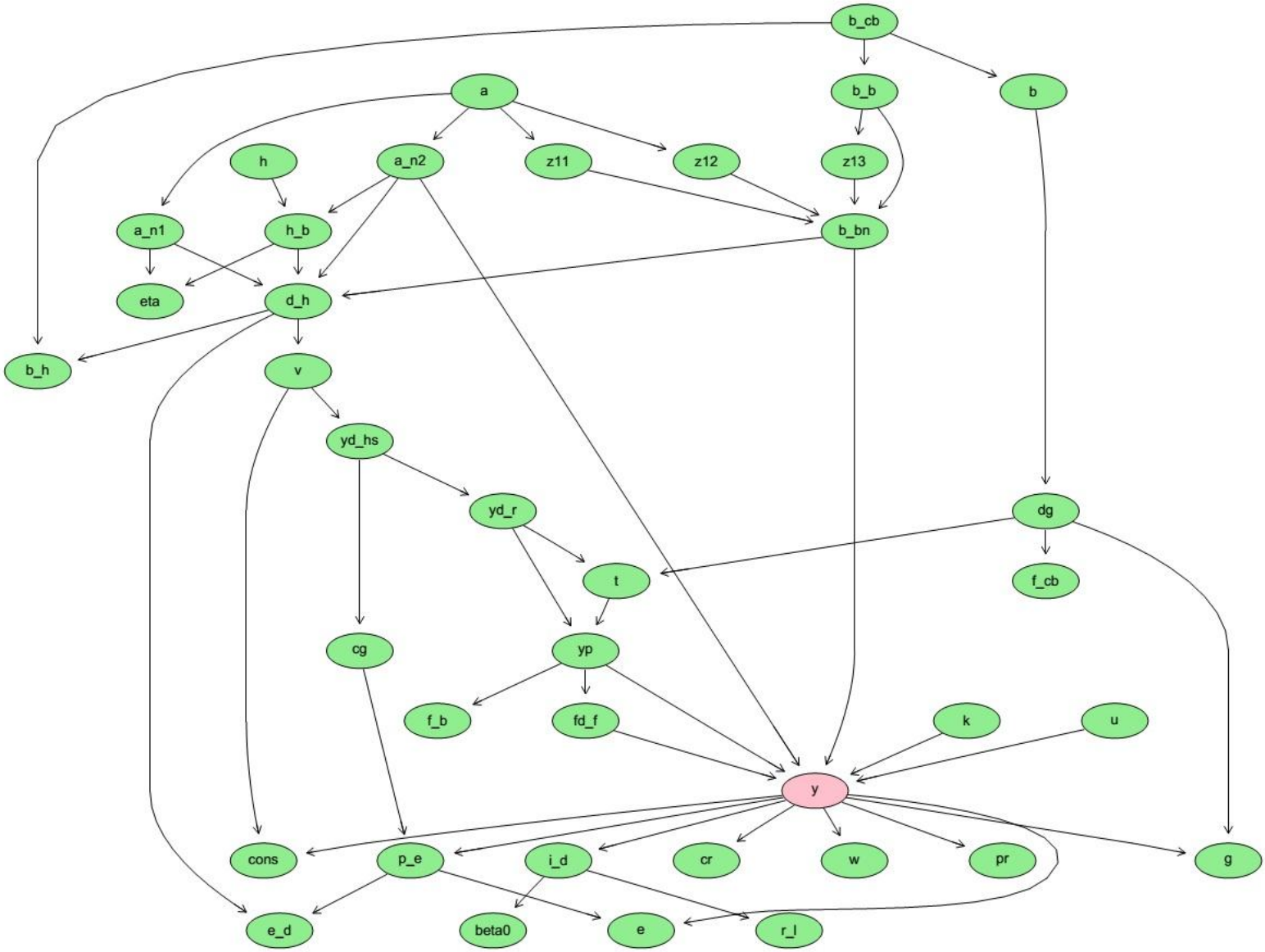
Source: Elaborated by the author

Figure 13 - SCC



Source: Elaborated by the author

Figure 14 - DAG



Source: Elaborated by the author

4.1.4 Some analytical considerations

Given the high number of equations and variables of our model, an analytical solution is almost intractable. Nonetheless, some simple formulations can be done in order to better understand the model.

Starting from equation (61) and plugging to it equations (30), (31), (35), (54), (60), and (72), and defining $grK = (K - K_{-1})/K_{-1}$, we get:

$$u = \frac{\alpha_1(1-\theta)YP_{-1} + \alpha_2 V_{-1} + \sigma_1 Y_{-1}}{vK_{-1}} - \frac{grK}{v} \tag{82}$$

So, except for the growth rate of the capital stock, the capacity utilization depends entirely on model's parameters and past values of endogenous variables. From the first term, it is possible to see that past households' consumption and past government expenditures affect positively the capacity utilization, whereas investment does the opposite.

Note that, from (61), it is possible to write:

$$Y = u.v.K_{-1} \tag{83}$$

Plugging (82) in (83), we get:

$$Y = \alpha_1(1-\theta)YP_{-1} + \alpha_2 V_{-1} + \sigma_1 Y_{-1} + grK.K_{-1} \tag{84}$$

We can also make an alternative definition of equities prices, by substituting (37) and (64) in (65):

$$p_e = \frac{V_{-1}}{K_{-1}}\left(\frac{h_{20} - h_{21}PDU}{x}\right) \tag{85}$$

Substituting (32), (33), and (85) in (34), we get:

$$V = (1-\alpha_2)V_{-1} + (1-\alpha_1)(1-\theta)YP_{-1} + \Delta p_e e_{d-1} \tag{86}$$

Note that the lagged personal income appears in (82), (84), and (86). Thus, this variable is the next to be analyzed. Plugging the equations (50) to (53), (55) to (57), and (84) in (29), we get:

$$YP = \left(1 + \left(\frac{W_{-1}}{pr_{-1}} - 1\right)s_f\right)Y + (s_f - 1)r_{l-1}L_{-1} + F_b + r_{d-1}D_{-1} + r_{b-1}B_{h-1} \tag{87}$$

Finally, plugging (41), (42), (58), (62), and (63) into (60), and performing some simple manipulations, we can get the growth rate of capital stock:

$$grK = \frac{L_{-1}}{K_{-1}} + (1-CR)\left(\beta_0 + \beta_1 u_{-1} + \beta_2\left(FU_f/K_{-1}\right) - \beta_3 r_l\right) - CR\left(\frac{FU_f + p_e\Delta e - repL_{-1}}{K_{-1}}\right) \tag{88}$$

A few comments should be made regarding equation (88). First, every SFC model, when it reaches the steady state, has its stocks growing at a constant ratio. So, the value for the growth rate of the capital stock is the same of the growth rate of other stocks in the model. This said, it is possible to see that the growth rate of the capital stock depends on firms' debt in relation to the capital stock; the investment function; the financing function; and the credit rationing. Note that increased credit rationing reduces the growth rate of the capital stock, evidencing the importance of credit for investment.

4.1.5 A note on the calibration of the model

Only a few parameters of the model are taken from a real economy. The values of the parameters σ_i are the mean values of government purchases share of output, government deficit, and government debt for Brazil from 2006 to 2016[6]. The labor productivity growth rate, as discussed above, is taken from Cavalcante and De Negri (2014). The simulation starting values for household consumption, firms' investment, and government purchases represents an approximate proportion of these entries as they appear in the Brazilian national accounts[7].

The majority of our parameters are taken from Dafermos (2012), but parameters from Godley and Lavoie (2007, cp. 11), Le Heron (2012b), and Pedrosa and Silva (2016) were also used.

4.2 THE BEHAVIOR OF THE MODEL UNDER THE DIFFERENT FISCAL REGIMES

Our goal here is to run the model with the four fiscal regimes discussed above. All simulations have the same initial values for the endogenous variables, the same parameters, and the same equations, except, of course, for the fiscal policy equations. Thus, the differences that arise are caused exclusively by the fiscal regimes.

It is important to note that the time frame of the graphs is fictitious. Here, we follow the time frame of Dafermos (2012), running the model for 510 periods, from 1500 to 2010. The label in itself is just a convenience. It could range from 1 to 510 without any change in the results. Other authors, like Godley and Lavoie (2007), use periods that run from 1950 to 2010.

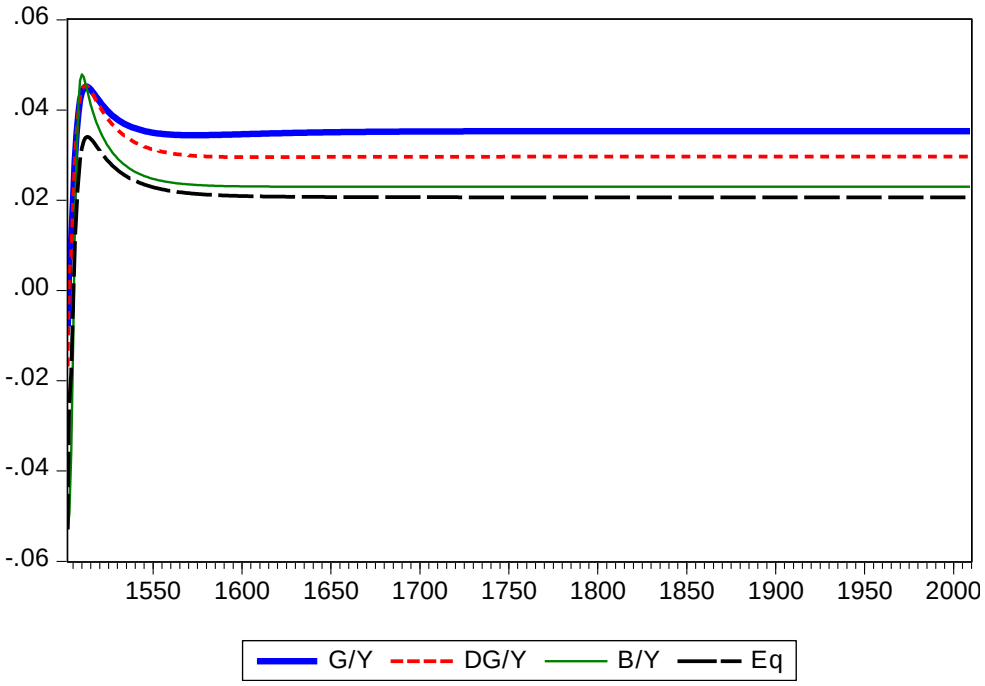
The discrepancies between the growth rates for output of the four regimes are significant, as can be seen on figure 15. The initial soaring in the growth rates is caused by the reinforcing role of consumption and investment growth, which causes output increases and, in the next period, generates higher government expenditures. The decline in the pace of growth rates is caused by a deceleration in consumption growth, which is caused by lower increases in households' income. In the steady state, the fixed G/Y ratio gives the highest value: 3,53%

6 The data are available at < http://sidra.ibge.gov.br> and <http://www.bcb.gov.br/pt-br/#!/n/SERIESTEMPORAIS>

7 They are approximate proportions because our model represents a closed economy. The Brazilian output share corresponding to the external sector was split in equal parts to households, firms and government in the calibration of the model.

per annum. Next, we have a fixed DG/Y ratio with 2,96% growth; a target for B/Y with 2,3% and the balanced budget (Eq) with the lowest: 2,06%.

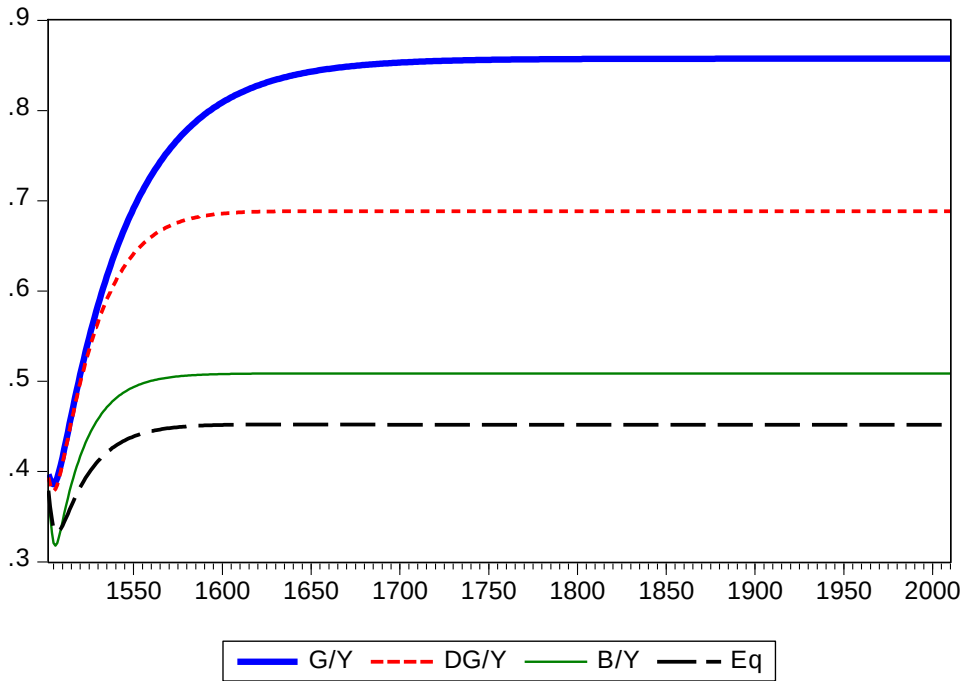
Figure 15 – Growth rate of output under the four fiscal regimes



Source: Elaborated by the author.

These growth rates cause impacts in the capacity utilization. The fiscal regimes rank in the same way as above, with the fixed proportion of government purchases over GDP (G/Y) at the top and the balanced budget at the bottom. The values are, respectively, 0,85; 0,68; 0,5; and 0,45. The initial fall in the capacity utilization in the B/Y and balanced budget regimes is caused by negative growth rates, which is due to government restrictive purchases in order to meet its debt target (B/Y regime) or to maintain the budget balanced. It is important to note that the starting point of the capacity utilization is extremely low, but the first two regimes were able to reach higher values, whereas the third regime achieved a mild growth and the last one put the economy in a state of permanent depressed capacity utilization.

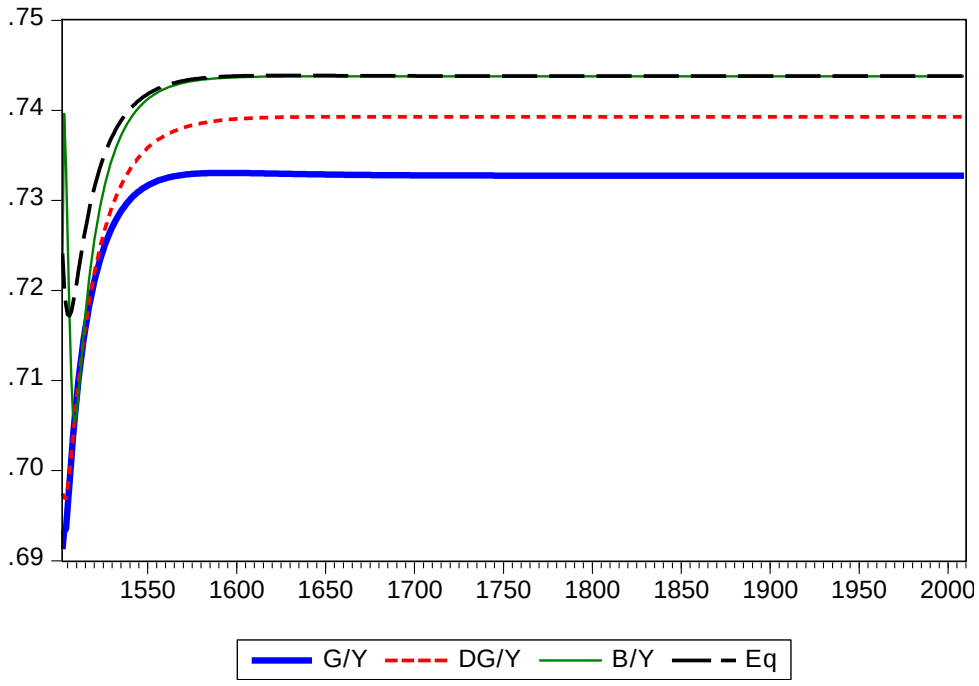
Figure 16 – Capacity utilization under the four fiscal regimes



Source: Elaborated by the author.

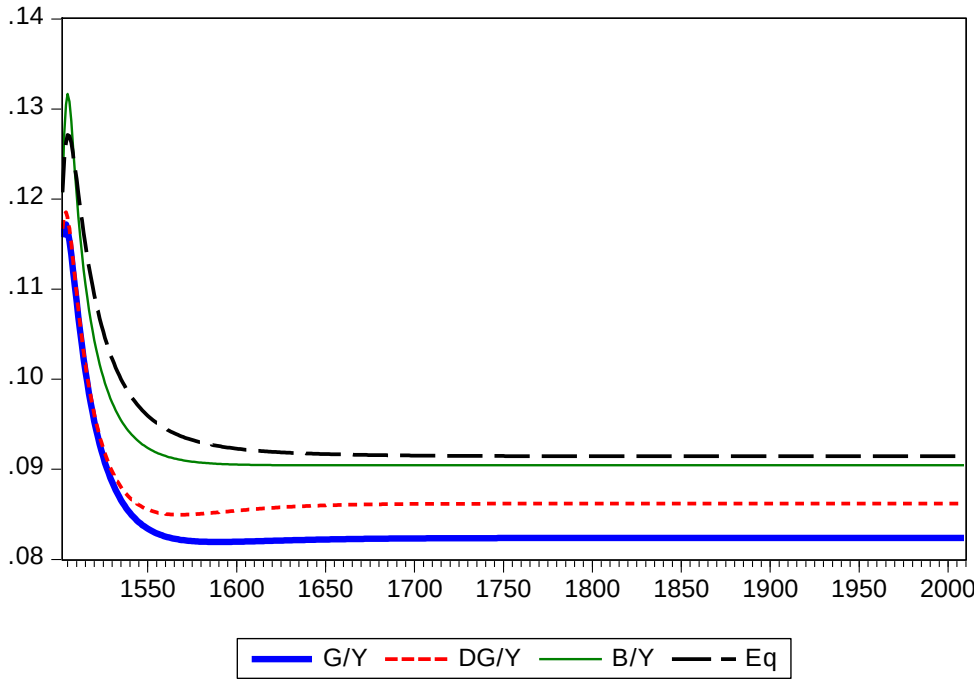
The output composition differs among the regimes. The highest consumption share (defined as the value of consumption divided by the value of the output) is the one generated by the B/Y and balanced budget regimes, which also present the highest share of investment in output. The G/Y and DG/Y regimes present the highest government expenditures share of output.

Figure 17 – Consumption as share of output under the four fiscal regimes



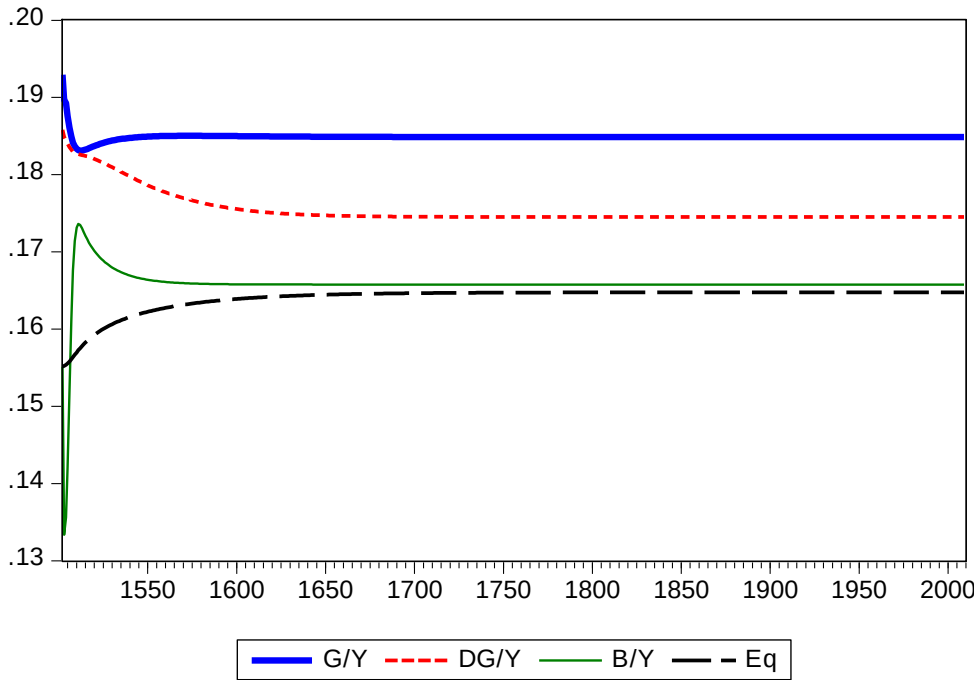
Source: Elaborated by the author.

Figure 18 – Investment share of output under the four fiscal regimes



Source: Elaborated by the author.

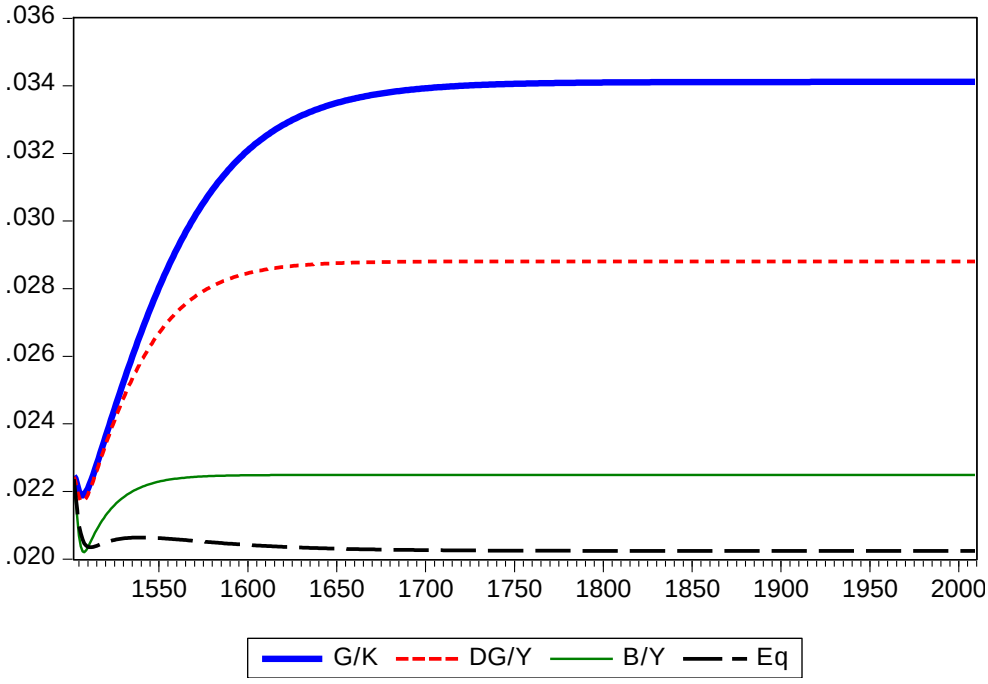
Figure 19 – Government expenditures as share of output under the four fiscal regimes



Source: Elaborated by the author.

There is an apparent paradox considering graphs 2 and 4. According to Kalecki (1965) and Steindl (1952), higher capacity utilization rates lead to higher investment. Our model, however, presents a different result: the regimes with the smaller capacity utilization rates are the ones with the higher investment share in output, even though the ratio of I/Y falls for all regimes. However, if we take the investment relative to the stock of capital (instead of output), we get an opposite ranking of the regimes, with the G/Y regime in the higher position and the balanced budget regime in the lower position.

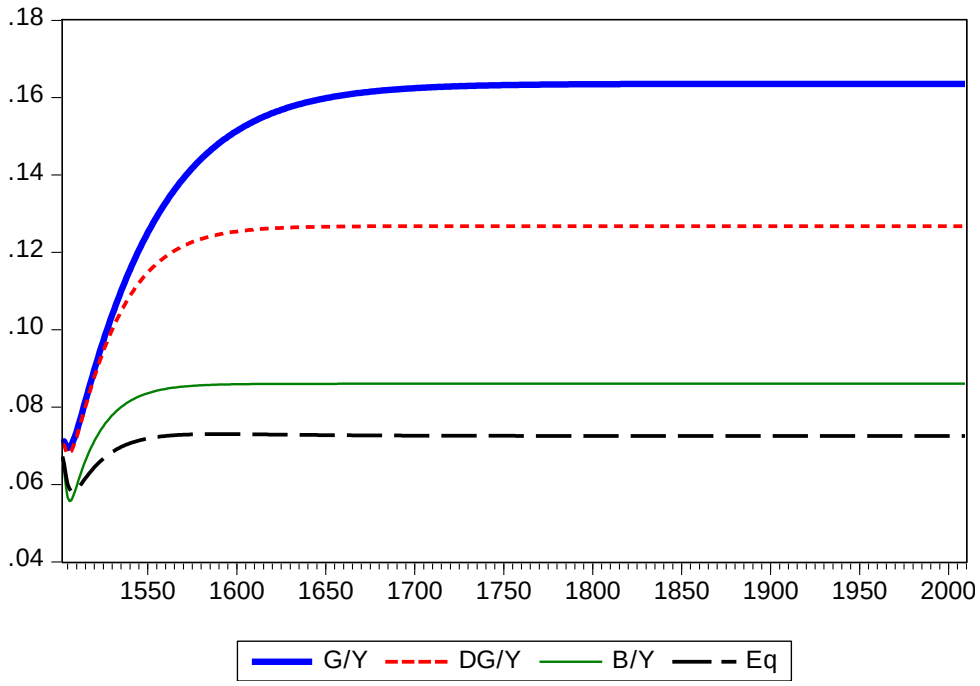
Figure 20 – Investment-Capital ratio under the four fiscal regimes



Source: Elaborated by the author.

A consequence of the higher (lower) output growth rates and capacity utilization is the higher (lower) profitability of firms, here defined as the ratio between profits and stock of capital (Ff/K). It is interesting to note that this result is the same predicted by Kalecki (1965), who argues that higher public expenditures, keeping taxes unchanged, generate higher private profits. This is precisely what happens here: the regime with the highest government expenditures as share of output (G/Y regime) has also the highest firms' profitability.

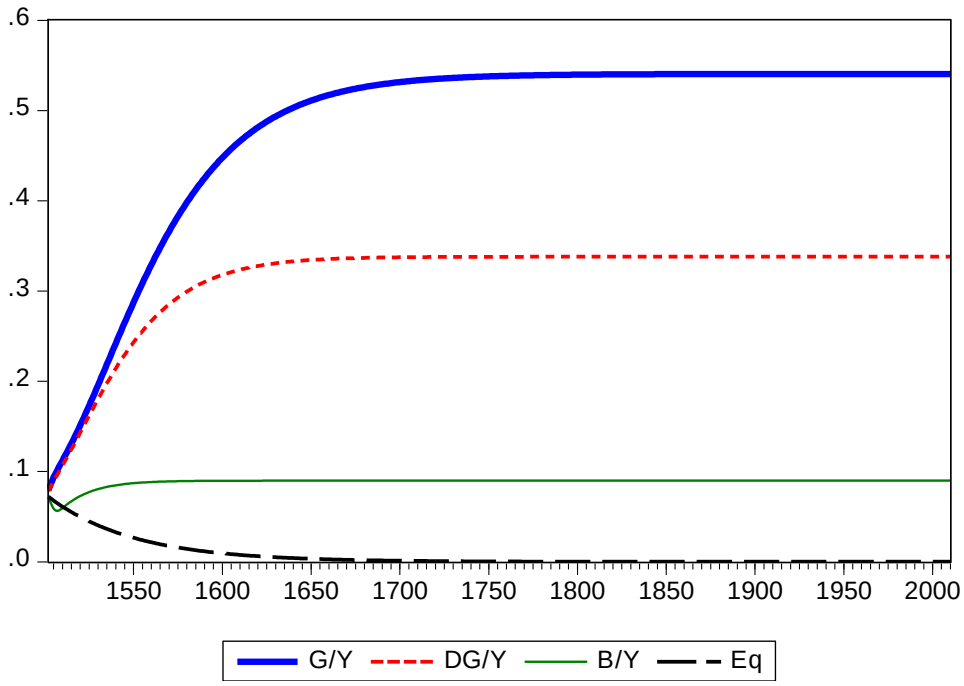
Figure 21 – Firms' profitability under the four fiscal regimes



Source: Elaborated by the author.

The government debt relative to the stock of capital is obviously dissimilar among the fiscal regimes. The first regime (G/Y) is the one that generates the highest public debt as a percentage of capital stock (0,54), followed by the deficit target (0,33) and by the debt target (0,08). The government debt in the balanced budget approaches zero in the steady state.

Figure 22 – Government debt relative to the stock of capital under the four fiscal regimes

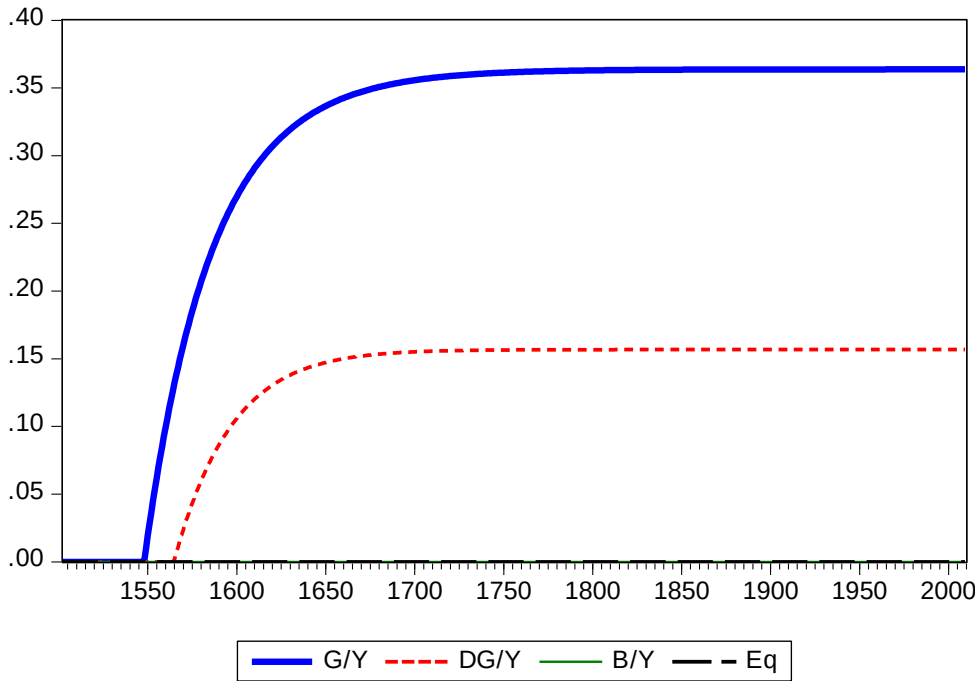


Source: Elaborated by the author.

The following graphs show the distribution of the government's bonds among the sectors described before. The first graph shows the percentage of bonds held by banks relative to the total supply: in the fixed G/Y regime, 36% of government's bonds are held by banks, but only 15% in the fixed DG/Y regime. In the other two regimes (fixed B/Y and balanced budget), no bonds are held by banks. This is a consequence of equations (45) to (47). In the last two regimes, commercial banks have no remaining resources to invest in government bonds. A consequence of this is that they must take central bank advances in order to meet their reserve requirements.

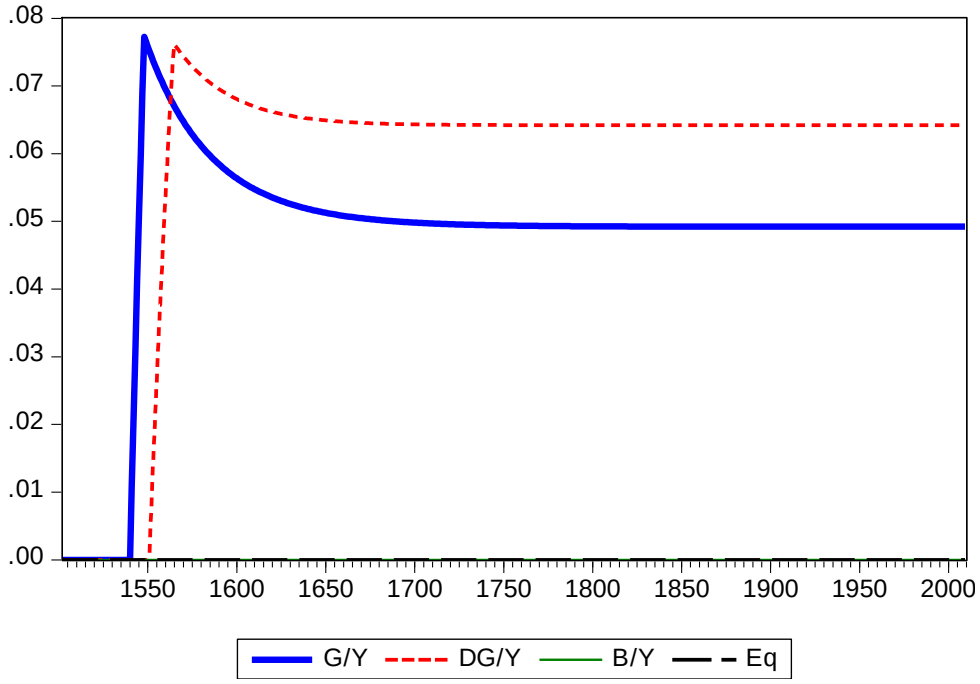
Similar figures appear in the central bank holding of bonds. Note that the central bank was defined as the residual purchaser of bonds, function that it does not need to perform in the B/Y and balanced budget regimes. Households' holdings are the opposite of the first graph: they hold all the government debt in the fixed B/Y and balanced budget regimes, 77% in the fixed DG/Y regime and 58% in the fixed G/Y regime.

Figure 23 - Share of government's bonds held by banks under the four fiscal regimes



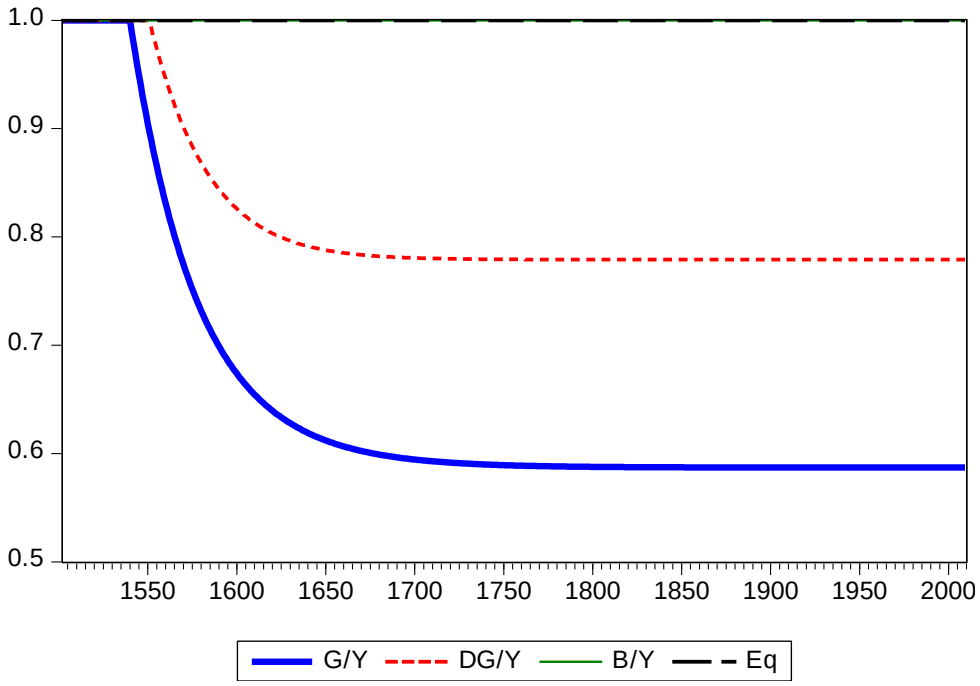
Source: Elaborated by the author.

Figure 24 - Share of government's bonds held by the Central Bank under the four fiscal regimes



Source: Elaborated by the author.

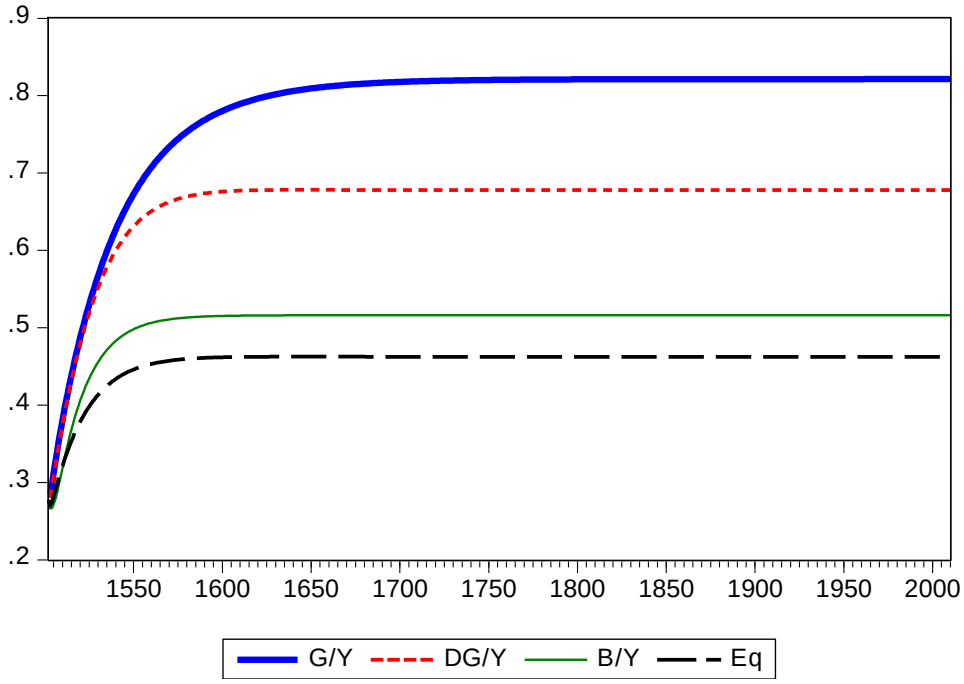
Figure 25 - Share of government's bonds held by households under the four fiscal regimes



Source: Elaborated by the author.

Since government bonds are a significant part of households' wealth, it is expected that the ratio V/K would change through the fiscal regimes. The rank of regimes here is the same outlined above: fixed G/Y in the first position, and the balanced budget regime in the last place.

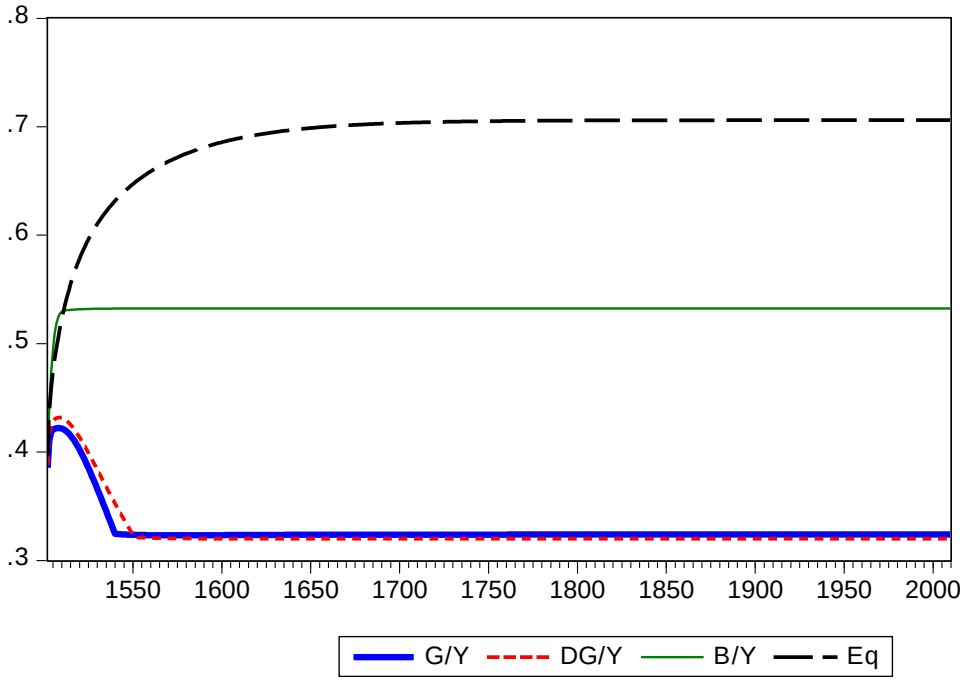
Figure 26 – Households' wealth relative to the stock of capital under the four fiscal regimes



Source: Elaborated by the author.

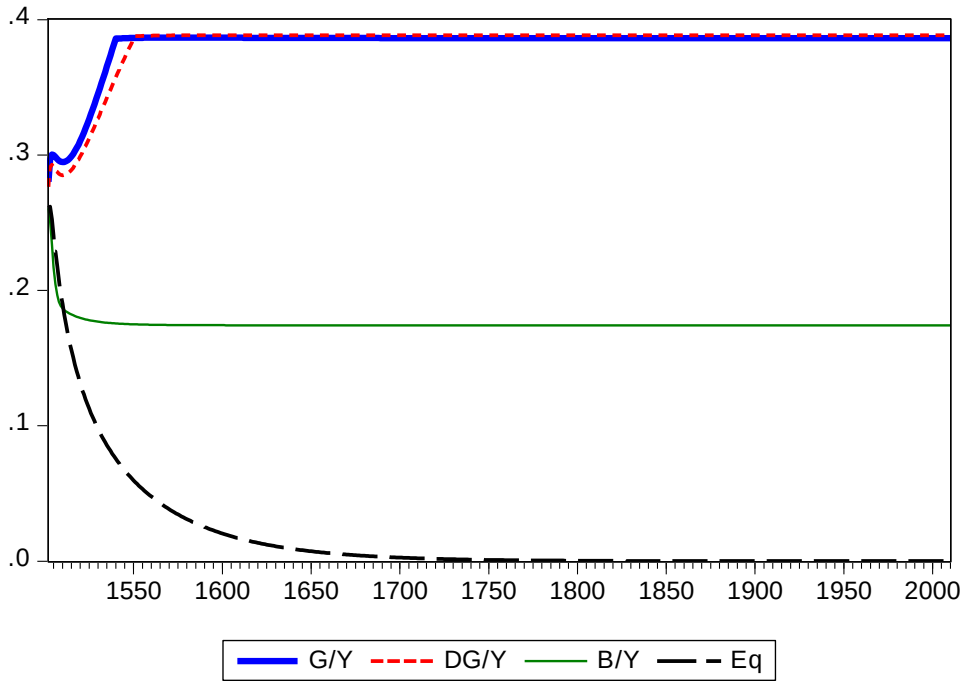
The composition of households' wealth differs under the different scenarios. Banks' deposits have their highest importance under the balanced budget regime. This is a consequence of the simple portfolio choice adopted by the model: households want to hold a fixed proportion of its wealth in the form of government debt; since this debt does not grow, but the wealth does, they must put their resources somewhere else; their demand for equities is fixed; the only flexible element here are the deposits. The graph that represents the proportion of government bonds in their wealth is just the opposite of their deposits' proportion. Equities holdings are roughly the same through the regimes.

Figure 27 – Deposits as share of households' wealth under the four fiscal regimes



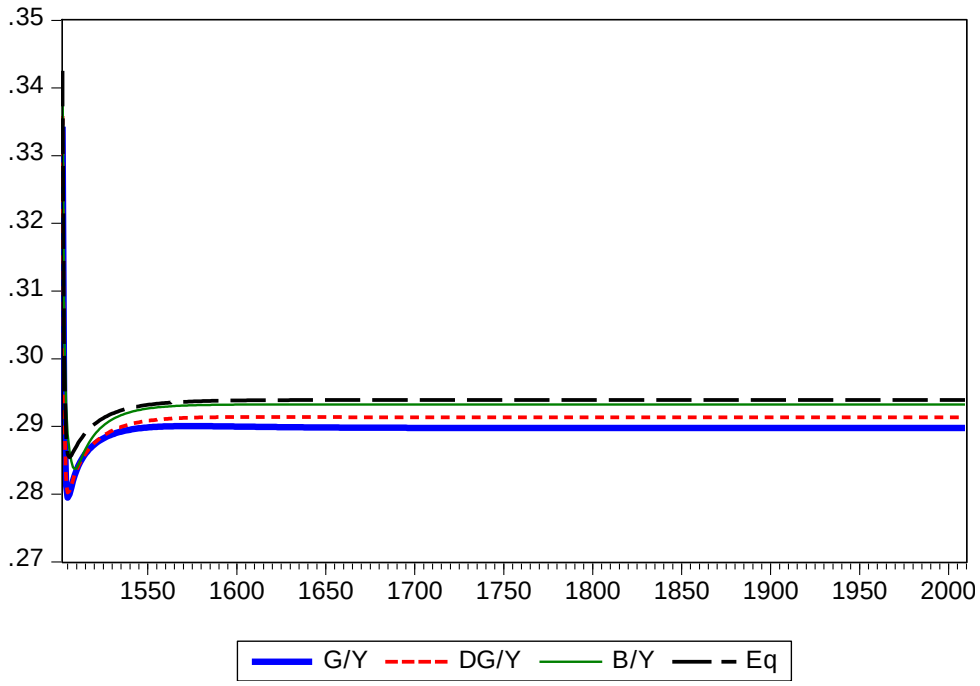
Source: Elaborated by the author.

Figure 28 – Government bonds as share of households' wealth under the four fiscal regimes



Source: Elaborated by the author.

Figure 29 – Equities as share of households' wealth under the four fiscal regimes

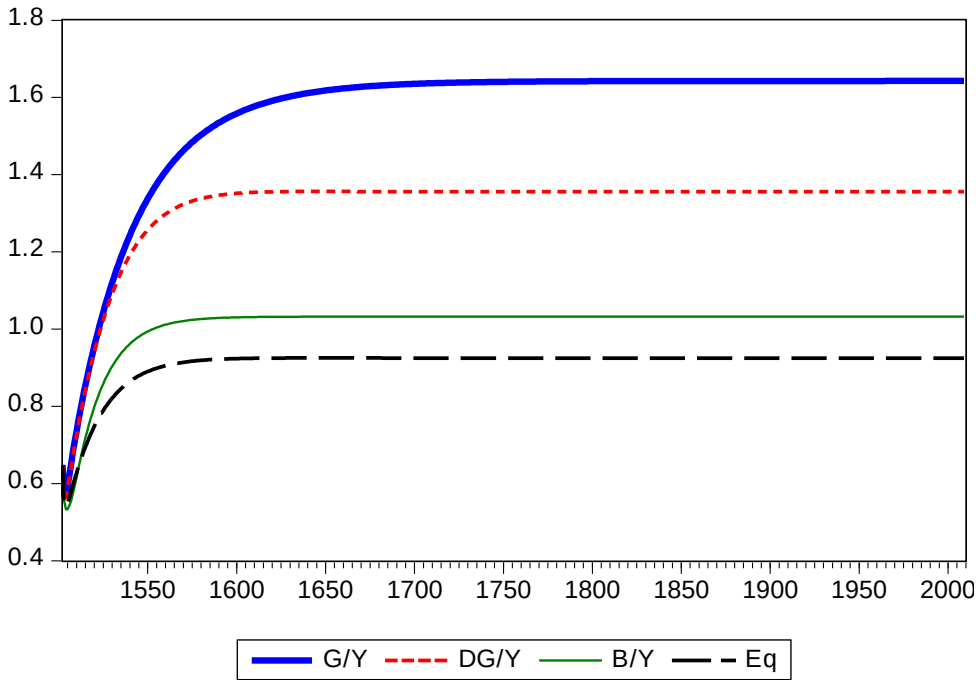


Source: Elaborated by the author.

Note that, for the first two regimes, households increase their holdings of government bonds until it reaches its desired level. In the last two regimes, households are not able to reach its desired holdings of government bonds because there are not enough bonds available to them. In the B/Y regime, this happens because government has a debt target that is below households' demand for bonds. In the balanced budget regime, the government never runs a deficit, and hence there is no supply of new bonds.

Equity prices reach diverse steady state values. The differences are caused by the growth rate of output, which increases households' wealth and thus the demand for equities.

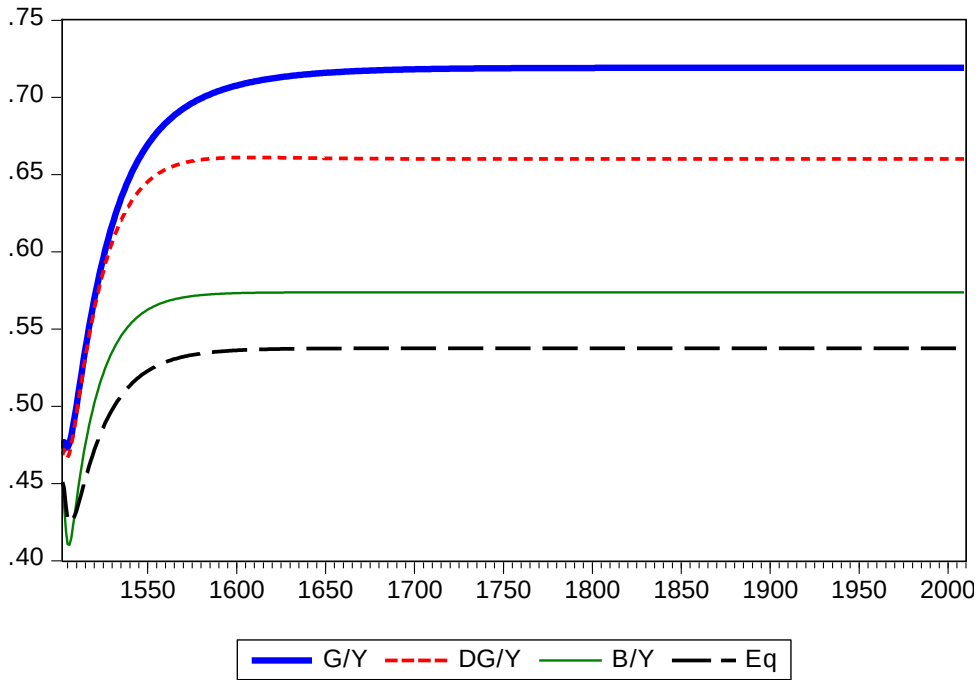
Figure 30 – Equity prices under the four fiscal regimes



Source: Elaborated by the author.

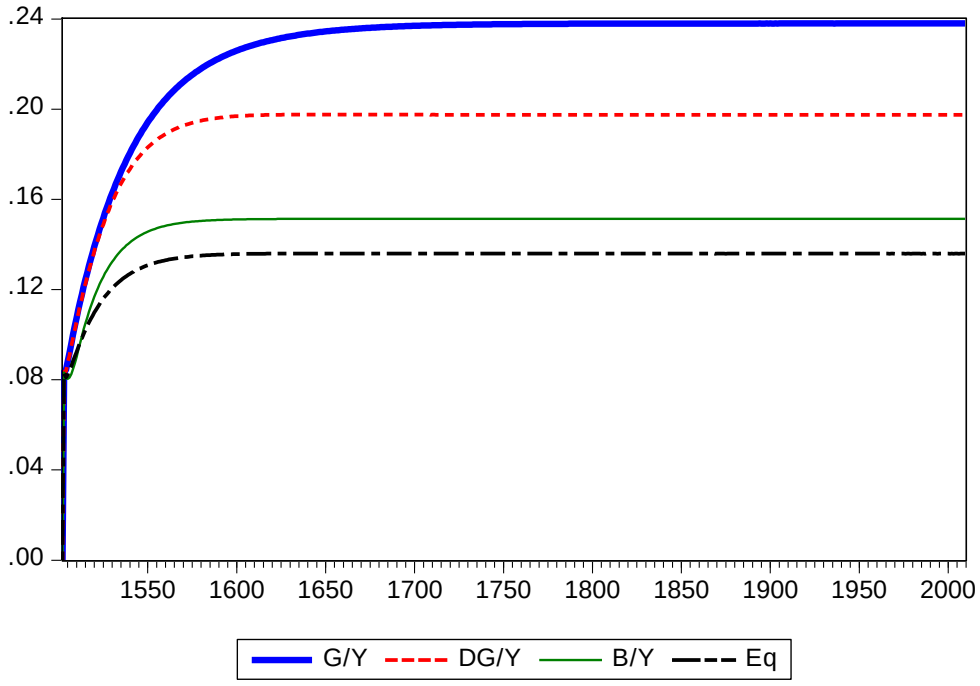
The sources of investment finance are also correlated with economic activity. The highest the growth rate of the economy, the higher the profits, and, thus, the retained profits, which reduces the demand for loans.

Figure 31 – Percentage of investment financed with retained earnings under the four fiscal regimes



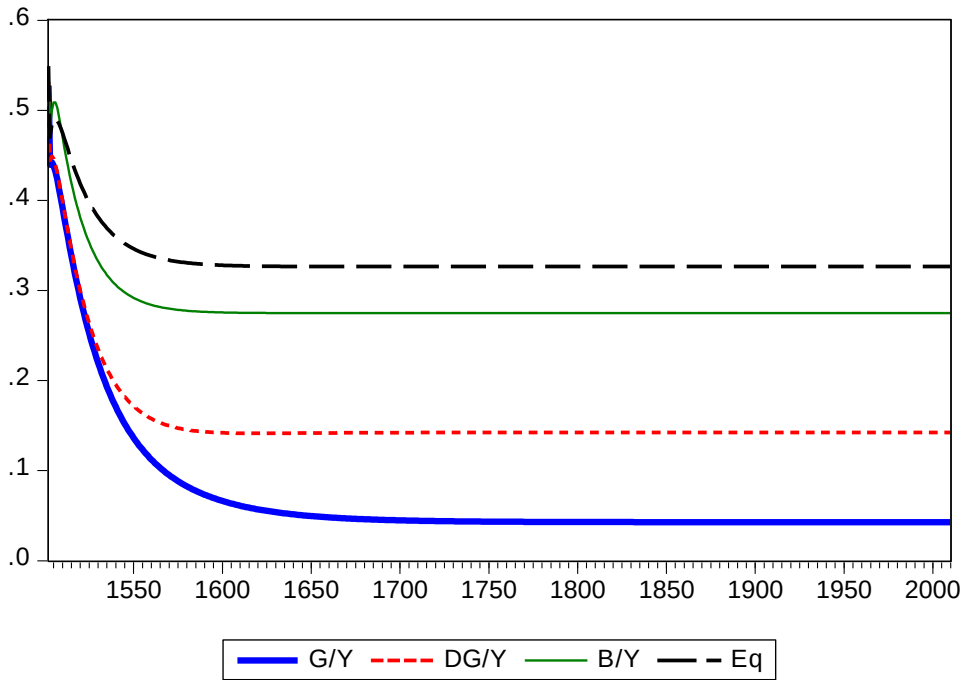
Source: Elaborated by the author.

Figure 32 – Percentage of investment financed with equity issues under the four fiscal regimes



Source: Elaborated by the author.

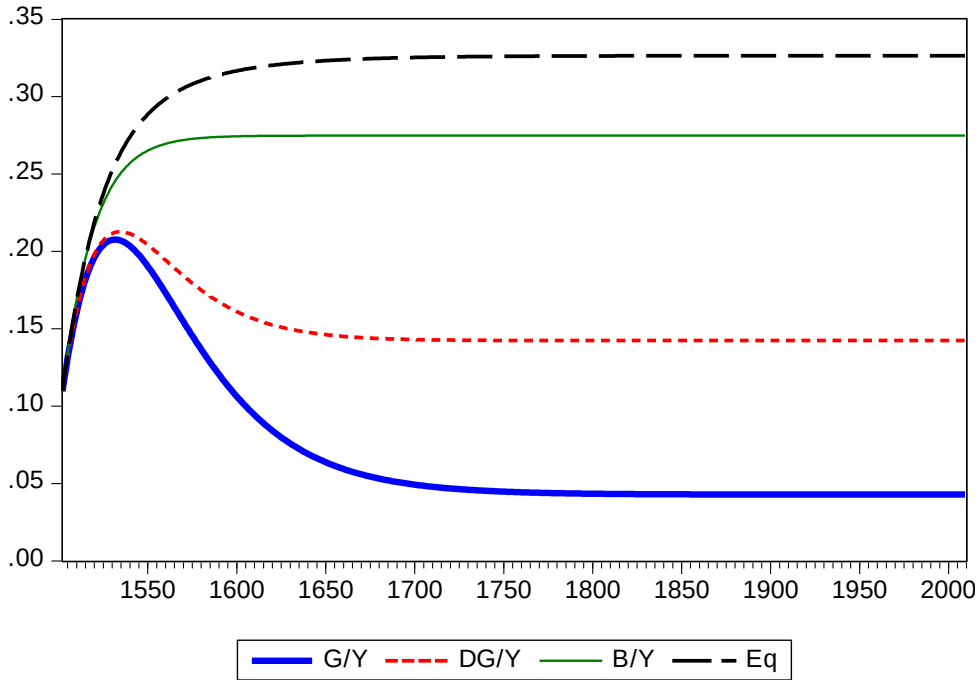
Figure 33 – Percentage of investment financed with loans under the four fiscal regimes



Source: Elaborated by the author.

The differences in the share of investment financed with loans are reflected in the firms' loans to capital ratio (leverage): the G/Y regime has the lowest value (0,04), whereas the balanced budget regime has the highest one (0,32).

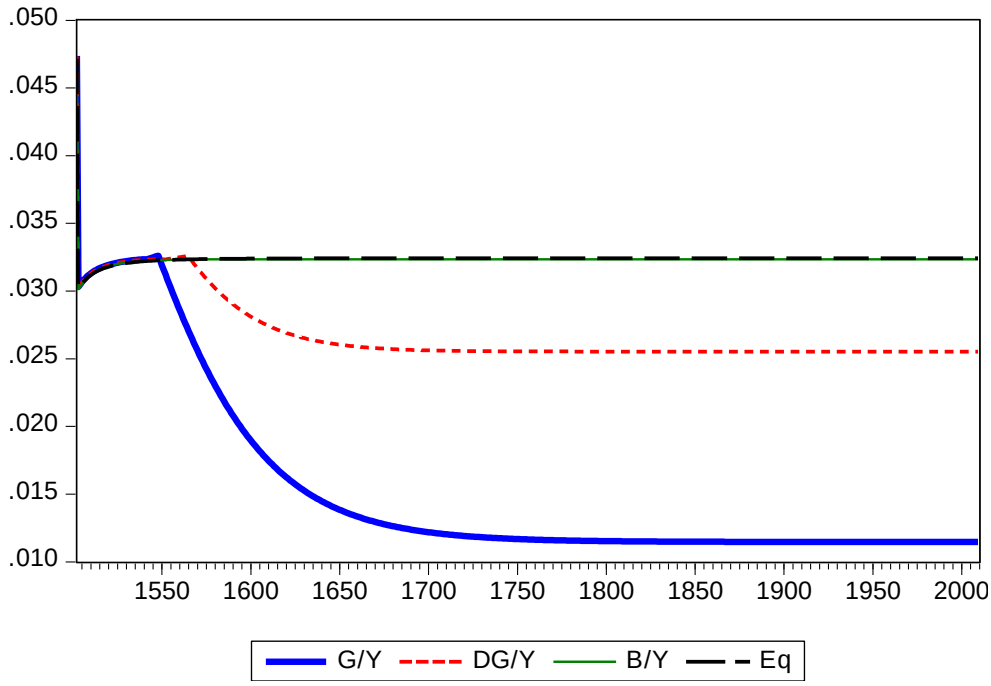
Figure 34 – Firms' debt relative to the stock of capital under the four fiscal regimes



Source: Elaborated by the author.

Firms' indebtedness has impacts on banks' profitability. The regimes that generate lower indebtedness levels also generate lower profitability for banks, here defined as the ratio between profits and assets' holdings (government bonds, high powered money, and loans) or ROA.

Figure 35 – Banks' profits relative to the value of their assets (ROA) under the four fiscal regimes



Source: Elaborated by the author.

It is possible to summarize all the relationships analyzed above. The first regime, in which the government seeks to maintain a fixed proportion of spending relative to GDP, is the one that generates the highest growth rate and, consequently, the highest capacity utilization rate, and the highest firm's profitability. The behavior of the latter results in the lowest loan to capital ratio, since firms generate more internal resources to finance their investment. A lower firm indebtedness (leverage) reduces banks' profitability. A consequence of the maintenance of government expenditures as a constant share of output, regardless of any deficit or debt size considerations, is the relatively big size of its debt, which is the highest among the four regimes. Since government debt is also private wealth, this higher debt level has its counterpart in a higher ratio of financial wealth to the stock of capital.

The opposite happens in the balanced budget regime. Lower government consumption causes a lower growth rate. This is reflected in lower capacity utilization and meager firms' profits, which reduces its internal resources, forcing them to use more loans as a mean to finance investment. The consequence of this is a higher profitability for banks. Since the government budget is balanced, it does not generate deficits and new debts. Households' wealth to capital ratio is the lowest one in this regime.

4.3 THE FOUR FISCAL REGIMES UNDER ADVERSE SHOCKS

In this section, the four fiscal regimes are subject to adverse exogenous shocks. The objective here is to analyze their resilience and their capacity to return to the previous steady state after the shock. In order to better analyze the volatility that accompany the shocks, all the steady states variables will be normalized to the same value, starting at 100. Thus, the reader must bear in mind that the steady state levels differ markedly between the regimes, as was discussed in the previous section, but here the analysis is about the changes relative to the original steady state.

4.3.1 An increase in the Perceived Degree of Uncertainty

The first shock to be analyzed is an increase in PDU after the steady state is reached, which happens after 300 periods (thus, in "1800"). The PDU will raise from 0,2 to 0,4. The response of the growth rate of output to the shock ranges from a deceleration in the G/Y and DG/Y regimes to a couple of recessionary periods in the B/Y and balanced budged regimes.

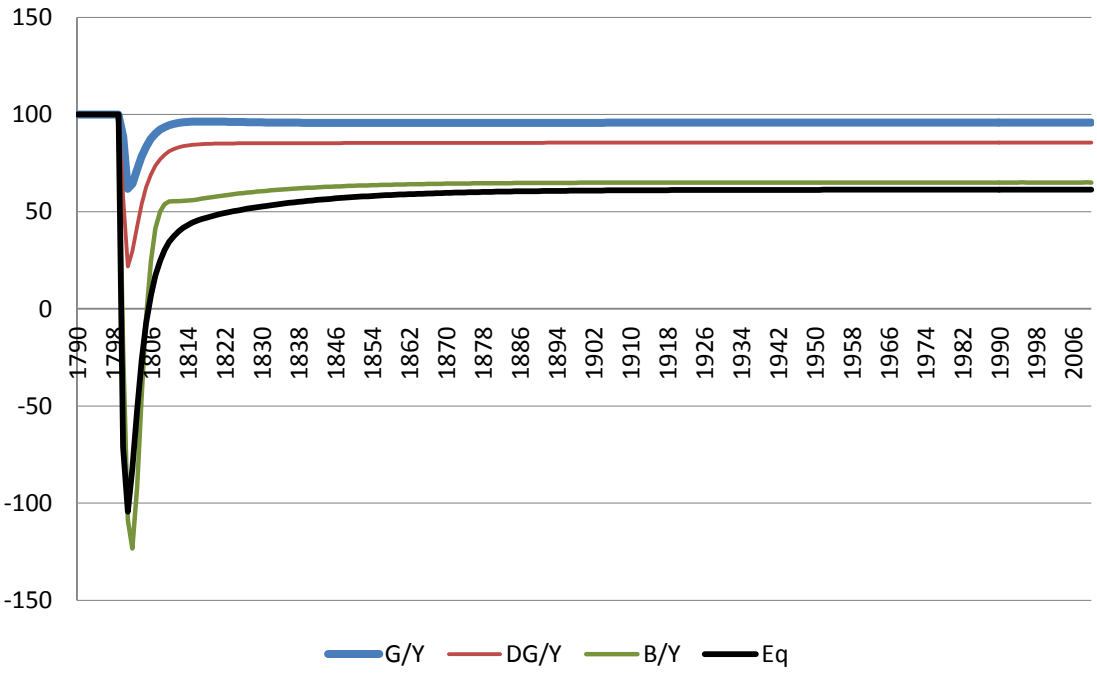
In the G/Y regime, the slowdown is caused by smaller investment rates, induced by the reduction inβ_0. The consumption of households and government, however, remains untouched, stimulating a faster recovery of the growth rate. As a consequence, via accelerator, the desired investment level also recovers. Note that the higher PDU reduces equities prices, cutting down a significant part of the investment's financing. The combination of falling equities prices and growing investment makes firms' demand for loans increase. This effect is so strong that it outpaces the higher credit rationing induced by the higher PDU. However, as the economic recovery keeps going, the retained profits and the equities prices start to increase, both effects contributing to the higher credit rationing to reduce the loans to capital ratio.

In the DG/Y regime, the cause of the economic deceleration is the same: a reduced investment demand. The government spending is also smaller, since the government purchases in this regime depend on the tax earnings, which decelerates with the output. These two effects explain why this regime achieves a smaller steady state output growth rate after the shock. This weaker recovery is reflected in the loans to capital ratio, which has a distinct behavior when compared to the previous regime.

The growth rate of output in the fixed B/Y regime falls to negative values, indicating a temporary recession. This is caused, in a first moment, by the fall in investment and in

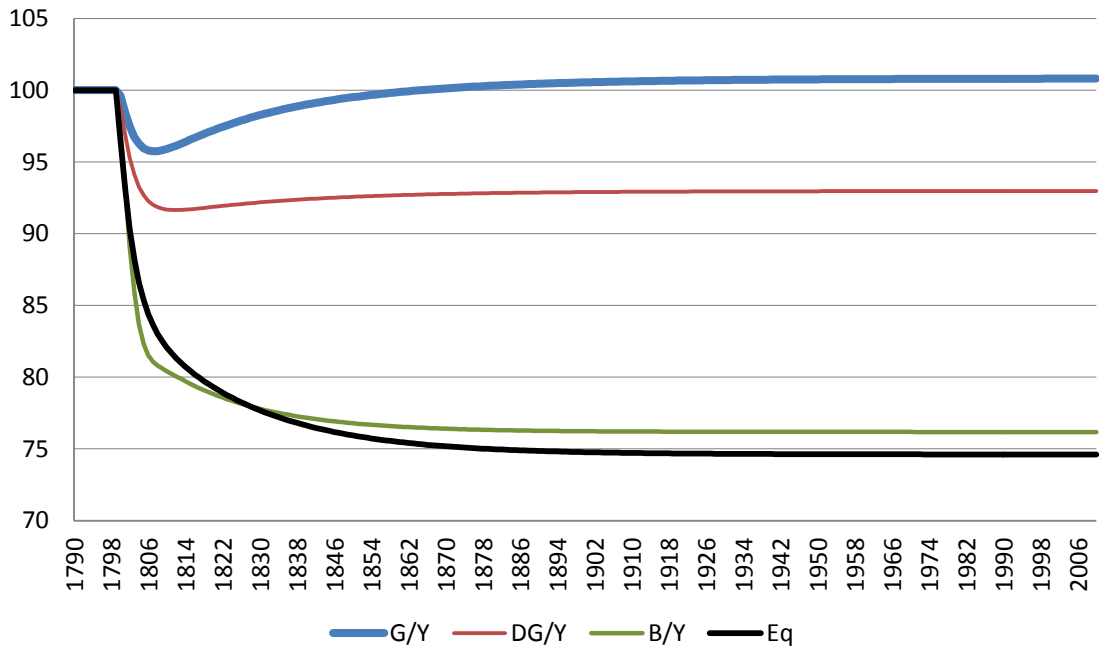
government consumption, in the same way that it happened in the previous regime. Nonetheless, in this case, the magnitude is higher, producing a fall in output. This generates a fall in households' consumption in the next periods, since it depends on the lagged output. The same process happens in the balanced budget regime.

Figure 36 – Growth rate of output with a higher PDU under the four fiscal regimes



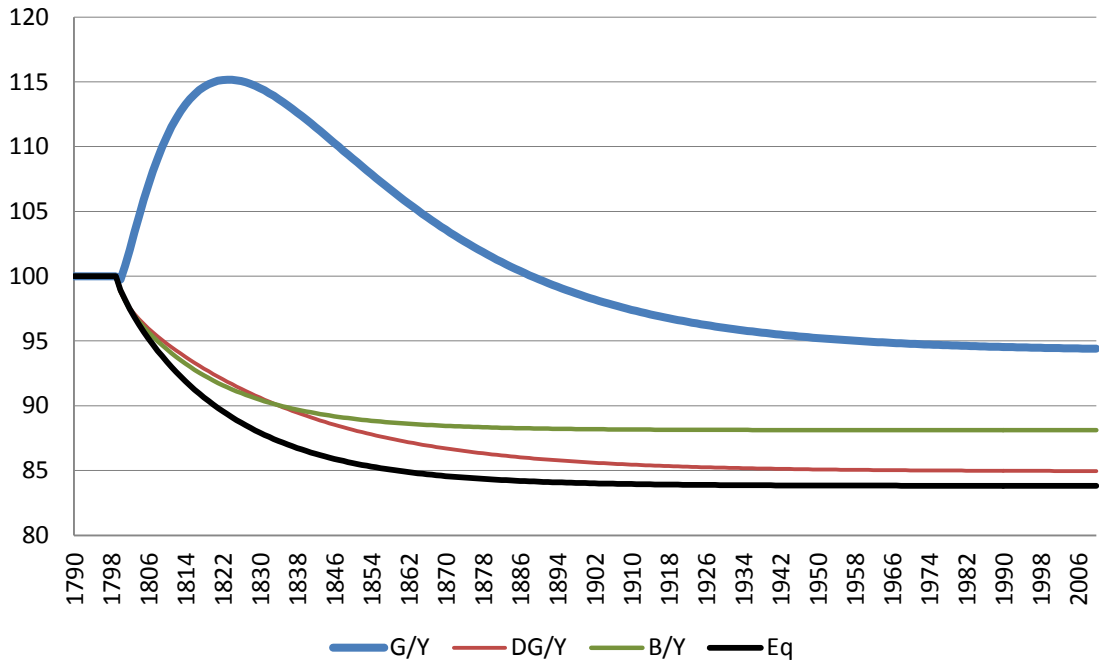
Source: Elaborated by the author.

Figure 37 – Capacity utilization with a higher PDU under the four fiscal regimes



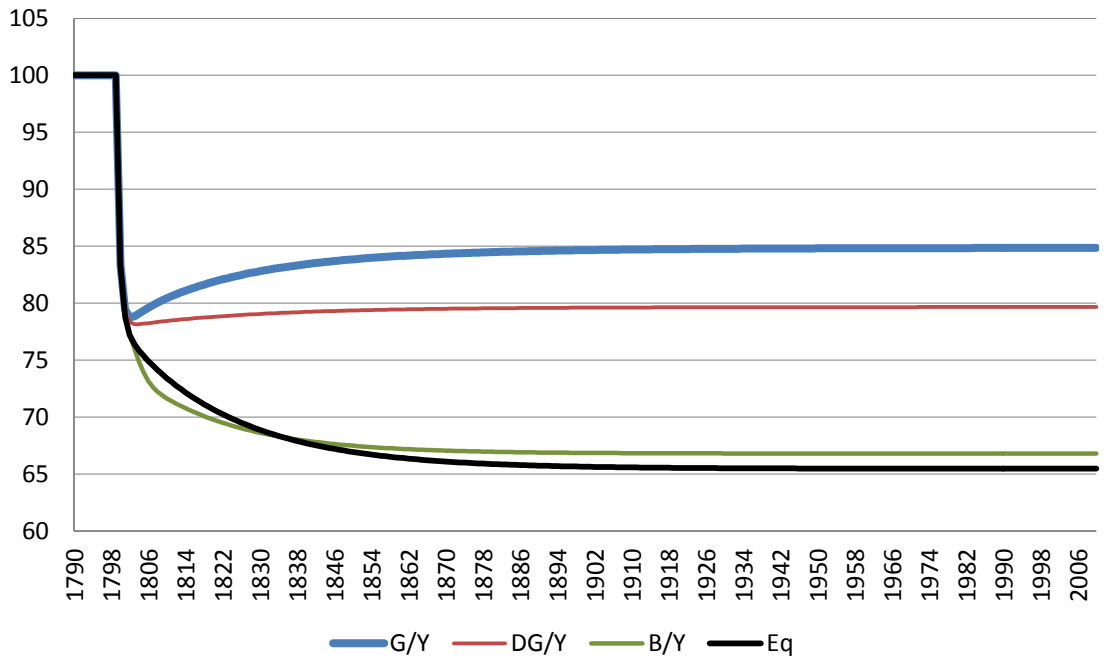
Source: Elaborated by the author.

Figure 38 – Loans to capital ratio with a higher PDU under the four fiscal regimes



Source: Elaborated by the author.

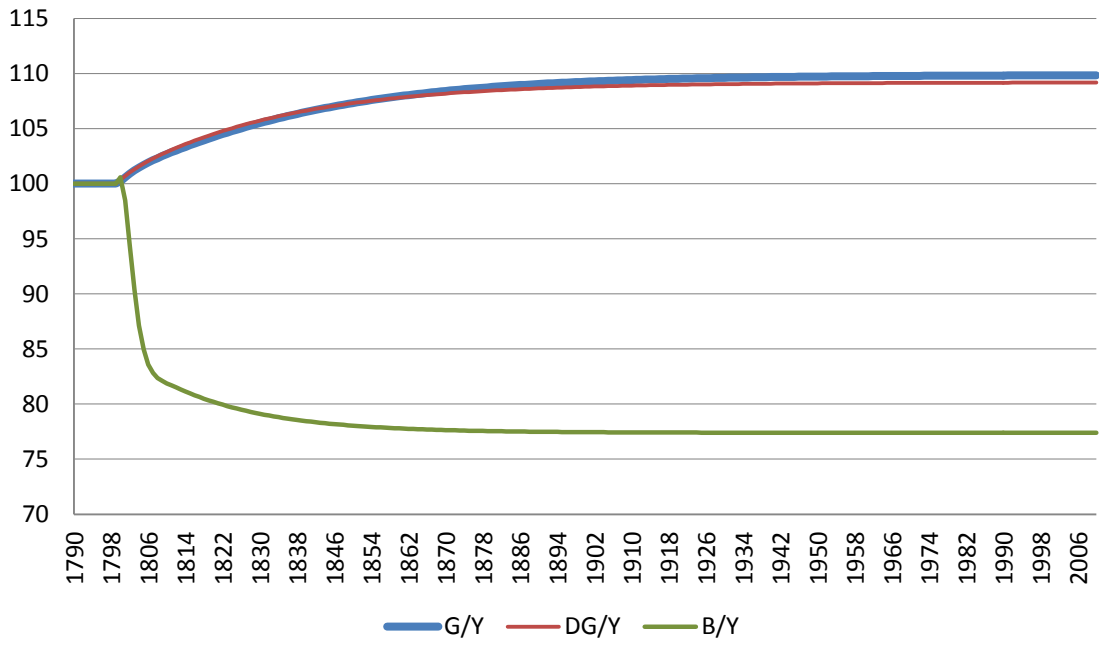
Figure 39 – Equity prices with a higher PDU under the four fiscal regimes



Source: Elaborated by the author.

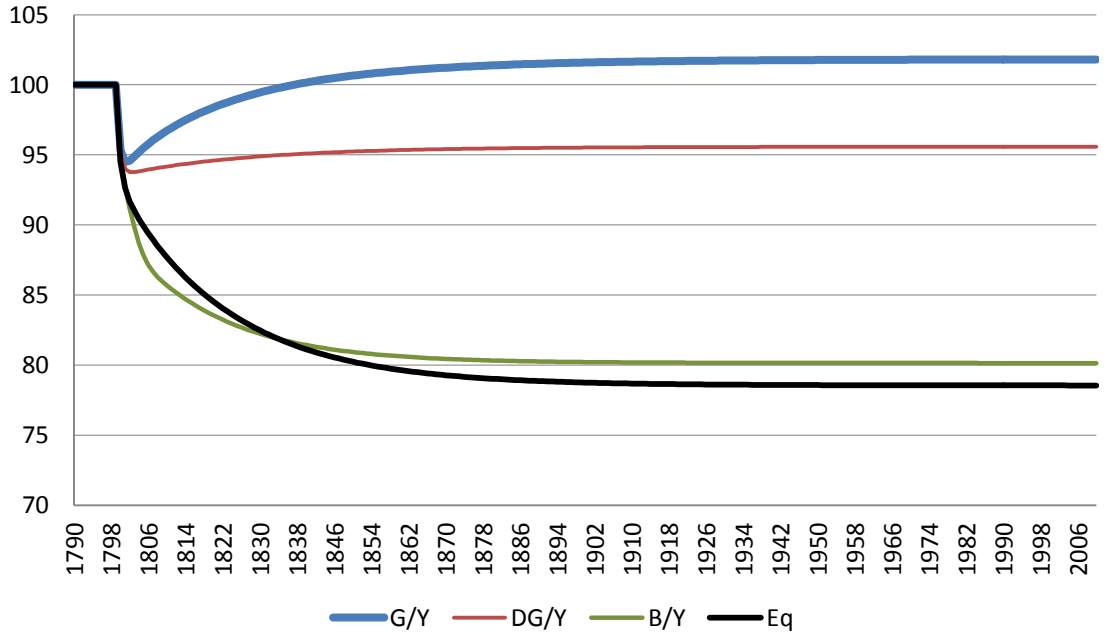
The government debt relative to the stock of capital grows in the first two regimes, a result produced by the countercyclical role of government spending. The opposite happens in the fixed B/Y regime. The households' wealth relative to the stock of capital falls because equity prices fall. In the first two regimes, the growing B/K relation induces a recovery of the V/K relation. In the last two regimes, however, the opposite happens.

Figure 40 – Government debt relative to the stock of capital with a higher PDU under the four fiscal regimes[8]



Source: Elaborated by the author.

Figure 41 – Households' wealth relative to the stock of capital with a higher PDU under the four fiscal regimes



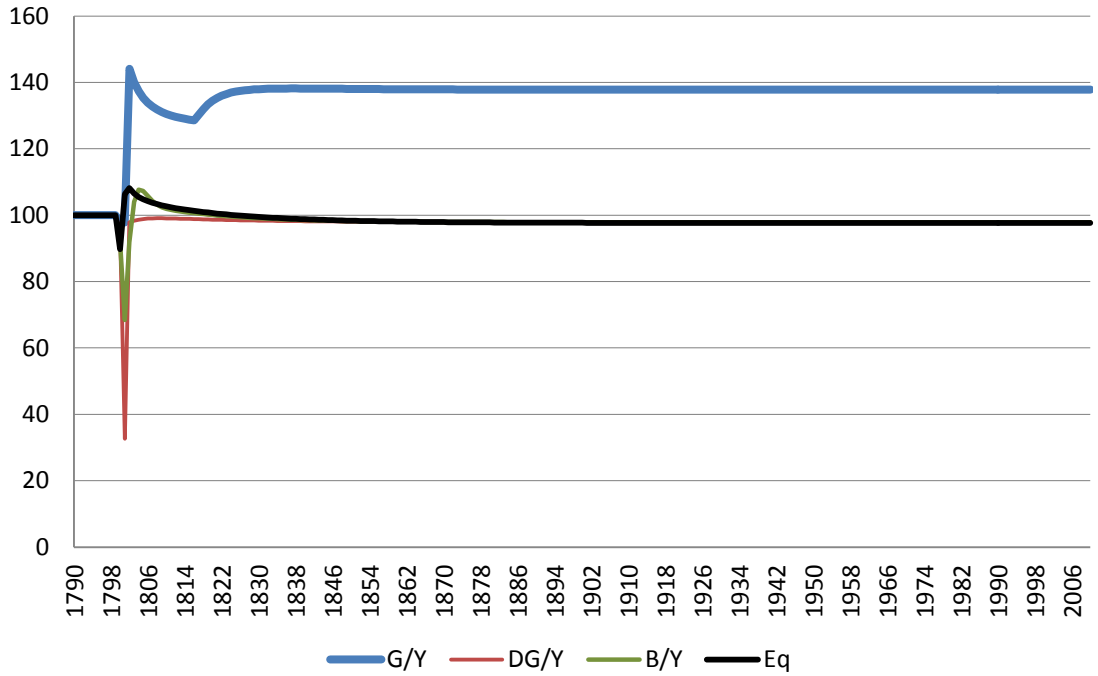
Source: Elaborated by the author.

8 The B/K relation for the balanced budget regime was omitted in the graph, since it converges to zero before the shock

4.3.2 An increase in the interest rate

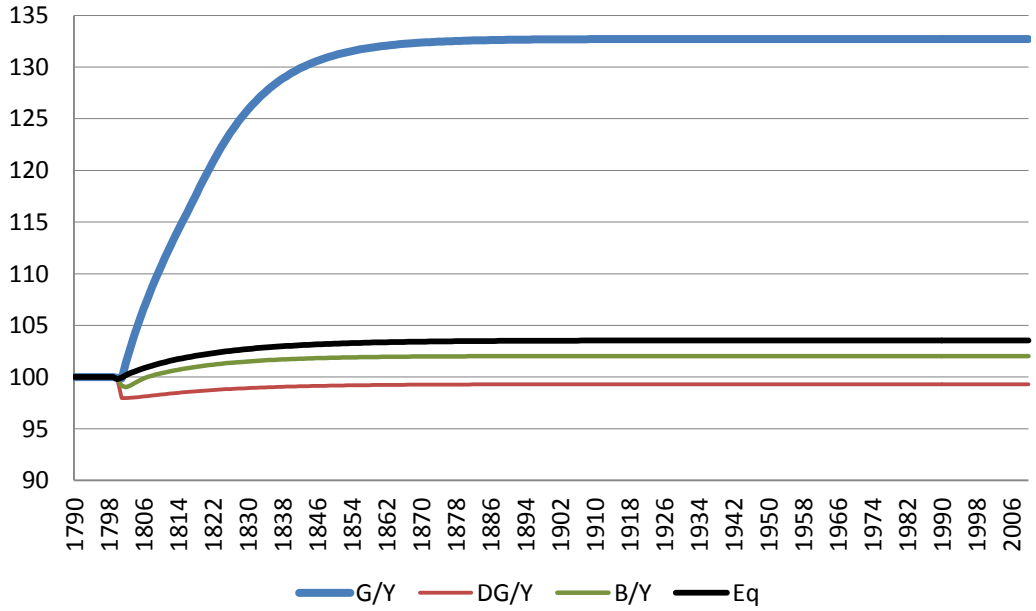
The second experiment is an increase in the interest rate, which raises permanently from 0,02 to 0,04 in "1800". The G/Y regime exhibits a strong increase in the growth rate of output after a brief recession. This is caused by the flow of interest payments that goes to households, fueling consumption and then economic growth. This phenomenon does not happen in the other regimes because the interest payments enter with a negative sign in the equations of government spending. Thus, a consequence of higher interest payments is a reduction in government purchases, leaving the growth rates almost untouched in the long run. The consequence of this higher growth rate in the first regime is an increase both in equity prices and in firms' profits. This eliminates the necessity to use loans as a mean to finance investment.

Figure 42 – Growth rate of output after a shock in the base interest rate under the four fiscal regimes



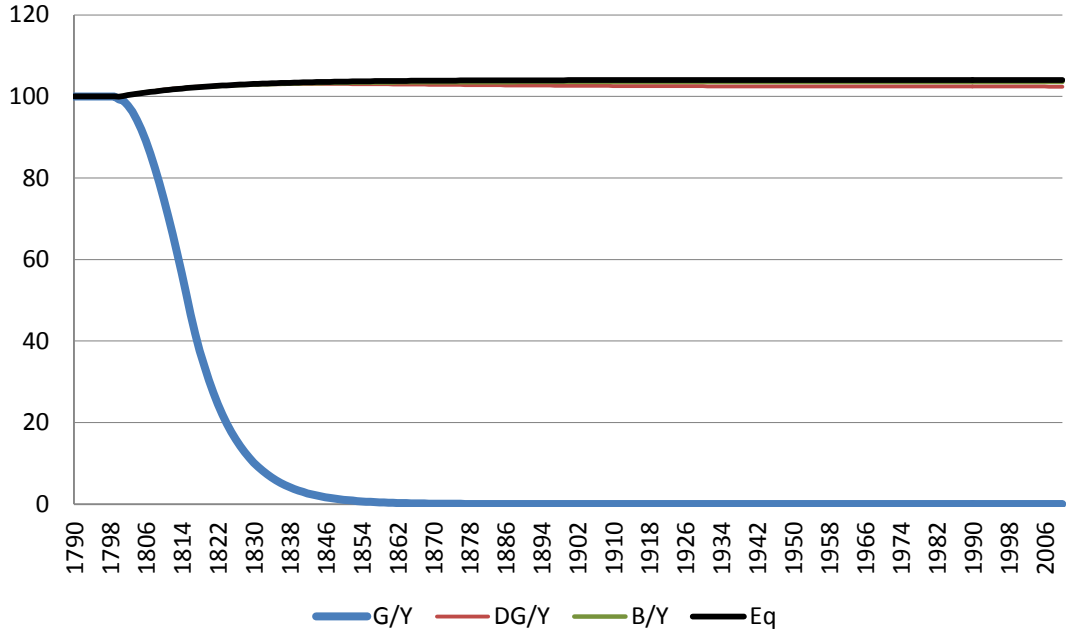
Source: Elaborated by the author.

Figure 42 – Capacity utilization after a shock in the base interest rate under the four fiscal regimes



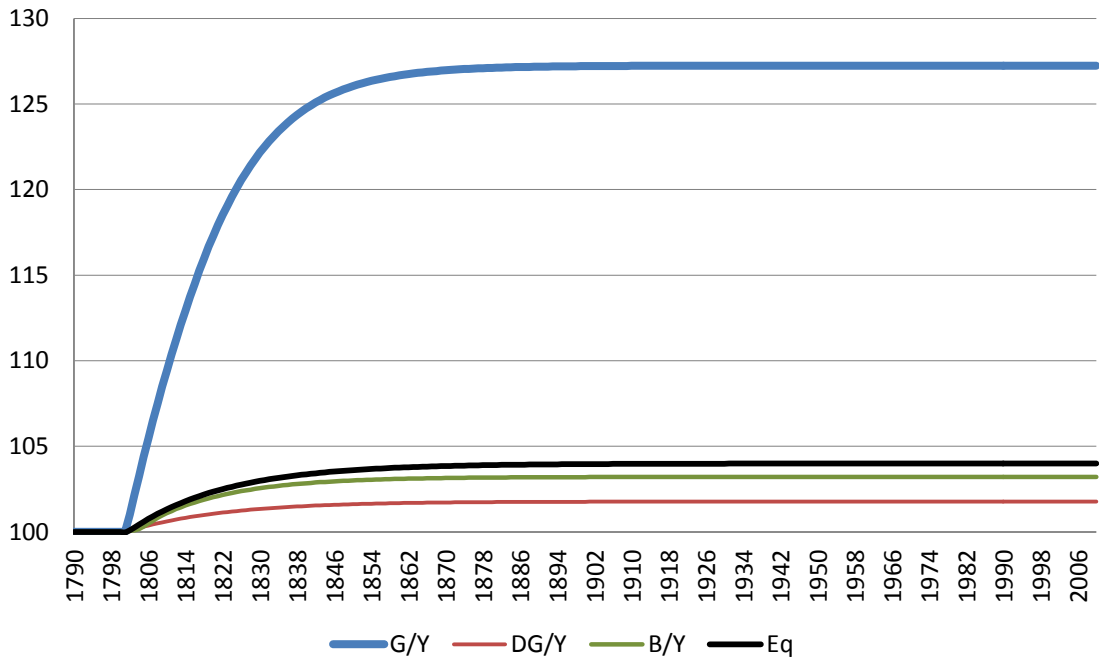
Source: Elaborated by the author.

Figure 43 – Loans to capital ratio after a shock in the base interest rate under the four fiscal regimes



Source: Elaborated by the author.

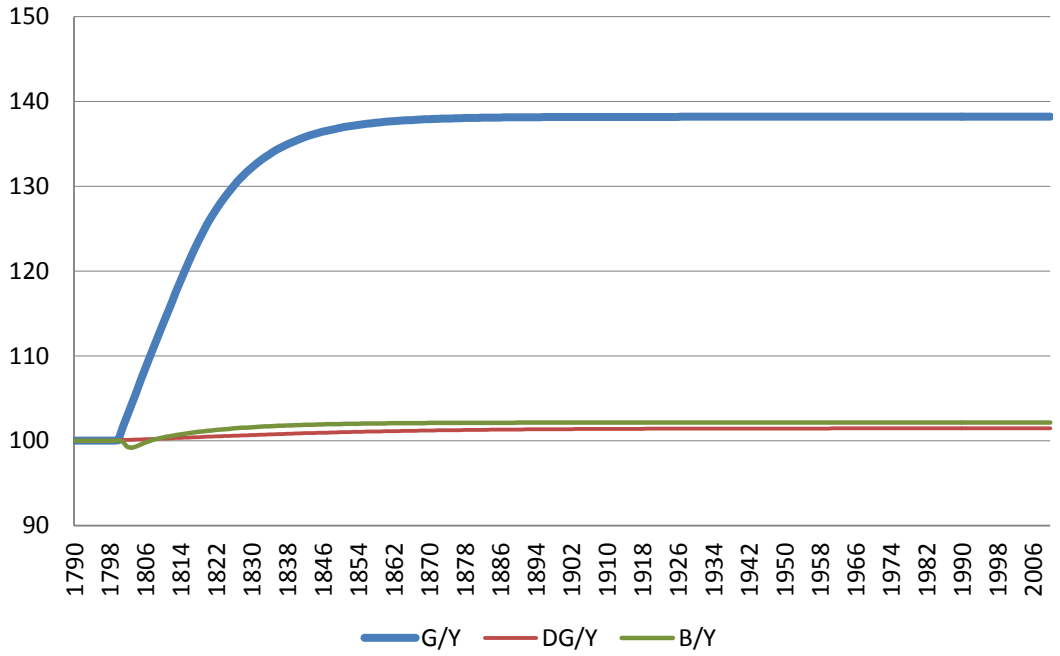
Figure 44 – Equity prices after a shock in the base interest rate under the four fiscal regimes



Source: Elaborated by the author.

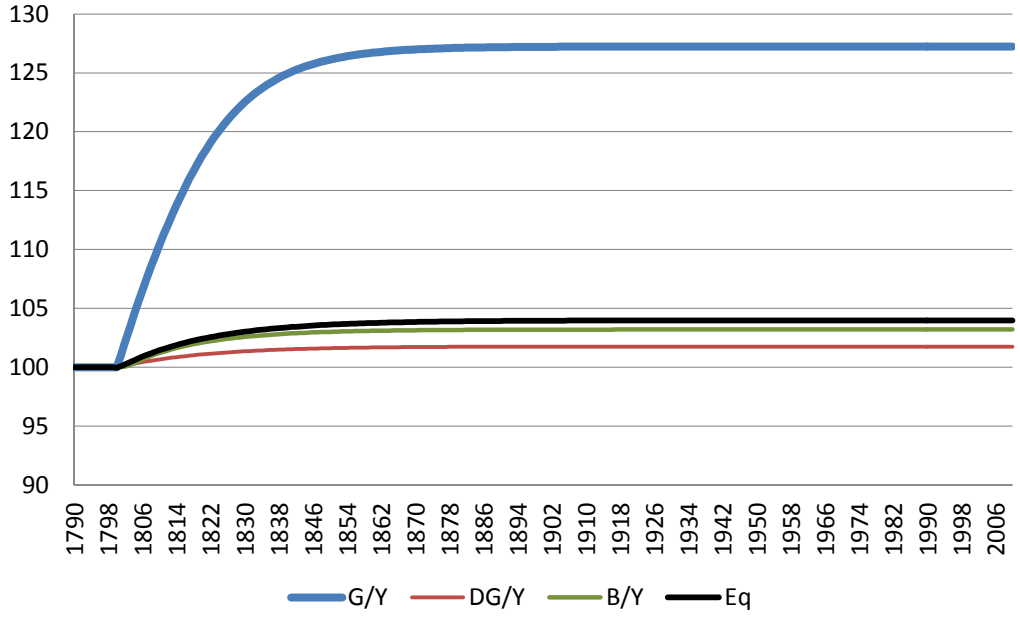
The payment of interest, along with government purchases, makes the ratio of government debt relative to the stock of capital grow in the G/Y regime. This, together with higher equity prices, explain the higher wealth to capital ratio in this regime.

Figure 45 – Government debt relative to the stock of capital after a shock in the base interest rate under the four fiscal regimes



Source: Elaborated by the author.

Figure 46 – Households' wealth relative to the stock of capital after a shock in the base interest rate under the four fiscal regimes

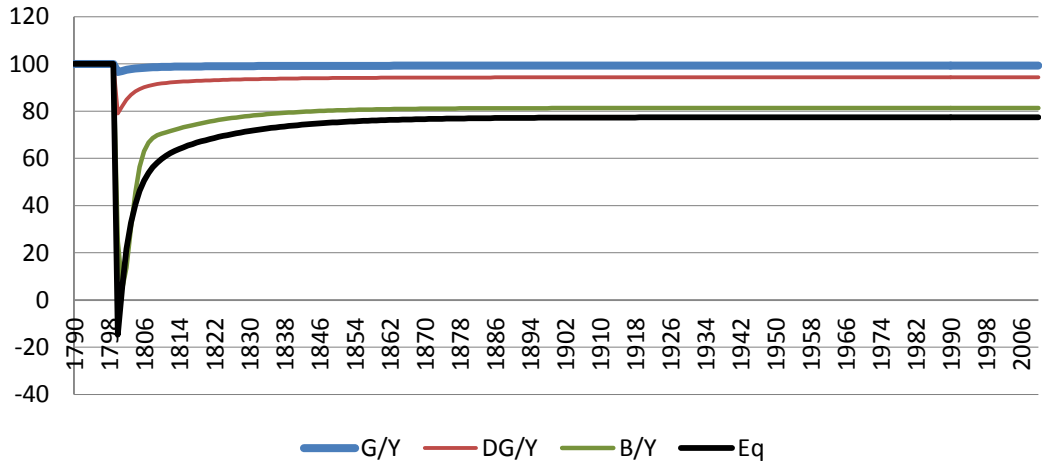


Source: Elaborated by the author.

4.3.3 A deleveraging process

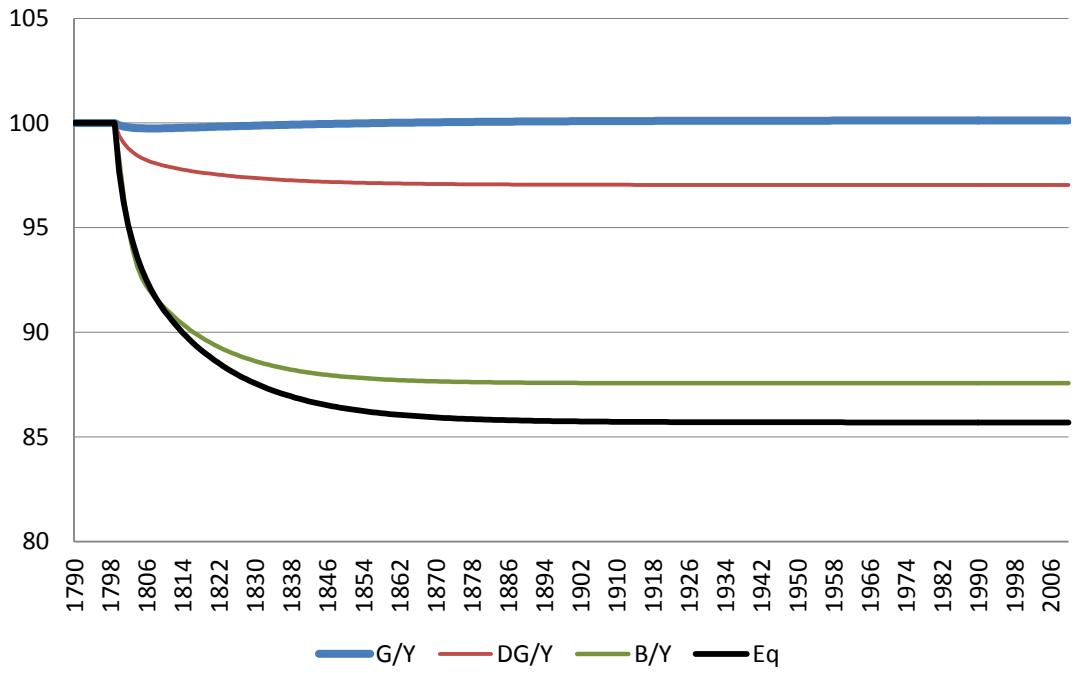
The third experiment is a deleveraging process for firms, captured by an increase in the repayments ratio (rep), which goes from 6,5% to 13%. The worst scenario is the balanced budget regime, in which the output growth rate fells abruptly and then stabilizes below its previous level. The G/Y regime is left almost untouched. It is easy to understand these differences: the bulk of investment financing in the G/Y regime comes from retained profits, whereas loans do this role in the other regime. If the repayment ratio goes up, investment financing is significantly cut down, reducing output, tax receipts, and government expenditures. If the growth rate becomes negative (as it is the case in the last regime), households' consumption also falls, because it is based on lagged income.

Figure 47 – Growth rate in a deleveraging context under the four fiscal regimes



Source: Elaborated by the author.

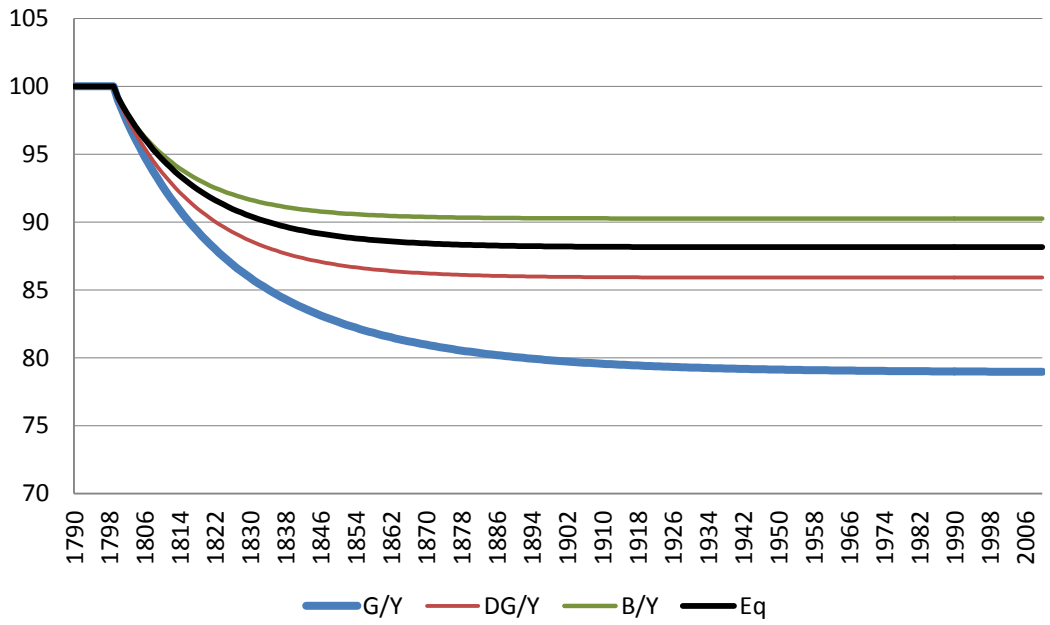
Figure 48 – Capacity utilization in a deleveraging context under the four fiscal regimes



Source: Elaborated by the author.

The loans to capital ratio differs among the fiscal regimes, mainly due to the differences in the output response. In the G/Y regime, the deleveraging occurs in a growing context, thus reducing the L/K ratio. In the balanced budget regime, however, the lower growth rates makes the deleveraging process less effective.

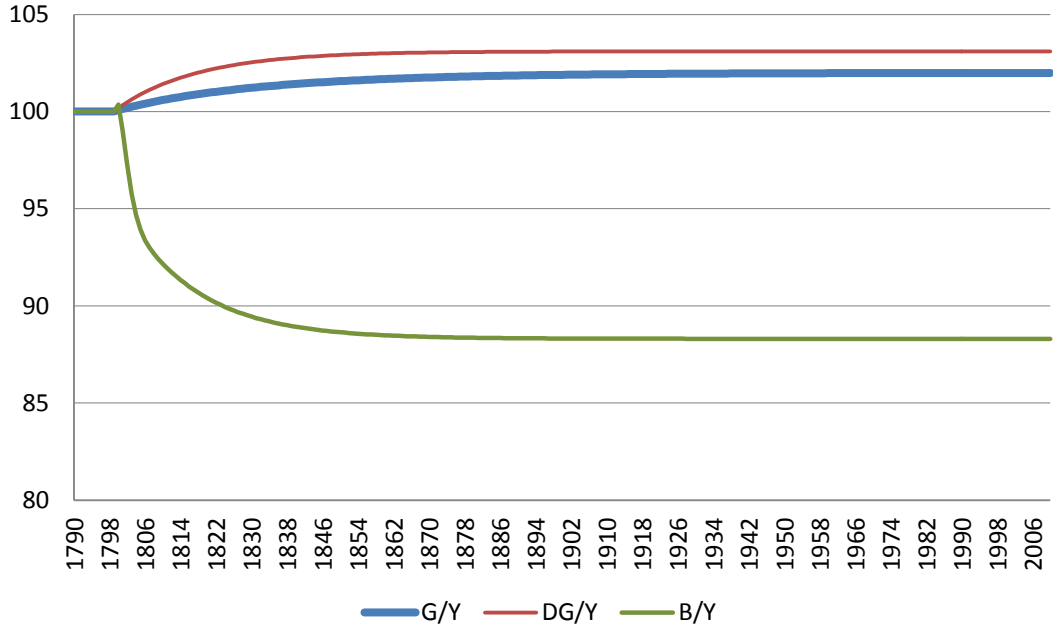
Figure 49 – Loans to capital ratio in a deleveraging context under the four fiscal regimes



Source: Elaborated by the author.

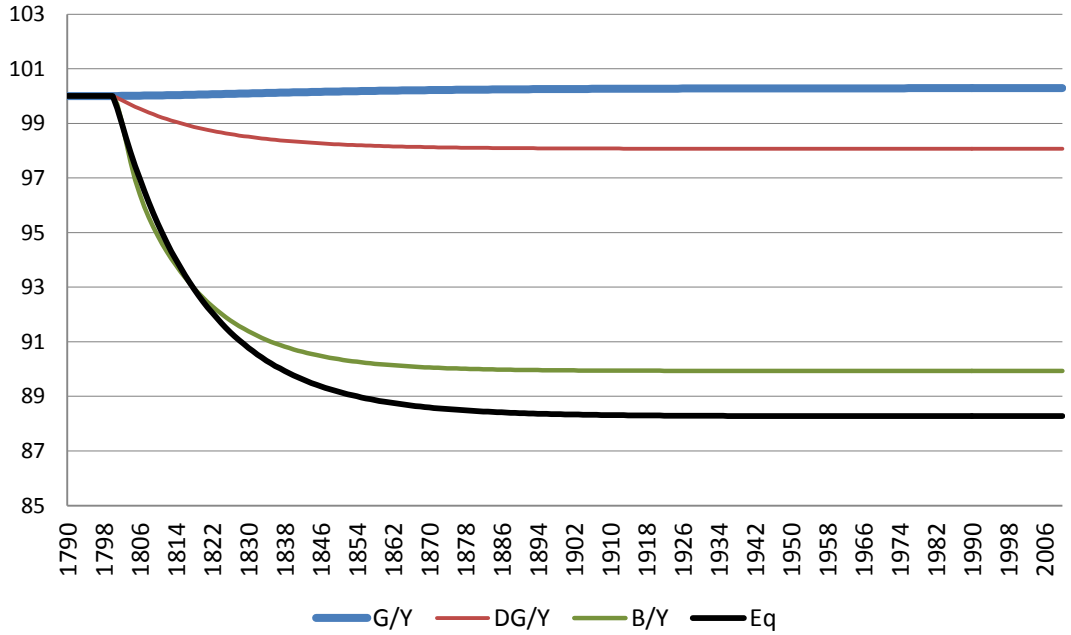
The government debt relative to the stock of capital fell in the fixed B/Y regime. This is due to the economic slowdown, which reduces the target level of indebtedness relative to the baseline, thus decreasing the ratio. The households' wealth to capital ratio decreases in the last three regimes due to a combination of reduced government debt and falling equity prices.

Figure 50 – Government debt relative to the stock of capital in a deleveraging context under the four fiscal regimes



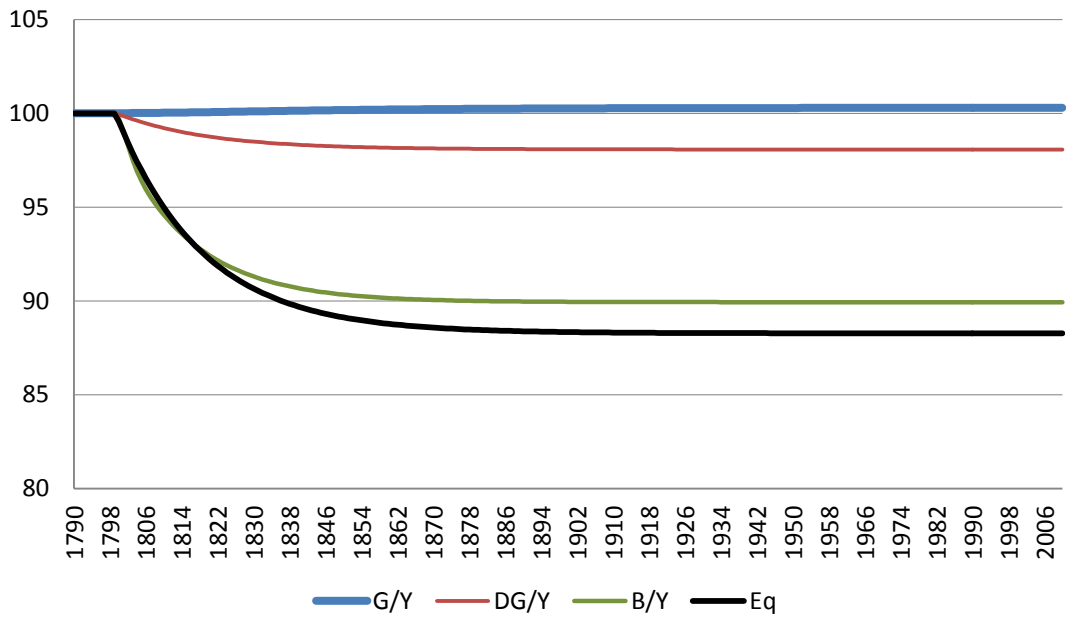
Source: Elaborated by the author.

Figure 50 – Equity prices in a deleveraging context under the four fiscal regimes



Source: Elaborated by the author.

Figure 51 – Household wealth relative to the stock of capital in a deleveraging context under the four fiscal regimes



Source: Elaborated by the author.

4.4 SHIFTING TO A CONTRACTIONARY FISCAL REGIME

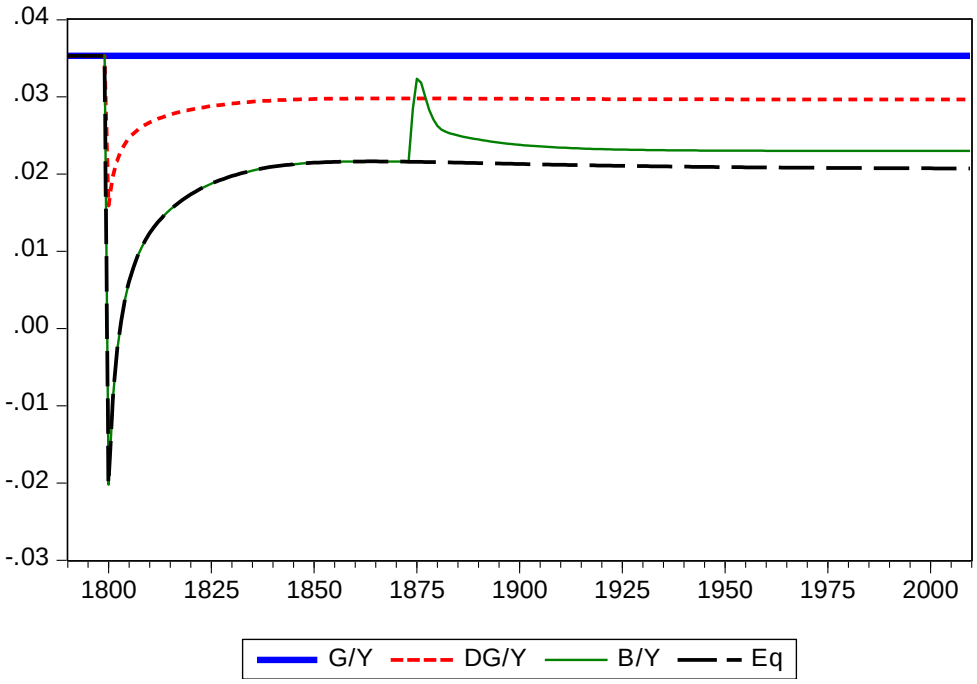
The objective of this section is to analyze the consequences of a shift in the fiscal regime. The model will be run with the G/Y regime until it reaches a steady state. Then, the regime will be changed, either to DG/Y, B/Y or balanced budget. The results will be compared with the steady state of the previous regime.

In the shift from G/Y to B/Y regime, a simplifying assumption was made. The value of B_{-1} in the period of the shift is well above the value of B^T, resulting in a negative *DG*. The magnitude of this negative value is higher than the other components of government budget, causing a negative *G* (see equations (76) to (79)). In order to avoid this inconsistency, a logical function was introduced in the computer simulation that eliminates negative values of *DG*. Thus, in the periods when the *DG* variable would assume negative values, it in fact assumes a value equal to zero, forcing the government expenditures to be $G = T + F_{cb} - (r_{b-1}B_{-1})$.

The steady state growth rate for the G/Y regime (3,5%) is higher than the one achieved by the other regimes. Both the B/Y and the balanced budget regimes present a significant fall in the growth rate. Their similar evolution in the first period is due to the logical function

described above. When the DG variable becomes positive, the government expenditures are allowed to increase, resulting in a higher growth rate.

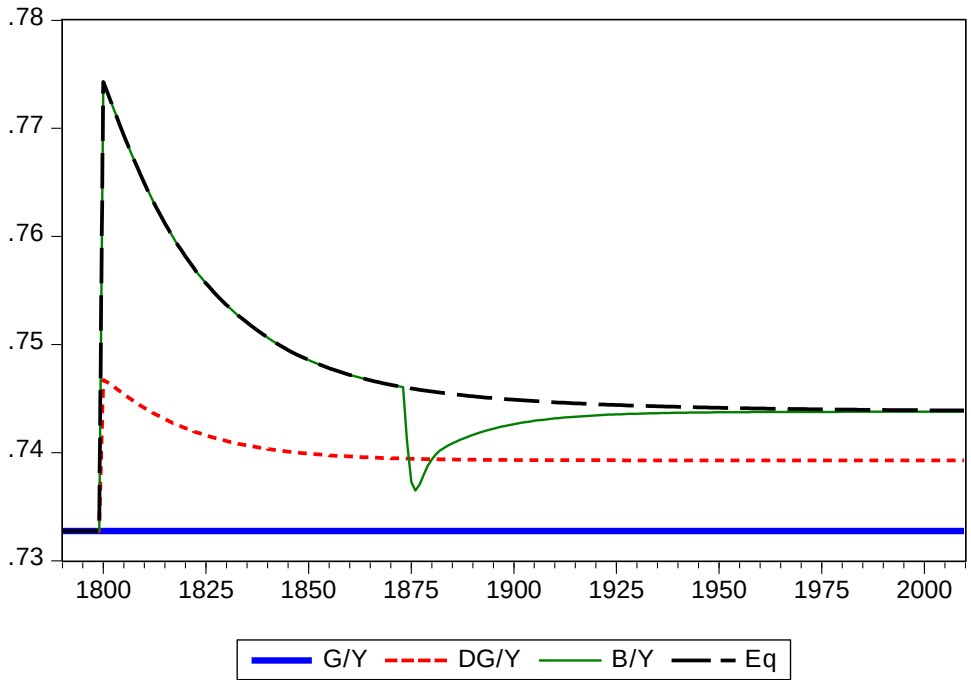
Figure 52 – Output growth rates after a fiscal regime shift



Source: Elaborated by the author.

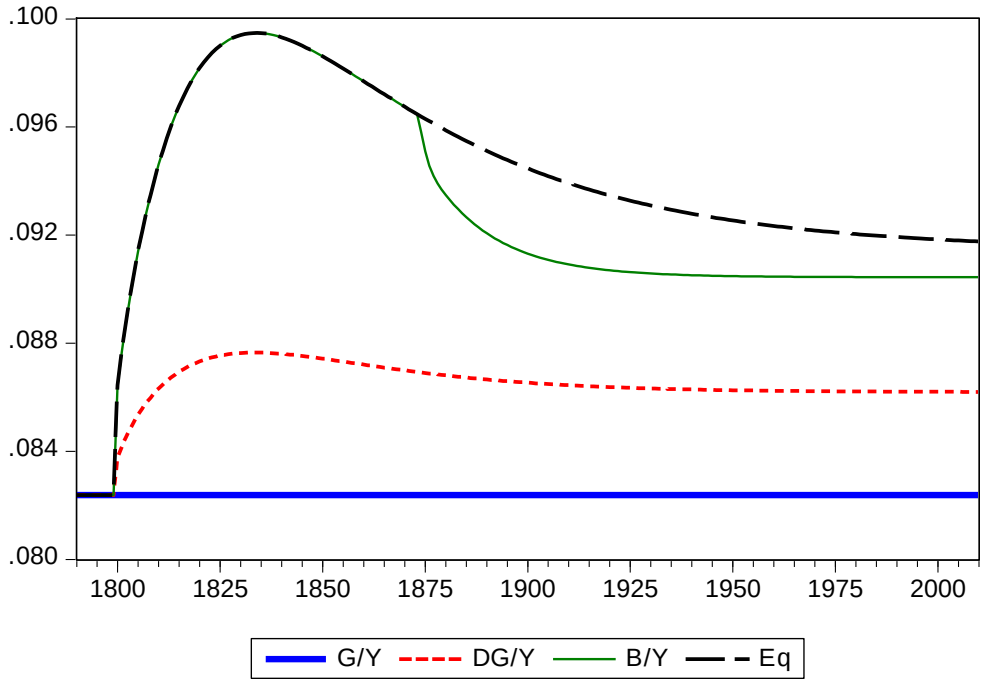
The distribution of GDP among households' consumption, firms' investment, and government expenditures changes as well. The G/Y regime maintains a higher government share and lower consumption and investment shares than the alternative scenarios. The trajectories after the regime change are more a result of the slowdown in growth than of a higher consumption (figure 53) or a higher investment (figure 54). This can be seen on figure 55, that shows the investment relative to the stock of capital.

Figure 53 – Consumption share of output after a fiscal regime shift



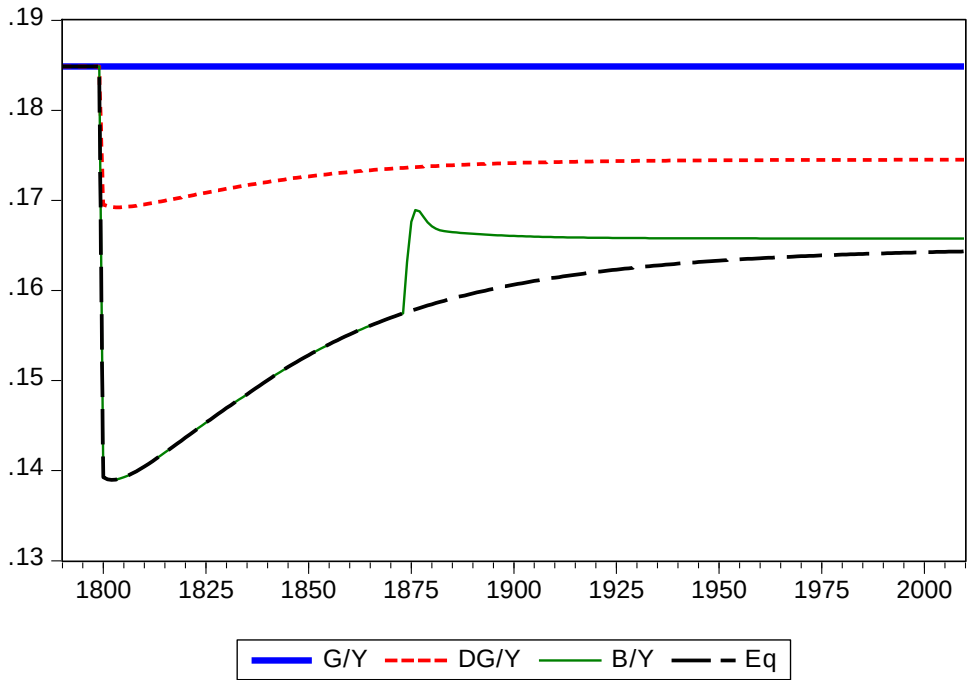
Source: Elaborated by the author.

Figure 54 – Investment share of output after a fiscal regime shift



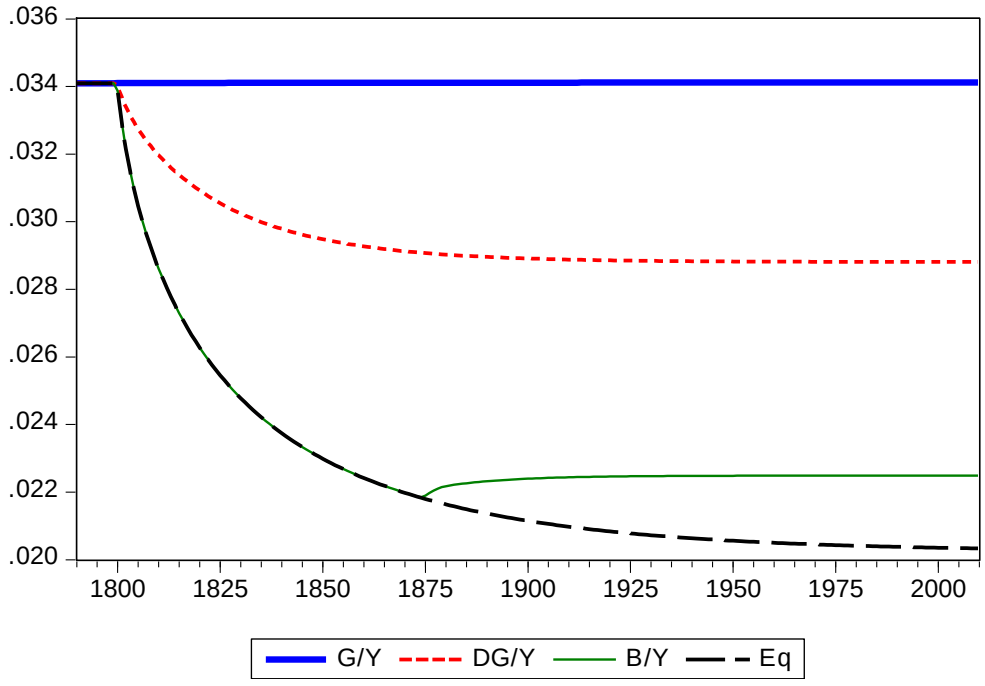
Source: Elaborated by the author.

Figure 55 – Government expenditures share of output after a fiscal regime shift



Source: Elaborated by the author.

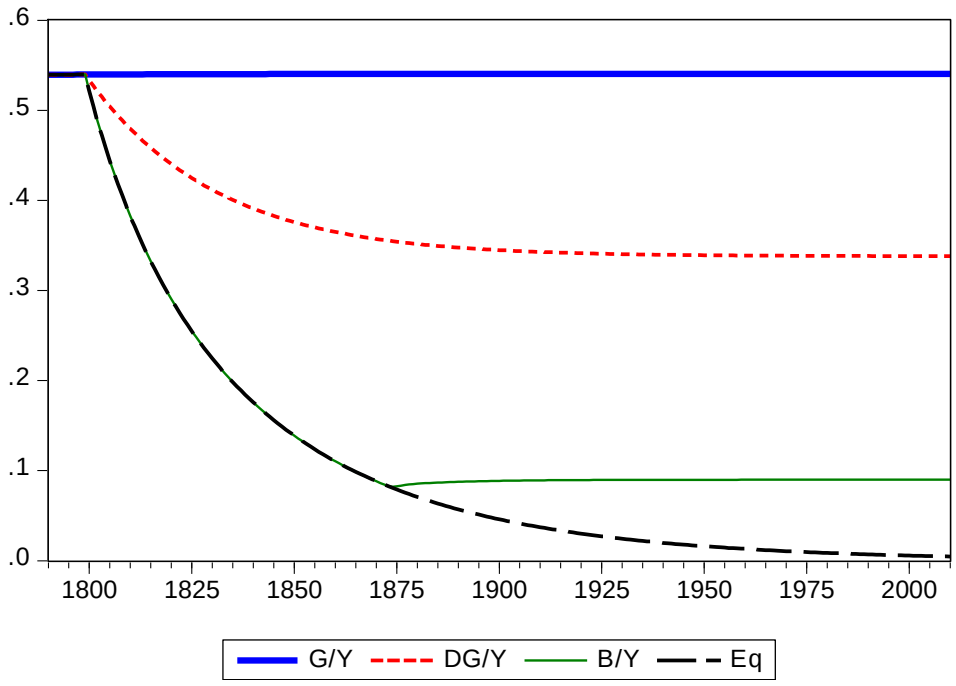
Figure 56 – Investment relative to stock of capital



Source: Elaborated by the author.

The austerity associated with the regime changes causes a fall in government debt relative to the stock of capital. The same happens with the wealth to capital stock ratio (the graph was suppressed because it has the same shape of the graph below).

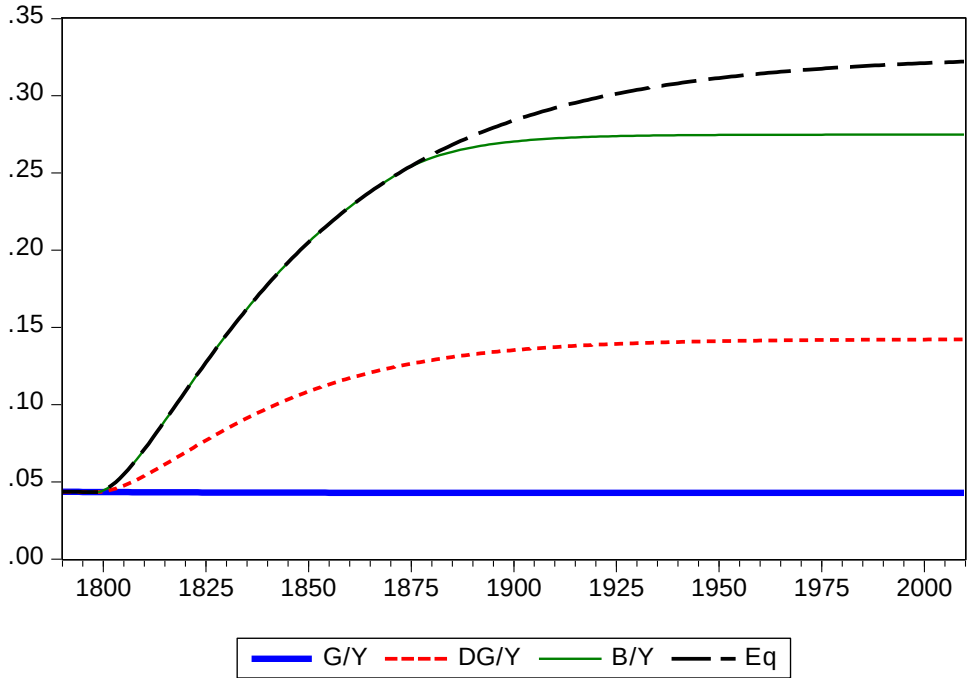
Figure 57 – Government debt relative to the stock of capital after a fiscal regime shift



Source: Elaborated by the author.

A counterparty of the lower government debt is a higher private indebtedness. This is caused by the reduction in internal sources of financing that follows the slowdown of economic growth.

Figure 58 – Loans relative to the stock of capital after a fiscal regime shift



Source: Elaborated by the author.

4.5 CONCLUDING REMARKS

In this chapter, a simple model was developed in order to analyze the macroeconomic impacts of different fiscal policy regimes. Their different steady-state norms were discussed, as well as their response to negative shocks. Moreover, a fiscal policy regime change was simulated. Some of the mains conclusions can be summarized as follows: the more expansionist (or less contractionist) regimes presents higher growth rates; they are also more resilient to negative shocks; there is an inverse relationship between government debt and private debt, as can be verified by the ratios B/K and L/K discussed above.

The model, however, has many shortcomings. It ignores inflation, household' indebtedness, inventories accumulation, and supply side constrains. It also presents very simplified portfolio choices and a naïve wage bargaining process. The calibration of the model also is problematic, since it was not intended to simulate a specific economy, and it lacks econometric support. A consequence of all these shortcomings is some unrealistic results of the model, such as the very low capacity utilization rates and low investment shares in output. A better treatment of these aspects will be done in future works.

5 CONCLUDING REMARKS

The amaranthine failures of mainstream macroeconomic theory gave rise to claims for alternative modeling techniques. The present dissertation discussed one of these alternatives: the SFC method. Among the contributions of the method, we can list: the potential for a common ground for all heterodox schools; the capacity of solving controversial issues, because it can be precisely pinpointed which parameters or equations are problematic; its capacity to predict crisis; and its general usage for forecasting proposals, as evidenced in the works of the Bank of England and Goldman Sachs. Jointly with this range of potentials, the motivation for the research in this topic was also induced by the current economic and political situation of Brazil, with its recent approval of a huge austerity plan.

In the first chapter, a conceptual discussion intended to provide the reader an elementary knowledge about the basic structure of the SFC models was conducted. Moreover, the origins of the approach were discussed. It was shown that the economic thinking about stocks and flows is not a new issue: it can be found in the writings of classical economists such as William Petty and Adam Smith. Neither the modeling of stock/flows relations is solely an innovation of SFC authors, since some authors have worked on these issues in the 1960s. The two schools that laid the roots for the current SFC approach was reviewed in that chapter: the Yale school, led by James Tobin, and the New Cambridge School, led by Wynne Godley. After that, a comprehensive literature review of the current SFC models was carried out. The potential of the method to tackle different aspects of the economic thought was evidenced by the variety of topics studied, that cover areas such as fiscal and monetary policy, ecological economics, financial fragility, housing market, global trade, and capital imbalances, etc.

The second chapter developed a methodological discussion. The different specifications of households' consumption function used in the SFC literature were highlighted. Although the differences between them are very tenuous, they give rise to cumulative discrepancies that have non-trivial effects on the economy's dynamic trajectory and on the composition of households' balance sheets. It was shown that output growth converges to the same steady-state rate when a system of equations has different specifications for expectations. However, the short term and medium term dynamics are quite different. It was also shown that the weight of the forecasting error in the expectation formula also biases the simulation results. Despite the simplicity of our exercise, it presents important consequences for a modeling step in the SFC models that has not been previously discussed.

Given the large number of behavioral equations in a typical SFC model, the problem may turn out to be more serious than could be suggested by the exercises done in the chapter. This means that additional methodological research is necessary to develop more robust SFC models regarding how important variables and parameters should be modeled.

Finally, in the third chapter, a simple model was developed in order to analyze the macroeconomic impacts of four different fiscal policy regimes: balanced budget; a target for government's expenditures; a target for government deficit; and a target for government debt. The different steady-state norms for each regime were discussed, as well as their response to negative shocks. The exercise reaches conclusions in line with recent findings in fiscal policy multipliers. The main conclusions of our model can be summarized as follows: the more expansionist (or less contractionist) regimes (a target for government's expenditures and a target for government deficit) presents higher growth rates; they are also more resilient to negative shocks; they maintain their higher growth rates even when the fiscal regime changes; there is an inverse relationship between government debt and private debt. The model, however, has many shortcomings. It ignores inflation, households' indebtedness, inventories accumulation, and supply side constrains. It also presents very simplified portfolio choices and a naïve wage bargaining process. The calibration of the model also is problematic, since it was not intended to simulate a specific economy, and it lacks econometric support. A better treatment of these aspects will be done in future works.

Our main goals, delineated in the introduction of the dissertation, were achieved. Despite the shortcomings of the model, it is clear that economic policy questions can be raised and answered by using Stock-Flow Consistent models, both in theoretical and empirical ways. For instance, our results suggest, along standard Post-Keynesian lines, that extreme fiscal austerity measures can lead to economic disaster, pointing to a dismal future to Brazil. We leave this challenge to orthodox thinking in macroeconomics and look forward to seeing how the policies they suggested will lead to their predictions of higher and stable growth rates for Brazil.

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APPENDIX A – MODEL'S SOURCE CODE

In this appendix, we provide the source codes of our model. They are suited for EvieWs 7, except for the DAGs, which use R software.

A.1 Source code

```
' Create a workfile, naming it modelo_1 to hold annual data from 1500 to 2010

wfcreate(wf=modelo_1, page=annual) a 1500 2010

' Creates and documents series
series Y
Y.displayname National income
series Cons
Cons.displayname Consumption
series I
I.displayname Firms investment
series G
G.displayname Government expenditures
series YP
YP.displayname Personal income
series WB
WB.displayname Wage bill
series FD_f
FD_f.displayname Distributed profits of firms
series F_b
F_b.displayname Banks profits
series r_d
r_d.displayname Interest rate on deposits
series D_h
D_h.displayname Personal deposits
series r_b
r_b.displayname Interest rate on Governments Bonds
```

```
series B_h
B_h.displayname Governments  bonds held by households
series YD_r
YD_r.displayname Regular disposable income
series T
T.displayname Taxes
series theta
theta.displayname Tax rate
series YD_hs
YD_hs.displayname Haigh-Simons disposable income
series CG
CG.displayname Capital gains
series p_e
p_e.displayname price of equities
series e_d
e_d.displayname Demand for equities
series V
V.displayname Nominal stock of wealth
series v_r
v_r.displayname Real stock of wealth
series alpha_1
alpha_1.displayname Propensity to consume out of financial income
series alpha_2
alpha_2.displayname Propensity to consume out of wealth
series h10
h10.displayname Parameter in portfolio choice
series h11
h11.displayname Parameter in portfolio choice
series h20
h20.displayname Parameter in portfolio choice
series h21
h21.displayname Parameter in portfolio choice
series PDU
PDU.displayname Perceived degree of uncertainty
```

```
series r_L
r_L.displayname Interest rate on loans
series L
L.displayname Loans
series r_A
r_A.displayname Interest rate on central bank advances
series A
A.displayname Central bank advances
series CR
CR.displayname Credit rationing
series rho_1
rho_1.displayname Parameter in credit rationing
series rho_2
rho_2.displayname Parameter in credit rationing
series rho_3
rho_3.displayname Parameter in credit rationing
series K
K.displayname Stock of capital
series NL
NL.displayname New loans
series L_d
L_d.displayname Desired loans
series rep
rep.displayname Repaiment of loans
series H_b
H_b.displayname Cash held by banks
series mi
mi.displayname Required reserves
series eta
eta.displayname Excess reserves
series eta0
eta0.displayname Parameter in excess reserves function
series eta1
eta1.displayname Parameter in excess reserves function
```

series eta2

eta2.displayname Parameter in excess reserves function

series B_bn

B_bn.displayname Resources left to bonds

series B_b

B_b.displayname Governments bonds held by banks

series m_l

m_l.displayname mark-up on loans

series m_d

m_d.displayname mark-up on deposits

series pr

pr.displayname productivity

series N

N.displayname Current employment

Series W

W.displayname Nominal wage

Series g_pr

G_pr.displayname Growth rate of productivity

series u

u.displayname Capacity utilization

series F_f

F_f.displayname Firms' profits

Series FU_f

FU_f.displayname Undistributed profits

Series sf

sf.displayname Proportion of undistributed profits

series beta0

beta0.displayname Parameter in investment function

series beta1

beta1.displayname Parameter in investment function

series beta2

beta2.displayname Parameter in investment function

series beta3

beta3.displayname Parameter in investment function

```
series beta4
beta4.displayname Parameter in investment function
series i_d
i_d.displayname Desired investment
Series chi_0
Chi_0.displayname Animal spirits parameter
Series chi_1
Chi_1.displayname Animal spirits parameter
Series e
e.displayname equities supply
series v_u
v_u.displayname Potential output-capital ratio
series i
i.displayname Realized investment
series x
x.displayname Proportion of investment financed by equities
series F_cb
F_cb.displayname Central bank profits
Series B
B.displayname Stock of government bonds
Series DG
DG.displayname Government deficit
Series sigma_1
Sigma_1.displayname Fiscal regime parameter
Series sigma_2
Sigma_2.displayname Fiscal regime parameter
Series sigma_3
Sigma_3.displayname Fiscal regime parameter
Series B_T
B_T.displayname Debt target
Series B_cb
B_cb.displayname Government bonds held by the central bank
Series h
h.displayname High-powered money supply
```

```
' Starting values for parameters
Theta = 0.17
Alpha_1 = 0.7
Alpha_2 = 0.1
H10 = 0.35
H11 = 0.25
H20 = 0.35
H21 = 0.25
Rho_1 = 0.85
Rho_2 = 0.1
Rho_3 = 0.1
Eta0 = 0.02
Eta1 = 0.1
Eta2 = 0.5
M_l = 0.03
M_d = 0.01
Sf = 0.15
Beta1 = 0.02
Beta2 = 0.02
Beta3 = 0.02
Beta4 = 0.02
v_u = 0.5
Chi_0 = 0.02
Chi_1 = 0.002
x = 0.15

' Values for exogenous variables
G_pr = 0.0185
PDU = 0.2
Mi = 0.1
Rep = 0.065
Sigma_1 = 0.1914
Sigma_2 = 0.03
```

Sigma_3 = 0.37

' Initial values for endogenous
r_d = 0.01
D_h = 600
r_b = 0.02
B_h = 270
B_b = 51.3
B_cb = 48.7
B = b_h + b_b + b_cb
E_d = 750
V = 1620
W = 6
Pr = 10
Yp = 888.25
T = 140
Yd_r = YP - T
r_l = 0.07
R_a = r_b
A = 1.3
K = 5000
Y = 1000
U = y/(v_u*k)
L = 500
L_d = l
'fd_f = 237.25
N = 380
e = e_d
p_e = e_d/e

fu_f = 127.75
H_b = 50
h = h_b
i = 180

```
i_d = i

' Create a model object, and name it fiscal
Model fiscal

' equations for households
Fiscal.append y = cons + i + G 'eq 1
Fiscal.append yp = wb + fd_f + f_b + r_d(-1)*d_h(-1) + r_b(-1)*b_h(-1) 'eq 2
Fiscal.append yd_r = yp - t ' eq 3
Fiscal.append t = theta*yp ' eq 4
Fiscal.append yd_hs = yd_r + CG 'eq 5
Fiscal.append cg = e(-1)*(p_e-p_e(-1))  'eq 6
Fiscal.append v = v(-1) + yd_hs - cons ' eq 7
Fiscal.append cons = alpha_1*yd_r(-1) + alpha_2*v(-1) 'eq 8
Fiscal.append b_h_d = (h10 +h11*PDU)*v(-1) ' eq 9a
Fiscal.append b_h = z10*b_h_d + z20*b 'eq 9b
Fiscal.append z10 =  0+ (b_h_d<=b) 'eq 9c
Fiscal.append z20 = 0+ (b_h_d>b) 'eq 9d
Fiscal.append e_d = (h20 - h21*PDU)*v(-1) ' eq 10
Fiscal.append d_h = v - b_h - e_d ' eq 11

' equations for commercial banks
Fiscal.append f_b = r_l(-1)*l(-1) + r_b(-1)*b_b(-1) - r_d(-1)*d_h(-1) - r_a(-1)*a(-1) '
eq 12
Fiscal.append cr = rho_1*PDU + rho_2*(l(-1)/k(-1)) + rho_3*r_b  'eq 13
Fiscal.append nl = l_d*(1-cr) ' eq 14
Fiscal.append l = (1-rep)*l(-1) + nl ' eq 15
Fiscal.append h_b = (mi + eta)*d_h ' eq 16
Fiscal.append eta = eta0 + eta1*PDU - eta2*r_b ' eq 17
Fiscal.append b_bn = d_h - mi*d_h - l ' eq 18

Fiscal.append  A_n1= eta*d_h 'eq 19 I
Fiscal.append  A_n2=h_b + L - d_h 'eq 19 II
Fiscal.append  A=z11*A_n1+z12*A_n2 'eq 19 III
```

```
Fiscal.append  z11=0+(B_bn>=0) 'eq 19 IV
Fiscal.append  z12=0+(B_bn<0) 'eq 19 V
Fiscal.append  B_b=z13*B_bn 'eq 20 I
Fiscal.append  z13=0+(B_Bn>=0) 'eq 20 II

Fiscal.append r_l = r_b + m_l ' eq 21
Fiscal.append r_d = r_b - m_d ' eq 22

' equations for firms
Fiscal.append w = w(-1)*(1 + g_pr) ' eq 23
Fiscal.append pr = pr(-1)*(1+g_pr) ' eq 24
Fiscal.append n = y/pr ' eq 25
Fiscal.append wb = n*w ' eq 26
Fiscal.append f_f = y - wb - r_l(-1)*l(-1) ' eq 27
Fiscal.append fu_f = sf*f_f ' eq 28
Fiscal.append fd_f = f_f - fu_f ' eq 29
Fiscal.append k = k(-1) + i ' eq 30
Fiscal.append i_d = (beta0 + beta1*u(-1) + beta2*(fu_f(-1)/k(-1)) - beta3*r_l)*k(-1) '
eq 31
Fiscal.append beta0 = chi_0 - chi_1*pdu ' eq 32
Fiscal.append u = y/(v_u*k(-1)) ' eq 33

Fiscal.append l_d_n = i_d - fu_f  - p_e*(e-e(-1)) + rep*l(-1) ' eq 34A
Fiscal.append l_d = l_d_n*z1 ' eq 34B
Fiscal.append z1 = 0 + (l_d_n>=0) ' eq 34C

Fiscal.append i = (l-l(-1)) + fu_f + p_e*(e-e(-1)) ' eq 35
Fiscal.append e =  x*k(-1) ' eq 36
Fiscal.append p_e = e_d/e ' eq 37

' equations for central bank
Fiscal.append f_cb = r_a(-1)*a(-1) + r_b(-1)*b_cb(-1) ' eq 38
Fiscal.append r_a = r_b ' eq 39
Fiscal.append h = h_b ' eq 40
```

```
Fiscal.append b = dg + b(-1) 'eq 41

Fiscal.append b_cb = b - b_h - b_b ' eq 42

' equations for the government
Fiscal.append dg = z30*dg_d
Fiscal.append z30 = 0 + (dg_d >=0)
Fiscal.append dg_d = g + (r_b(-1)*b(-1)) - t - f_cb '43a
Fiscal.append g = sigma_1*y(-1) '44a


' end of fiscal model

' Select the baseline scenario

fiscal.scenario baseline

' Set simulation sample
smpl 1502 @last

' Solve the model for the current sample

fiscal.solve(i=p)
```

A.2 Shocks

```
'The shocks:
'PDU
smpl 1800 @last
pdu=0.4
smpl @all
fiscal.solve(i=p)l

'Rep
```

```
PDU = 0.2
smpl 1800 @last
rep = 0.13
smpl @all
fiscal.solve(i=p)

' r_b
Rep = 0.065
smpl 1800 @last
r_b = 0.04
smpl @all
fiscal.solve(i=p)
```

A.3 Analysis

```
' nominal GDP growth
genr gry_0 = (y_0 - y_0(-1))/y_0(-1)
genr gry_1 = (y_1 - y_1(-1))/y_1(-1)
genr gry_2 = (y_2 - y_2(-1))/y_2(-1)
genr gry_3 = (y_3 - y_3(-1))/y_3(-1)

'Consumption share in GDP
genr cy_0 = cons_0/y_0
genr cy_1 = cons_1/y_1
genr cy_2 = cons_2/y_2
genr cy_3 = cons_3/y_3

'Investment share in GDP
genr iy_0 = i_0/y_0
genr iy_1 = i_1/y_1
genr iy_2 = i_2/y_2
genr iy_3 = i_3/y_3

'Government purchases share in GDP
```

```
genr gy_0 = g_0/y_0
genr gy_1 = g_1/y_1
genr gy_2 = g_2/y_2
genr gy_3 = g_3/y_3

'Ratio D_h/V
genr dv_0 = d_h_0/v_0
genr dv_1 = d_h_1/v_1
genr dv_2 = d_h_2/v_2
genr dv_3 = d_h_3/v_3

'Ratio B_h/V
genr bv_0 = b_h_0/v_0
genr bv_1 = b_h_1/v_1
genr bv_2 = b_h_2/v_2
genr bv_3 = b_h_3/v_3

'Ratio e_d/V
genr ev_0 = e_d_0/v_0
genr ev_1 = e_d_1/v_1
genr ev_2 = e_d_2/v_2
genr ev_3 = e_d_3/v_3

' Ratio V/K
genr vk_0 = v_0/k_0
genr vk_1 = v_1/k_1
genr vk_2 = v_2/k_2
genr vk_3 = v_3/k_3


' Ratio B/K
genr bk_0 = b_0/k_0
genr bk_1 = b_1/k_1
genr bk_2 = b_2/k_2
```

```
genr bk_3 = b_3/k_3

' Ratio L/K
genr lk_0 = l_0/k_0
genr lk_1 = l_1/k_1
genr lk_2 = l_2/k_2
genr lk_3 = l_3/k_3

'Ratio FU/K
genr fuk_0 = fu_f_0/k_0
genr fuk_1 = fu_f_1/k_1
genr fuk_2 = fu_f_2/k_2
genr fuk_3 = fu_f_3/k_3

'Ratio F_f/K
genr ffk_0 = f_f_0/k_0
genr ffk_1 = f_f_1/k_1
genr ffk_2 = f_f_2/k_2
genr ffk_3 = f_f_3/k_3

'holdings of bonds:
genr bhb_0 = b_h_0/b_0
genr bbb_0 = b_b_0/b_0
genr bcb_0 = b_cb_0/b_0
genr bprop_0 = bhb_0 + bbb_0 + bcb_0

genr bhb_1 = b_h_1/b_1
genr bbb_1 = b_b_1/b_1
genr bcb_1 = b_cb_1/b_1
genr bprop_1 = bhb_1 + bbb_1 + bcb_1

genr bhb_2 = b_h_2/b_2
genr bbb_2 = b_b_2/b_2
genr bcb_2 = b_cb_2/b_2
```

```
genr bprop_2 = bhb_2 + bbb_2 + bcb_2

genr bhb_3 = b_h_3/b_3
genr bbb_3 = b_b_3/b_3
genr bcb_3 = b_cb_3/b_3
genr bprop_3 = bhb_3 + bbb_3 + bcb_3

'Redundant equation
genr red_0 = a_0 + b_cb_0
genr redd_0 = red_0 - h_0

genr red_1 = a_1 + b_cb_1
genr redd_1 = red_1 - h_1

genr red_2 = a_2 + b_cb_2
genr redd_2 = red_2 - h_2

genr red_3 = a_3 + b_cb_3
genr redd_3 = red_3 - h_3

'banks profits relative to its assets
genr fb_ratio_0 = f_b_0/(b_b_0 + h_b_0 + l_0)
genr fb_ratio_1 = f_b_1/(b_b_1 + h_b_1 + l_1)
genr fb_ratio_2 = f_b_2/(b_b_2 + h_b_2 + l_2)
genr fb_ratio_3 = f_b_3/(b_b_3 + h_b_3 + l_3)

'investment financing
genr li_0 = (l_0 - l_0(-1))/i_0
genr li_1 = (l_1 - l_1(-1))/i_1
genr li_2 = (l_2 - l_2(-1))/i_2
genr li_3 = (l_3 - l_3(-1))/i_3
genr fui_0 = fu_f_0/i_0
genr fui_1 = fu_f_1/i_1
genr fui_2 = fu_f_2/i_2
```

```
genr fui_3 = fu_f_3/i_3
genr ei_0 = e_d_0/i_0
genr ei_1 = e_d_1/i_1
genr ei_2 = e_d_2/i_2
genr ei_3 = e_d_3/i_3
```

A.4 Regime changes

```
'substitute the line test.scenario baseline for
test.scenario actuals
```

'to change the regimes, open the model in the workfile, change the scenario, edit equations 43 and 44 and solve. Change the scenario and edit the equations again, until all the regimes have been modeled.

```
'original equations
'dg_d = g + (r_b(-1)*b(-1)) - t - f_cb
'g = sigma_1*y(-1)

'equations for DG/Y
'dg_d = sigma_2*y(-1)
'g = dg - r_b(-1)*b(-1) + t + f_cb

'equations for B/Y
'dg_d = sigma_3*y(-1) - b(-1)
'g = dg - r_b(-1)*b(-1) + t + f_cb

'equations for equilibrated budget
'g = t + f_cb -r_b(-1)*b(-1)
'dg_d  = t + f_cb - r_b(-1)*b(-1) - g

'ANALYSIS

' nominal GDP growth
```

```
genr gry = (y - y(-1))/y(-1)
genr gry_0 = (y_0 - y_0(-1))/y_0(-1)
genr gry_1 = (y_1 - y_1(-1))/y_1(-1)
genr gry_2 = (y_2 - y_2(-1))/y_2(-1)


'Consumption share in GDP
genr cy = cons/y
genr cy_0 = cons_0/y_0
genr cy_1 = cons_1/y_1
genr cy_2 = cons_2/y_2


'Investment share in GDP
genr iy = i/y
genr iy_0 = i_0/y_0
genr iy_1 = i_1/y_1
genr iy_2 = i_2/y_2


'Government purchases share in GDP
genr gy = g/y
genr gy_0 = g_0/y_0
genr gy_1 = g_1/y_1
genr gy_2 = g_2/y_2


'Ratio D_h/V
genr dv = d_h/v
genr dv_0 = d_h_0/v_0
genr dv_1 = d_h_1/v_1
genr dv_2 = d_h_2/v_2
```

```
'Ratio B_h/V
genr bv = b_h/v
genr bv_0 = b_h_0/v_0
genr bv_1 = b_h_1/v_1
genr bv_2 = b_h_2/v_2


'Ratio e_d/V
genr ev = e_d/v
genr ev_0 = e_d_0/v_0
genr ev_1 = e_d_1/v_1
genr ev_2 = e_d_2/v_2


' Ratio V/K
genr vk = v/k
genr vk_0 = v_0/k_0
genr vk_1 = v_1/k_1
genr vk_2 = v_2/k_2



' Ratio B/K
genr bk = b/k
genr bk_0 = b_0/k_0
genr bk_1 = b_1/k_1
genr bk_2 = b_2/k_2


' Ratio L/K
genr lk = l/k
genr lk_0 = l_0/k_0
genr lk_1 = l_1/k_1
genr lk_2 = l_2/k_2
```

```
'Ratio FU/K
genr fuk = fu_f/k
genr fuk_0 = fu_f_0/k_0
genr fuk_1 = fu_f_1/k_1
genr fuk_2 = fu_f_2/k_2


'Ratio F_f/K
genr ffk = f_f/k
genr ffk_0 = f_f_0/k_0
genr ffk_1 = f_f_1/k_1
genr ffk_2 = f_f_2/k_2


'holdings of bonds:
genr bhb = b_h/b
genr bbb = b_b/b
genr bcb = b_cb/b
genr bprop = bhb + bbb + bcb

genr bhb_0 = b_h_0/b_0
genr bbb_0 = b_b_0/b_0
genr bcb_0 = b_cb_0/b_0
genr bprop_0 = bhb_0 + bbb_0 + bcb_0

genr bhb_1 = b_h_1/b_1
genr bbb_1 = b_b_1/b_1
genr bcb_1 = b_cb_1/b_1
genr bprop_1 = bhb_1 + bbb_1 + bcb_1

genr bhb_2 = b_h_2/b_2
genr bbb_2 = b_b_2/b_2
```

```
genr bcb_2 = b_cb_2/b_2
genr bprop_2 = bhb_2 + bbb_2 + bcb_2



'Redundant equation
genr red = a + b_cb
genr redd = red - h

genr red_0 = a_0 + b_cb_0
genr redd_0 = red_0 - h_0

genr red_1 = a_1 + b_cb_1
genr redd_1 = red_1 - h_1

genr red_2 = a_2 + b_cb_2
genr redd_2 = red_2 - h_2
```

A.5 DAGs.

First of all, you have to download the package developed by Antoine Godin here: https://github.com/S120/PKSFC

Then, read the instructions in order to learn how to develop your DAGS.

The following lines are the source codes to be used in R to plot the DAGs.

```
#1. equations
y = cons + i + g
yp = wb + fd_f + f_b + r_d(-1)*d_h(-1) + r_b*b_h(-1)
yd_r = yp - t
t = theta*yp
yd_hs = yd_r + cg
cg = e(-1)*(p_e-p_e(-1))
v = v(-1) + yd_hs - cons
cons = alpha_1*yd_r(-1) + alpha_2*v(-1)
```

b_h = (h10 +h11*pdu)*v(-1)

e_d = (h20 - h21*pdu)*v(-1)

d_h = v - b_h - e_d

f_b = r_l(-1)*l(-1) + r_b*b_b(-1) - r_d(-1)*d_h(-1) - r_a(-1)*a(-1)

cr = rho_1*pdu + rho_2*(l(-1)/k(-1)) + rho_3*r_b

nl = l_d*(1-cr)

l = (1-rep)*l(-1) + nl

h_b = (mi + eta)*d_h

eta = eta0 + eta1*pdu - eta2*r_b

b_bn = d_h - mi*d_h - l

a_n1= eta*d_h

a_n2=h_b + l - d_h

a=z11*a_n1+z12*a_n2

z11=0+(b_bn>=0)

z12=0+(b_bn<0)

b_b=z13*b_bn

z13=0+(b_bn>=0)

r_l = r_b + m_l

r_d = r_b - m_d

w = w(-1)*(1 + g_pr)

pr = pr(-1)*(1+g_pr)

n = y/pr

wb = n*w

f_f = y - wb - r_l(-1)*l(-1)

fu_f = sf*f_f

fd_f = f_f - fu_f

k = k(-1) + i

i_d = (beta0 + beta1*u(-1) + beta2*(fu_f(-1)/k(-1)) - beta3*r_l)*k(-1)

beta0 = chi_0 - chi_1*pdu

u = y/(v_u*k(-1))

l_d = i_d - fu_f - p_e*(e-e(-1)) + rep*l(-1)

i = (l-l(-1)) + fu_f + p_e*(e-e(-1))

e = x*k(-1)

p_e = e_d/e

```
f_cb = r_a(-1)*a(-1) + r_b*b_cb(-1)
r_a = r_b
h = h_b
b = dg + b(-1)
b_cb = b - b_h - b_b
dg = g + (r_b*b(-1)) - t - f_cb
g = sigma_1*y(-1)
#2. parameters
theta = 0.17
alpha_1 = 0.7
alpha_2 = 0.1
h10 = 0.35
h11 = 0.25
h20 = 0.35
h21 = 0.25
rho_1 = 0.85
rho_2 = 0.1
rho_3 = 0.1
eta0 = 0.02
eta1 = 0.1
eta2 = 0.5
m_l = 0.03
m_d = 0.01
omega_3 = 0.45
sf = 0.15
beta1 = 0.02
beta2 = 0.02
beta3 = 0.02
beta4 = 0.02
v_u = 0.5
chi_0 = 0.02
chi_1 = 0.002
x = 0.15
#exogenous
```

g_pr = 0.0185

pdu = 0.2

mi = 0.1

rep = 0.065

sigma_1 = 0.1914

sigma_2 = 0.03

sigma_3 = 0.37

r_b = 0.02

#initial values

r_d = 0.01

d_h = 600

b_h = 750

b_b = 51.3

b_bn = 51.3

b_cb = 48.7

b = 850

e_d = 750

v = 2100

w = 6

wb = 600

pr = 10

yp = 888.25

t = 140

yd_r = 748.25

yd_hs = 748.25

r_l = 0.07

r_a = 0.02

a = 1.3

k = 5000

y = 1000

u = 0.4

l = 500

l_d = 500

n = 380

e = 750

p_e = 1

f_f = 365

fd_f = 237.25

fu_f = 127.75

f_cb = 1

f_b = 30

h_b = 50

h = 50

i = 180

i_d = 180

cons = 630

g = 190

eta = 0.03

beta0 = 0.0196

#3. timeline

timeline 1500 2010