University Institute of Lisbon
School of Social Sciences
Department of Political Economy

A stock-flow consistent model of the Portuguese economy

Pedro Oliveira Pratas e Sousa

Dissertation submitted as partial requirement for the conferral of Master in Financial and Monetary Economics

Supervisor:
Ph. D. Sofia de Sousa Vale
Auxiliary Professor of the Department of Economy
ISCTE – University Institute of Lisbon

October 2015

University Institute of Lisbon

School of Social Sciences

Department of Political Economy

A stock-flow consistent model of the Portuguese economy

Pedro Oliveira Pratas e Sousa

Dissertation submitted as partial requirement for the conferral of Master in Financial and Monetary Economics

Supervisor:

Ph. D. Sofia de Sousa Vale

Auxiliary Professor of the Department of Economy

ISCTE – University Institute of Lisbon

October 2015

Resumo

Segundo Olivier Blanchard, a crise financeira de 2007-2008 veio abanar a macroeconomia e pôr a nu as insuficiências dos modelos de eleição da teoria Neoclássica, os modelos DSGE (Dynamic Stochastic General Equilibrium).

Nesta tese procurámos apresentar uma abordagem alternativa ou complementar aos referidos modelos DSGE, baseada nos princípios dos modelos stock-flow consistent de Godley e Lavoie e inspirada na teoria de sistemas complexos defendida por Steve Keen. As suas principais características são: a possibilidade de integração de um sector financeiro bem desenvolvido com a economia real; uma visão holística da economia baseando-se numa análise sectorial da mesma; o principio da incerteza fundamental, rejeitando assim a hipótese de expectativas racionais; o reconhecimento da natureza monetária da economia, da dívida e da endogeneidade do dinheiro; e a visão de que a economia se encontra em constante desequilíbrio.

Assente nestes princípios, construímos um modelo da Economia Portuguesa que nos permitiu analisar as políticas de austeridade que foram aplicadas em Portugal nos últimos anos. Para isso, numa primeira fase, foi construído e calibrado um modelo de referência que replica o período de 2008 a 2013. Numa segunda fase foram alteradas algumas variáveis desse mesmo modelo, recriando cenários e opções politicas alternativas que foram depois analisadas e comparadas com o modelo de referência. Mais do que respostas precisas, o objectivo deste exercício é de contribuir para uma ‘intuição informada’ do funcionamento da economia Portuguesa.

Palavras-chave: Modelos stock-flow consistent; Modelos macroeconómicos; Crise da zona Euro; Políticas de austeridade.

Classificação JEL: E12, E16, E65

Abstract

According to Olivier Blanchard, one of the silver linings of the 2007-2008 financial crisis has been to jolt macroeconomics and macroeconomic policy and to demonstrate some of the shortcomings of DSGE (Dynamic Stochastic General Equilibrium) models.

In this thesis we tried to present an alternative or complementary approach to the referred models, an approach based on the stock-flow consistent models of Godley and Lavoie and on the complexity theory approach championed by Steve Keen. Its main characteristics are: the possibility of integration of the real economy with a well-developed financial sector; a holistic view of the economy, in which sectoral balances take center stage; the acknowledgement of the principle of fundamental uncertainty, rejecting the hypothesis of rational expectations; the recognition of the monetary nature of the economy, the role of debt and the endogeneity of money; and the rejection of the methodological equilibration of neoclassical theory with the economy being seen, instead, as basically in constant disequilibrium.

Based on this principles we built a model of the Portuguese economy, in order to analyze the austerity policies applied in the last years in our country. In a first phase, our work consisted in building a benchmark model that replicated the 2008-2013 period. In a second stage, we changed some of the variables, recreating alternative scenarios and options, and analyzed the results obtained comparing them with the benchmark case. More than precise answers, the goal of this work is to contribute to an informed intuition of the functioning of the Portuguese economy.

Keywords: Macroeconomic modelling, Stock-flow consistent models, Euro-zone crisis, Austerity

JEL Classification: E12, E16, E65

Table of Contents

List of figures

List of tables

Introduction

One thing the crisis we are going through has shown us is how limited the usefulness of the benchmark neoclassical models really is (Buiter, 2009, Solow, 2010, Keen, 2013a, Colander et al 2008). In a recent article Blanchard (2014) recognizes some of the shortcomings of this kind of approach, its assumption of linearity and oblivion of the financial system. He concludes his article by saying that DSGE (Dynamic Stochastic General Equilibrium) models can still be useful if we stay away from what he calls the dark corners - where the economy can malfunction badly - and leaves an insightful policy advice…" stay away from dark corners"! (Blanchard 2014, p. 4) Reading this, one comes to mind a famous quote from Keynes, that slightly modified seems quite appropriate: Economists set themselves too easy, too useless a task if in the dark corners they can only tell us that if we stay away from those dark corners everything will be fine.

But in this article, signs of a way forward can also be found. In what may seem as cries for help, Blanchard appeals for some change in the way research and modeling is being made. Referring to research, he says that "the message should be to let a hundred flowers bloom", "Now that we are more aware of nonlinearities and the dangers they pose, we should explore them further theoretically and empirically—and in all sorts of models" and in his concluding paragraph he says "The crisis has been immensely painful. But one of its silver linings has been to jolt macroeconomics and macroeconomic policy" (Blanchard 2014, p. 4).

The failure at the macroeconomic level of Neoclassical theory, and its DSGE models, not to predict the crisis, but to even recognize its possibility has led to the creation of several movements all around the world calling for pluralism in methods and approaches in Economics.

Acknowledging Blanchard's message, and accompanying the call for pluralism in Economics, this thesis hopes to be a petal of one of the hundred flowers about to be bloomed. Our contribution consists in building a continuous time, stock-flow consistent model of the Portuguese economy, based on National Accounts data that replicates the

2008-2013 period and then analyze alternative paths by changing some of the relevant variables.

Its purpose is twofold. On one hand, it tries to divulge alternative or complementary approaches to the mainstream DSGE models, namely the stock-flow consistent approach and the complexity theory approach as well as new valuable tools, as is the case of the Minsky software. On the other hand it will confront the austerity policies followed in Portugal during the sovereign debt crisis with a few alternative paths analyzing and comparing their outcomes.

The thesis is structured in the following way. In the introduction we state our motivation and purpose. In the first chapter we characterize the mainstream approach and contrast it with the approach we advocate, and describe succinctly the work done in this thesis. The second chapter describes the relevant events, which we will try to replicate, of the period we are focusing on, the 2008-2013 period. The third chapter consists in the model description. The different sectors, its assets and liabilities and the behavioral equations that define the interactions between them are defined here. In the fourth chapter we define the benchmark case, i. e. the model's parameters that replicate the events described in chapter two and to which the simulations done in the next chapter are compared with. In the fifth chapter we define alternative scenarios, describe how those are translated regarding the model's inputs and analyze the outcomes, comparing them with the benchmark case.

Chapter I - Literature Review

In this chapter we contrast the mainstream approach to macroeconomic modeling, with the approaches taken in this thesis which is based on the stock-flow consistent approach and the complexity theory approach. We then briefly outline what we propose to do.

1.1 - DSGE models

Solow's (2003) "crude caricature" synthetizes pretty well some of the essential characteristics of DSGE models: "The preferred model has a single representative consumer optimizing over infinite time with perfect foresight or rational expectations, in an environment that realizes the resulting plans more or less flawlessly through perfectly competitive forward-looking markets for goods and labor, and perfectly flexible prices and wages. How could anyone expect a sensible short-to-medium-run macroeconomics to come out of that set-up?" (Solow 2003, p. 1) The DSGE models currently used add frictions and rigidities of all kinds in order to capture the observed behavior of the economy.

A defining characteristic of DSGE models are their micro-foundations, their atomistic view of the economy, their focus on the individual. The aggregation problems of this approach (Sonnenschein 1972), has led to the ad hoc assumption of a representative agent but the fundamental problem remains. "… (W)hat makes macroeconomics a separate field of study is the complex properties of aggregate behavior that emerge from the interaction among agents. Since in a complex system aggregate behavior cannot be deduced from an analysis of individuals alone, representative agent models fail to address the most basic questions of macroeconomics" (Colander et al 2008, p. 2). What this means is that "The behavior of large and complex aggregates of elementary particles, it turns out, is not to be understood in terms of a simple extrapolation of the properties of a few particles. Instead, at each level of complexity entirely new properties appear…Psychology is not applied biology, nor is biology applied chemistry." (Anderson 1972, p. 393).

This view is justified by the need, identified by the Lucas critique, to incorporate the expectations of agents in macroeconomic models. The choice of modeling these

expectations as rational expectations – prophetic expectations would describe it better (Keen 2014, p. 9) – is based not on empirical reasons but on analytical ones. “The reason researchers clung to the rational expectations representative agent models for so long is not that they did not recognize their problems, but because of the analytical difficulties involved in moving beyond these models.” (Colander et al 2008, p.6).

Another feature accompanying micro-foundations and the representative agent is the intertemporal optimization framework, which, according to Skott (2009) is a straitjacket that besides misrepresenting real-world decision making it forces simplifications to be made in other areas in order to keep the model tractable.

As Blanchard recognizes, the financial system as well as debt and default are generally absent from DSGE models. This disregard of money and debt is a consequence of the neoclassical view of money neutrality (at least in the long run) and the loanable funds concept which allows to conclude that debt is just a transfer of purchasing power from one agent to another. It’s justified by the assumption of complete markets (markets for every goods, where the same good in a different place or time is considered a distinct good) and the Efficient Market Hypothesis. After the crisis, the number of DSGE models attempting to fill this shortcoming increased dramatically, but none that we know of has done it successfully.

Perhaps the most fundamental feature of DSGE models and neoclassical theory is according to Varoufakis and Arnsperger (2006) their methodological equilibration. “First, one discovers an equilibrium. Second, one assumes (axiomatically) that agents (or their behaviour) will find themselves at that equilibrium. Lastly, one demonstrates that, once at that equilibrium, any small perturbations are incapable of creating centrifugal forces able to dislodge self-interested behaviour from the discovered equilibrium. This three-step theoretical move is tantamount to what we, here, describe as methodological equilibration” (Varoufakis and Arnsperger 2006, p.6). Equilibrium is assumed to be achieved so assumptions are made and parameters are determined to make sure that that is the case. To calculate and analyze the steady-state solution of a DSGE model is necessary to obtain a linear approximation of it, the linearity assumption referred by Blanchard. Once the solution of the linearized version of the model is found, the equilibrium is perturbed and the reaction of the model to it analyzed. By working with the linearized version of the model, the size of the perturbations must be small otherwise the approximation will be significantly different from the original model. “Technically,

the non-linear stochastic dynamic models were linearized (often log-linearized) at a deterministic (non-stochastic) steady state. The analysis was further restricted by only considering forms of randomness that would become trivially small in the neigbourhood of the deterministic steady state. Linear models with additive random shocks we can handle – almost!" (Buiter 2009, p. 3) But that's not the end of it, the equilibrium is usually unstable which means that after perturbed the system doesn´t always return to its previous position. "When you linearize a model, and shock it with additive random disturbances, an unfortunate by-product is that the resulting linearised model behaves either in a very strongly stabilising fashion or in a relentlessly explosive manner. There is no 'bounded instability' in such models. The dynamic stochastic general equilibrium (DSGE) crowd saw that the economy had not exploded without bound in the past, and concluded from this that it made sense to rule out, in the linearized model, the explosive solution trajectories. What they were left with was something that, following an exogenous random disturbance, would return to the deterministic steady state pretty smartly. No L-shaped recessions. No processes of cumulative causation and bounded but persistent decline or expansion. Just nice V shaped recessions." (Buiter 2009, p. 3). This means that, trajectories that diverge from the stable-state, which usually are the vast majority, are ruled out because the economy is seen as in equilibrium.

To illustrate how at odds these models are with reality one can look at the mechanism by which unemployment happens in them. In DSGE models there is no involuntary unemployment, but it's the representative agent that decides to work fewer hours as a reaction to changes in real wages or lifetime income. "Fluctuations in employment in the DSGE models are hence always an optimal reaction of households to changes in labour market conditions… Those who seem unemployed are just enjoying more leisure this year because they expect their real wages to be higher next year when they are in consequence going to work longer hours then." (Dullien 2011, p. 13-14).

Summing up and quoting Solow again: "Especially when it comes to matters as important as macroeconomics, a mainstream economist like me insists that every proposition must pass the smell test: does this really make sense? I do not think that the currently popular DSGE models pass the smell test." (Solow 2010, p. 16).

1.2 - Stock flow consistent approach

The stock-flow consistent approach is a macroeconomic modelling approach, usually associated with post-Keynesian theory that tries to coherently integrate all stocks and flows of an economy. At the basis of this approach are the sectors' balance sheets in a double entry book keeping framework and the interactions between them through financial flows. Stock-flow consistency refers to two aspects in macroeconomic modeling, the fact that every flow has a source and a destination, and the fact that the evolution of stocks is explained by flows.

Typically the sectors considered are households, firms, government, banks and a foreign sector and each of them as several financial assets and liabilities. The balance sheets and the financial flows are represented by a set of matrices, the balance sheet matrix, the transactions flow matrix and the capital gains matrix. The transactions between sectors and the correspondent financial flows are determined by behavioral equations.

This approach has its roots in the work of Copeland (1949) on flow of funds accounting. A similar approach was taken by Tobin (1982), a neoclassical economist which in his Nobel Prize acceptance speech pointed to the following distinguishing characteristics of his approach: precision regarding time; tracking of stocks; several assets and rates of return; modeling of financial and monetary policy operations; Walras Law and adding up constraints. "While neoclassical economists have rejected Tobin's approach and have fallen back on the unrealistic 'representative agent', where consumers and producers are one and the same, some post-Keynesians have embraced Tobin's approach, incorporating it, however, into a monetary production economy where the supply of money is endogenous and where behavioural equations respond to Kaleckian or Keynesian precepts rather than neoclassical ones" (Lavoie 2014). In fact it's in the work of one of these post-Keynesian economists, Wynne Godley, that this framework appears more thoroughly and systematically developed, as can be seen in his collaboration with Marc Lavoie in Godley and Lavoie (2007).

The methodology usually followed is described in Godley and Lavoie (2007), "The method will be to write down systems of equations and accounting identities, attribute initial values to all stocks and all flows as well as to behavioural parameters, using stylized facts so well as we can to get appropriate ratios (e.g. for the proportion of

the national income taken by government expenditure). We then use numerical simulation to check the accounting and obtain a steady state for the economy in question. Finally we shock the system with a variety of alternative assumptions about exogenous variables and parameters and explore the consequences. It will be our contention that via the experience of simulating increasingly complex models it becomes possible to build up knowledge, or 'informed intuition', as to the way monetary economies must and do function"

This description shows that there exists some methodological similarities with the neoclassical approach, but conceptually the idea of equilibrium is radically different. "Steady states are theoretical constructs which would be achieved 'if all parameters and functions of the model are taken as given. Since in reality they are not given, the real-world counterparts of such constructs do not imply that the economy is at a position of rest' (Dutt 1997: 450). The steady state is just an analytical device never in practice reached, because parameters and exogenous variables are actually changing all the time. This implies that steady states should be treated as a reference point (Turnovsky 1977: 7)". (Godley and Lavoie 2007, p. 10)

There are some limitations to this approach, more realistic and detailed models get cumbersome real quickly, there are only a few empirical models (Caverzasi and Godin, 2013) like Kinsella and Aliti (2012) B. Papadimitriou et all (2013) and the parameters are "…chosen with an eye to the stability of its equilibrium…, rather than to economic realism" (Keen 2014, p. 15). This option for the use of comparative dynamics according to Keen, 2014 "… is more an unconscious result of the evolution of the SFCA in partial isolation from other strands in Post Keynesian economics—especially that represented by Goodwin with his emphasis upon nonlinearity and endogenous cycles—than a necessity or a deliberate choice." (Keen 2014, p. 15). Nonlinearities and complex dynamics have been identified within stock-flow consistent models: "There may also be a problem of chaos and complexity within these models. Obviously sensitive dependence on initial conditions does not mean the models are intrinsically chaotic or capable of generating complex dynamics, but the recursive nature of the modeling, the existence of multiple feedbacks within each models and the computation issues I and my co-authors have come across when practically trying to model a real economy give me pause that there might be the seeds of a complex system somewhere within stock flow modelling…" (Kinsella 2011, p. 7). But the tools of differential equations and non-linear dynamics advocated by several post-Keynesian and heterodox economists (Peter Flaschel, Steve

Keen, Peter Skott, Barkley Rosser, Lance Taylor) are rarely used. The structural nonlinearities of economic relationships identified by some of these authors which make the economy a complex system, justify the use of the right tools and concepts to analyze this kind of systems. This tools and concepts have been used by the economists referred above and constitute what is called the complexity theory approach.

1.3 - Complexity theory approach

According to Day (1994) a complex dynamical system is a system whose pattern can´t be described in a finite way as is the case of systems that tend to a stationary state, periodic cycles or a steady state. So it happens that every complex dynamical system has some nonlinearity within them, nonlinearities that have been largely ignored by neoclassical economists as Blanchard admits.

At the end of the 19th century, Walras, Jevons and their fellow marginalists radically changed Economics in their attempt to turn it into a mathematical science. The tools and techniques they borrowed from physics and mathematics that were available at the time are fundamentally different from today's state of the art in those fields. At the time static methods were adopted because dynamics were considered too difficult to deal with. "We must carefully distinguish at the same time between the Statics and Dynamics of this subject. The real condition of industry is one of perpetual motion and change. Commodities are continually being manufactured and exchanged and consumed. If we wished to have a complete solution of the problem in all its natural complexity we should have to treat it as a problem of dynamics. But it would surely be absurd to attempt the more difficult question when the more easy one is yet so imperfectly within our power." Jevons, W. S. (1888). Since then the study of dynamical systems has evolved radically and this justification makes no longer sense. "…The shift from reductionism to holism, the importance of nonlinearity, the recognition of emergent properties in large scale systems, the rise of complex systems analysis, and the development of methods to enable such nonlinear, large scale, complex systems to be analysed by predominantly numerical methods…" (Keen, 2014, p. 1) are the components of this extensive change aided by the computing power available today. As referred by Keen, most of the complex systems are analyzed through numerical methods and simulations due to the difficulty and most of the times impossibility of solving them analytically. These methods have been applied to

numerous fields as biology, meteorology, physics and economics as well. Some examples can be found in the works of Lorenz (1993), Day (1994), Chiarella et all (2011), Ryoo (2010) or Keen (2013b).

1.4 – Methodology

The modeling approach proposed in this thesis allows the integration of the real economy with a well-developed financial sector and recognizes the non-linearity of economic phenomena, two of the shortcomings of DSGE models identified by Blanchard. Following post-Keynesian principles it distinguishes itself from DSGE models in several other ways. First, it takes a holistic view, contrasting with the atomistic view of neoclassical theory and the consequent representative agents of DSGE models and it's free of the straitjacket that is intertemporal optimization. Sectoral balances analysis is one of the main pillars of the approach that will be taken. Second, it acknowledges the principle of fundamental uncertainty, rejecting the hypothesis of rational expectations. Third, it recognizes the monetary nature of the economy, the role of money and debt and the endogeneity of money. Lastly it rejects the methodological equilibration of neoclassical theory and the economy is instead, seen as basically in constant disequilibrium.

The approach followed has strong affinities with the two approaches to macroeconomic modelling described before, the stock flow consistent approach of Wynne Godley and the complexity theory approach championed by Steve Keen. The model itself will be inspired in the stock-flow consistent literature but it can be considered closer to Steve Keen´s approach, as I will be working in continuous time and with the software developed by him. The differences between these two approaches regarding the structure of the model are not fundamental and can be found in Keen (2009).

The software I will be using is Minsky, named in honor of the late Hyman Minsky, the biggest influence in the work of Steve Keen, the economist behind this program. Quoting from its website, Minsky is a "Free open-source computer program for building and simulating dynamic, monetary economic models, models without equilibrium and with a financial sector. A vital tool for a new approach to economics. Similar to Mathcad,

Mathematica, Matlab and other mathematical modeling/ simulation tools, but optimized for accounting-based, flow-of-funds analysis."

The modelling work done in this thesis can be divided into two parts. The first one consists in building a model of the Portuguese economy, based on the National Accounts that replicates in a satisfying manner the events of the 2008-2013 period which are described in chapter two. This will be our benchmark case, the outcome to which the other simulations are compared. An overview of the model is the following:

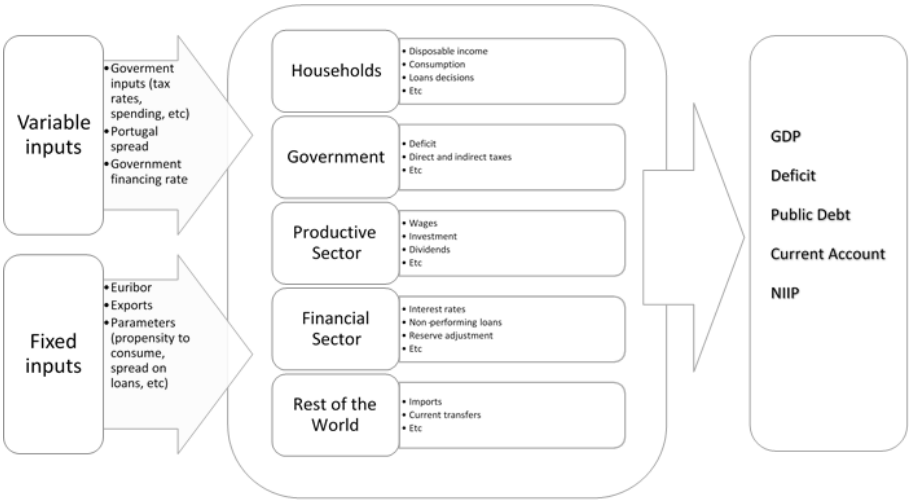


Figure 1.1 – Model overview

The model is represented by the middle section of figure 1.1 and is described in detail in chapter 2. It is defined by a balance sheet matrix where the sectors' assets and liabilities are determined, a transactions matrix which shows how the sectors' balance sheets interact and the behavioral equations that define this transactions.

To run the model, we must define the model inputs. We divide this into two types of inputs, the fixed inputs which will be the same for every simulation and the variable inputs which will be changed to reflect the different scenarios we intent to analyze. Examples of fixed inputs are the propensity to consume, exports, the euribor, the initial values of all the state variables like Capital or households' deposits, etc. The variable inputs are the decisions taken by the government (tax rates, government spending and social transfers), the government's financing rate and the Portugal spread. The Portugal spread is a spread that reflects credit market conditions and is explained in more detail in section 3.4 of chapter 3.

In the second part of the modelling work we consider different scenarios, changing the relevant inputs of the model and analyze the outcomes comparing them with the benchmark case. Examples of the cases considered are, a no austerity policy scenario, or austerity policies focused on the revenue side or even a scenario of low interest rates for government financing.

Chapter II – A brief description of events

In this chapter we will describe succinctly the 2008-2013 period. The facts and data are taken from the State's General Account, the Memorandum of Understanding reviews by the ECB and the IMF, the National Accounts and from the Bank of Portugal. Another important source was the crisis timeline by the Observatory on Crisis and Alternatives of the Centre for Social Studies.

A prelude to austerity

2008

2008 was a year marked by the financial crisis that started the year before and by its dramatic transformation into the global financial crisis in September 2008, triggered by the Lehman Brothers bankruptcy. What ensued was a collapse in activity in a large number of financial markets with spreads on short term interest rates reaching extraordinarily high levels and a credit crunch that soon spilled into the real economy, halting international trade and slowing down credit to households and firms. Reacting to the events, the ECB, along with several other major central banks, reduced their policy interest rates in the 8th of October, something they would do repeatedly in the following months, totaling a 325 basis points cut by May 2009.

At a government level, the initial worldwide concerted measures in dealing with the crisis were first seen in the G20 summit in Washington in November of 2008 and included fiscal measures to stimulate domestic demand, as well as measures to guarantee the stabilization of the financial system through liquidity and capital reinforcements. Following this the European Commission presented its Economic recovery plan with €200bn in measures to boost purchasing power and generate jobs and growth, with the bulk of the money (€170bn) coming from national budgets.

In Portugal this approach was reflected in the nationalization of BPN and in an anti-crisis plan presented by the Portuguese Government, "Investment and employment" in December, which included increases in public investment and strengthening of social transfers amounting to a total of 1.25% of GDP.

Portugal entered 2009 with €178.87bn GDP, a 3.8% deficit, a public debt of 71.7% of GDP, an 8.3% unemployment rate and a current account of -12.6%.

2009

2009 was a year of severe contraction in the world economy with Portugal being no exception. The effects of the financial crisis were mainly visible in the significant deceleration of credit to the non-financial sector and the decline in gross fixed capital formation, resulting in a GDP of €175.45bn and an unemployment of 11.3% by the end of the year. Automatic stabilizers and the anti-crisis plan increased government expenses and a slowdown of economic activity combined with a reduced (since July 2008) VAT tax rate reduced government receipts. The result was a 9.8% government deficit and a public debt of 83.6% of GDP.

This situation was common around Europe, and some tension was being felt in financial markets regarding the sustainability of public finances in several countries. When Greece announced a drastic upward revision of its 2009 deficit, Greek bond yields started to rise, later culminating in a first bailout in April 2010. The rise of sovereign bond yields soon spread to another countries reflecting markets concern over excessive indebtedness and the ability of these countries to repay its debt which in a self-fulfilling way, made it even harder. The Global Financial Crisis had become the Sovereign Debt Crisis and the answer for it was austerity. Fiscal consolidation and the reduction of public deficits became priorities.

Release the austerity

2010

Although concerns about the sustainability of public finances were already present, the 2010 government budget proposed in January 2010 was still, essentially, a timid stimulus budget, with increases in public investment and a slight tax reduction.

It was only in March, with the budget approval and the Stability and Growth Program (SGP) for the 2010-2013 period, that these concerns took center stage. The SGP I, as it

became known, intended to calm international investors and agency ratings by presenting an austerity package that was supposed to start in 2011 and would obtain a 2,8% deficit by 2013.

Only two months later, facing consecutive downgrades by the agency ratings and rising bond yields, the Portuguese government saw the need to anticipate some of the measures scheduled in the SGP I as well as to introduce some new ones in what was called the SGP II. Among these were, to be applied immediately, a 1% increase in all VAT rates, a 1% increase in individual income tax for monthly incomes below 2.375 € and 1.5% otherwise and a 2.5% increase in corporate tax for taxable profits above 2mn €. On the expenditure side it included the anticipation of the end of anti-crisis measures, a reduction in social transfers and a suspension in public hiring as well as in public wage increases.

With the proposed objectives for the 2010 and 2011 deficits in jeopardy, the Government introduced in late September the third version of the SGP. This included the reinforcement of some of the measures to be applied in 2010 but the bulk of it pertained to the 2011 budget where the austerity measures more than doubled when compared with the previous SGP. For 2011 it predicted an expenditure reduction of 2% of GDP and tax increases amounting to 1% of GDP including a 2% increase of the normal VAT rate.

Accompanying the rise in sovereign bond yields in 2010, there was a further tightening of credit standards by the financial sector, that were starting to stabilize in the beginning of the year, resulting in the continuation of the deceleration of credit to the non-financial sector. Despite this and the beginning of the austerity measures, 2010 was a year where GDP grew to €179.93bn. The deficit reached 11.2% of GDP, public debt was at 96.2% of GDP and unemployment at 12.2% by the end of the year.

2011

2011 started like 2010 ended, with rising sovereign bond yields, downgrades by rating agencies and a new SGP that was presented in March. This included austerity measures for 2011 amounting to 0.8% of GDP, mostly on the expenditure side including pension cuts and stricter criteria regarding social transfers. The SGP IV failed to gather a majority support in the Portuguese parliament, leading immediately to the Government

resignation in March 23rd with elections being scheduled to June 5th. In April 6th the resigning government asked officially for a €78bn bailout and after a month of negotiations the Memorandum of Understanding (MoU) between the Troika (ECB, IMF and European Commission) and Portugal, containing the goals and measures to achieve them, was signed.

The MoU included an ambitious fiscal consolidation, structural reforms concerning competitiveness issues and the stabilization of the financial system. Focusing on the fiscal aspect, the MoU predicted a 5.9% deficit in 2011, 4.5% in 2012 and 3% in 2013, its final year. To achieve this it predicted 0.8% of GDP of spending cuts in 2011 and 5% of GDP in austerity measures in 2012-2013, 3.5% being on the expenditure side and 1.5% on the revenue side.

The 5th of June elections resulted in a right wing majority government. The newly elected government, alleging a €2bn deviation from the MoU, immediately announces a one-off surcharge on the personal income tax of 3.5%, the anticipation of the increase to 23% from 6% in the VAT for gas and electricity and the transfer of banks pension funds to the state social security system to hit the 2011 objectives. The recorded deficit at the time was 4.4% of GDP, but with the new rules in ESA 2010 regarding the transfer of pension funds, this was later revised to 7.4%.

A predictable outcome of the bailout was the further tightening of credit standards by the financial sector motivated by funding issues, liquidity position and expectations regarding economic activity (see section 4.4). The combination of this with low levels of consumer confidence resulted in a reduction in credit conceded to the non-financial sector.

In 2011 GDP decreased to €176.17bn, the deficit was 7.4%, current account 7% and by the end of the year public debt reached 111.1% and unemployment 14.4%.

2012

The 2012 budget was very ambitious. Despite the shortfall in the previous year deficit regarding the MoU target, the 2012 budget maintained the 4.5% goal. To achieve this, it included an additional 2.5% of GDP in austerity measures (6.1% vs the predicted 3.6%). The suspension of holiday and Christmas bonuses for public sector workers and

pensioners and the shift of a large number of goods and services to a higher VAT rate were some of the measures taken.

In September, facing a revenue shortfall, deficit targets were adjusted to 5% for 2012, 4.5% in 2013 with the final target of 3% pushed to 2014 and additional measures to be applied still in 2012 were announced.

Credit standards in the first half of 2012 continued their tightening trend, which stabilized in the second half of the year. Confidence levels remained low and credit to the non-financial sector continued to decline.

Despite (or maybe not) of the effort towards fiscal consolidation the deficit for 2012 was 5.5% of GDP with public debt reaching 125.8% of GDP. GDP decreased tremendously to €168.4bn and unemployment stood at a whopping 17.3% by the end of the year.

2013

The 2013 budget predicted a fiscal contraction of 3.2% of GDP to meet the desired target of 4.5% deficit. This was due to two factors, the 2012 deficit was obtained with some one-off measures and the deterioration of the macro-economic outlook for 2013, justified in part by some of the austerity measures to be taken.

80% of the austerity measures were taken on the revenue side, with 1.7% of GDP coming from a revision of the personal income tax structure and 0.4% from increases in indirect taxes. On the expenditure side, across the board cuts were predicted, including a 2% reduction in the public sector work force.

Another issue with the 2013 budget, was the decision by the Constitutional Court to annul, on equity grounds, the suspension of holiday and Christmas bonuses for public sector workers and pensioners, which were supposed apply during the bailout. In response to this decision, the Government decided to reinstate one of the bonuses and to charge a general solidarity surcharge on personal income tax.

In April, the Constitutional Court ruled unconstitutional the cuts in the bonus payments for public sector workers and pensioners as well as other measures included in the 2013 budget amounting to a total of 0.8% of GDP. This and the weaker growth outlook for

2013 led to the revision of the fiscal targets for 2013 and the following years. The deficit target for 2013 was now 5.5% instead of 4.5% and 4% for 2014 instead of 3%.

Credit standards continued to stabilize throughout 2013, and for enterprises there was even some loosening. Despite this, credit to the non-financial sector continued to decline in 2013.

GDP in 2013 was €169.39bn, a slight nominal increase due to a better than expected behavior in the second half of the year. In real terms this signified a 1.4% decrease. The deficit was 4.8% of GDP and public debt was 129.7% of GDP by the end of the year. Unemployment decreased throughout 2013, and reached the end of the year with 15.1%.

Chapter III - Model Description

3.1 – Overview

The model consists of five institutional sectors, government (Gov), households (HH), productive sector (PS), financial sector (FS) where the Portuguese central bank is included and a rest of the world sector (RoW). These are based on the National Accounts, but there are a few differences in order to simplify, without distorting, the interactions between sectors.

The productive sector includes all output produced and sold in the Portuguese economy which is modelled as single kind of output. This means for instance that output produced by households in the National Accounts, in the model will appear has being produced by the productive sector. Another example is government output of non-market services - an imputed revenue in the National Accounts counterbalanced by another imputed expense, government final consumption – which in the model will appear as government spending and as a revenue of the productive sector. Part of this revenue is returned to the government in a transaction we called gross operating surplus of the government. This way, GDP and the government deficit will be closer to reality. A consequence of this is that the productive sector is the only sector that pays wages in the model, wages that include the operating surplus and mixed income of households of the National Accounts. Another consequence of this modelling option is that output sold by the productive sector less imports is equal to GDP.

Assets and liabilities for each sector are defined with the same goal in mind, simplify interactions while maintaining the structural outcome. The modelling option consisted in making the financial sector the main intermediary of financial relationships. For example, in the real world, households own public debt. In the model all public debt domestically owned will be an asset of the financial sector and the only asset of households will be deposits, a liability of the financial sector. Another example is corporate bonds owned by non-residents. In the model all liabilities of the productive sector are loans from the financial sector, and rest of the world assets are liabilities of the financial sector. The exception to this is public debt, with part of it being owned by the rest of the world sector.

This can be seen more clearly by looking at the balance sheet matrix and the transactions matrix.

3.2 – Balance sheet matrix

	Households	**Productive Sector**	**Financial Sector**	**Government**	**Rest of the World**	**∑**
Deposits	$+Deposits_{HH}$	$+CurrAc_{tPS}$ $+CapAct_{PS}$	$-Deposits_{HH}$ $-CurrAc_{tPS}$ $-CapAct_{PS}$ $-Deposit_{Gov}$	$+Deposit_{Gov}$		0
Loans	$-Loans_{HH}$	$-Loans_{PS}$	$+Loans_{HH}$ $+Loans_{PS}$ $+Loans_{RW}$ -PvtExtDebt		$-Loans_{RW}$ +PvtExtDebt	0
Public Debt			$+PublicDebt_{FS}$	$-PublicDebt_{FS}$ $-PublicDebt_{RW}$	$+PublicDebt_{RW}$	0
Reserves			+Reserves		-Reserves	0
Balance (Net Worth)	$-HH_{NW}$	$-PS_{NW}$	$-FS_{NW}$	$-Gov_{NW}$	$-RW_{NW}$	0
∑	0	0	0	0	0	

Table 3.1 – The balance sheet matrix

In the balance sheet matrix assets are represented with a plus sign and liabilities with a minus sign. The sum of assets and liabilities for each sector results in the sector's net worth which appears with a minus sign to balance the accounts.

As we can see, and mentioned before, the financial sector is the counterpart of all financial assets and liabilities of the other sectors except public debt owned by the rest of the world sector.

Households have one asset, deposits which includes demand and term deposits and one liability, loans from the financial sector. We don't distinguish between demand and term deposits but when calculating interest payments on households' deposits we take into account that only a fraction of the deposits earn interest.

The productive sector has two assets, a current account and a capital account and one liability, loans from the financial sector. The reason for considering two accounts comes from the need to have an origin and a destination for investment. Current account is always equal to zero, with profits being immediately transferred to the capital account. As was the case with households, we don't distinguish between term and demand deposits but we take it into account when calculating interest on deposits.

Government has one asset, deposits and two liabilities, public debt owned by the financial sector and public debt owned by the rest of the world. Government's deposits will always be equal to zero, as it will usually run a deficit which will automatically be financed by increasing public debt. If eventually the government runs a surplus it will reduce its public debt.

The rest of the world sector has two assets, public debt and private external debt and two liabilities, loans from the financial sector and reserves. Loans from the financial sector represent claims on foreign assets owned by residents and they will be unchanged during the simulations.

3.2.1 - Reserves and private external debt

In the real world Portuguese banks are forced by the ECB to have a reserve account at the Portuguese central bank which has to be superior to what is called the minimum reserve requirements. It is by using funds from this account that banks settle their transactions. Domestic transactions don't change the level of reserves of the financial sector as a whole (note: directly at least. It may create reserve shortages in some banks which may get funds in international markets), but international transactions do. When the level of reserves is below the minimum required, banks must seek funds to replenish their reserve account increasing the liabilities of the domestic financial sector vis-à-vis the rest of the world sector.

Until 2010 most of the funds came directly from other European banks, but when banks were unable to finance themselves in the usual way the ECB provided liquidity lines through the Portuguese central bank. The Portuguese Central Bank expanded its balance sheet, increasing its assets vis-à-vis the Portuguese banks and increasing its liabilities vis-à-vis the ECB which appear in its target2 balances. What this means, in the end, is that if we consider the domestic financial sector as a whole, including the Portuguese Central Bank, current account imbalances or capital flights result in an increase in liabilities towards the foreign sector, via the interbank market or via target2 balances. So, although reserves are an asset and a liability of the consolidated domestic financial sector and should cancel out, they ought to be present since they are instrumental in the process of external debt determination. Considering this, in the model, reserves are defined as an asset of the domestic financial sector and a liability of the ECB which is included in the rest of the world sector.

3.3 – Transactions flow matrix

	Households	*Productive Sector*		*Financial Sector*	*Government*	*Row*	∑
		Current Account	Capital Account				
1- Consumption and housing	-ConsH	+ConsH					0
2 - Government Spending		+G			-G		0
3 - Investment		$+GFCF_{PS}$	$-GFCF_{PS}$				0
4 -Exports		+Exp				-Exp	0
5 - Imports		-Imp				+Imp	0
		(GDP)					
6 - Wages	+Wages	-Wages					0
7 - Government transfers	+GovTrsf				-GovTrsf		0
8 – Current transfers	+CurrTrsf					-CurrTrsf	
9 -Indirect taxes		-IndTax			+IndTax		0
10 - HH income tax	$-IncTax_{HH}$				$+IncTax_{HH}$		0
11 - PS income tax			$-IncTax_{PS}$		$+IncTax_{PS}$		0
12 - FS income tax				$-IncTax_{FS}$	$+IncTax_{FS}$		0
13 – Gross operational surplus of Government		$-GOS_{Gov}$			$+GOS_{Gov}$		
14 - Operational profits		-OP	+OP				0
15- Dividends	$+Div_{HH}$		$-Div_{HH}$ $-Div_{RW}$			$+Div_{RW}$	0
16 - Interest payments	$-IntLoans_{HH}$ $+IntDep_{HH}$		$-IntLoans_{PS}$ $+IntDep_{PS}$	$+IntLoans_{HH}$ $+IntLoans_{PS}$ $+IntPD_{FS}$ $+IntLoans_{RW}$ $-IntDep_{HH}$ $-IntDep_{PS}$ - IntPED	 $-IntPD_{FS}$ $-IntPD_{RW}$	 $-IntLoans_{RW}$ +IntPED $+IntPD_{RW}$	0 0 0 0 0 0 0 0
17 - Default on Loans	$+Def_{HH}$		$+Def_{PS}$	$-Def_{HH}$ $-Def_{PS}$			0 0
Change in Net Worth	$\sum_{1}^{17} = -\frac{dHH_{NW}}{dt}$	$\sum_{1}^{17} = 0$	$\sum_{1}^{17} = -\frac{dPS_{NW}}{dt}$	$\sum_{1}^{17} = -\frac{dFS_{NW}}{dt}$	$\sum_{1}^{17} = -\frac{dGov_{NW}}{dt}$	$\sum_{1}^{17} = -\frac{dRoW_{NW}}{dt}$	
18 - Change in Loans and Public Debt	$+ChL_{HH}$		$+ChL_{PS}$	$-ChL_{HH}$ $-ChL_{PS}$ $-Def_{FS}$ $+ChPED_{FS}$	 $+GovDef_{FS}$ $+GovDef_{RW}$	 $-Def_{RW}$ - $ChPED_{FS}$	0 0 0 0 0
19 – Change in Deposits	$-ChD_{HH}$		$-ChD_{PS}$	$+ChD_{HH}$ $+ChD_{PS}$			0 0
20 – Change in Reserves				-ChRes		+ChRes	0
$\sum_{1}^{20}$	0	0	0	0	0	0	

Table 3.2 – The transactions flow matrix

The transactions flow matrix is very useful to give us a bird's-eye view of the main interactions between sectors. It also helps us to be sure no accounting error has been made, that all flows have a source and a destination. As Godley and Lavoie put it:

"…it is impossible to overestimate the usefulness, when deploying a macroeconomic model, however simple, of using a system of accounts like that of Table 3.2. The system is comprehensive, in the sense that 'everything comes from somewhere and everything goes somewhere'. Or, to put it more formally, all flows can be fitted into a matrix in which columns and rows all sum to zero. Without this armature, accounting errors may pass unnoticed and unacceptable implications may be ignored." Godley and Lavoie (2007).

Following Godley and Lavoie approach, flows with a plus sign are a source of funds and flows with a minus sign are a use of funds. For example, wages are a use of funds of the productive sector and a source of funds of households. Households can spend their income or "use" it to accumulate financial assets. In this sense, the accumulation of wealth (in this case deposits) is a use of funds and appears with a minus sign. In the same way change in loans appears with a plus sign, since an increase in loans increases the available funds of the sector. The flow regarding default on loans is not exactly a source of funds, but it's a positive change in the defaulting sector's net-worth so it appears with a plus sign for households and the productive sector.

The numbered rows correspond to transactions or changes in financial stocks and the two non-numbered rows are merely informative. The first non-numbered row after the fifth row simply indicates that GDP can be obtained by summing the transactions above that row (demand approach) or below that row (income approach) in the column of the current account of the productive sector. The other non-numbered row indicates that the transactions in the first seventeen rows define the change in wealth or net-worth for each sector. How this is distributed between the different assets and liabilities is defined in the following two rows. For example, households receive wages, government transfers, current transfers, interest and dividends which they spend on consumption, housing, taxes and interest. The result of this transactions with the default on loans (when households default, their loans decrease without the corresponding decrease in deposits, so their net-worth increases) yields households' change in net-worth. This change in wealth is also equal to the changes in deposits and loans. In the case of households change in deposits is defined residually.

3.3 – Behavioral equations

Behavioral equations define the transactions shown in the transactions flow matrix as well as other auxiliary variables. Each transaction is defined in the section of the sector that determines it. For commercial transactions this means the sector making the payment, for loans decisions this means the sector asking for the loan. Tax payments are defined in the government's section. Interest payments are defined in a separate section along with interest rates.

3.3.1 – Households

Households' income consists of wages (***Wages***), government transfers (***GovTrsf***), dividends ($\boldsymbol{Div_{HH}}$), interest on their deposits ($\boldsymbol{IntDep_{HH}}$) and current transfers (***CurrTrsf***) from the Rest of the World sector which are mostly remittances by emigrants. After paying interest ($\boldsymbol{IntLoans_{HH}}$) and income taxes ($\boldsymbol{IncTax_{HH}}$) which is equal to an exogenously defined percentage of total income we get disposable income (***HHDI***)

$$\boldsymbol{HHDI = Wages + GovTrsf + Div_{HH} + IntDep_{HH} + CurrTrsf - IncTax_{HH} - IntLoans_{HH}} \quad (1)$$

As an aggregate, households don't immediately adjust their consumption and investment decisions with changes in disposable income, there is a delay involved. This led us to define an auxiliary variable that will be very relevant in the model, households' expected disposable income (***ExpDI***) which will "track" disposable income.

$$\frac{\boldsymbol{dExpDI}}{\boldsymbol{dt}} = AF_{DI} * (\boldsymbol{HHDI - ExpDI}) \quad (2)$$

When disposable income is higher than expected disposable income, the derivative of expected disposable income will be positive, getting it closer to disposable income. How fast this adjustment is made depends on the value of the adjusting factor ($\boldsymbol{AF_{DI}}$).

From expected disposable income we define consumption (***Cons***) and gross fixed capital formation ($\boldsymbol{GFCF_{HH}}$) of households.

$$\boldsymbol{Cons} = (\gamma_C - \delta_C * \boldsymbol{PortugalSpread}) * \boldsymbol{ExpDI} + \theta_C * \boldsymbol{HH_{NW}} \quad (3)$$

$$\boldsymbol{GFCF_{HH}} = (\gamma_H - \delta_H * \boldsymbol{PortugalSpread}) * \boldsymbol{ExpDI} \quad (4)$$

In the absence of credit restrictions, represented here as a linear function of the Portugal spread (see subsection 3.4 on interest rates), households will consume a given percentage ($\boldsymbol{\gamma_C}$) of their expected disposable income plus a part ($\boldsymbol{\theta_C}$) of their net-worth ($\boldsymbol{HH_{NW}}$). The higher the credit restrictions the lower the percentage of expected disposable income they will consume. Gross fixed capital formation ($\boldsymbol{GFCF_{HH}}$) by households is defined analogously. Total expenses by households to the productive sector (***ConsH***) are simply the sum of consumption and gross fixed capital formation by households.

$$\boldsymbol{ConsH} = \boldsymbol{Cons} + \boldsymbol{GFCF_{HH}} \quad (5)$$

The default rate on loans ($\boldsymbol{DefRate_{HH}}$) is defined as tending to a certain average ($\boldsymbol{AvgDefRate_{HH}}$), with disturbances coming from a fall in expected disposable income.

$$\frac{\boldsymbol{dDefRate_{HH}}}{\boldsymbol{dt}} = AF_{Def} * (AvgDefRate_{HH} - \boldsymbol{DefRate_{HH}}) + \mu_{HH} * I_{[R^+]}[-\frac{\boldsymbol{dExpDI}}{\boldsymbol{dt}}] \quad (6)$$

The function $I_{[R^+]}(x)$ is the identity function when x is positive and returns 0 otherwise and it is used in several other variables. So, when expected disposable income of households is not falling, the default rate will tend to its average value, the speed of this depends on the adjustment factor ($\boldsymbol{AF_{Def}}$).

Default on loans by households ($\boldsymbol{Def_{HH}}$) is simply the default rate ($\boldsymbol{DefRate_{HH}}$) multiplied by household loans ($\boldsymbol{Loans_{HH}}$).

$$\boldsymbol{Def_{HH}} = \boldsymbol{DefRate_{HH}} * \boldsymbol{Loans_{HH}} \quad (7)$$

Households' loans incurrence can be divided in consumption loans (***NewConsLoans***) and housing loans (***NewHousingLoans***).

$$\boldsymbol{NewConsLoans} = (\gamma_{CL} - \delta_{CL} * \boldsymbol{PortugalSpread}) * \boldsymbol{ExpDI} \quad (8)$$

$$\boldsymbol{NewHousingLoans} = (\gamma_{HL} - \delta_{HL} * \boldsymbol{PortugalSpread}) * \boldsymbol{ExpDI} \quad (9)$$

The idea is the same as before, without credit restrictions households would incur in a certain amount of loans, defined as a percentage ($\boldsymbol{\gamma_{CL}}$ and $\boldsymbol{\gamma_{HL}}$) of their expected disposable income. This percentage is diminished when credit restrictions (***PortugalSpread***) increase. The sum of these gives us new loans incurred by households ($\boldsymbol{NewLoans_{HH}}$).

$$\boldsymbol{NewLoans_{HH}} = \boldsymbol{NewConsLoans} + \boldsymbol{NewHousingLoans} \quad (10)$$

Households repay ($\boldsymbol{LoanRepay_{HH}}$) a certain percentage ($\boldsymbol{\tau_{HH}}$) of their loans per year.

$$\boldsymbol{LoanRepay_{HH}} = \tau_{HH} * \boldsymbol{Loans_{HH}} \quad (11)$$

The sum of this flows gives us total change in households' loans ($\boldsymbol{ChL_{HH}}$).

$$\boldsymbol{ChL_{HH}} = \boldsymbol{NewLoans_{HH}} - \boldsymbol{LoanRepay_{HH}} - \boldsymbol{Def_{HH}} \quad (12)$$

3.3.2 – Productive Sector

Productive sector's revenues are registered in its current account. These are consumption and housing from households (***ConsH***), government spending (***G***), exports to the rest of the world (***Exp***) and investment from the productive sector ($\boldsymbol{GFCF_{PS}}$), sold to their capital account. To get GDP or total revenues, we must deduct imports (***Imp***) from this amount, which can be seen as all imports being acquired by a distributor, belonging to the productive sector, before being sold to other sectors.

$$\boldsymbol{GDP} = \boldsymbol{ConsH} + \boldsymbol{G} + \boldsymbol{GFCF_{PS}} + \boldsymbol{Exp} - \boldsymbol{Imp} \quad (13)$$

Imports are defined as a percentage of every other component of aggregate demand, with the parameters, later defined, based on Cardoso et all (2013), with total investment (***TotInv***) being the sum of gross fixed capital formation of all sectors.

$$\begin{aligned} \boldsymbol{Imp} = [(\alpha_I - \alpha_{IC} * \boldsymbol{PortugalSpread}) * \boldsymbol{Cons} + \\ \theta_I * \boldsymbol{TotInv} + \beta_I * \boldsymbol{Cons_{Gov}} + \delta_I * \boldsymbol{Exp}] * (1 - \delta_{Imp} * IntCrdCond) \end{aligned} \quad (14)$$

$$\boldsymbol{TotInv} = \boldsymbol{GFCF_{PS}} + \boldsymbol{GFCF_{Gov}} + \boldsymbol{GFCF_{HH}} \quad (15)$$

The percentage of consumption needs to take into account the fact that imported consumption (mostly durables) is much more dependent on credit then consumption as a whole. All of this is multiplied by a factor (***IntCrdCond***) that represents the conditions on international credit markets. This is an exogenous variable that we needed to replicate the events of 2008-2009 in international credit market conditions when international trade halted. This variable has no effects on the simulations done after, since it only affects the referred period and it's also used in the investment function which is also highly dependent on international credit market conditions.

The productive sector has a desired level of wages ($\boldsymbol{Wages_{Tgt}}$), defined as a percentage ($\boldsymbol{\vartheta_W}$) of GDP after paying indirect taxes (***IndTax***).

$$\boldsymbol{Wages_{Tgt}} = \vartheta_W * (\boldsymbol{GDP} - \boldsymbol{IndTax}) \quad (16)$$

Wages (***Wages***) track this desired level, with the speed of adjustment being dependent on the adjustment factor ($\boldsymbol{AF_W}$). This is justified because wages don't immediately respond to changes in GDP, being much less volatile.

$$\frac{dWages}{dt} = AF_W * (\boldsymbol{Wages_{Tgt}} - \boldsymbol{Wages}) \quad (17)$$

A part ($\boldsymbol{\vartheta_{GOS}}$) of the operating surplus (***GDP-IndTax-Wages***) has to be paid to the government ($\boldsymbol{GOS_{Gov}}$) so that we can use the government consumption figures of the National Accounts used for GDP calculations and have close to reality deficit values for the government sector.

$$\boldsymbol{GOS_{Gov}} = \vartheta_{GOS} * (\boldsymbol{GDP - IndTax - Wages}) \quad (18)$$

As mentioned before the current account of the productive sector is always equal to zero, so what is left - operational profits (***OP***) – is immediately transferred to the capital account.

$$\boldsymbol{OP = GDP - IndTax - Wages - GOS_{Gov}} \quad (19)$$

A percentage (***DivRate***) of the productive sector's capital account is distributed as dividends. Part ($\boldsymbol{\theta_{DomDiv}}$) of it is paid to households ($\boldsymbol{Div_{HH}}$) and the remaining part is paid to the rest of the world sector ($\boldsymbol{Div_{RW}}$).

$$\boldsymbol{Div_{HH}} = DivRate * \boldsymbol{CapAct_{PS}} * \theta_{DomDiv} \quad (20)$$

$$\boldsymbol{Div_{RW}} = DivRate * \boldsymbol{CapAct_{PS}} * (1 - \theta_{DomDiv}) \quad (21)$$

An important outflow from the capital account is investment ($\boldsymbol{GFCF_{PS}}$), this means corporate investment which includes the non-financial sector as well as the financial sector.

The idea behind the investment decision of the productive sector is that firms have a desired future level of capital which is based on actual revenues and growth expectations and invest accordingly.

Expected revenues (***ExpRev***) of firms is a variable that simply tracks GDP.

$$\frac{\boldsymbol{dExpRev}}{\boldsymbol{dt}} = AF_{Rev} * (\boldsymbol{GDP - ExpRev}) \quad (22)$$

This expected revenue is projected into the future with a growth perspective (***g-*** $\boldsymbol{\delta_{Kap}}$****PortugalSpread***) dependent on the general economic feeling represented by the Portugal Spread (see section 3.4). Dividing this by the productivity of capital (***p***), and the desired utilization rate of capital (***u***) we would obtain the desired level of capital for the whole economy. To obtain the desired level of capital of the productive sector (***KapTgt***) we must multiply this by a weighting factor ($\boldsymbol{PS_{Weight}}$).

$$\boldsymbol{KapTgt} = \boldsymbol{ExpRev} * \left(g - \delta_{Kap} * \boldsymbol{PortugalSpread}\right) * \frac{PS_{Weight}}{p * u} \quad (23)$$

Firms then invest to close the gap between actual (***Kapital***) and desired level of capital (***Kap$_{Tgt}$***), taking into account the depreciation of capital (***ConsFC***). This is done faster or slower depending on the associated adjustment factor (***AF$_K$***) and making sure that gross investment can´t be negative by using the $I_{[R^+]}(x)$ function. As mentioned before investment is highly dependent on international credit market conditions and was severely affected by the 2008-2009 financial crisis. To capture this we use the previously explained variable ***IntCrdCond***.

$$\boldsymbol{GFCF_{PS}} = I_{[R^+]}[AF_K * (\boldsymbol{KapTgt} - (\boldsymbol{Kapital} - \boldsymbol{ConsFC}))] * (1 - \delta_{Inv} * IntCrdCond) \quad (24)$$

$$\boldsymbol{ConsFC} = DepRate * \boldsymbol{Kapital} \quad (25)$$

Depreciation of capital or capital consumption (***ConsFC***) is simply obtained by multiplying the existing corporate capital (***Kapital***) by a depreciation rate (***DepRate***).

This means that corporate capital changes in the following way.

$$\frac{\boldsymbol{dKapital}}{\boldsymbol{dt}} = \boldsymbol{GFCF_{PS}} - \boldsymbol{ConsFC} \quad (26)$$

Default on loans (***Def$_{PS}$***) is defined along the lines of what was done for households but using expected revenues (***ExpRev***) instead of expected disposable income.

$$\frac{\boldsymbol{dDefRate_{PS}}}{\boldsymbol{dt}} = AF_{DefPS} * (AvgDefRate_{PS} - \boldsymbol{DefRate_{PS}}) + \mu_{PS} * I_{[R^+]}[-\frac{\boldsymbol{dExpRev}}{\boldsymbol{dt}}] \quad (27)$$

$$\boldsymbol{Def_{PS}} = \boldsymbol{DefRate_{PS}} * \boldsymbol{Loans_{PS}} \quad (28)$$

New loans are incurred by firms (***NewLoans*$_{PS}$**) to finance investment as well as their daily activities. This last portion we define as a percentage (***α*$_{PSL}$**) of expected revenues (***ExpRev***).

$$\boldsymbol{NewLoans_{PS}} = \boldsymbol{Inv} + \alpha_{PSL} * \boldsymbol{ExpRev} \tag{29}$$

Firms repay (***LoanRepay*$_{PS}$**) a certain percentage (***τ*$_{PS}$**) of their loans per year.

$$\boldsymbol{LoanRepay_{PS}} = \tau_{PS} * \boldsymbol{Loans_{PS}} \tag{30}$$

Default, new loans and loans repayment determine the change in the productive sector's loans (***ChL*$_{PS}$**).

$$\boldsymbol{ChL_{PS}} = \boldsymbol{NewLoans_{PS}} - \boldsymbol{LoanRepay_{PS}} - \boldsymbol{Def_{PS}} \tag{31}$$

3.3.3 – Financial Sector

The financial sector's revenues are the interest it receives from other sectors.

$$\boldsymbol{IntRec} = \boldsymbol{IntLoans_{HH}} + \boldsymbol{IntLoans_{PS}} + \boldsymbol{IntLoans_{RW}} + \boldsymbol{IntPD_{FS}} \tag{32}$$

Its expenses are the interest it pays to other sectors.

$$\boldsymbol{IntPay} = \boldsymbol{IntDep_{HH}} + \boldsymbol{IntDep_{PS}} + \boldsymbol{IntPED} \tag{33}$$

The difference between these two combined with defaults by households and the productive sector give us the financial sector's profits (***Profits*$_{FS}$**).

$$\boldsymbol{Profits_{FS}} = \boldsymbol{IntRec} - \boldsymbol{IntPay} - \boldsymbol{Def_{HH}} - \boldsymbol{Def_{PS}} \tag{34}$$

The financial sector has a required minimum level of reserves (***MinResReq***) which is defined as a percentage (***α*$_{Res}$**) of their liabilities, households' deposits (***Deposits*$_{HH}$**), productive sector's capital account (***CapAct*$_{PS}$**) and private external debt (***PvtExtDebt***).

Government deposits and productive sector's current account are always equal to zero so they are absent from the equation.

$$\boldsymbol{MinResReq} = \alpha_{Res} * (\boldsymbol{Deposits_{HH}} + \boldsymbol{CapAct_{PS}} + \boldsymbol{PvtExtDebt}) \quad (35)$$

To meet the minimum requirement level as well as to get rid of excess reserves, the financial sector adjusts their quantity of reserves ($\boldsymbol{R_{Adj}}$). This adjustment is given by the difference between actual reserves and the minimum required level and the speed of this adjustment is determined by the adjustment factor ($\boldsymbol{AF_{Res}}$).

$$\boldsymbol{R_{Adj}} = AF_{Res} * (\boldsymbol{MinResReq} - \boldsymbol{Reserves}) \quad (36)$$

When this adjustment is positive, i. e. when the financial sector needs to get reserves, it is financed by an increase in external debt (***PvtExtDebt***). On the other hand, when the adjustment is negative, i.e. when the financial sector has excess reserves it reduces its external debt.

$$\frac{\boldsymbol{dPvtExtDebt}}{\boldsymbol{dt}} = \boldsymbol{R_{Adj}} \quad (37)$$

All transactions with the rest of the world sector are settled with reserves. Take for instance the payment of dividends to the rest of the world from the productive sector's capital account. It implies a reduction in the financial sector's liabilities, as well as in the financial sector's assets by a correspondent reduction of reserves. Reserves are then replenished to reach the minimum required level via the adjustment previously defined. So, the change in reserves is given by all transactions with the rest of the world sector and by the adjustment of reserves.

$$\frac{\boldsymbol{dReserves}}{\boldsymbol{dt}} = \boldsymbol{Exp} + \boldsymbol{Def_{RW}} + \boldsymbol{IntLoans_{RW}} - \boldsymbol{Imp} - \boldsymbol{Div_{RW}} - \boldsymbol{IntPED} - \boldsymbol{IntPD_{RW}} + \boldsymbol{R_{Adj}} \quad (38)$$

3.3.4 – Government

Government sector's decisions are our main focus on the simulations analysis. Government related variables are determined by political decisions and constitute the main inputs being changed in the simulations so most of these are exogenously defined.

Tax rates (***TaxRate$_{incHH}$***, ***TaxRate$_{incPS}$***, ***TaxRate$_{incFS}$***, ***TaxRate$_{ind}$***) are exogenously defined. Income tax payments are simply obtained by multiplying the tax rate by the related income. Income tax on households include social contributions. Indirect taxes refer mainly to value added tax, other taxes on production and consumption and taxes on imports. These are mostly levied on products sold domestically.

$$\boldsymbol{IncTax_{HH} = TaxRate_{incHH} * (Wages + GovTrsf + Div_{HH} + IntDep_{HH})} \quad (39)$$

$$\boldsymbol{IncTax_{PS} = OP * TaxRate_{incPS}} \quad (40)$$

$$\boldsymbol{IncTax_{FS} = Profits_{FS} * TaxRate_{incFS}} \quad (41)$$

$$\boldsymbol{IndTax = TaxRate_{ind} * (ConsH + G + Inv)} \quad (42)$$

$$\boldsymbol{TaxRevenue = IncTax_{HH} + IncTax_{PS} + IncTax_{FS} + IndTax} \quad (43)$$

Government transfers (***GovTrsf***) and government spending (***G***) are exogenously defined with government spending being the sum of government consumption (***Cons$_{Gov}$***) and government gross fixed capital formation (***GFCF$_{Gov}$***).

$$\boldsymbol{G = Cons_{Gov} + GFCF_{Gov}} \quad (44)$$

The difference between expenses and revenues impacts immediately on public debt. Since the government usually runs a deficit we simply designated this difference as deficit. If it's positive there is an equal increase in public debt while if it's negative an equal decrease. Part of the deficit is financed by the financial sector and the rest of it, by the rest of the world sector. This ratio (***α_{DomDef}***) is constant throughout.

$$\boldsymbol{Deficit = G + GovTrsf + IntPD_{FS} + IntPD_{RW} - TaxRevenue} \quad (45)$$

$$\boldsymbol{GovDef_{FS} = \alpha_{DomDef} * Deficit} \quad (46)$$

$$\boldsymbol{GovDef_{RW} = (1 - \alpha_{DomDef}) * Deficit} \quad (47)$$

3.4 - Interest rates and credit conditions

One of the important features of the model is that it tries to take into account the influence of credit and credit market conditions on aggregate demand. Broadly speaking, the way we did this was to define a banks' funding rate determined by a reference rate, the six month Euribor, plus a spread reflecting funding costs and expectations regarding economic activity. We then use this spread to restrict credit conceded to households and firms as well as their decisions to consume and invest. In this chapter we explain and justify the interest rate structure of the model and how credit conditions affect aggregate demand.

The interest rate structure of the model is based on two main concepts. Banks' funds transfer pricing and the composition of banks' funding costs. For detailed discussions see Cadamagnani et all (2015) and Beau et all (2014).

Banks' funds transfer price is an internal rate reflecting the relevant costs and risks of their business that banks use to determine interest rates on loans by adding a spread and on deposits by subtracting a spread. This price is determined within the funds transfer pricing methodology which sees banks as having a treasury department that works as a bank within the bank, and several different business lines as for example a lending business line or a deposit taking business line. The treasury department is responsible to obtain funding, internally (through the deposit business lines) or externally, for the lending business lines. In doing this it pays a price for funds transferred from the deposit business line and charges another price on funds transferred to the lending business line. Each business line then charges a mark-up on this internal transfer price. In the case of the deposits business line this means that the rate being offered to the clients is inferior the rate being paid by the banks treasury. This can be seen more clearly in figure 3.1 taken from Cadamagnani et all (2015).

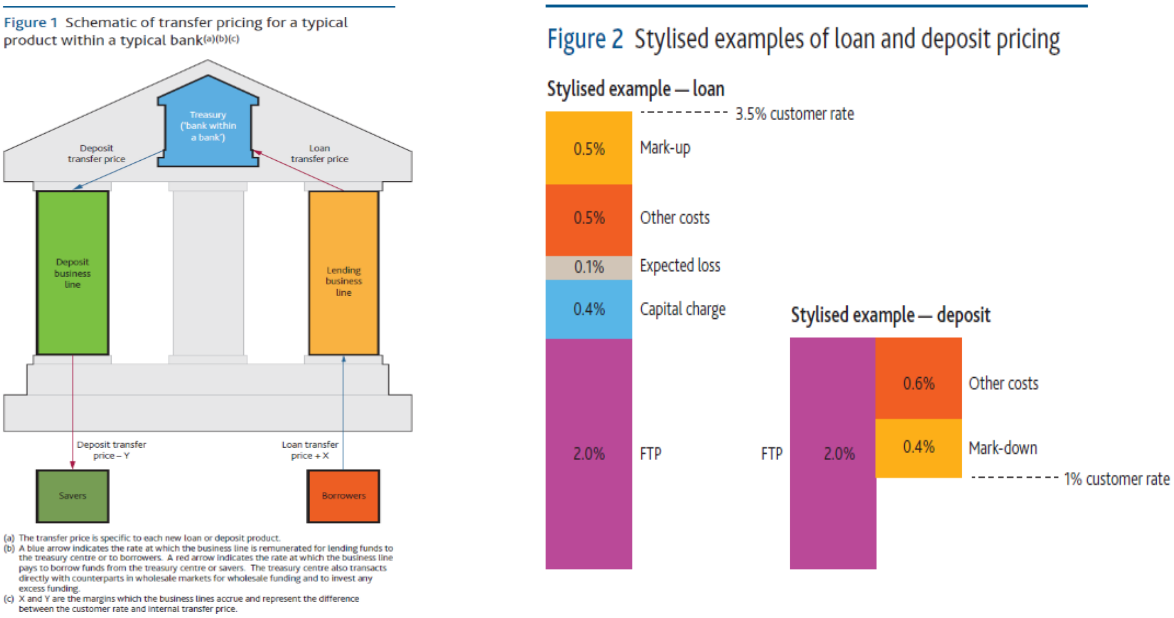


Figure 3.1 – Transfer pricing scheme and a stylized example of loan and deposit pricing. Taken from Cadamagnani et all (2015)

In the model we consider the deposit transfer price equal to the loan transfer price and call it the **banks' funding rate**. From this transfer price we add fixed spreads to obtain interest rates on new loans to households and firms and subtract a fixed spread to obtain the interest rate on new deposits.

The second concept is the composition of banks' funding costs and consequently the composition of banks' funds transfer price. According to Beau et all (2014) "The cost of funding can be decomposed into a risk free component, and a combination of credit risk and liquidity risk premia, and other costs (Figure 4). The risk premia are influenced by a combination of general, 'macro' factors (such as the broad economic outlook, or an increase in the riskiness of the banking sector) and factors that are idiosyncratic to any given bank, such as a business model focused on a particularly risky type of lending." Figure 4 of the quoted article is shown next.

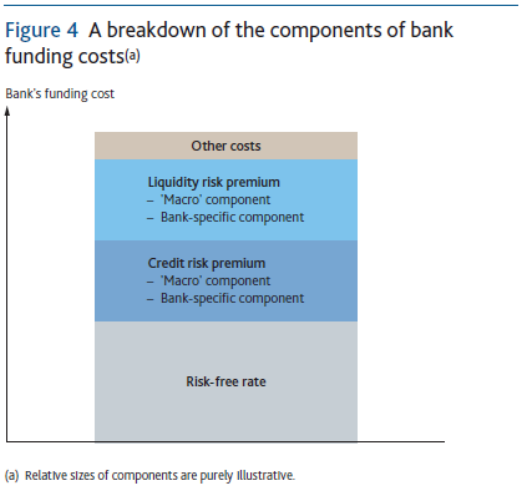


Figure 3.2 – Breakdown of banks funding costs. Taken form Beau et all (2014)

In the model the banks' funding rate (***FundingRate***) will be equal to a benchmark rate, the 6 month Euribor plus a spread reflecting liquidity and credit risk called the **Portugal spread**.

Portugal spread is exogenously defined in the model. We estimated it by first estimating a hypothetical funds transfer price, or banks' funding rate, as the average between a weighted interest rate charged on new loans and a weighted interest rate offered on new deposits by the Portuguese financial sector. Subtracting the 6 month Euribor to the estimated banks' funding rate we obtained the following Portugal spread.

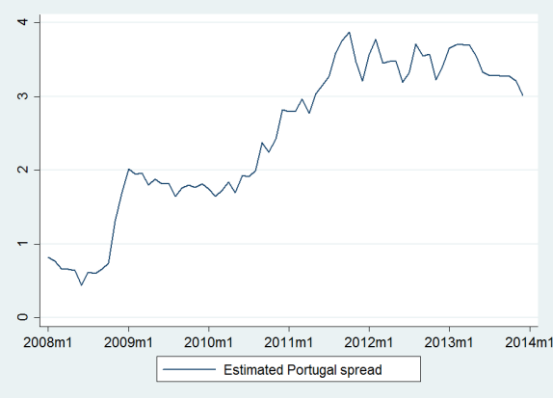


Figure 3.3 – Estimated Portugal spread

As mentioned before, this spread reflects funding costs as well as a combination of general macro factors and it's a good indicator of credit market conditions. We can

confirm this by looking at the bank lending survey for the Portuguese banks. This quarterly survey made to five banks asks them, among many other questions, if their credit standards have tightened in the last 3 months. A diffusion index is then built from their answers, which goes from -100 when every bank considerably loosened their credit standards to +100 when every bank considerably tightened their credit standards. As we can see the estimated funding rate for the Portuguese banks, is consistent with the answers from the bank lending survey. After the financial crisis' peak at the end of 2008, credit standards became relatively stable at the end of 2009 before deteriorating again with the beginning of the sovereign debt crisis in mid-2010.

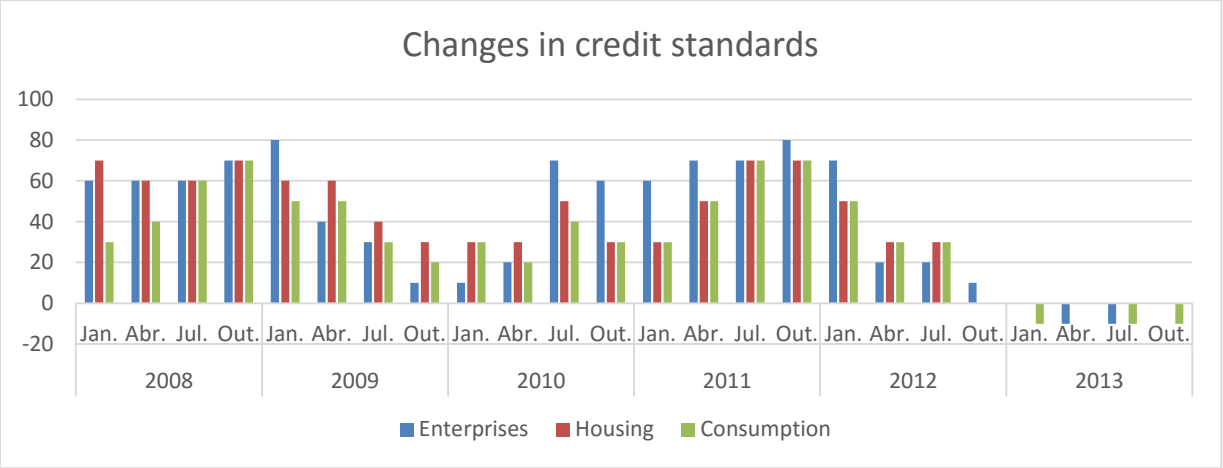
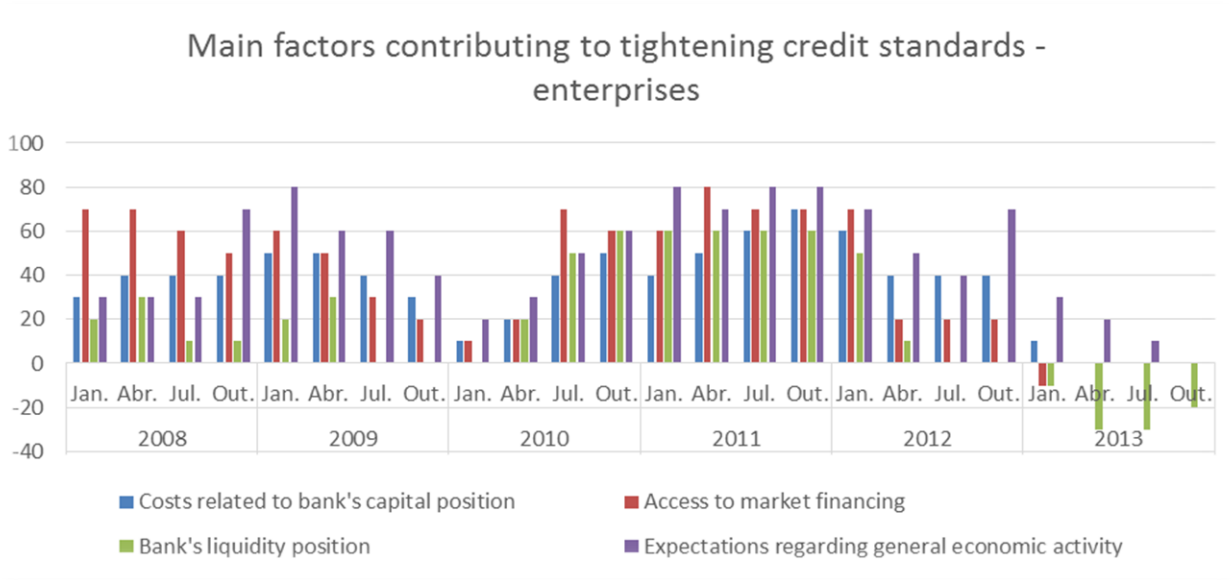
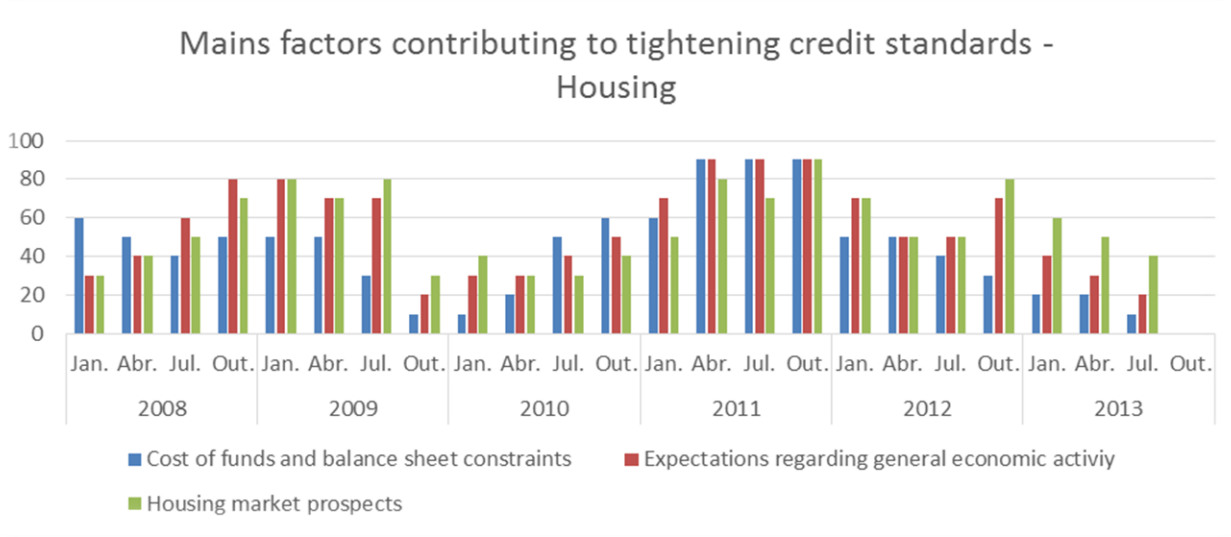


Figure 3.4 – Changes in credit standards. Quarterly survey answers

Associated with the banks decision to tighten or loosen credit standards is usually an expectation regarding the economic outlook. In fact this is the factor with a higher diffusion index indicated by banks in the bank lending survey when asked about the reasons behind their tightening of credit standards for enterprises, housing and consumption.





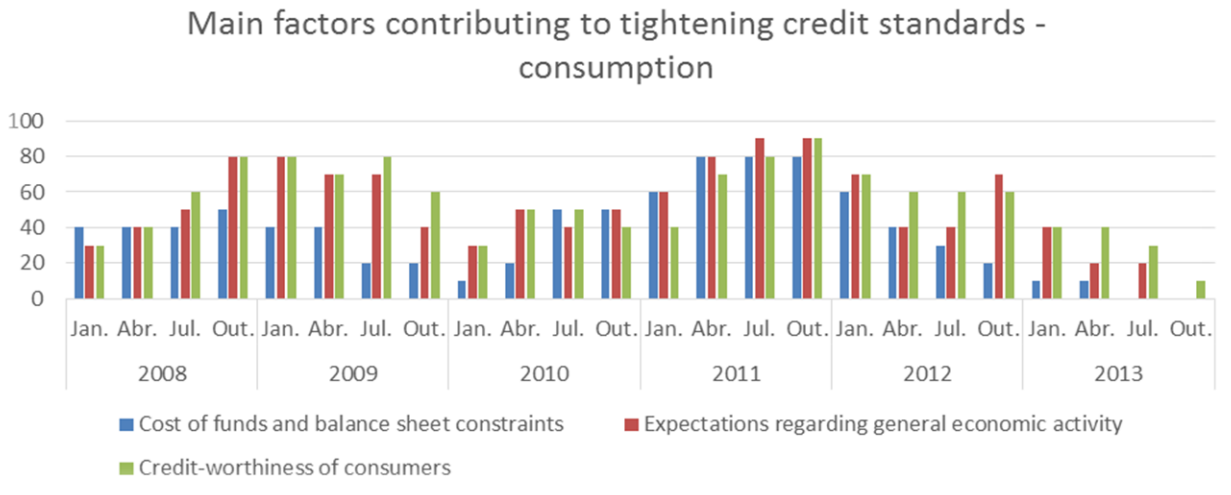


Figure 3.5 – Main factors contributing to tightening credit standards

In the bank lending survey, banks are also asked about increases or decreases in the demand for loans and for the reasons behind this. In this case a diffusion index of 100 means that all banks observed a significant increase in the demand for loans and -100 the opposite. Looking at the answers regarding the reasons leading to a decrease in the demand for housing and credit loans we can see that consumers' confidence, housing market prospects and reduced spending on durables go hand in hand with the previously observed supply factors and with the estimated Portugal spread.

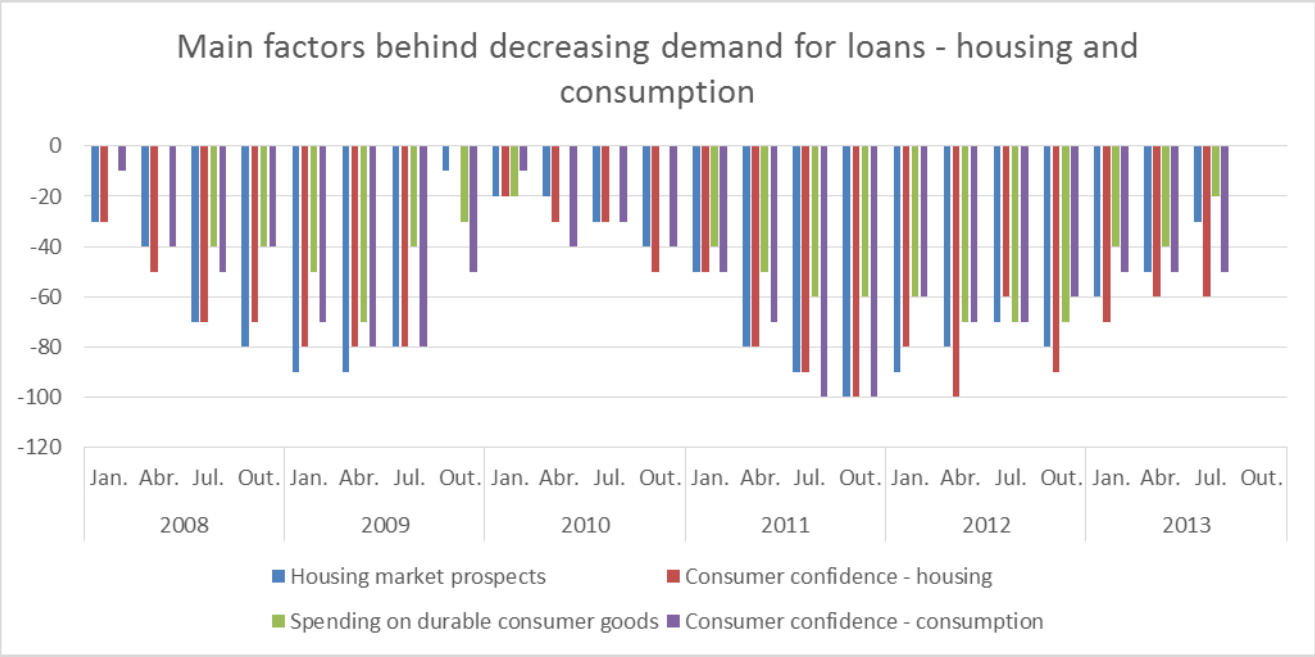


Figure 3.6 – Main factors behind decreasing demand for loans

Finally looking at the consumer confidence index for Portugal we can see that its behavior is almost mirrored by the estimated Portugal spread. In fact the correlation between these from 2003 to 2014 is -0.7677.

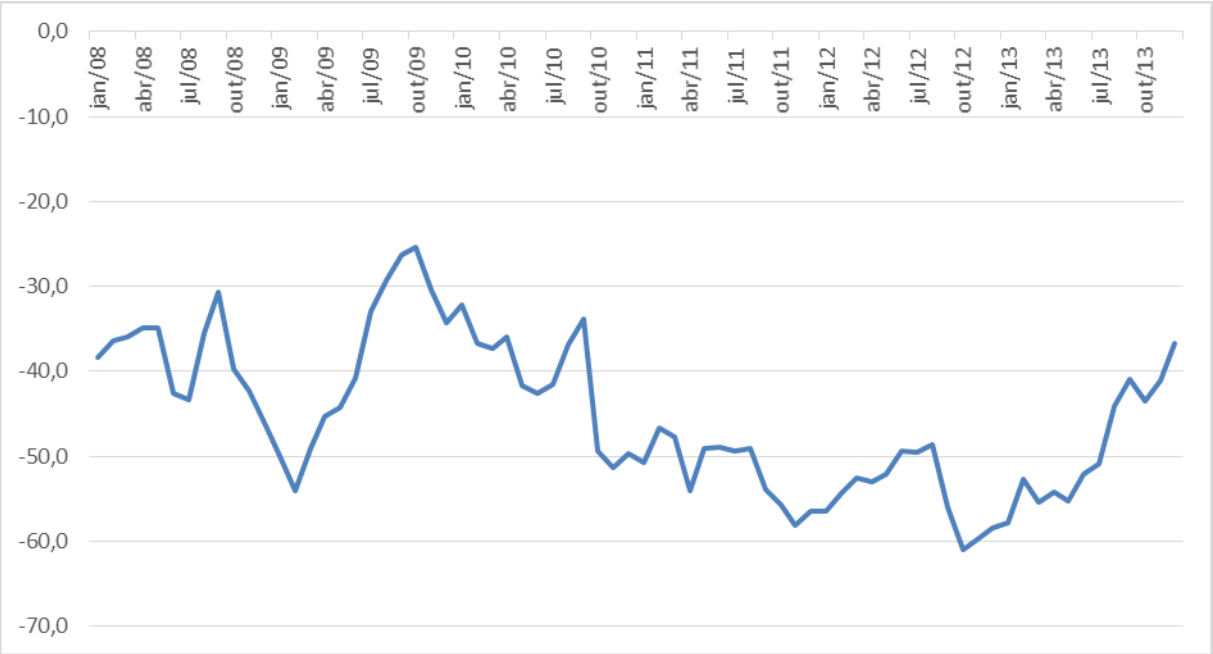


Figure 3.7 – Consumer confidence index. Source: INE

We think it can be concluded that the spread between the estimated funding rate of the Portuguese banks and the benchmark rate, the 6 month Euribor, is a good indicator of credit market conditions and of the general economic feeling. This justifies the use of this variable in modeling consumption and investment decisions by households and firms as well as the demand for loans. For example, in the model households will consume a certain percentage of their expected disposable income. This percentage will be inversely related with the Portugal spread.

Fixed and floating interest rates

The way changes in interest rates and spreads on new loans affect interest rates being paid on outstanding loans depends on the kind of interest rate we are dealing with, if it's fixed or if it's floating. This is relevant because in the real world, government pays a fixed interest rate on the majority of its debt, while households and firms finance themselves mostly through floating rate loans. With this in mind we have two kinds of interest rates in the model, fixed and floating.

With fixed interest rates a significant change in interest rates on new loans ($IntRate_{NL}$) has a gradual influence in interest being paid on outstanding loans ($IntRate_{OL}$). The dynamics of this can be approximated in the following way:

$$\boldsymbol{IntRate_{NL} = Euribor + Spread_{NL}} \quad (48)$$

$$\boldsymbol{\frac{dIntRate_{OL}}{dt} = \rho * (IntRate_{NL} - IntRate_{OL})} \quad (49)$$

The change in interest on outstanding loans is defined by itself, the interest rate on new loans and the weight of new loans on total loans given by ρ (ρ can also be defined as the inverse of the average maturity of outstanding loans).

In the case of floating rates, a significant change in interest rates has an immediate effect on the interest being paid on outstanding loans. This dynamic can be approximated in the following way:

$$\boldsymbol{\frac{dSpread_{OL}}{dt} = \rho * (Spread_{NL} - Spread_{OL})} \quad (50)$$

$$\boldsymbol{IntRate_{OL} = Euribor + Spread_{OL}} \quad (51)$$

The interest on outstanding loans is given by the reference rate (Euribor in this case) and the average spread on outstanding loans ($Spread_{OL}$) whose dynamic depends on itself, the spread on new loans ($Spread_{NL}$) and the weight of new loans on total loans given by ρ (as for fixed interest, this can also be average maturity of outstanding loans). So the relevant dynamic is the change in average spread on outstanding loans.

In the model we have only two floating interest rate assets/liabilities, loans to the productive sector and loans to households.

In the case of loans to the productive sector the spread is given by the Portugal spread plus 1.4% or 140 basis points. This means that the financial sector charges 140 basis points above its funding rate on new loans to the productive sector.

$$\boldsymbol{Spread_{NLPS} = PortugalSpread} + 0.014 \quad (52)$$

$$\frac{\boldsymbol{dSpread_{OLPS}}}{\boldsymbol{dt}} = \frac{\boldsymbol{NewLoans_{PS}}}{\boldsymbol{Loans_{PS} + CHL_{PS}}} * (\boldsymbol{Spread_{NLPS} - Spread_{OLPS}}) \quad (53)$$

$$\boldsymbol{IntRate_{OLPS} = Euribor + Spread_{OLPS}} \quad (54)$$

$$\boldsymbol{IntLoans_{PS} = IntRate_{OLPS} * Loans_{PS}} \quad (55)$$

For loans to households the spread we use is Portugal spread plus 1.8% or 180 basis points. This means that the financial sector charges 180 basis points above its funding rate on new loans to households.

In the case of household loans there is another important point that must be taken into account which is how frequently the interest rate on a loan is updated. For instance a floating interest rate loan can update its benchmark rate every month or every 3 or 6 months with the effective interest rate being the previous month average, which means that changes in the benchmark rate are not immediately reflected in interest rates on outstanding loans. This was clearly observed at the end of 2008, when the Euribor fell dramatically but the correspondent decrease in households interest expenses happened only a few months later. To model this, we created a variable – Effective Euribor - that acts as a delay on the Euribor rate.

$$\boldsymbol{Spread_{NLHH} = PortugalSpread} + 0.018 \quad (56)$$

$$\frac{\boldsymbol{dEffEur}}{\boldsymbol{dt}} = AF_{EffEur} * (\boldsymbol{Euribor - EffEur}) \quad (57)$$

$$\frac{\boldsymbol{dSpread_{OLHH}}}{\boldsymbol{dt}} = \frac{\boldsymbol{NewLoans_{HH}}}{\boldsymbol{Loans_{HH} + CHL_{HH}}} * (\boldsymbol{Spread_{NLHH} - Spread_{OLHH}}) \quad (58)$$

$$\boldsymbol{IntRate_{OLHH} = EffEur + Spread_{OLHH}} \quad (59)$$

$$\boldsymbol{IntLoans_{HH} = IntRate_{OLHH} * Loans_{HH}} \quad (60)$$

The remaining assets/liabilities have fixed term interest rates. Interest rates on new deposits offered to firms and households are obtained by subtracting a 150 basis points spread to the funding rate of the financial sector.

$$\boldsymbol{IntRate_{NDep} = FundingRate} - 0.015 \quad (61)$$

$$\frac{\boldsymbol{dIntRate_{ODep}}}{\boldsymbol{dt}} = \rho_{Dep} * (\boldsymbol{IntRate_{NDep} - IntRate_{ODep}}) \quad (62)$$

Interest rate on new private external debt is given by adding a fraction of the Portugal Spread to the Euribor. The justification for this is that a significant part of new private external debt in the period being studied was financed by the ECB in very favorable conditions to the Portuguese financial sector.

$$\boldsymbol{IntRate_{NPED}} = \boldsymbol{Euribor} + \alpha_{PED} * \boldsymbol{PortugalSpread} \quad (63)$$

$$\frac{\boldsymbol{dIntRate_{OPED}}}{\boldsymbol{dt}} = \rho_{PED} * (\boldsymbol{IntRate_{NPED}} - \boldsymbol{IntRate_{OPED}}) \quad (64)$$

Interest rate on new loans to the rest of the world is defined similarly, the justification being that the credit risk premia in foreign assets is not, on average, as high as the one charged on the Portuguese financial sector.

$$\boldsymbol{IntRate_{NLRW}} = \boldsymbol{Euribor} + \alpha_{LRW} * \boldsymbol{PortugalSpread} \quad (65)$$

$$\frac{\boldsymbol{dIntRate_{OLRW}}}{\boldsymbol{dt}} = \rho_{LRW} * (\boldsymbol{IntRate_{NLRW}} - \boldsymbol{IntRate_{OLRW}}) \quad (66)$$

The interest rates on new government debt is exogenously defined and the interest rate on outstanding public debt is given by:

$$\frac{\boldsymbol{dIntRate_{OPD}}}{\boldsymbol{dt}} = \rho_{PD} * (\boldsymbol{IntRate_{NPD}} - \boldsymbol{IntRate_{OPD}}) \quad (67)$$

Chapter IV – Replicating the events – the benchmark case

In this chapter we begin by describing how we determined the most relevant fixed inputs of the model that will be common to all simulations. We then define the variable inputs that will yield our benchmark case that tries to replicate the events as they happened.

4.1 - The fixed inputs

4.1.1 - Assets and liabilities

The sector's balance sheets starting point is based on the end of period values for 2007 from the National Accounts.

F.2.1.1 Contas nacionais financeiras - Património financeiros
Por setor institucional e instrumento financeiro - 2007
Valores consolidados

National financial accounts - Financial assets and liabilities
By institutional sector and financial instrument - 2007
Consolidated values

Fonte / Source: Banco de Portugal

10^6 euros

	Código SEC 95	(S.1) Total da economia			(S.11) Sociedades não financeiras			(S.12) Sociedades financeiras			(S.13) Administrações públicas			(S.14+S.15) Particulares			(S.2) Resto do mundo			
		Ativos	Passivos	Saldo	Ativos	Passivos	Saldo	Ativos	Passivos	Saldo	Ativos	Passivos	Saldo	Ativos	Passivos	Saldo	Ativos	Passivos	Saldo	
	ESA 95 Code	Assets	Liabilities	Net	Assets	Liabilities	Net	Assets	Liabilities	Net	Assets	Liabilities	Net	Assets	Liabilities	Net	Assets	Liabilities	Net	
		Total economy			Non-financial corporations			Financial corporations			General government			Households+NPISH			Rest of the world			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
1 Ativos financeiros líquidos	BF.90	1 107 169	1 254 730	-147 561	144 196	408 350	-264 155	539 567	550 273	-10 706	43 743	127 894	-84 151	379 664	168 213	211 451	457 650	303 017	154 633	Net financial assets
2 por memória: em percentagem do PIB				-87.1			-156.0			-6.3			-49.7			124.9			91.3	memo item: as a percentage of GDP
3 Ouro monetário e DSE	AF.1	7 073	0	7 073	0	0	0	7 073	0	7 073	0	0	0	0	0	0	0	0	0	Monetary gold and SDR
4 Numerário e depósitos	AF.2	250 787	306 297	-55 510	43 788	0	43 788	67 679	286 291	-218 611	7 853	20 007	-12 153	131 467	0	131 467	146 435	90 925	55 510	Currency and deposits
5 Numerário	AF.21	7 367	2 882	4 485	2 003	0	2 003	1 179	2 376	-1 197	78	506	-428	4 107	0	4 107	0	4 485	-4 485	Currency
6 Depósitos transferíveis e outros depósitos	AF.22+AF.29	243 420	303 415	-59 995	41 785	0	41 785	66 500	283 914	-217 414	7 775	19 500	-11 725	127 360	0	127 360	146 435	86 440	59 995	Transferable deposits and other deposits
7 Títulos exceto ações	AF.3	133 422	152 886	-19 465	1 902	29 607	-27 705	109 631	37 685	71 946	2 049	85 720	-83 671	19 840	-125	19 966	114 696	95 232	19 465	Securities other than shares
8 Títulos exceto ações excluindo derivados financeiros	AF.33	133 739	153 297	-19 557	1 899	29 868	-27 969	109 894	37 685	72 209	2 106	85 744	-83 638	19 840	0	19 840	114 696	95 139	19 557	Securities other than shares excluding financial derivatives
9 De curto prazo	AF.331	19 058	29 595	-10 538	184	18 994	-18 811	17 757	530	17 227	6	10 071	-10 065	1 112	0	1 112	15 094	4 556	10 538	Short-term
10 De longo prazo	AF.332	114 682	123 701	-9 020	1 716	10 873	-9 158	92 137	37 155	54 982	2 100	75 672	-73 573	18 729	0	18 729	99 602	90 582	9 020	Long-term
11 Derivados financeiros	AF.34	-318	-410	93	3	-261	264	-263	0	-263	-57	-24	-33	0	-125	125	0	93	-93	Financial derivatives
12 Empréstimos	AF.4	326 909	360 423	-33 513	18 972	163 459	-144 487	280 044	29 774	250 270	2 253	16 887	-14 634	25 640	150 303	-124 663	61 435	27 921	33 513	Loans
13 De curto prazo	AF.41	52 883	54 122	-1 239	419	40 435	-40 015	52 463	982	51 482	1	3 257	-3 256	0	9 449	-9 449	4 130	2 891	1 239	Short-term
14 De longo prazo	AF.42	274 026	306 301	-32 275	18 553	123 024	-104 471	227 581	28 792	198 788	2 252	13 630	-11 378	25 640	140 854	-115 214	57 305	25 030	32 275	Long-term
15 Ações e outras participações	AF.5	257 340	304 543	-47 203	49 001	190 401	-141 400	60 124	114 142	-54 018	23 625	0	23 625	124 590	0	124 590	123 727	76 524	47 203	Shares and other equity
16 Ações e outras participações excluindo fundos de investimento	AF.51	216 207	274 879	-58 672	45 213	190 401	-145 188	51 262	84 478	-33 217	23 032	0	23 032	96 701	0	96 701	121 640	62 968	58 672	Shares and other equity excluding mutual funds shares
17 Unidades de participação em fundos de investimento	AF.52	41 133	29 664	11 469	3 788	0	3 788	8 862	29 664	-20 802	593	0	593	27 890	0	27 890	2 087	13 556	-11 469	Mutual funds shares
18 Reservas técnicas de seguros	AF.6	71 388	71 189	198	2 891	2 044	847	413	69 145	-68 732	20	0	20	68 064	0	68 064	215	413	-198	Insurance technical reserves
19 Seguros de vida e fundos de pensões	AF.61	63 995	63 995	-0	0	2 044	-2 044	0	61 951	-61 951	0	0	0	63 995	0	63 995	0	0	0	Net equity of households in life insurance & pension funds reserves
20 Outras	AF.62	7 392	7 194	198	2 891	0	2 891	413	7 194	-6 781	20	0	20	4 068	0	4 068	215	413	-198	Other
21 Outros débitos e créditos	AF.7	60 251	59 391	860	27 642	22 840	4 802	14 603	13 236	1 368	7 943	5 280	2 663	10 062	18 035	-7 973	11 142	12 002	-860	Other accounts receivable and payable
22 Créditos comerciais e adiantamentos	AF.71	31 161	30 826	334	27 296	13 917	13 379	685	435	249	917	1 789	-852	2 263	14 705	-12 442	10 792	11 127	-334	Trade credits and advances
23 Outros	AF.79	29 090	28 565	526	347	8 924	-8 577	13 919	12 801	1 118	7 026	3 511	3 515	7 799	3 330	4 469	350	875	-526	Other

Figure 4.1 – Assets and liabilities at the end of 2007. Taken from the Statistical Bulletin of the Bank of Portugal

In the model households have only one asset, its deposits, that correspond to the sum of currency and deposits, securities other than shares, loans, and insurance technical reserves. It also has only one liability, loans.

The productive sector has one relevant asset (remember that its current account is always equal to zero), its capital account which is defined similarly to households' deposits. Its liability, loans, includes loans and securities other than shares.

The government's balance sheet is defined by public debt, with part of it owned by the financial sector and the remaining part by the rest of the world sector. Following the definition of the Maastricht treaty, public debt includes the liabilities in currency and deposits, securities other than shares (excluding financial derivatives), and loans.

The rest of the world sector has two assets, public debt that was defined before and private external debt. Private external debt includes all claims on the domestic sector except shares and other equity, other accounts receivable and payable, and public debt. Its two liabilities are loans from the financial sector and reserves. Loans from the financial sector include all liabilities of the rest of the world sector except shares and other equity, and other accounts receivable and payable. Reserves, as explained before, are merely instrumental and its initial value is set to 1% of the financial sector's liabilities.

The financial sector's balance sheet is residual in the sense that it is completely defined by the other sector's balance sheet.

The initial values of the sectors' simplified balance sheets in billions of euros are shown in table 4.1

	Households	**Productive Sector**	**Government**	**Financial Sector**	**Rest of the World**
Household Deposits	+245			-245	
Household Loans	-150			+150	
Capital Account (PS)		+68		-68	
Loans to the productive sector		-193		+193	
Public debt			-123	+35	+88
Private external debt				-235	+235
Loans to the rest of the world				+214	-214
Reserves				+5.5	-5.5
Net worth	+95	-125	-123	+49.5	+103.5

Table 4.1 – Initial assets and liabilities of the model

4.1.2 – Tax rates

Income tax of the productive sector

For the income tax rate of the productive sector we simply obtained the annual implied tax rates by dividing the income tax paid by the operating surplus of non-financial corporations in the National Accounts. Figure 4.2 shows the obtained values and the values used in the model.

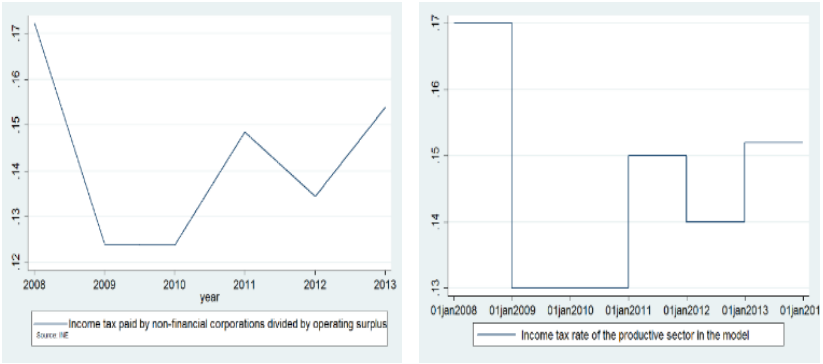


Figure 4.2 – Income tax rate of the productive sector – actual and in the model

Income tax of the financial sector

In the model the income of the Financial Sector is simply given by the net interest and the default on loans. Wages and other expenses as well as other receipts are ignored. So the income of the financial sector, in the model, should be something in between net interest paid and the operating surplus in reality.The implied tax rate given by dividing income tax paid by both of these can be seen in figure 4.3

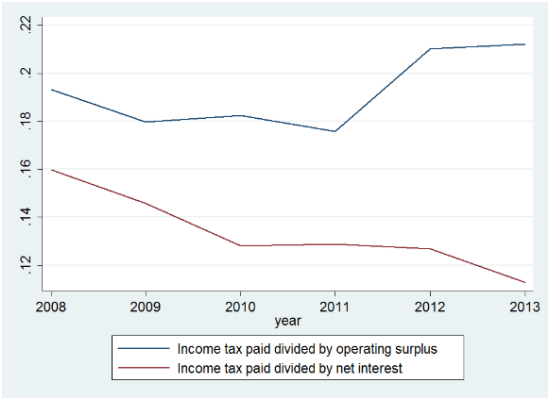


Figure 4.3 – Implied income tax rates of the financial sector

So the income tax rate of the financial sector in the model should be between these two values. We assumed it constantly equal to 0.17 in all simulations.

4.1.3 – Some parameters of behavioral equations

We will now write some of the more important behavioral equations defined in chapter 3, substituting the fixed parameters by the values used which are based on observed data. The full model with all parameters for the benchmark case can be seen in Annex A.

Households

$$\boldsymbol{Cons} = (0.92 - 1.5 * \boldsymbol{PortugalSpread}) * \boldsymbol{ExpDI} + 0.04 * \boldsymbol{HH_{NW}}$$

$$\boldsymbol{GFCF_{HH}} = (0.09 - 1.2 * \boldsymbol{PortugalSpread}) * \boldsymbol{ExpDI}$$

$$\boldsymbol{NewConsLoans} = (0.1 - 1.8 * \boldsymbol{PortugalSpread}) * \boldsymbol{ExpDI}$$

$$\boldsymbol{NewHousingLoans} = (0.2 - 5 * \boldsymbol{PortugalSpread}) * \boldsymbol{ExpDI}$$

$$\boldsymbol{LoanRepay_{HH}} = 0.1 * \boldsymbol{Loans_{HH}}$$

Productive Sector

$$\boldsymbol{Imp} = [(0.26 - 1.2 * \boldsymbol{PortugalSpread}) * \boldsymbol{Cons} + 0.41 * \boldsymbol{TotInv} + 0.12 * \boldsymbol{Cons_{Gov}} + 0.41 * \boldsymbol{Exp}] * (1 - IntCrdCond)$$

$$\boldsymbol{Wages_{Tgt}} = 0.79 * (\boldsymbol{GDP} - \boldsymbol{IndTax})$$

$$\boldsymbol{GOS_{Gov}} = 0.15 * (\boldsymbol{GDP} - \boldsymbol{IndTax} - \boldsymbol{Wages})$$

$$\boldsymbol{Div_{HH}} = 0.17 * \boldsymbol{CapAct_{PS}} * 0.65$$

$$\boldsymbol{Div_{RW}} = 0.17 * \boldsymbol{CapAct_{PS}} * (1 - 0.65)$$

$$\boldsymbol{KapTgt} = \boldsymbol{ExpRev} * \frac{0.5}{0.4 * 0.8} * (1.03 - 1 * \boldsymbol{PortugalSpread})$$

$$\boldsymbol{ConsFC} = 0.065 * \boldsymbol{Kapital}$$

$$\boldsymbol{GFCF_{PS}} = I_{[R^+]}[0.7 * (\boldsymbol{KapTgt} - (\boldsymbol{Kapital} - \boldsymbol{ConsFC}))] * (1 - 2 * IntCrdCond)$$

$$\boldsymbol{NewLoans_{PS}} = \boldsymbol{GFCF_{PS}} + 0.25 * \boldsymbol{ExpRev}$$

$$\boldsymbol{LoanRepay_{PS}} = 0.3 * \boldsymbol{Loans_{PS}}$$

4.2 – Variable inputs

Variable inputs, as stated before, are the inputs that will be changed in the simulations done in the next chapter. Among these we should stress the government controlled inputs from the remaining inputs. These are the inputs directly decided by the Portuguese government, the amount it spends and the tax rates it charges. The other inputs that will be changed are the financing rate of the government and the Portugal spread.

4.2.1 – Government controlled inputs

Government spending and government transfers

Government spending is equal to the sum of government consumption and government gross fixed capital formation. For the benchmark case the values are taken from the National Accounts. The seasonally adjusted values as well as the approximation in continuous time used in the model can be seen in the top graphs of figure 4.4.

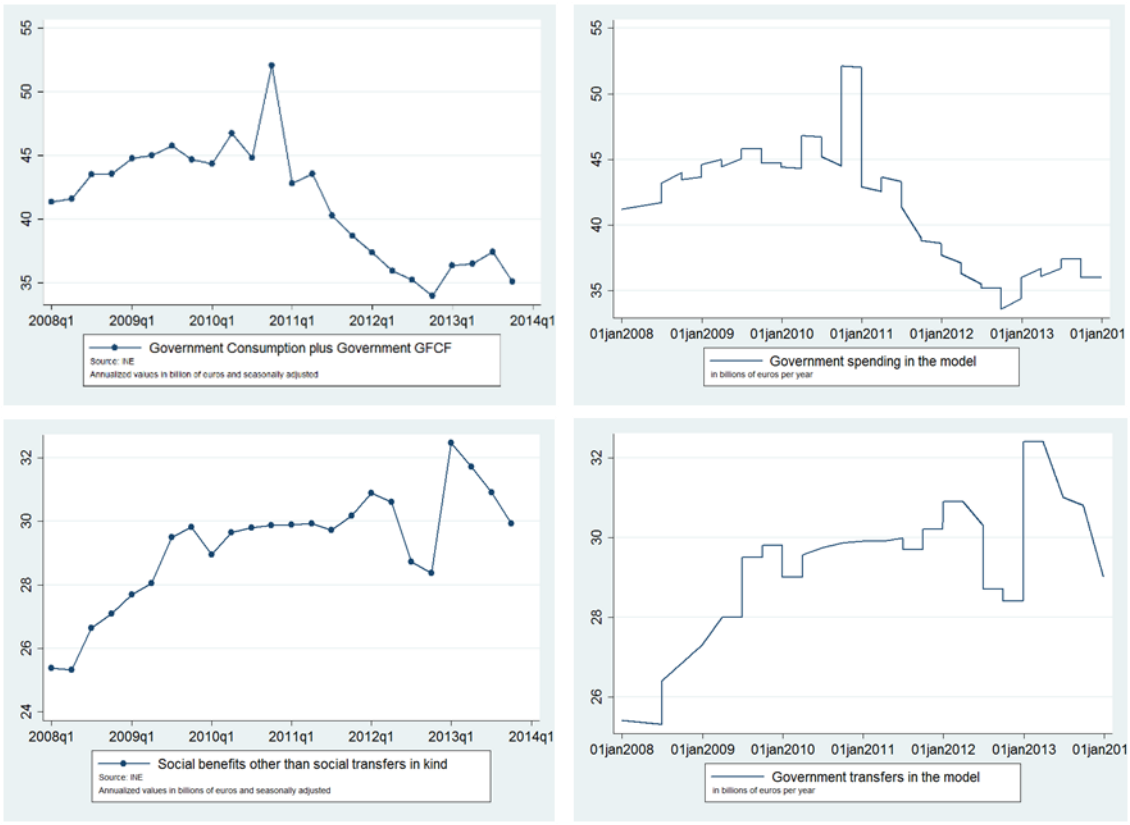


Figure 4.4 – Government spending and government transfers – actual and in the model

Government transfers are equal to social benefits other than social transfers in kind which are already included in government consumption. The values from the National Accounts and the approximation used in the model can be seen in the bottom graphs of figure 4.4.

Tax rates

Income tax and social contributions of households

The implied tax rate paid by households is given by the income tax and social contributions paid divided by the income included in the model. This gives us the following annual values which can be seen in the left graph of figure 4.5.

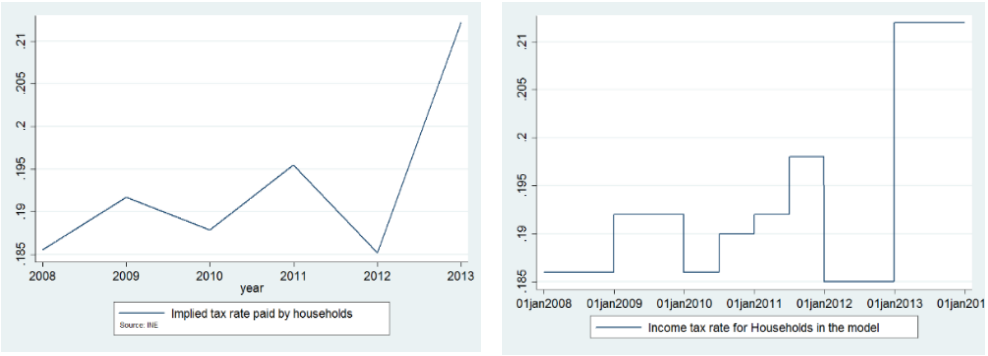


Figure 4.5 – Implied income tax rate paid by households and income tax rate for households in the model

During this period we can identify the following significant changes related to this tax rate:

- In 2008 and 2009 there were no significant changes
- The 2010 budget introduced a slight fiscal relief for households
- In the 30th of June of 2010 the government increases by 1% the individual income tax for monthly incomes below 2.375 € and 1.5% otherwise
- In 2011 there were reductions in income tax deductions
- In August of 2011 the governemnt announces a one-off surcharge on the personal income tax of 3.5% to be collected by a 50% cut in the Christmass bonus

- In 2012, there was a 2.5% surcharge for annual incomes above 153.000€ and more reductions in income tax deductions. Despite this, the implied tax rate decreased which can be explained by the close to 3% reduction in average wage
- In 2013 there was a revision of the personal income tax structure which predicted an increase in revenues of 1.7% of GDP

Taking this into account the income tax rate for households can be seen in the right graph of figure 4.5.

Indirect taxes

The implied annual tax rates of indirect taxes obtained by dividing taxes paid by GDP can be seen in the left graph of figure 4.6. To build an approximation of this in continuous time it is useful to look at the most relevant changes in some of this taxes in the 2008-2013 period:

- In July of 2008 the normal VAT rate was lowered to 20% from 21%
- In July of 2010 all VAT rates were increased by 1%
- In 2011 the normal VAT rate was increased to 23%
- In October of 2011 the VAT for electricity and gas was raised to 23% from 6%
- In 2012 there was a shift of a large number of goods and services to a higher VAT rate

With this information the continuous time approximation for the indirect tax rate is shown in the right graph of figure 4.6.

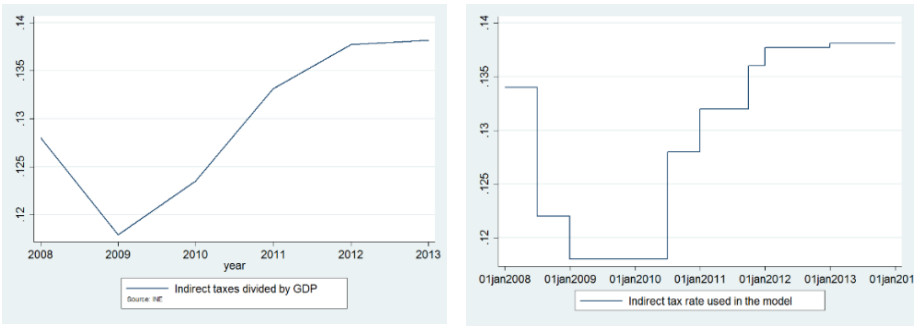


Figure 4.6 – Implied indirect tax rate and indirect tax rate in the model

4.2.2 – Other variable inputs

Government financing rate

When the bailout was solicited by the Portuguese government in April 2011, 10 year government bond yields had already past 8%. Despite this, Portugal never financed itself at this interest rates. The only significant issue of public debt in 2011 before the bailout was in February, with a 5 year treasury bond with a 6.4% yield. After the bailout, the initial average interest rate on the loans by the troika was 4%, in 2012 it was 3% and in 2013 it was 2.84% according to the IGCP, the agency responsible for public debt management. So, the approximation for the financing interest rate of the government is shown in figure 4.7.

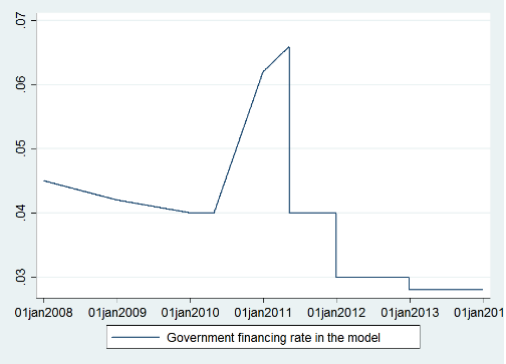


Figure 4.7 – Government financing rate in the model

Portugal spread

Portugal spread, as explained in chapter 4, is simply the spread between an estimated "funding rate" for the Portuguese financial sector and the model's benchmark rate, the 6 month Euribor. The spread obtained with monthly data is shown in figure 4.8 as well as the approximation used in the model.

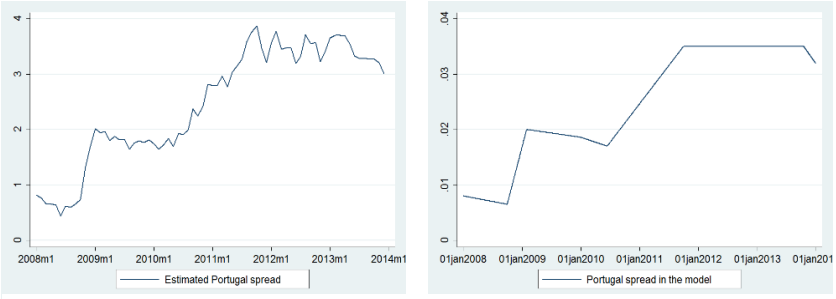


Figure 4.8 – Estimated Portugal spread and approximation used in the model

4.3 – Running the benchmark case

The benchmark model was run with the inputs described in this chapter and it has the objective of replicate the 2008-2013 events.

To evaluate the model results let´s compare the values obtained for some of the more relevant variables with the actual ones, starting with GDP for each quarter. Figure 4.9 shows the actual values on the left and the values obtained in the model on the right.

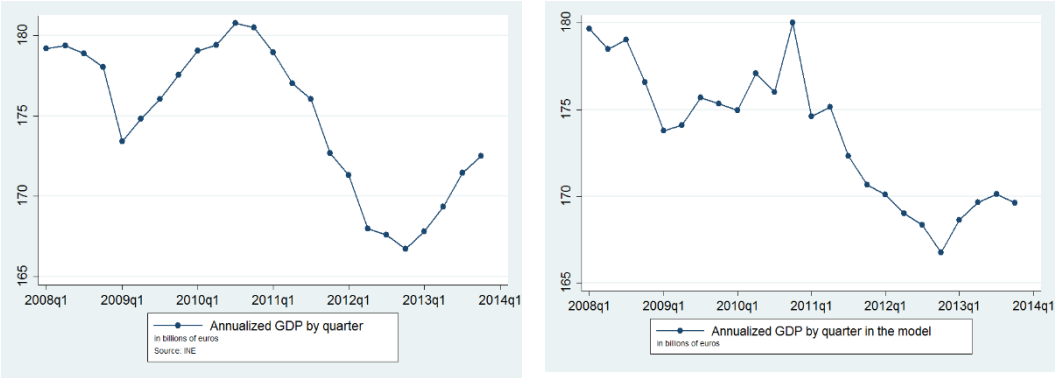


Figure 4.9 – Annualized GDP by quarter – actual and in the model

The model reproduces GDP behavior satisfyingly well, but more than getting the values right we are interested in depicting the correct relationship between variables or at least not getting any abnormal behavior. With this in mind let's look at annual figures for some of the more relevant variables which can be seen in table 4.2.

		2008	**2009**	**2010**	**2011**	**2012**	**2013**
GDP bn €	Actual	178.87	175.45	179.93	176.17	168.4	169.39
	Model	178.44	174.73	177.02	173.17	168.55	169.41
Deficit bn € (% GDP)	Actual	6.74 (3.8%)	17.2 (9.8%)	20.1 (11.2%)	12.97 (7.4%)	9.45 (5.6%)	8.18 (4.8%)
	Model	6.67 (3.75%)	16.73 (9.6%)	19.17 (10.82%)	13.86 (8%)	11.7 (6.94%)	9.04 (5.3%)
Public Debt bn € (%GDP)	Actual	128.19 (71.7%)	146.69 (83.6%)	173.06 (96.2%)	195.69 (111.1%)	211.78 (125.8%)	219.64 (129.7%)
	Model	129.66 (74.6%)	146.37 (83.7%)	165.6 (94.7%)	179.43 (105.4%)	191.16 (115%)	200.15 (117.9%)
Current Account	Actual	-12.6%	-10.9%	-10.6%	-7%	-2%	0.5%
	Model	-12%	-9.3%	-10.2%	-4.97%	-1.4%	1.1%

Table 4.2 – Comparing the benchmark case with reality

Looking at table 4.2 we can fairly say that nothing abnormal is going on with any of the variables and their behavior in the model follows relatively closely the actual ones.

Going one step further, table 4.3, shows us the GDP components on the expenditure side that are not exogenously defined (remember exports and government consumption are exogenously defined).

		2008	2009	2010	2011	2012	2013
Consumption bn €	Actual	118.5	113.5	118.3	115.9	111.6	111.1
	Model	117.1	115.3	116.8	114.4	113	110.8
GCF bn €	Actual	42.15	36.48	37.93	32.76	26.47	24.91
	Model	43.32	34.16	38.22	30.29	25.89	24.91
Imports bn €	Actual	73.05	59.66	67.35	67.95	64.36	65.57
	Model	73.25	59.89	69.07	66.85	65.03	65.82

Table 4.3 – Comparing the GDP components of the benchmark case with reality

And finally each sector net lending/borrowing can be compared by looking at figure 4.10.

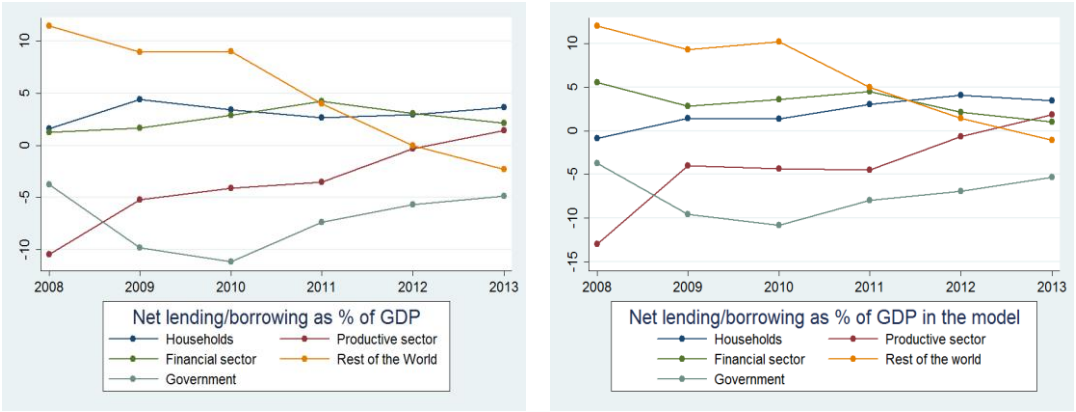


Figure 4.10 – Net lending/borrowing – actual and in the model

The benchmark model replicates satisfyingly well the evolution of net lending/borrowing of the various sectors in the 2008-2013 period.

To have an idea of what's going on in the financial side of the model we show some of the relevant variables in figure 4.11. We can see the evolution of interest rates on loans and on deposits, decreasing in a first stage accompanying the reference rate and increasing in a second stage following the higher spreads that were practiced in Portugal when the sovereign crisis begun. We can also see the initial deceleration of private sector loans, described in chapter 2, which later ended up in an actual decrease of private sector credit.

Finally we can also see the default rates of households and the productive sector with the latter having much higher values.

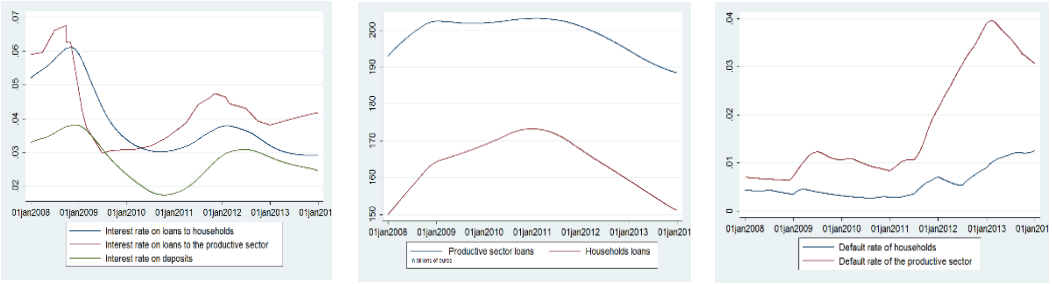


Figure 4.11 – Some financial variables of the benchmark model

Chapter V – What if?

In this chapter we will change the variable inputs and analyze the effects of this on the behavior of the economy. By doing this we hope to build an informed intuition of the consequences of the austerity policies and of the existence of an alternative path.

We will start by looking at what would happen if no austerity measures were taken, to have an idea of the trade-off between deficit reduction and GDP growth. First we do this without changing the Portugal spread, i. e. maintaining credit standards and confidence levels. We then consider the consequences of a different Portugal spread justified by the absence of austerity measures. The next simulation examines the effect of a 5% reduction, over 3 years, of the imported weight in the remaining components of aggregate demand. After that we consider the case of an austerity policy more focused on the revenue side, without reducing government consumption. This leads to the issue of fiscal multipliers, which we briefly address. Our final simulation considers the effect of a more swift reaction by the ECB, reflected in government financing rates, combined with the mix of austerity policies of the previous simulation, which doesn't involve cuts in government consumption.

Simulation 1

For the first simulation we will consider the case of no austerity measures, which means no spending cuts and no tax raises. This will give us an idea of the trade-off between the accomplishment of deficit targets and GDP growth.

In this simulation government consumption and investment, from 2011 to 2013 will be kept constant and close to 2010 levels. Income tax rate on households and the indirect tax rate will also be set at 2010 levels for 2011 to 2013. This variables as well as social transfers can be seen in figure 5.1 where they are compared with the values for the benchmark case.

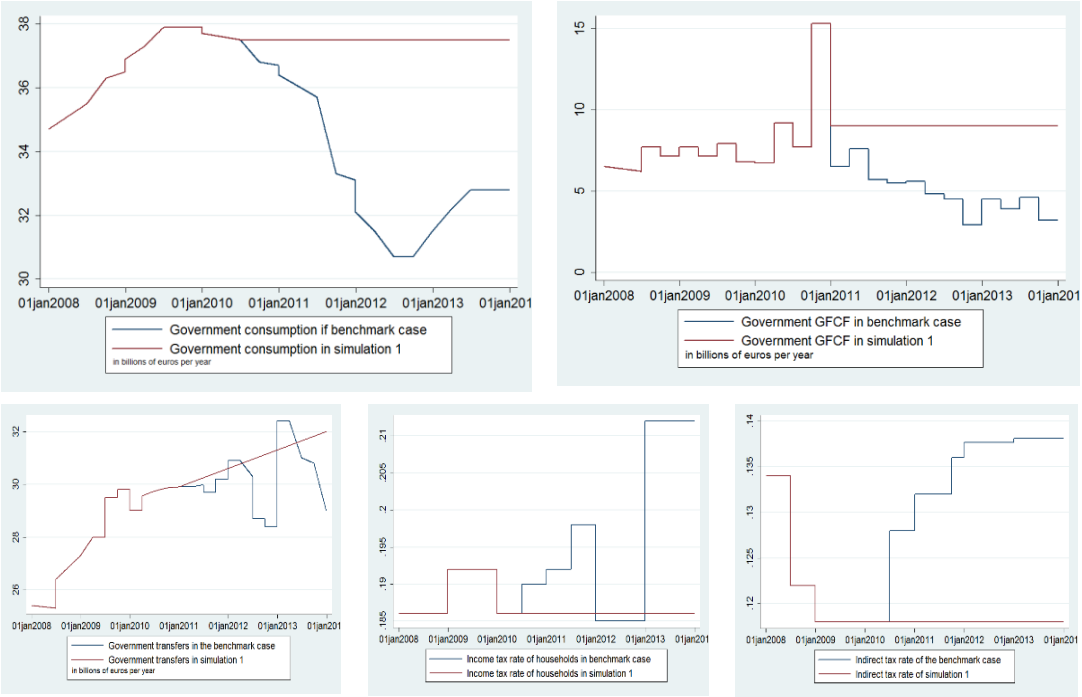


Figure 5.1 – Variable inputs for simulation 1

The GDP, the deficit and public debt in simulation 1 can be observed in figure 5.2 and compared to the benchmark case.

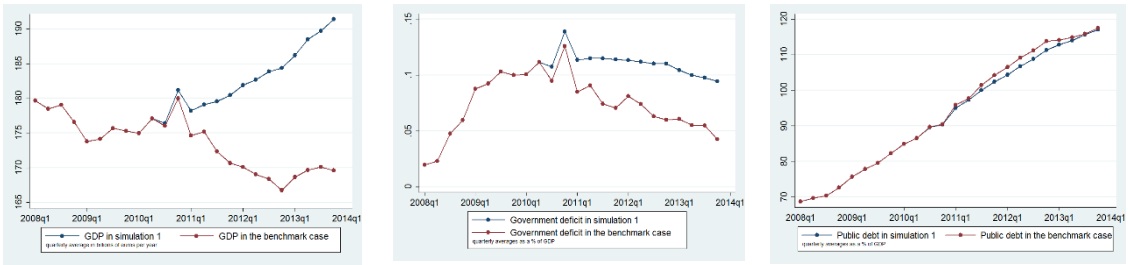


Figure 5.2 – GDP, government deficit and public debt for simulation 1

As expected, GDP rises considerably in the absence of austerity measures while the deficit only reaches the 10% level in 2013.

Curiously, public debt as a percentage of GDP is lower than in the benchmark case for most of the time, being only reached by the end of 2013 due to GDP's growth in that year for the benchmark case.

An expected consequence of higher domestic demand is the persistence of the current account and of the balance of trade deficit when compared to the benchmark case. This can be seen in figure 5.3.

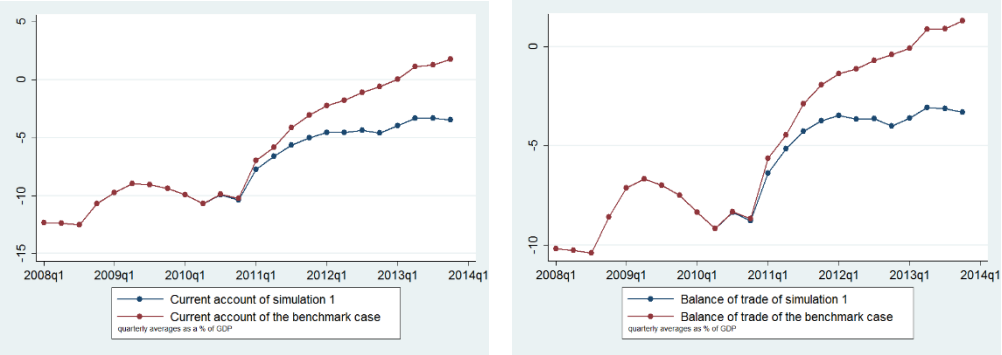


Figure 5.3 – Current account and balance of trade for simulation 1

Table 5.1 shows the annual figures for this variables and for the endogenous GDP components, consumption, investment and imports.

	2008	2009	2010	2011	2012	2013
GDP in bn€	178.44	174.73	177.42	179.33	183.19	188.96
Deficit as % of GDP	3.75%	9.57%	11.47%	11.44%	11.13%	9.9%
Public debt as % of GDP	74.6%	83.74%	93.71%	103.14%	112.76%	117.74%
Current account as % of GDP	-12%	-9.29%	-10.23%	-6.23%	-4.52%	-3.51%
Consumption in bn€	117.1	115.3	116.99	116.63	118.57	121.93
Investment in bn€	43.32	34.16	38.27	33.95	33.9	35.73
Imports in bn€	73.25	59.89	69.16	69.15	70.28	73.27

Table 5.1 – Annual figures for simulation 1

This shows well the trade-off between deficit reduction and GDP growth. In this case, a 4.6 p. p. (9.9% vs 5.3% of the benchmark case) reduction in the government deficit comes with a cost of a more than €19 bn (€188.96 bn vs €169.41 bn of the benchmark case) reduction of the country's GDP by 2013.

The magnitude of the trade-off really begs the question, is it worth the brutal sacrifice? Are we really so sure of the benefits of reducing the amount the government spends in excess of what it receives, in the time it takes for a rock to complete a full circle around the sun to ask for such sacrifice? We believe we are not.

Simulation 2

The Portugal spread reflects both credit standards by the financial sector, which we saw were strongly influenced by the expectations regarding economic outlook, as well as the consumers' confidence. With this in mind, it makes sense to consider a different Portugal spread in a no austerity scenario to see what the effect of looser credit standards is. So in simulation 2 we repeat simulation 1 but considering a different Portugal spread, which can be seen in figure 5.4.

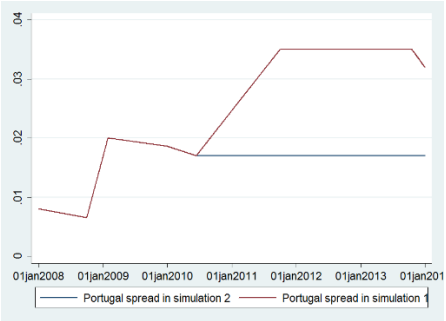


Figure 5.4 – Portugal spread for simulation 2

The results obtained, in terms of GDP, deficit and public debt are not significantly different from simulation 1 as shown in figure 5.5 and table 5.2.

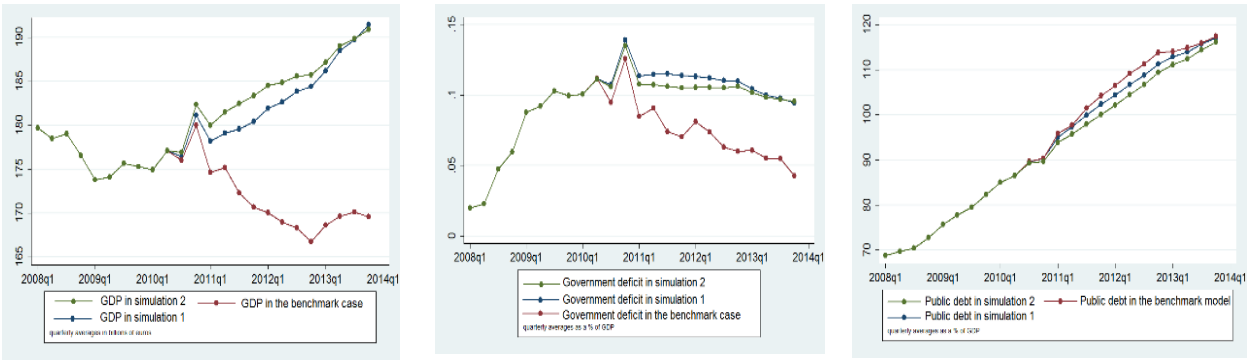


Figure 5.5 - GDP, government deficit and public debt for simulation 2

	2008	2009	2010	2011	2012	2013
GDP in bn€	178.44	174.73	177.85	181.85	185.17	189.22
Deficit as % of GDP	3.75%	9.57%	11.33%	10.66%	10.55%	9.82%
Public debt as % of GDP	74.6%	83.74%	92.81%	100.86%	110.89%	117.23%
Current account as % of GDP	-12%	-9.29%	-10.61%	-8.89%	-7.85%	-6.45%
Consumption in bn€	117.1	115.3	117.38	119	120.6	122.6
Investment in bn€	43.32	34.16	38.98	38.52	38.97	39.7
Imports in bn€	73.25	59.89	69.85	73.57	75.41	77.65

Table 5.2 – Annual figures for simulation 2

The reason for this is that the extra demand, which is credit and confidence dependent, has a significant imported content. The effect of this in the balance of trade and the current account can be seen in figure 5.6.

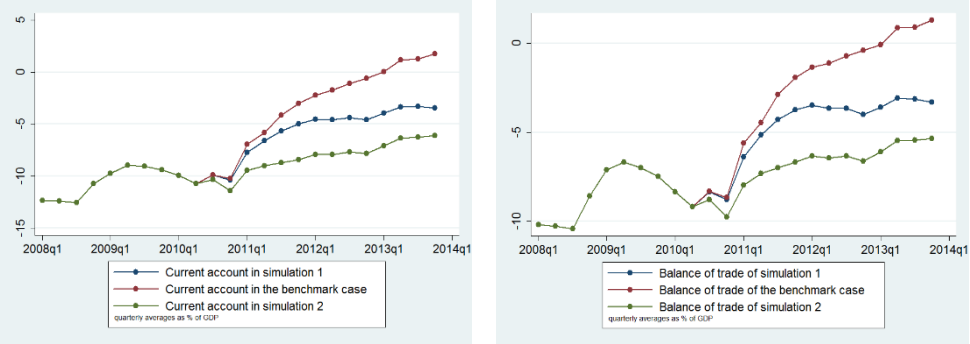


Figure 5.6 – Current account and balance of trade for simulation 2

This leads us to consider the effect of a reduction in the imported weight of the remaining components of aggregate demand.

Simulation 3

In this simulation we consider the effect of a change in the imported weight of the remaining GDP components. We suppose the reduction starts in the beginning of 2011 and by the end of 2013 it managed to achieve a 5% reduction. The rest of the inputs will

be equal to simulation 2, so the comparisons will be made with this simulation as well as with the benchmark case.

The effect in the current account and in the balance of trade can be seen in figure 5.7.

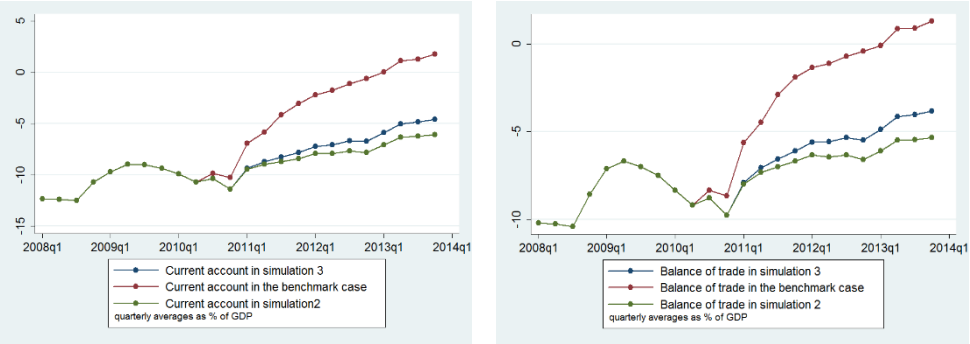


Figure 5.7 - Current account and balance of trade for simulation 3

How this effects the evolution of GDP, government deficit and public debt is shown in figure 5.8.

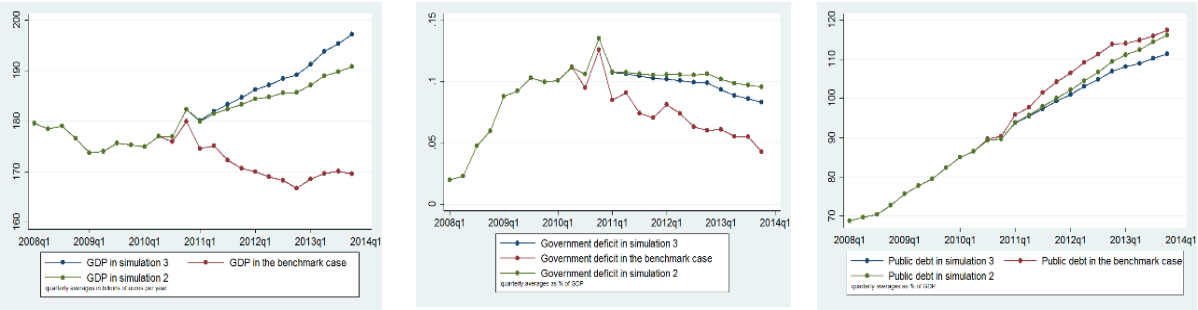


Figure 5.8 - GDP, government deficit and public debt for simulation 3

The results are obviously not surprising, and can be seen in more detail in table 5.3 which shows the annual values for the same variables as before

	2008	2009	2010	2011	2012	2013
GDP in bn€	178.44	174.73	177.85	182.56	187.78	194.43
Deficit as % of GDP	3.75%	9.57%	11.33%	10.5%	10.01%	8.76%
Public debt as % of GDP	74.6%	83.74%	92.81%	99.92%	108.18%	112.01%
Current account as % of GDP	-12%	-9.29%	-10.61%	-8.55%	-6.93%	-5.09%
Consumption in bn€	117.1	115.3	117.38	119.06	121.13	124.12
Investment in bn€	43.32	34.16	38.98	38.6	39.51	41.01
Imports in bn€	73.25	59.89	69.85	73	73.86	75.27

Table 5.3 – Annual figures for simulation 3

In this we can see that this 5% reduction over 3 years, which means a €2.4 bn reduction in imports in the last year, results in a €5.2 bn higher GDP in 2013. Regarding the deficit this translates to a more than 1 p.p. reduction and close to 4 p.p. less public debt by 2013.

Simulation 4

A recurrent debate when it comes to deficit reduction is whether expenditure cuts are more recessionary than tax hikes. 2013 gave some hints about this issue. After 2 years of spending cuts and tax hikes, the deficit was reduced from 11.2% to 5.6% but GDP fell to €168.4 bn from €179.93 bn. Then, in 2013, with a significant tax hike (described at the time by the Portuguese Finance Minister as a huge tax hike) and a slight increase in Government spending, GDP surprisingly grew. This leads us to pose the question, what if the bailout was more focused on the revenue side? That is considered in this simulation.

To simulate this we will use government consumption as defined for simulation 1, while all the remaining inputs will be the same as the benchmark case including government gross fixed capital formation. So the only difference from the benchmark case is the absence of cuts in government consumption.

The results for GDP, government deficit and public debt can be seen in figure 5.9.

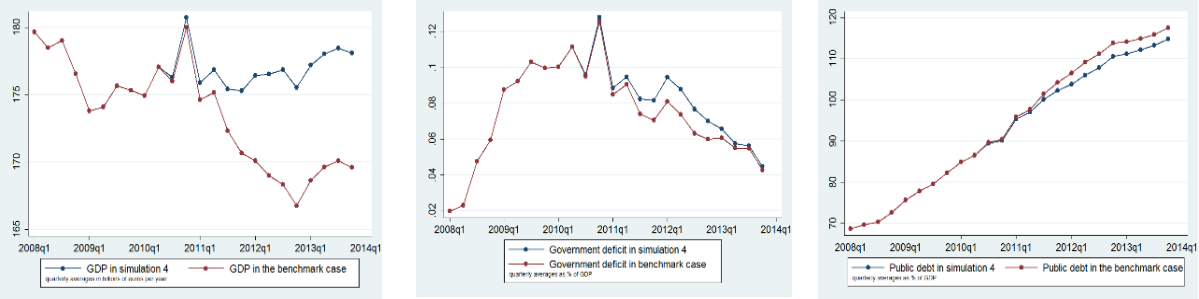


Figure 5.9 - GDP, government deficit and public debt for simulation 4

We can see that the deficit reduction in simulation 4 follows very closely the one in the benchmark case, while achieving much higher levels of GDP. This should not be surprising, since a 1€ cut in government spending is, by definition, a 1€ reduction in GDP (not exactly, due to the imported weight of government consumption which is around 10%, see Cardoso et all, 2013). Adding to that the indirect effects caused by income

reduction and it's hard to see how the consequence of spending cuts would be any different.

This brings us to the issue of fiscal multipliers. In its June 2013 report on the Greek bailout (IMF, 2013) the IMF admitted it had seriously underestimated the value of the fiscal multiplier it used in the design of the austerity package applied in Greece when it considered it to be 0.5. It's fair to say the same value was used in the case of Portugal.

To explore this in our model and see the effect in the model of a spending cut, we run the model again as in simulation 4, but this time with a €1 bn reduction in government spending starting in 2011 as shown in figure 5.10. We call this simulation 4b.

Figure 5.10 – Government consumption in simulation 4b

The results for GDP and government deficit can be seen in figure 5.11.

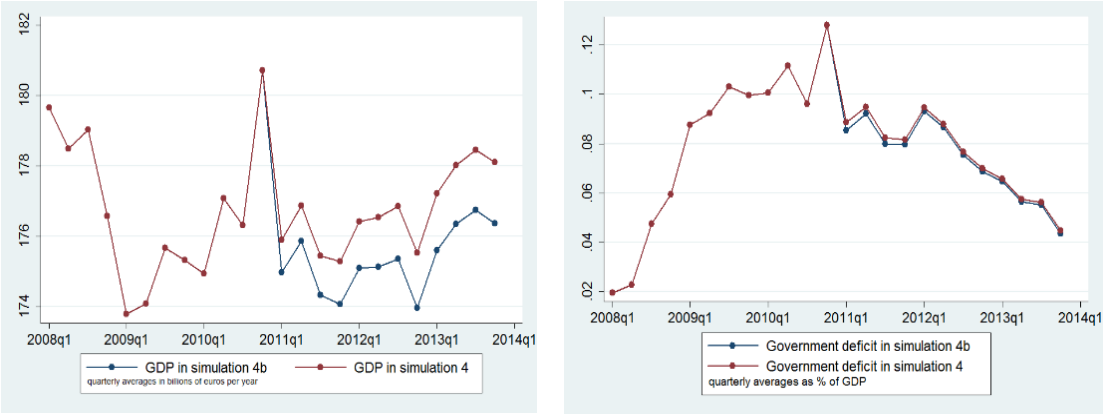


Figure 5.11 – GDP and government deficit in simulation 4b

We can clearly see that the effects on government deficit are negligible while on GDP are significant. Table 5.4 shows us the numbers starting in 2011.

		2011	2012	2013
GDP in €bn	Simulation 4	175.87	176.34	177.95
	Simulation 4b	174.81	174.89	176.27
Deficit in €bn	Simulation 4	15.27	14.5	9.97
	Simulation 4b	14.73	14.15	9.69
Deficit as % of GDP	Simulation 4	8.68%	8.22%	5.6%
	Simulation 4b	8.42%	8.09%	5.5%

Table 5.4 – Comparing simulation 4 with simulation 4b

The definition of fiscal multiplier is generally "the change in real GDP or other measure of output caused by a one-unit increase in a fiscal variable" (Itzetzki et all, 2011).

Using nominal GDP to measure output and the fiscal variable being government consumption we can calculate the impact multiplier and the cumulative multiplier as defined in Itzetzki et all (2011).

$$Impact\ multiplier = \frac{\Delta y_0}{\Delta g_0}$$

$$Cumulative\ multiplier = \frac{\sum_{t=0}^{T} \Delta y_t}{\sum_{t=0}^{T} \Delta g_t}$$

For our model we have:

$$Impact\ multiplier = \frac{175.87 - 174.81}{1} = 1.06$$

$$Cumulative\ multiplier$$
$$= \frac{(175.87 - 174.81) + (176.34 - 174.89) + (177.95 - 176.27)}{1 + 1 + 1}$$
$$= 1.39(6)$$

Even taking into account that our fiscal multipliers use nominal GDP, our model leads us to agree with the IMF when they admit their underestimation mistake.

Simulation 5

The Outright Monetary Transactions (OMT) programme announced in September of 2012 had significant effects on the reduction of government bond yields throughout Europe which were at such high levels mainly due to fears of sovereign default rather than economic fundamentals (Castels et all, 2014). This programme replaced the Security Markets Programme, which was put in place in May 2010 in conjunction with the creation of the European Financial Stability Fund. The main differences between the two programs are the absence of quantitative limits to OMT and the non-seniority of the ECB in OMT. This, accompanied by the 'whatever it takes speech' of Mario Draghi, was the long awaited and decisive response by the ECB to the sovereign debt crisis.

For our final simulation we consider the case of this decisive reaction being taken initially in May of 2010. This would certainly have effects on the amount of austerity measures to be taken, so we consider the mix of austerity measures defined in simulation 4. This means that regarding government inputs the only difference for the benchmark case is in government consumption where a no cuts policy is considered. With this two options, it doesn't make sense to use the original Portugal spread, which, as explained in simulation 2, is highly dependent on expectations regarding the economic outlook, so we use the one defined in simulation 2. Summing up the differences for the benchmark case are in government financing rates, government consumption and the Portugal spread which are shown in figure 5.12.

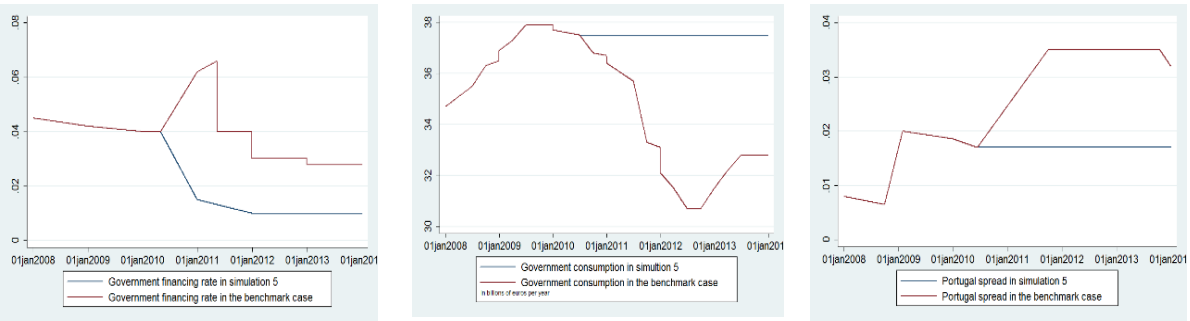


Figure 5.12 – Variable inputs for simulation 5

The effects of this on the interest rates actually paid (or the implicit interest rates) can be seen in figure 5.13.

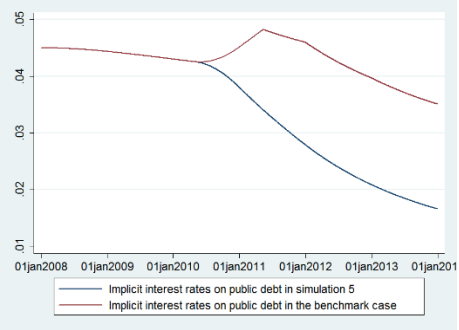


Figure 5.13 – Interest rates paid by the government in simulation 5 and in the benchmark case

Regarding GDP, government deficit and public debt, the outcome can be seen in figure 5.14.

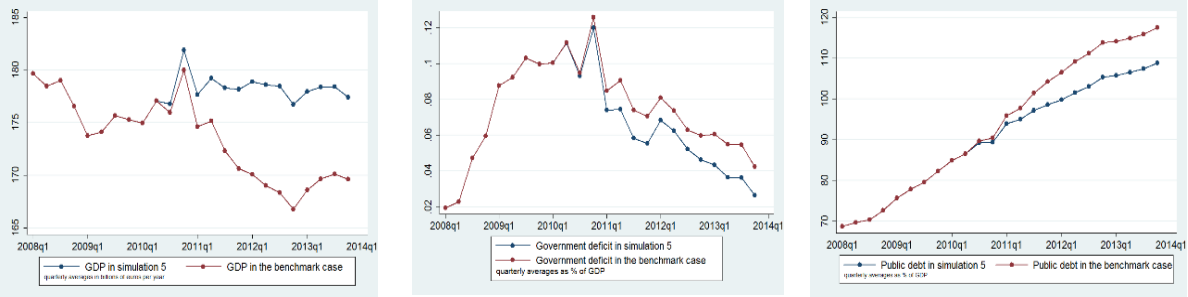


Figure 5.14 - GDP, government deficit and public debt for simulation 5

Not surprisingly the effect on the deficit reduction is significant. The slack this would mean, regarding the austerity measures that were taken is something to be considered. In the model, this would mean that a significantly less severe austerity package would achieve much better results regarding the fiscal targets set out in the bailout. While avoiding a fall in GDP it would reduce the deficit to 3.59% of GDP vs the 5.3% of the benchmark case and by the end of 2013, public debt as % of GDP would be 109.36% vs 117.9% of the benchmark case.

	2008	2009	2010	2011	2012	2013
GDP in bn€	178.44	174.73	177.7	178.35	178.19	178.06
Deficit as % of GDP	3.75%	9.57%	10.62%	6.56%	5.73%	3.59%
Public debt as % of GDP	74.6%	83.74%	93.16%	99.01%	106.46%	109.36%

Table 5.5 – Annual figures for simulation 5

Conclusion

In the introduction of this thesis we stated that we hoped this work would be a petal of one of the hundred flowers about to be bloomed following Blanchard's appeal of theoretical and empirical exploration "in all sorts of models". Our contribution consisted in presenting alternative or complementary approaches to the mainstream DSGE models, namely the stock-flow consistent approach and the complexity theory approach and apply them to the analysis of the austerity policies imposed on our country. While doing this we considered important to also divulge a very useful and appropriate tool in macro economy modelling, the Minsky software developed by Steve Keen, with which we built our model of the Portuguese economy.

The model is a continuous time, stock-flow consistent model with endogenous money and an integrated financial sector. In a first stage, our work consisted in replicating the 2008-2013 events, in what we called the benchmark case. In the next stage we considered several changes in some of the variables and analyzed the outcomes comparing them with the benchmark case. More than obtaining precise answers, the goal was to gain "informed intuition" regarding the workings of the Portuguese economy.

Despite being a simple model with a lot of room for improvement, it already allowed us to analyze several economic issues. For instance, the model clearly shows us the trade-off between deficit reduction and GDP growth. We could also see the limited effect of looser credit standards in GDP growth in a small open economy as is the case of Portugal. The model also allowed us to quantify the impact of import reductions in the country's GDP and the effect of reduced sovereign interest rates in the government deficit. Another issue that was clear is the ineffectiveness of cuts in government spending in achieving a deficit reduction.

All of this conclusions are far from definitive, since the model fails to capture some relevant aspects. Of this we would highlight the absence of a price level and of inflationary issues. The endogenization of some of the variables as for example part of government spending (automatic stabilizers) or the Portugal spread and the introduction of a labor market are some of the other improvements we believe are important.

Still, we are happy with what was done, being a first attempt, in a Master's degree thesis with the associated deadline constrains. We believe a more sophisticated and developed

version of the model can be a powerful and useful instrument in macroeconomic analysis and we hope we were able to show that.

References

Anderson, P. W. (1972): "More Is Different." Science 177(4047): 393-396.

Beau, E, Hill, J, Hussain, T and Nixon, D (2014), “Bank funding costs: what are they, what determines them and why do they matter?”, Bank of England Quarterly Bulletin, Vol. 54, No. 4, pages 370–84,

Blanchard, Olivier (2014): “Where danger lurks”, Finance & Development, Vol. 51, Nº 3.

Buiter, W. (2009): “The unfortunate uselessness of most “state of the art” academic monetary economics”. March 3, Financial Times.

Cadamagnani, F, Harlmohan, R and Tangri, K (2015), “A bank within a bank: how a commercial bank’s treasury function affects the interest rates set for loans and deposits”, Bank of England Quarterly Bulletin, Vol. 55, No. 2, pages 153–63.

Cardoso, F, Esteves, P, and Rua, A (2013): “O conteúdo importado da procura global em Portugal”. Boletim económico do Banco de Portugal, Vol. 19-III.

Castels, M, Georgakopoulos, A, Trill, E, Lastunen, J and Lymperakis-Pitas, K (2014): “An Evaluation of the ECB’s Outright Monetary Transactions”

Caverzasi, Eugenio and Godin, Antoine, (2013): “Stock-Flow Consistent Modeling Through the Ages”. Levy Economics Institute of Bard College Working Paper No. 745.

Chiarella, Carl, Peter Flaschel, Willi Semmler (2011): “Reconstructing Keynesian Macroeconomics”.

Colander, David, Peter Howitt, Alan Kirman, Axel Leijonhufvud, and Perry Mehrling. (2008): "Beyond DSGE Models: Toward an Empirically Based Macroeconomics." American Economic Review, 98(2): 236-40.

Copeland, M. A. (1949): “Social Accounting for Moneyflows.” The Accounting Review 24(3): 254–264.

Day, R.H. (1994): “Complex Economic Dynamics: An Introduction to Dynamical Systems and Market Mechanism, Volume I”, Cambridge, MA: MIT Press.

Dullien, S. (2011): “The New Consensus from a Traditional Keynesian and Post-Keynesian Perspective,” Économie Appliquée, 64 (1), 173–200.

Godley, Wynne and Marc Lavoie (2007): “Monetary economics. An integrated approach to credit, money, income, production and wealth”.

Ilzetzki, Ethan & Mendoza, Enrique G. & Végh, Carlos A., 2013. "How big (small?) are fiscal multipliers?," Journal of Monetary Economics, Elsevier, vol. 60(2), pages 239-254

IMF (2013): “Greece: Ex Post Evaluation of Exceptional Access under the 2010 Stand-By Arrangement”

Jevons, W. S. (1888): “The Theory of Political Economy”. Internet, Library of Economics and Liberty.

Keen, Steve (2013a): “Predicting the ‘Global Financial Crisis’: Post-Keynesian Macroeconomics”. Economic Record, 89: 228–254.

Keen, Steve (2009):”The dynamics of the monetary circuit”.In:Rossi,S.,Ponsot,J.-F.(Eds.),ThePoliticalEconomyofMonetaryCircuits:Tradition and Change. Palgrave Macmillan, London, pp.161–187.

Keen, Steve (2013b): “A Monetary Minsky Model of the Great Moderation and the Great Recession”, Journal of Economic Behavior & Organization.

Keen, Steve (2014): “The dodgy dynamics of Economics”

Kinsella, Stephen and Tiou-Tagba Aliti, Gnanonobodom, (2012): “Simulating the Impact of Austerity on the Irish Economy Using a Stock-Flow Consistent Model”.

Lavoie, Marc (2014): “Post-Keynesian Economics: New Foundations”.

Lorenz, Hans Walter (1993): “Nonlinear Dynamical Economics and Chaotic Motion”

Dimitri B. Papadimitriou, Gennaro Zezza and Michalis Nikiforos, (2013): “A Levy Institute Model for Greece”

Ryoo, S. (2010): “Long Waves and Short Cycles in a Model of Endogenous Financial Fragility”. Journal of Economic Behavior and Organization, Vol.74, No.3, 163-186.

Skott, P, 2010. "The Great Detour," UMASS Amherst Economics Working Papers 2010-07, University of Massachusetts Amherst, Department of Economics.

Solow, Robert M. (2003): “Dumb and dumber in Macroeconomics”.

Solow, Robert M. (2010): “Building a science of economics for the real world”. Hearing before the U.S. House of representatives, July 20, 2010.

Sonnenschein, H. (1972): "Market Excess Demand Functions." Econometrica 40(3): 549-563.

Tobin, J. (1982): “Money and Finance in the Macroeconomic Process.” Journal of Money, Credit and Banking 14(2): 171–204.

Varoufakis, Y. and C. Arnsperger (2006): "What Is Neoclassical Economics? The three axioms responsible for its theoretical oeuvre, practical irrelevance and, thus, discursive power." post-autistic economics review 38.

Annex A – the full model with the parameters for the benchmark case

Households

$$\boldsymbol{HHDI} = \boldsymbol{Wages} + \boldsymbol{GovTrsf} + \boldsymbol{Div_{HH}} + \boldsymbol{IntDep_{HH}} + \boldsymbol{CurrTrsf} - \boldsymbol{IncTax_{HH}} - \boldsymbol{IntLoans_{HH}}$$

$$\frac{\boldsymbol{dExpDI}}{\boldsymbol{dt}} = 2 * (\boldsymbol{HHDI} - \boldsymbol{ExpDI})$$

$$\boldsymbol{Cons} = (0.91 - 1.5 * \boldsymbol{PortugalSpread}) * \boldsymbol{ExpDI} + 0.04 * \boldsymbol{HH_{NW}}$$

$$\boldsymbol{GFCF_{HH}} = (0.09 - 1.2 * \boldsymbol{PortugalSpread}) * \boldsymbol{ExpDI}$$

$$\boldsymbol{ConsH} = \boldsymbol{Cons} + \boldsymbol{GFCF_{HH}}$$

$$\frac{\boldsymbol{dDefRate_{HH}}}{\boldsymbol{dt}} = 1 * (0.002 - \boldsymbol{Def_{HH}}) + 0.5 * \boldsymbol{I}_{[\boldsymbol{R}^+]}\left[-\frac{\boldsymbol{dExpDI}}{\boldsymbol{dt}}\right]$$

$$\boldsymbol{Def_{HH}} = \boldsymbol{DefRate_{HH}} * \boldsymbol{Loans_{HH}}$$

$$\boldsymbol{NewConsLoans} = (0.1 - 1.8 * \boldsymbol{PortugalSpread}) * \boldsymbol{ExpDI}$$

$$\boldsymbol{NewHousingLoans} = (0.2 - 5 * \boldsymbol{PortugalSpread}) * \boldsymbol{ExpDI}$$

$$\boldsymbol{NewLoans_{HH}} = \boldsymbol{NewConsLoans} + \boldsymbol{NewHousingLoans}$$

$$\boldsymbol{NewLoans_{HH}} = (0.12 - 6.8 * \boldsymbol{PortugalSpread}) * \boldsymbol{ExpDI}$$

$$\boldsymbol{LoanRepay_{HH}} = 0.1 * \boldsymbol{Loans_{HH}}$$

$$\boldsymbol{ChL_{HH}} = \boldsymbol{NewLoans_{HH}} - \boldsymbol{LoanRepay_{HH}} - \boldsymbol{Def_{HH}}$$

Productive sector

$$\boldsymbol{Imp} = [(0.26 - 1.2 * \boldsymbol{PortugalSpread}) * \boldsymbol{Cons} + 0.41 * \boldsymbol{TotInv} + 0.11 * \boldsymbol{Cons_{Gov}} + 0.41 * \boldsymbol{Exp}] * (1 - IntCrdCond)$$

$$\boldsymbol{GDP} = \boldsymbol{ConsH} + \boldsymbol{G} + \boldsymbol{Inv} + \boldsymbol{Exp} - \boldsymbol{Imp}$$

$$\boldsymbol{Wages_{Tgt}} = 0.8 * (\boldsymbol{GDP} - \boldsymbol{IndTax})$$

$$\frac{dWages}{dt} = 1.5 * (\boldsymbol{Wages_{Tgt}} - \boldsymbol{Wages})$$

$$\boldsymbol{OP} = \boldsymbol{GDP} - \boldsymbol{IndTax} - \boldsymbol{Wages}$$

$$\boldsymbol{Div_{HH}} = 0.17 * \boldsymbol{CapAct_{PS}} * 0.65$$

$$\boldsymbol{Div_{RW}} = 0.17 * \boldsymbol{CapAct_{PS}} * (1 - 0.65)$$

$$\frac{\boldsymbol{dExpRev}}{\boldsymbol{dt}} = 0.4 * (\boldsymbol{GDP} - \boldsymbol{ExpRev})$$

$$\boldsymbol{KapTgt} = \boldsymbol{ExpRev} * \frac{0.5}{0.4 * 0.8} * (1.03 - 1 * \boldsymbol{PortugalSpread})$$

$$\boldsymbol{ConsFC} = DepRate * \boldsymbol{Kapital}$$

$$\boldsymbol{GFCF_{PS}} = I_{[R^+]}[0.7 * (\boldsymbol{KapTgt} - (\boldsymbol{Kapital} - \boldsymbol{ConsFC}))] * (1 - 2 * IntCrdCond)$$

$$\frac{\boldsymbol{dKapital}}{\boldsymbol{dt}} = \boldsymbol{GFCF_{PS}} - \boldsymbol{ConsFC}$$

$$\frac{\boldsymbol{dDefRate_{PS}}}{\boldsymbol{dt}} = 1 * (0.006 - \boldsymbol{Def_{PS}}) + 3.3 * \boldsymbol{I}_{[R^+]}\left[-\frac{\boldsymbol{dExpRev}}{\boldsymbol{dt}}\right]$$

$$\boldsymbol{Def_{PS}} = \boldsymbol{DefRate_{PS}} * \boldsymbol{Loans_{PS}}$$

$$\boldsymbol{NewLoans_{PS}} = \boldsymbol{GFCF_{PS}} + 0.25 * \boldsymbol{ExpRev}$$

$$\boldsymbol{LoanRepay_{PS}} = 0.3 * \boldsymbol{Loans_{PS}}$$

$$\boldsymbol{ChL_{PS}} = \boldsymbol{NewLoans_{PS}} - \boldsymbol{LoanRepay_{PS}} - \boldsymbol{Def_{PS}}$$

Financial Sector

$$\boldsymbol{IntRec} = \boldsymbol{IntLoans_{HH}} + \boldsymbol{IntLoans_{PS}} + \boldsymbol{IntLoans_{RW}} + \boldsymbol{IntPD_{FS}}$$

$$\boldsymbol{IntPay} = \boldsymbol{IntDep_{HH}} + \boldsymbol{IntDep_{PS}} + \boldsymbol{IntPED}$$

$$\boldsymbol{Profits_{FS}} = \boldsymbol{IntRec} - \boldsymbol{IntPay} - \boldsymbol{Def_{HH}} - \boldsymbol{Def_{PS}}$$

$$\boldsymbol{MinResReq} = 0.01 * (\boldsymbol{Deposits_{HH}} + \boldsymbol{CapAct_{PS}} + \boldsymbol{PvtExtDebt})$$

$$\boldsymbol{R_{Adj}} = 50 * (\boldsymbol{MinResReq} - \boldsymbol{Reserves})$$

$$\frac{\boldsymbol{dPvtExtDebt}}{\boldsymbol{dt}} = \boldsymbol{R_{Adj}}$$

Interest Rates

$$Spread_{NLPS} = PortugalSpread + 0.014$$

$$\frac{dSpread_{OLPS}}{dt} = \frac{NewLoans_{PS}}{Loans_{PS} + CHL_{PS}} * (Spread_{NLPS} - Spread_{OLPS})$$

$$IntRate_{OLPS} = Euribor + Spread_{OLPS}$$

$$IntLoans_{PS} = IntRate_{OLPS} * Loans_{PS}$$

$$Spread_{NLHH} = PortugalSpread + 0.018$$

$$\frac{dEffEur}{dt} = 2 * (Euribor - EffEur)$$

$$\frac{dSpread_{OLHH}}{dt} = \frac{NewLoans_{HH}}{Loans_{HH} + CHL_{HH}} * (Spread_{NLHH} - Spread_{OLHH})$$

$$IntRate_{OLHH} = EffEur + Spread_{OLHH}$$

$$IntLoans_{HH} = IntRate_{OLHH} * Loans_{HH}$$

$$FundingRate = Euribor + PortugalSpread$$

$$IntRate_{NDep} = FundingRate - 0.015$$

$$\frac{dIntRate_{ODep}}{dt} = 1.2 * (IntRate_{NDep} - IntRate_{ODep})$$

$$IntDep_{HH} = 0.75 * IntRate_{ODep} * Deposits_{HH}$$

$$IntDep_{PS} = 0.5 * IntRate_{ODep} * CapAct_{PS}$$

$$IntRate_{NPED} = Euribor + 0.1 * PortugalSpread$$

$$\frac{dIntRate_{OPED}}{dt} = 2 * (IntRate_{NPED} - IntRate_{OPED})$$

$$IntRate_{NLRW} = Euribor + 0.4 * PortugalSpread$$

$$\frac{dIntRate_{OLRW}}{dt} = 2 * (IntRate_{NLRW} - IntRate_{OLRW})$$

$$\frac{\boldsymbol{dIntRate_{OPD}}}{\boldsymbol{dt}} = 0.5 * (\boldsymbol{IntRate_{NPD}} - \boldsymbol{IntRate_{OPD}})$$