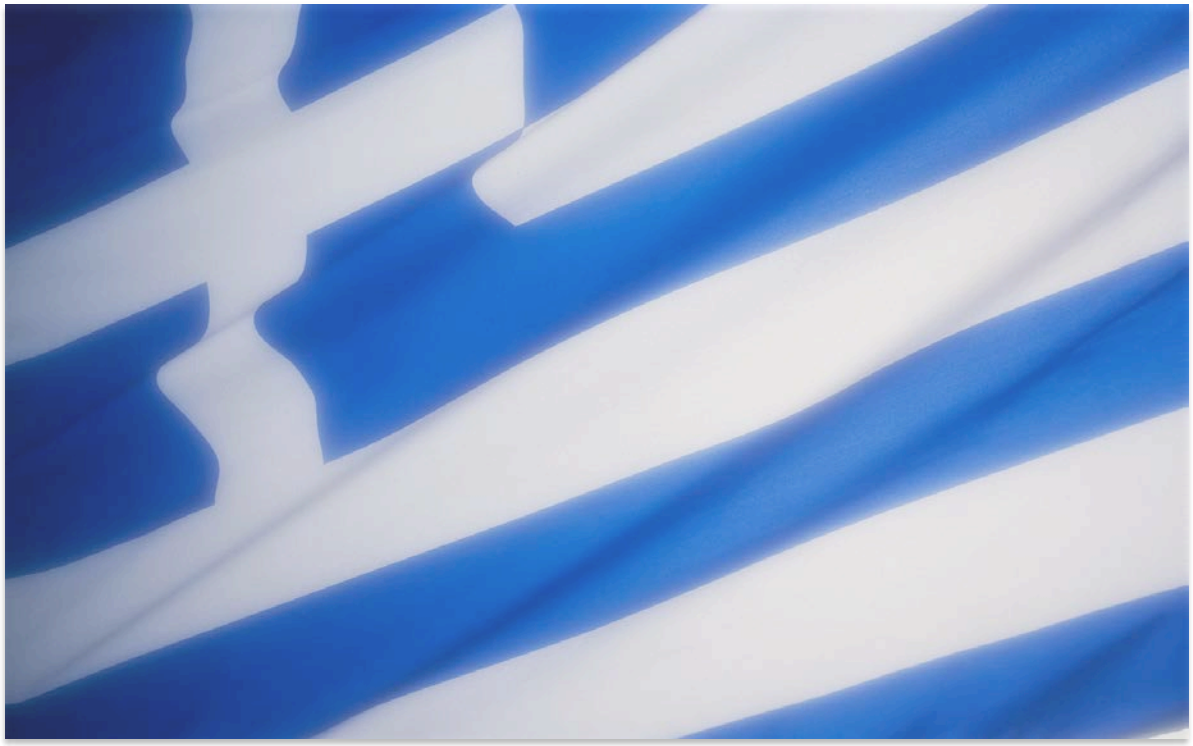
Sovereign Debt Crisis in Greece

A System Dynamics Approach to Policy Analysis

Wei Shao



Sovereign Debt Crisis in Greece:

A System Dynamics Approach to

Policy Analysis

Wei Shao

Supervised by

Dr. I. David Wheat

Associate Professor of System Dynamics

University of Bergen

Norway

For Melissa,

who is inspiring.

相濡以沫.....

Abstract

Although the budget deficit modification by new elected government and following government bonds downgrading by world rating agencies directly triggered the sovereign debt crisis in Greece, the most substantial cause is its prodigal and extravagant fiscal policy. Greece has enjoyed "living beyond its salary" life since it became member of Eurozone in 2001, because it can borrow heavily from international markets especially from member countries to fund its huge budget deficit. Greece requested financial support formally and formulated fiscal austerity and structural reform for exchanging 110 billion Euros bailout from both Europe and IMF. This paper reproduced the history of this issue using System Dynamics model in which the government debt is the most important researching object. System Dynamics as the most powerful problem-replication tool is also used in the paper to analyze those fiscal consolidation policies putting in a relative long-term period, which could help the official policymakers to formulate effective policies for the sake of making the government debt sustainable.

Keywords: *sovereign debt crisis, budget deficit, government revenue, government expenditure, pension system, healthcare system, civil servants system, system dynamics*

Acknowledge

I here will express my heartfelt gratitude to my supervisor Dr. David Wheat. He devoted much attention to guiding my thesis and provided important suggestions. Besides, David is a very organized and rigorous professor, I enjoyed his lectures very much during the first year study and surely learned a lot from them, which paved a solid foundation for my research.

Even now I clearly remember the moment when I received admission letter from System Dynamics through email. I just finished my business trip and was making a transfer in Hong Kong airport to home. The sincere thanks to professor Pål Davidsen and professor Erling Moxnes and any other faculty members for offering me the opportunity to study in University of Bergen.

I also want to express my thanks to professor Pål Davidsen and professor Erling Moxnes for their attractive lectures and also to all the teaching assistants for their guidance. During the two years study in Bergen, I made many new friends from different countries who share many good memories with me.

Finally, I would deliver my truehearted appreciation and love to my soul mate Melissa Wu, my parents and parents-in-law. Without their unconditional love, comprehension and support, I cannot make it happen at all.

Content

List of Figures

List of Tables

1. Introduction

Historically, financial crises have been followed by the fears of governments defaulting on their debt obligations. Financial crises tend to lead to, or exacerbate, sharp economic downturns, low government revenues, widening government deficits, and high levels of debt, pushing many governments into the edge of default. The burden of public debt will become even larger in the next few years given the current financial crisis where governments around the world spend billions of euros in order to stabilize the financial system (Greiner, 2011). As global economy is still surviving in the recovery from financial crisis that started in fall 2008, Greece's sovereign debt crisis brought a second wave of the crisis which held EU back from recovery, especially the Eurozone.

During the decade preceding the global financial crisis, Greek government borrowed heavily from abroad to fund substantial government budget deficits. Between 2001, when Greece adopted the euro as its currency, and 2008, Greece's reported budget deficits averaged 5% per year, compared to a Eurozone average of 2%. In the past 6 years, government expenditure grew at a high rate of 87% compared with a relatively low rate of 31% at which its revenues grew. Moreover, in 2009, public expenditure reached 50% of GDP.

Greece had a chronically high external debt of €298 billion in 2009, 126.8% of GDP, and the budget deficit was 15.4% of GDP. Both Greece's budget deficit and external debt level are well above those permitted by the rules governing the EU's Economic and Monetary Union. Specifically, the euro convergence criteria (also known as the Maastricht Treaty) calls for budget deficit ceilings of 3% of GDP and external debt ceilings of 60% of GDP. Greece is not alone, however, in exceeding these limits. Of the 27 EU member states, 20 currently exceed the deficit ceiling set out in the Maastricht Treaty, especially Portugal, Ireland, Italy, Greece, Spain (PIGS). Figure 1.1 and Figure 1.2 show both general government debt and budget deficit as a percentage of GDP of PIGS countries.

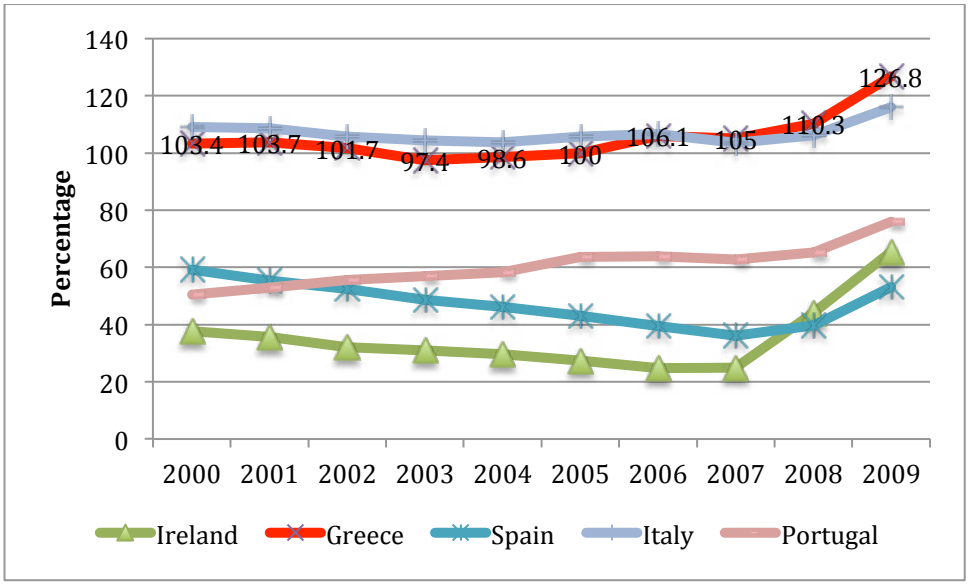


Figure 1.1: General Government Debt as a Percentage of GDP

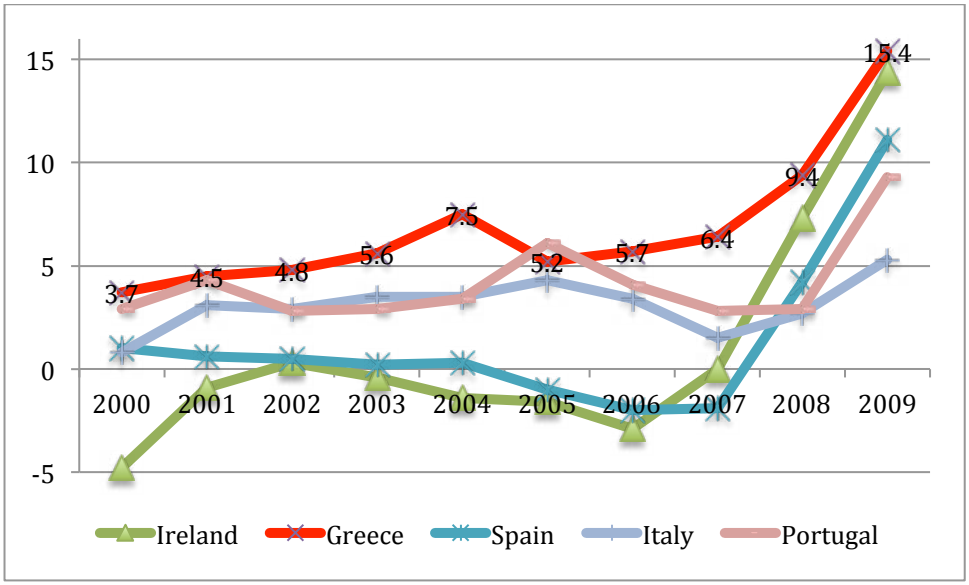


Figure 1.2: Budget Deficit as a Percentage of GDP

Greece's reliance on external financing for funding budget deficits left its economy highly vulnerable to shifts in investor confidence. Since late 2009, investor confidence in the Greek government has been rattled. In October 2009, the new socialist government, led by Prime Minister George Papandreou, revised the estimate of the government budget deficit for 2009, nearly doubling the existing estimate of 6.7% of GDP to 12.7% of GDP. This was shortly followed by rating downgrades of Greek bonds by the three major credit rating agencies. Countries with large external

debts, like Greece, were of particular concern for investors. Allegations that Greek governments had falsified statistics and attempted to obscure debt levels through complex financial instruments offered by Goldman Sachs also contributed to a drop in investor confidence.

Investor jitteriness spiked again in 2010, when Eurostat released its estimate of Greece's budget deficit. At 15.4% of GDP (Figure 1.2), Eurostat's estimate was almost 3 full percentages higher than the previous estimate released by the Greek government in October 2009. This led to renewed questions about Greece's ability to repay its debts, with €8.5 billion ($11.1 billion) falling due in mid-May 2010. The main incentive for repaying sovereign debt is to maintain access to international capital markets (Alichi, 2008). On April 23, 2010, the Greek government formally requested financial assistance from the IMF and other Eurozone countries. The European Commission, backed by Germany, requested that the details of Greece's budget cuts for 2010, 2011, and 2012 be released before providing the financial assistance. In late April 2010, the spread between Greek and German 10-year bonds reached a record high of 650 basis points, and one of the major credit rating agencies, Moody's, downgraded Greece's bond rating.

Greece's current economic problems have been caused by a mix of domestic and international factors. Domestically, high government spending, structural rigidities, tax evasion, and corruption have all contributed to Greece's accumulation of debt over the past decade. At the beginning of that Euro was adopted as the common currency for the monetary union, several disciplines are regulated to limit deficit. The central bank is strictly forbidden to finance budget deficits, i.e. it is not allowed to operate on the primary debt market. In order to ensure that it will abide by these legal requirements, it has been made strongly independent from governments. Finally, a no bailout clause fully shields governments and all official institutions (including the Eurosystem and the Commission) from any one authority's liabilities. These are strong and highly credible safeguards(Wyplosz, 2006). The conditions of the Stability and Growth Pact have not been enforced very strictly. Indeed, during the first economic slowdown at the beginning of the 2000s, France and Germany set a poor standard by transgressing the limits the Pact set to public debt and budget deficit. The

Commission in the end did not impose sanctions(MAMADOUH and WUSTEN, 2010). So, internationally, the adoption of the euro and lax enforcement of EU rules aimed at limiting the accumulation of debt are also believed to have contributed to Greece's current crisis. As a result, Greece was able to borrow funds at low interest rates normally available only to more creditworthy countries.

The Greek economic structure depends too much on tourism and international shipping, both of which are easily influenced by financial crisis very much and they are really depressed by the financial crisis from 2008. Government revenue from these two sectors was cut down. Besides, tax evasion is very popular all over the country. "Countries like Spain, Portugal and Greece have had continuous democracies only since the 1970s, and people aren't used to governments representing the public interest." "In most of these countries, what matters is your family. … There is less of a sense of duty towards the state," said Alberto Alesina, a professor of political economy at Harvard University, "Evading taxes is something you can freely talk about – and be proud of – at a dinner party in these countries." The situation is definitely like snow plus frost to the pitiful government revenue, eventually increasing the budget deficit.

Besides weak government revenue, there are many heavy government expenditures. The civil servants have high wages and excellent pensions. The wages of civil servants have a 6% annual growth rate, doubling the average in Eurozone. Nevertheless, the government sectors are overstaffing with poor productivity. They can get 14 months' wages a year and subsidies up to €1300 for reasons of using computer, speaking foreign language, or getting to work on time.

Civil servants in Greece employed before 1992 can retire after 35 years service, if they have reached 58, and retire on 80% of their final basic salary. It is more startling that the government has been paying dead people. The Greek government pays 500 pensioners over the age of 110. Apparently, 300 of them have already passed away. Besides this recent discovery, the Greek government may be guilty other wasteful compensation practices. For example, it pays pensions to unmarried or divorced daughters of deceased civil servants. In some cases, it also pays government workers

bonuses for speaking foreign languages, using a computer, arriving to work on time and working outdoors, according to Thomson Reuters. That certainly sounds a great deal more generous than similar civil service schemes in Germany, which seem to insist on 40 years of service, and set the pensions rates in the low 70% range of final basic salaries. It is not just that German politicians and newspaper commentators are really cross about the idea of bailing out the profligate Greek government. It is striking how often their annoyance is expressed in angry comparisons of the Greek and German retirement pension rules. Even the news that the Greek government was planning to raise the legal retirement age from 61 to 63 as part of swinging austerity measures seems to have been like a red rag to a bull in Germany, which not long ago increased its legal age from 65 to 67. "The Greeks go onto the streets to protest against the increase of the pension age from 61 to 63. Does that mean that the Germans should in future extend the working age from 67 to 69, so that the Greeks can enjoy their retirement?"

Healthcare is a large industry sector in developed countries, with total health expenditure accounting for around 9% of GDP, ranking top among OECD countries. The Ministry of Health and Welfare is the leading institution in developing and financing health policies. The "healthcare system" of a nation comprises those activities that aim to improve the health of the population, either by providing personal services to the individual or non-personal interventions to groups of the population. The World Health Organization (WHO) broadly defines health as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity". Therefore, in addition to the healthcare system, many other areas of human and social activity contribute indirectly to the health and wellbeing of the nation, including education as well as environmental and social infrastructure. Many Greeks have been calling for reform to their country's healthcare system. Despite this, it was ranked by the World Health Organization as one of the best in the world; with average healthcare costs among the lowest of the European Union member countries. Currently, there are moves from the government to upgrade the healthcare system, having obtained funding assistance from the European Union. Such improvements include the building of new facilities, developing mobile medical units, improving accident and emergency facilities and the installation of high-tech

medical equipment. The public health system in Greece provides free, or low cost, healthcare services to residents (and their families) contributing to the social security system. Other benefits include free laboratory services, maternity care, medical-related appliances or devices and transportation. Other European Union nationals can also avail of free healthcare benefits provided they have their E111 forms. Emergency care is provided free of charge in public hospitals to anyone, regardless of nationality. There are also smaller outpatient clinics in rural areas which are attached to bigger public hospitals. These facilities provide faster emergency treatment than the bigger public hospitals. Medications are of good quality and the pharmacists are highly trained. Medicines are also highly subsidized with only 25% of the cost of the prescription being charged. The insurance funds (IKA, OGA, TEVE, and others) have been under the jurisdiction of the Ministry of Labour and Social Insurance since September 1995. They play a significant role in the provision and financing of ambulatory services. IKA, the largest social insurance fund (50% of the population) covering mainly blue- and white-collar workers, is responsible for the financing and provision of health care services through its wide and decentralized network of primary health care facilities (over 200 urban polyclinics and clinics). OGA, the second largest social insurance fund, covers farmers and their families (25% of the population) who use the NHS services (i.e. rural health centres). The rest of the funds provide health care services to their beneficiaries mainly through contracts with private physicians for the ambulatory sector, and public or private hospitals for secondary and tertiary health care services. Secondary and tertiary care is provided by NHS hospitals which are publicly owned and financed mainly by the state budget as well as by the insurance funds. Apart from the Ministry of Health and the social insurance funds, the private sector plays a significant role in health care provision(WHO, 1996).

In an effort to restore investor confidence in the Greek economy, the Papandreou government has pursued a series of wide-ranging fiscal austerity measures. However, the combination of spending cuts and tax increases do not appear to have appeased investors enough to enable Greece to raise the money it needs to cover its maturing debt payments. On 2 May 2010, a loan agreement was reached between Greece, the other Eurozone countries, and the IMF. The deal consists of an immediate €45 billion

in low interest loans to be provided in 2010, with more funds available later. A total of €110 billion has been agreed in order to avoid defaulting on its debt obligations. Although European leaders and the IMF have welcomed the austerity measures taken by the Greek government thus far, they are expected to request additional measures and further details on plans to meet budget deficit targets in exchange for financial assistance.

In order to get the bailout package and maybe more in the future, the Greek government has approved a new Stability and Growth Program in January 2010, which including a bunch of policies and reforms in government revenue and expenditures. Besides making the model to replicate what the problem is, I also analyze the policies in the new Stability and Growth Program to see their effects on the government debt both in medium-term and long-term period.

The whole paper will be organized chapter by chapter. The introduction to the debt crisis is in chapter 1; chapter 2 includes the dynamic problem and reference mode followed by chapter 3 which lists the literatures review; chapter 4 shows causal loop and stock & flow diagrams of the model; validations of the model comprises chapter 5 and policy analysis comes up in chapter 6; the final chapter 7 includes conclusion and recommendations to the Greek debt crisis.

2. Dynamic Problem

Since Greece adopted Euro as its national currency in 2001, there has been budget deficit for 9 years (Figure 2.1), meaning that government spending exceeded its revenue in every fiscal year. At the end of 2009, the budget deficit got to 15.4% of GDP. So the Greek government had to borrow more heavily from international market.

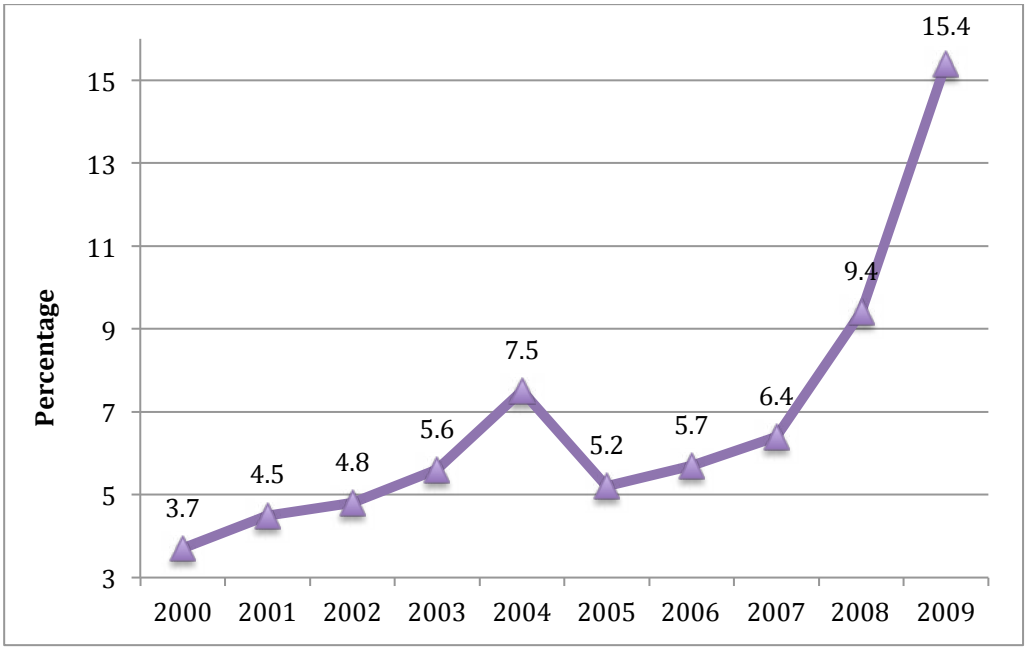


Figure 2.1: Greek Budget Deficit as a Percentage of GDP

Moreover, joining the Eurozone, Greece can easily get loans from banks in Eurozone at low interest rate to finance state budget and service existing debt. Due to budget deficit, government debt increased exponentially and accumulated to €298 billion till end of 2009, 126.8% of GDP (Figure 2.2).

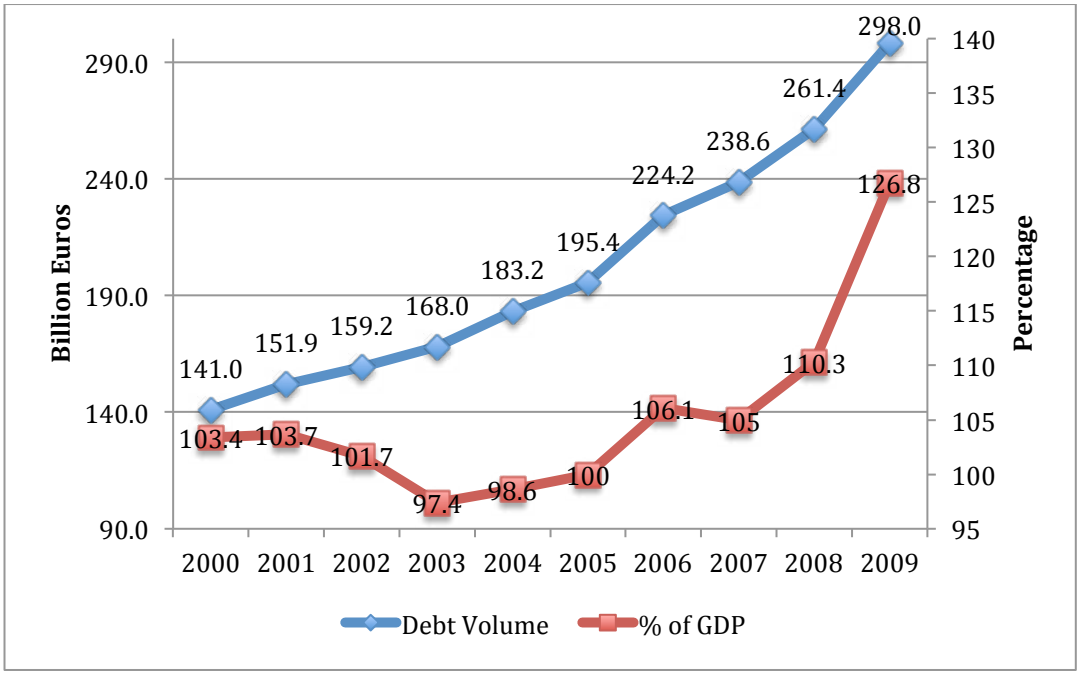


Figure 2.2: Greek General Government Debt

In the Stability and Growth Pact, Member States of the EMU committed themselves to strict financial rules: a maximum public debt of 60 per cent of the GDP and a maximum budget deficit of 3 per cent (the Maastricht Treaty that regulated access to the euro contained the same thresholds). The European Commission was made responsible for the oversight of the implementation of the Pact and should make sure that a Member State that did not comply with these rules got back to the 'normal' situation as soon as possible through budget cuts, improvements of its trade balance or the refinancing of its debt with private bankers. No financial help could be expected from the European Central Bank which is required to protect the euro against the policies of the Member States.

From both Figure 2.1 and Figure 2.2, we can see that the Greek government neither obeys the budget deficit nor public debt rules. And the conditions of the Stability and Growth Pact have not been enforced very strictly. Indeed, during the first economic slowdown at the beginning of the 2000s, France and Germany set a poor standard by transgressing the limits the Pact set to public debt and budget deficit. The Commission in the end did not impose sanctions. That did not help the serious application of these norms (MAMADOUH and WUSTEN, 2010).

There is widespread consensus that poor debt management can have a destabilizing impact on the government budget through the unexpected increase in debt servicing costs (Velandia, 2002). The reliance on funding budget deficit from international capital markets left Greece highly vulnerable to shifts in investor confidence. Investors became jittery in October 2009, when the newly elected Greek government revised the estimate of the government budget deficit for 2009 from 6.7% of gross domestic product (GDP) to 12.7% of GDP. In 2010, Eurostat, the European Union (EU)'s statistical agency, estimated Greece's deficit to be even higher, at 15.4% of GDP. Investors have become increasingly nervous about Greece's ability to repay its maturing debt obligations, estimated at €54 billion ($72.1 billion) for 2010. Euro also depreciated along with the debt crisis. From a view of export, though, Euro depreciation fulfilled the interests of Germany and France, it harmed the economic stability of Eurozone and the European integration process. The Greek debt crisis has evolved into European debt crisis and this frustrated the confidence of international investors who withdrew capital from the dangerous zone. The European Commission as the EU's executive body who represents and upholds the interests of Europe as a whole cannot turn a blind eye on it. The EC is calling for strong policies from Greek government to manage its budget deficit as well as maintain EU economy grow stably.

3. Literature Review

Since the debt crisis emerged, there are lots of academicians and institutions researching on similar topic. Relative literature will be reviewed under the following categories:

3.1. What is Happening in Greece

Several researchers explained what is happening in Greece. Nelson and other 2 researchers (2010) in European Affairs gave the introduction to Greece's debt crisis. They gave the background and analyzed possible causes of the crisis. They expounded and proved that high government spending and weak government revenues contributed to Greece's budget deficits. That Greek industry is suffering from declining international competitiveness is another causes domestically. Internationally, Greece's adoption of the euro as its national currency in 2001 is seen by some as a contributing factor in Greece's buildup of debt. The lack of enforcement of the Stability and Growth Pact is also seen as a contributing factor to Greece's high level of debt (Nelson et al., 2010).

Arghyrou and Tsoukalas (2010) used insights from the literature on currency crises to offer an analytical treatment of the crisis unfolding in the market for Greek government bonds. They conclude that the crisis and its escalating nature are the result of (a) steadily deteriorating macroeconomic fundamentals over the period 2001-2009 to levels inconsistent with long-term EMU participation; and (b) a double shift in markets' expectations, from a regime of credible commitment to future EMU participation under an implicit EMU/German guarantee of Greek fiscal liabilities, to a regime of non-credible EMU commitment without fiscal guarantees, respectively taking place in November 2009 and February/March 2010. Following this shift, resorting to the EU/IMF mechanism of emergency financing on 23 April 2010 was the only option available for Greece to avert an imminent EMU-exit. There is now a clear binary path regarding the outcome of the Greek debt crisis. Either Greece will introduce the reforms necessary to

address the crisis' initial source, i.e. deteriorating fundamentals, in which case and, assuming a favorable external environment, her economy will gradually regain the markets' confidence and the country will stay in the EMU; or Greece will not promote any reforms, in which case she will have no option other than to leave the euro (Arghyrou and Tsoukalas, 2010).

3.2. Influences

After Greek debt crisis emerged, researchers also had expressed influences to Greece and other countries. Das said ASEAN (Thailand, Singapore, Malaysia and Indonesia) is undergoing its own regional economic integration process. ASEAN leaders are aiming to establish an ASEAN Economic Community by 2015. However, it has its own challenges and one of them is the issue of the development divide, especially since the admission of Cambodia, Laos, Myanmar and Vietnam. ASEAN must be able to narrow the divide at least partially by 2015 because with economic integration the member countries would be more dependent on each other in terms of export and investment, securities and property markets, and even consumer and investor confidence. This implies that any disturbance or problem of one country can eventually lead to disruption in another. Thus, in an increasingly integrated region the policy planning must take into account the issues of the weaker members so that a situation similar to EU does not occur in ASEAN (Das, 2010).

Nelson (2010) afraid that there is a risk of contagion to other Southern European countries, including Portugal, Ireland, Italy, and Spain, which, along with Greece, have been nicknamed the "PIGS". Like Greece, these countries borrowed heavily during the credit bubble before the current global financial crisis and have encountered investors who are increasingly nervous about the sustainability of their debt. They also discuss the influence on European integration: How imbalances will be resolved within the Eurozone may be an important component of debates about EU integration in the future.

In addition, Greece's debt crisis could have major implications for the United States. A weaker euro would likely lower U.S. exports to the Eurozone and increase U.S. imports from the Eurozone, widening the U.S. trade deficit; Widespread financial instability in the EU could impact trade and growth in the region, which in turn could impact the U.S. economy; a Greek default could have implications for U.S. commercial interests.

3.3. Policy Proposals

Policies to this debt crisis are also discussed. Fiscal consolidation and austerity policies are mentioned in nearly every research. A paper from Oxford Economics mainly talked about the defaulting or exiting from Eurozone and devaluation or combinations of policies above. Greece could repudiate or more likely seek to restructure its public debt while remaining a Eurozone member. In principle there is no barrier to this, but the consequences would be severe in terms of financial contagion within the Eurozone and in the wider world. Greece would leave the Eurozone and engineer a substantial devaluation of a newly issued national currency. This would have the impact of improving competitiveness and boosting growth and government revenues. It would also leave Greece able to finance the budget by monetary means. But if Greece's debt remained in euros, then Greece's debt ratios would worsen significantly and the risk of default could increase. And if Greece attempted to redenominate its debt into a new national currency (to allow it to be inflated away) this would be considered a legal default. Default reduces the debt interest component of Greece's deficit, and exiting the Eurozone and devaluing allows monetary financing of the deficit and an improvement of the external balance. But the financial contagion effects would be very large and unpredictable both on Greece, its neighbors, and the rest of the world, and the political costs to Greece enormous.

But few of them discuss and analyze the policies – especially the most "feasible" ones – deeply over a relative long-term period. Will the policy recommendations work well or not? What are the influences on the economy of Greece in the future? How can the policies combine with each other to yield a better result? These are the main questions need to be answered in this paper using System Dynamics approach.

4. Dynamic Hypothesis

4.1. Hypothesis Overview

"Debt is that which is owed." "In the case of assets, debt is a means of using future purchasing power in the present before a summation has been earned." A debt is created when a creditor agrees to lend a sum of assets to a debtor. In modern society, debt is usually granted with expected repayment, and in most cases, plus interest. Speaking from a stock & flow perspective, for a country, debt, which is a stock, is increased by the government borrowing which is the inflow, and less by repayment that is the outflow and net government borrowing is budget deficit; while from a causal loop diagram view, the more the budget deficit, the lager the debt, then the more the interest and in return the more the budget deficit. Figure 4.1 presents the reinforcing loop drives debt into an exponential growth pattern.

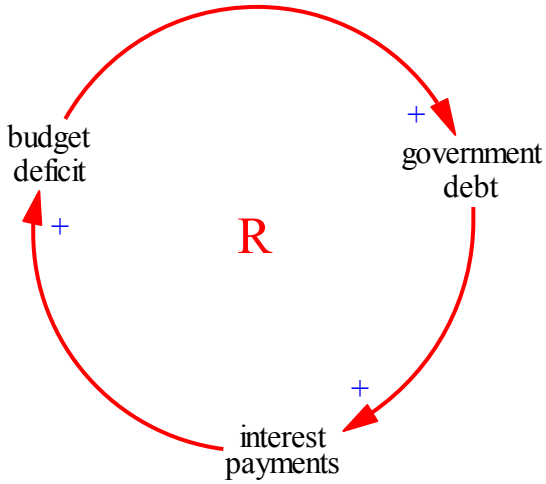


Figure 4.1: Simple Causal Loop Diagram of Government Debt

A budget deficit occurs when an entity spends more money than it takes in. The gap between government expenditure and government revenue contributes to budget deficit. Greece, as one of the most generous country in Europe, has implemented inappropriate fiscal policy-expansive government expenditure and weak government revenue for decade. Meanwhile, the preceding governments had

absence of the willing to maintain fiscal discipline and the membership of Eurozone made Greece easy to finance itself through low interest loans, which all push the country onto the present position.

In the following sections, I will discuss the finance of main structure of government expenditure and revenue. They are population, civil servants system, pension system, healthcare system and taxation system, all these modules will be integrated into government debt module, which displays the whole picture of relationships among the modules above.

4.2. Casual Loop Diagram

4.2.1. Population Module

Population for a country is the fundamental element to develop. It's the wellhead of productive power while it's also the source of public expenditure. Figure 4.2 displays the causal loop diagram of Population module. The reinforcing loop R is marked with red lines and counteracting loops C1~C5 with blue lines.

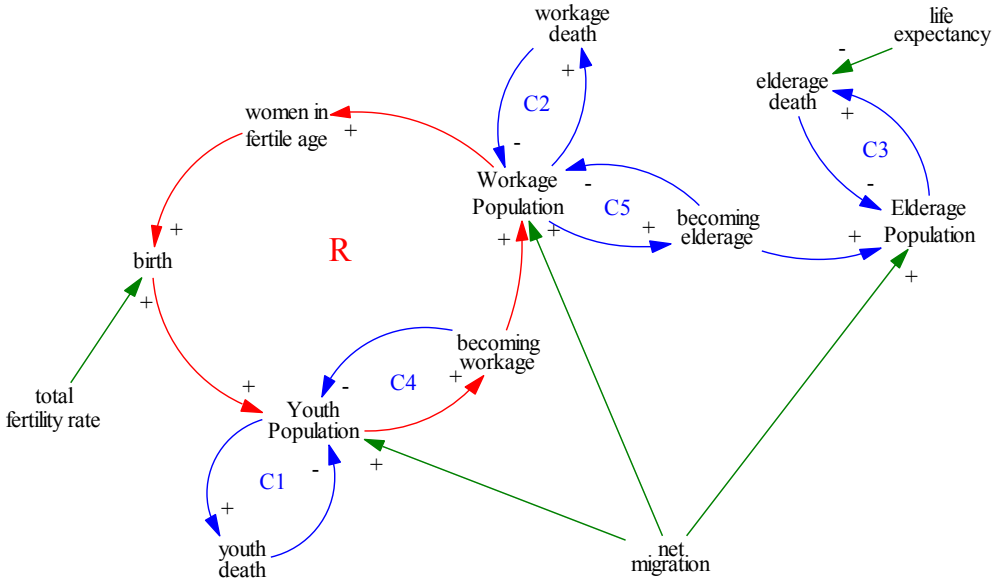


Figure 4.2: Causal Loop Diagram of Population Module

The total population is composed of young, workage and elderage population that are in the aging chain. Workage population constitutes the potential labor force of the country and also includes women in fertile age. The more the workage population, the more the women in fertile age would be. Under condition of the same total fertility rate, there would be more birth, then more young population and more workage population. They could be also contributed by total fertility rate that is the average number of children that would be born to a woman over her lifetime. Counteracting loops C1~C3 are because of death of each population cohort. Life expectancy can influence the duration of elderage population. The increasing in life expectancy will

accumulate more elderage population. Net migration into each population cohort is another factor affecting these cohorts.

4.2.2. Taxation System Module

The government revenue is mainly from income tax and social contribution. In Greece, companies resident in Greece are subject to corporate income tax on their worldwide income and capital gains. Non-resident companies that have a permanent establishment in Greece are subject to corporate income tax on income and capital gains derived through the permanent establishment. An employer is obligated to deduct tax at source from an employee and to make additional contributions to social security as in many other EU member states. The causal loop diagram of Greek government revenue is shown in Figure 4.3.

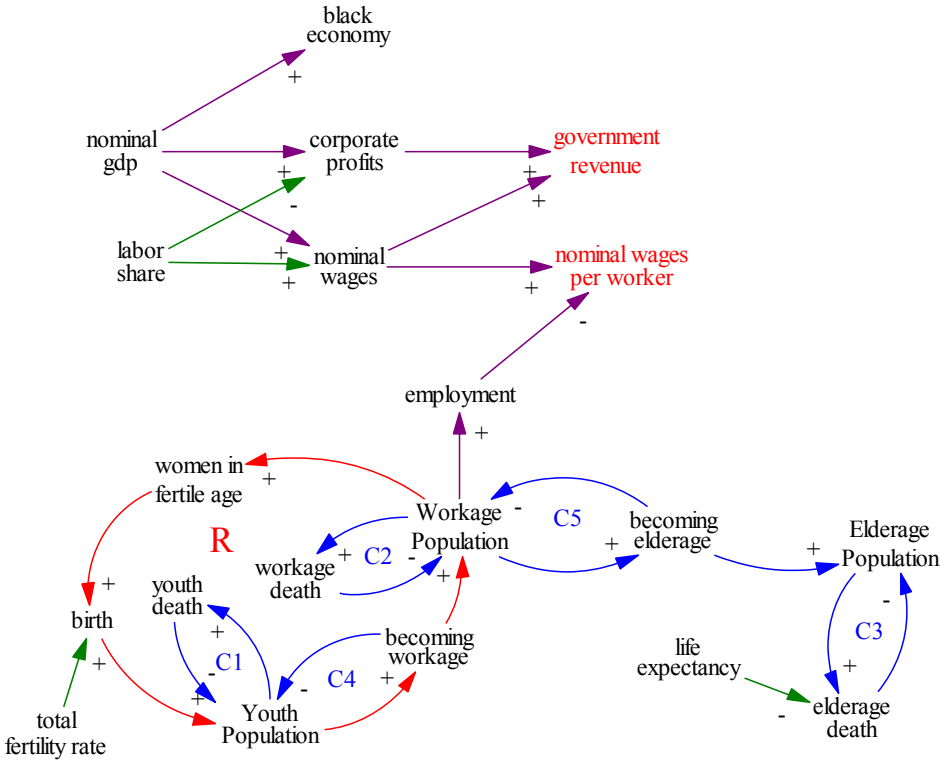


Figure 4.3: Causal Loop Diagram of Taxation System Module

Normally, nominal GDP could be divided into corporate profits and nominal wages of employees, which is measured by labor share. Labor's share of GDP is the nominal wages of employees. The more the labor share, the more the nominal wages are, comparing to corporate profits. Nominal wages will increase along with the increasing in nominal GDP, and so as corporate profits, on condition that labor share is a constant. Government revenue is mainly composed of personal income tax, corporation tax and both personal and corporation social contribution based on nominal wages of employees. The government formulates the tax rates for a period. On employment side, labor force is the base. Under the same productivity, employment is proportional of labor force. Nominal wages per worker are then decided by nominal wages and employment.

Black economy, also known as shadow economy or underground economy, which has no contribution to government revenue, accounts a lot of economic activities in Greece. It is the segment of a country's economic activity that is derived from sources that fall outside of the country's rules and regulations regarding commerce. The activities can be either legal or illegal depending on what goods and/or services are involved. Basically, the amount of black economy is positive relative with the legal part – nominal GDP. The higher the tax rate, the more people would like to participate into black economy in order to hold effective tax evasion or tax avoidance to achieve maximum profits. Aggressive tax avoidance in terms of transfer pricing practices and formation of offshore companies has flourished in recent years, and the current tax reforms have taken into account such methods of tax avoidance (Skouloudis et al., 2011).

4.2.3. Pension System Module

Pensions are provided through an earnings-related public scheme with two components plus a series of minimum pensions/social safety nets. The earnings measure is the average over the last five years before retirement.

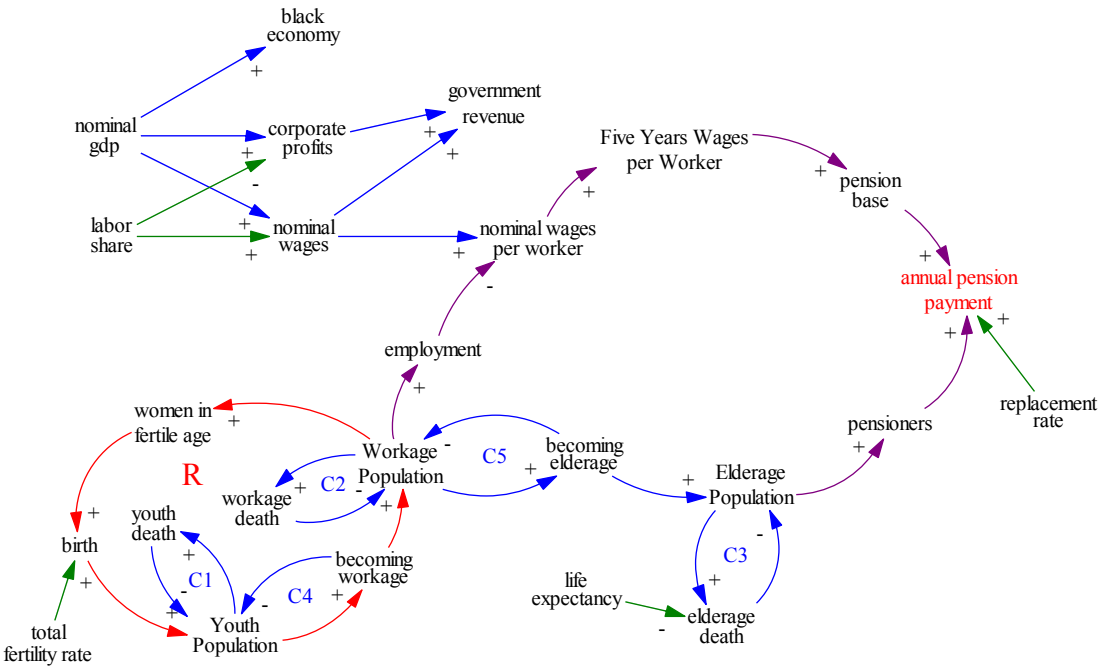


Figure 4.4: Causal Loop Diagram of Pension System Module

Figure 4.4 displays the causal loop diagram of pension system relating with taxation system and population. The governmental pension expenditure depends on the pension base (average wages of the last 5 years before retirement), pension population and replacement rate.

The pension base is positive relative to nominal wages per worker, the growth of nominal wages results in the growth of pension base. Not all elderage population can have the pension because some don't meet the requirement of pension plan such as people supported by their family or living off their property or investment and so on. Farmers are also excluded from pension population in the model for the reason that the farmers are subject to another pension plan different with the one applied to urban workers. Pension population is the population that can get the pension. More elderage population means more pension population. Recently, more people become elderage population and life expectancy is growing, which results in rapid growing in elderage population and so as pensioners.

Furthermore, the government would not pay the pension the same amount with average wages before retirement. Hence replacement rate is a useful tool to calculate the pension. Replacement rate is the percentage of a worker's pre-retirement income that is paid out by a pension program upon retirement. In some cases, workers can use replacement rates to help estimate what their retirement income might be from the plan.

4.2.4. Healthcare System Module

The finance of healthcare system in Greece is both from public and private sector. Healthcare spending as a percentage of GDP reveals how much the country spends on healthcare. Total healthcare spending is the total national spending on healthcare by both public and private. Public healthcare expenditure is derived from total healthcare spending by public source percentage. Figure 4.5 shows the causal diagram of the finance of healthcare system.

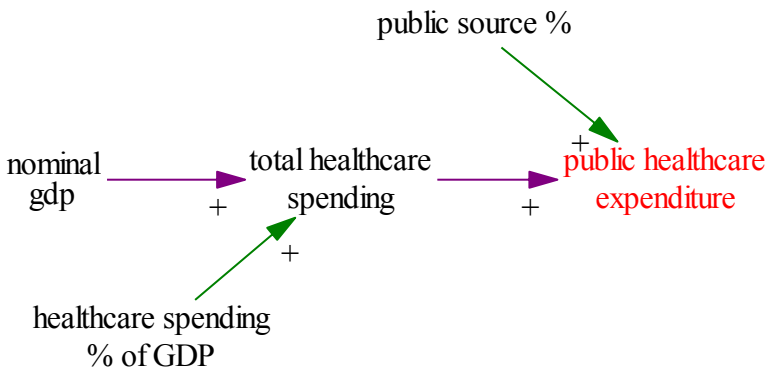


Figure 4.5: Causal Diagram of Healthcare System Module

There are two exogenous variables in the diagram. They are healthcare spending as a percentage of GDP and public source percentage. The two variables are relatively stable during the simulation period. Hence, public healthcare expenditure increases if nominal GDP increased.

4.2.5. Civil Servants System Module

A civil servant or public servant is a public sector employee working for a government department or agency other than military. Same with pension system, the finance of civil servants system is decided by civil servants population and average wages of civil servants – pc civil servants wages. Figure 4.6 gives the causal loop diagram of civil servants system.

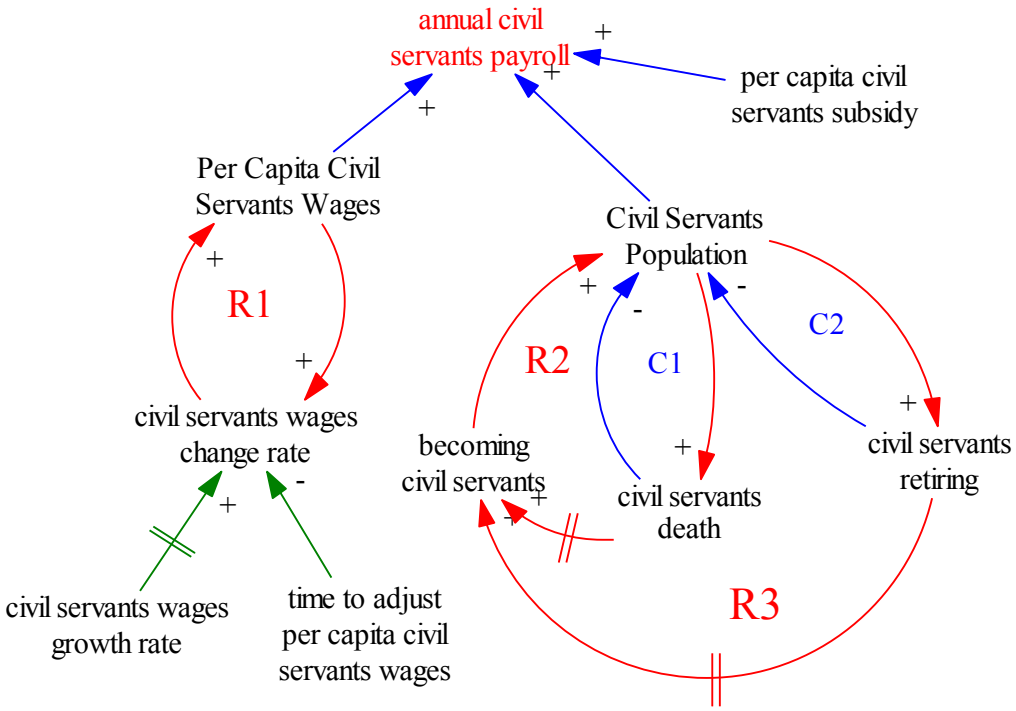


Figure 4.6: Causal Loop Diagram of Civil Servants System Module

Different from pension population, known as pensioners, civil servants population is controllable. Government could control the civil servants population through recruiting, freezing or cutting those positions. From Figure 4.6, the civil servants population is driven by two reinforcing loops R2 & R3 and two counteracting loops C1 & C2. During the simulation period, government tried to maintain the civil servants population, which is the result driven by those two kinds of loops, though it's rather redundant and low productive.

Civil servants wages is also derived from nominal wages per worker. And civil servants wages is growing with a stable high growth rate that is bigger than nominal wages growth rate. So, that civil servants wages grows at a higher rate compared with normal workers. Furthermore, the civil servants have various kinds of subsidies for speaking foreign languages, using a computer or getting to work on time.

Then annual civil servants payroll is the product of pc civil servants wages, pc civil servants subsidy and civil servants population.

4.2.6. Government Debt

All modules talked above eventually will be integrated into a top-level model of the government debt whose causal loop diagram is shown in Figure 4.7. Wheat (2007) gave a government debt sub-model in his *MacroLab*, which is adapted to my model. The government revenue and government expenditure from where the green arrows link are all displayed as exogenous in the diagram, which have been talked in above modules. The emphasis of this model is on government borrowing, government debt, debt repayments and interest payments. Figure 4.1 has shown a simple relationship among these elements. Without doubt, it's far more complex in the real world but it'll be simplified with three reinforcing loops R1, R2, R3 and one counteracting loop C1.

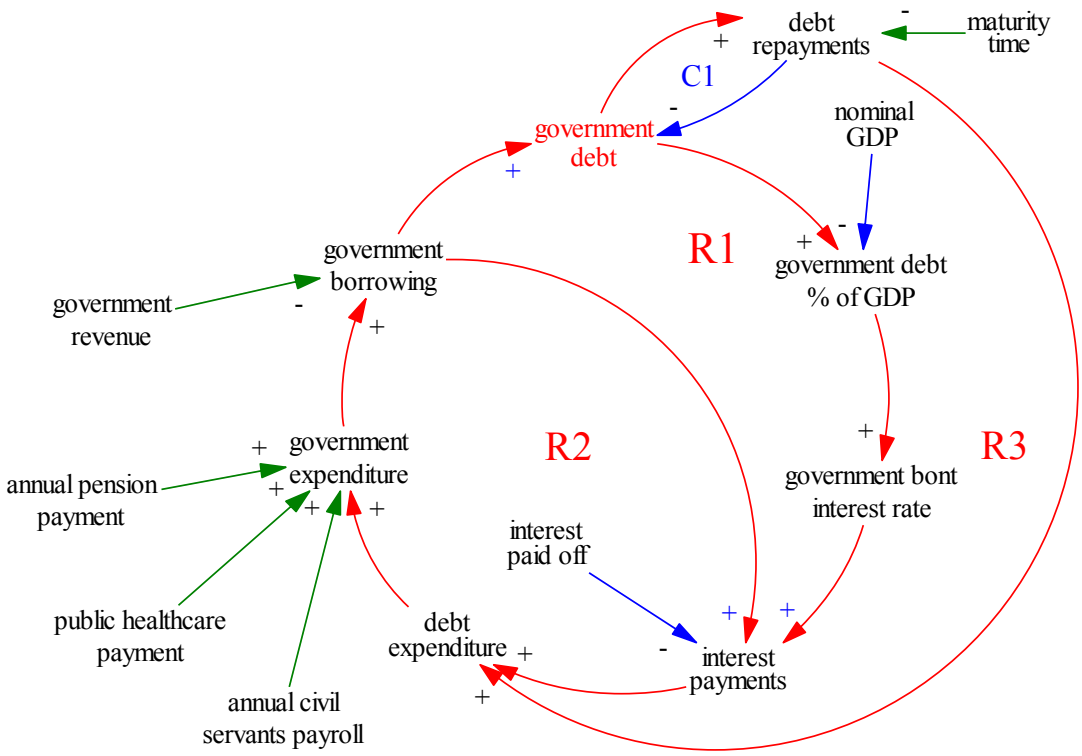


Figure 4.7: Causal Loop Diagram of Government Debt

Beginning with government borrowing, as its name, government borrowing is the gap between revenue and expenditure of the government. The more the government expenditure and the less the government revenue, the more the government borrowing will be. On the other side, debt repayments is the principle the government need pay to the creditor when the debt is due. Both of the two flows influence the government debt directly. And the difference between government borrowing and debt repayments is budget deficit. In each single year, debt repayments has no influence on budget deficit and government debt (C1 counteracts R3 perfectly), but it does in next years. Because the government finances its debt through borrowing new debt to repay the old one, but the quantity of borrowing will influence the interest payments, then government debt.

More government debt implies higher cost of borrowing new debt, which will push interest rate of government bond high, then higher interest for new borrowing, it is named new interest. The new interest of new borrowing

adding up to interest payments of old debt constitutes the total interest payment of each single year. It will be reduced by interest paid off – When an amount of debt is due, the government has to pay the last amount of interest and the principle to the creditor, meaning that this amount of debt has been paid off, its interest for a single year needs not to be paid any more. The interest payments go into government expenditure eventually, which will in turn lift the budget deficit. This is how R1 works.

Besides, government borrowing could lead the new interest to a higher level directly through R2. Once the new borrowing occurred, the interest (new interest) to be paid for the new borrowing is decided. These two reinforcing loops could drive government debt to a dramatically high level.

The problem is that there are no feedbacks into the government revenue and expenditure branches such as pension payment, healthcare payment and civil servants payroll. The government spent according to the demand – how much the government need to pay, but didn't consider the supply – how much the government need to earn. The unwillingness to make change and long time cumulated debt results in the debt crisis, that the Greek government cannot repay mature debt through issuing new government bond because investors lost confidence in Greek bond market.

4.3. Major Model Assumptions and Boundaries

Any models cannot replicate the real world completely, but they can still represent the real world by condensed and more understandable structures. All of these give the credit to reasonable model assumptions and clear model boundaries.

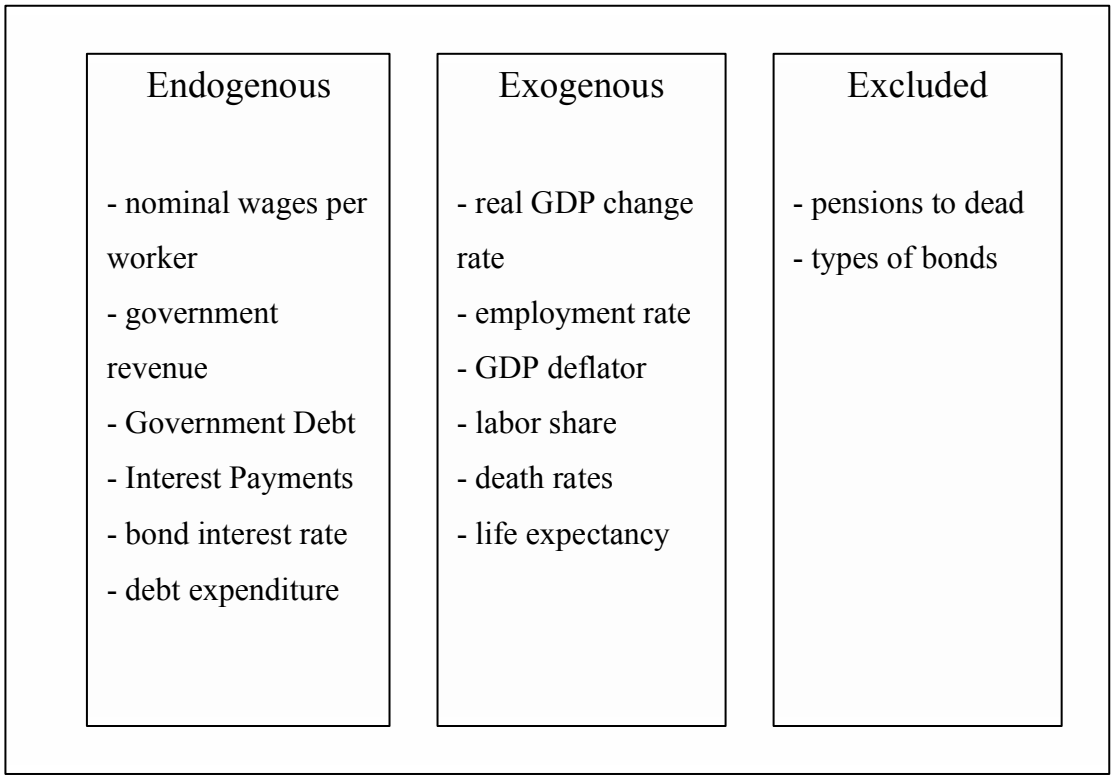
Major Model Assumptions:

1. Men and women are treated the same, they will all retire when 65 years old. And after 65 years old, nobody can be employed. Besides, all the citizens in Greece what ever male or female will share the same rights and responsibilities;
2. The recruitment of civil servants is well planned;
3. The pensions delivered to dead people are excluded, because the quantity is relative low compared with the whole pension payment;
4. All government revenue is from taxation system;
5. All government borrowing could be funded successfully by issuing government bonds;
6. The government could fund its budget deficit successfully in each year, in other words, the government could borrow enough money to fill the gap between its expenditure and revenue;
7. All bonds issued by the government are fixed interest rate bonds. The interest rate would not change before matured;
8. The government pays annual interests to creditors and pays the principal and the last interest at the matured year.

Major Model Boundaries:

Not all ingredients related to one issue need to be endogenous. Some factors whose forming mechanisms are very complex could be treated exogenous because they beyond the study of the research. May some also be excluded from the model.

A boundary chart is displayed below. The main variables in the model are divided into three categories: endogenous, exogenous and excluded. Variables like nominal wages per worker and bond interest rates are decided by other variables, while variables such as GDP deflator and real GDP change rate are treated as exogenous because the generations of them have low relativeness to the model under study. Some are absolutely excluded like pensions paid to dead people. They have little influence on the simulation.



4.4. Stock & Flow Diagram

The model is designed with modules, which gives a more organized and clearer view into the working mechanism. Modules are self-contained models that you can connect to other models. Modules allow you to break a single model into well-defined "chunks". Each module within a model is a cohesive model on its own, which you can run separately or within the larger model.

By using modules, you can:

- Build small, self-contained portions of a model, one-at-a-time.
- Test a single portion of a large model.
- Represent a hierarchical system in a model, by making each level of the hierarchy into a separate module, with each module linked to one or more levels above it.
- Work with teams to build a complex model by having each team member build separate modules that are later linked together.
- Reuse portions of a model in as many models as you want.
- Create very large models (models that may have previously exceeded size limits).
- Incorporate locked models into other models.

You can create as many modules as you need, and you can incorporate as many modules as you want into a single model. This allows you to create very large or complex models that are broken down into cohesive, self-contained pieces.

Furthermore, I also made some color-coding in order to differentiate the function of so many stocks, flows or variables. As we can see, blue represents the model elements that replicate the reference mode; purple is for policy model; green means module inputs from other modules in the model; red shows module outputs to other modules in the model or important indicators. Only selected equations are showed in this section, others are listed in Appendix.

4.4.1. Population Module

Population module is a classical aging chain. An aging chain can have any number of stocks (called cohorts), and each cohort can have any number of inflows or outflows.

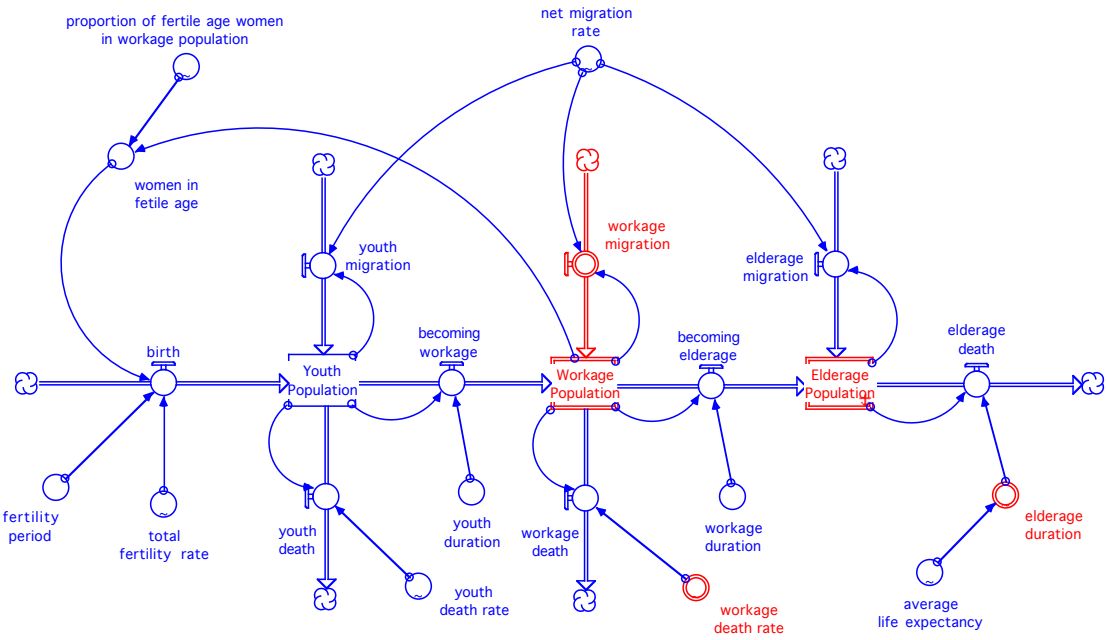


Figure 4.8: Stock and Flow Diagram of Population

Figure 4.8 displays the stock and flow diagram of Greek population. For the sake of studying effectively, the whole population is divided into 3 stocks: youngage population, workage population and elerage population. Migration goes into each cohort and death goes out. Population leaves from one cohort to another depending on pre-set age duration. The women in fertile age decide the birth, equations as below:

$$birth = \frac{women\ in\ fertile\ age * total\ fertility\ rate}{fertility\ period}$$

4.4.2. Taxation System Module

Government revenue is mostly from taxation system. Tax income is derived from nominal GDP. Both individual employee and employer are responsible to pay tax to government.

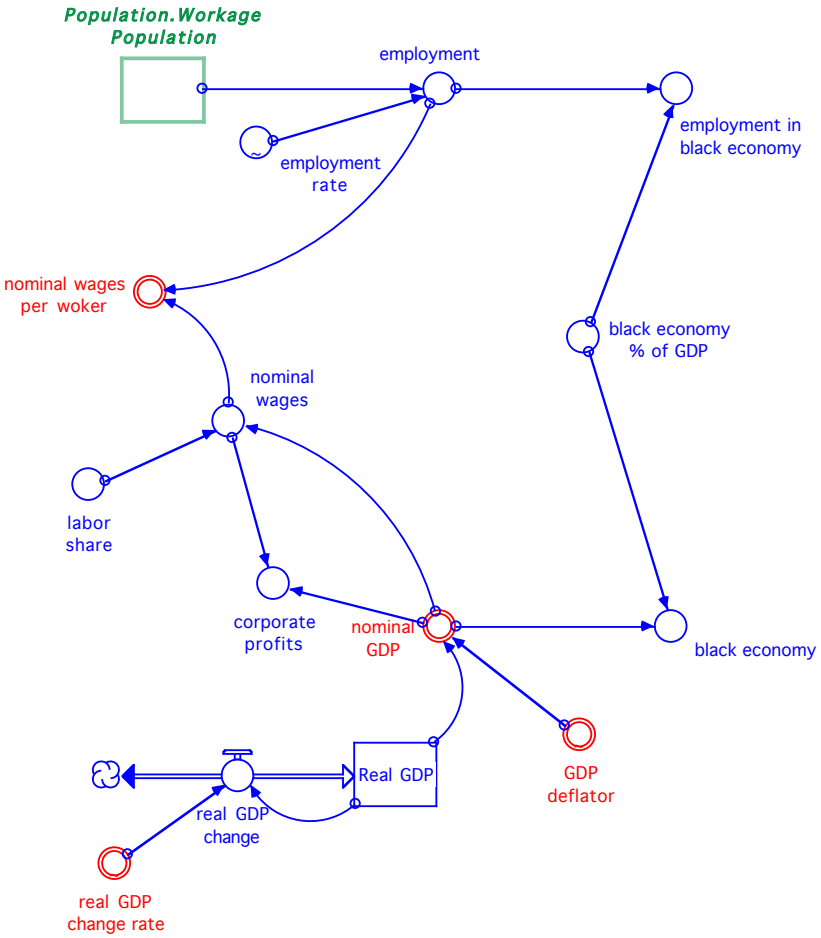


Figure 4.9: Stock and Flow Diagram 1 of Taxation System

Figure 4.9 displays the main index of economy including nominal GDP, nominal wages from labor share and corporate profits, also employment and nominal wages per worker which is the output to both pension and civil servants system. The calculation of nominal wages is:

$$nominal\ wages = nominal\ GDP * labor\ share$$

Black economy in Greece is estimated accounting for 25% of nominal GDP, but it is untaxed. How to move black economy back to legal market is what the government needs confront.

The government collects tax through various kinds of tax, mainly from income tax and social contribution. Figure 4.10 shows the detail.

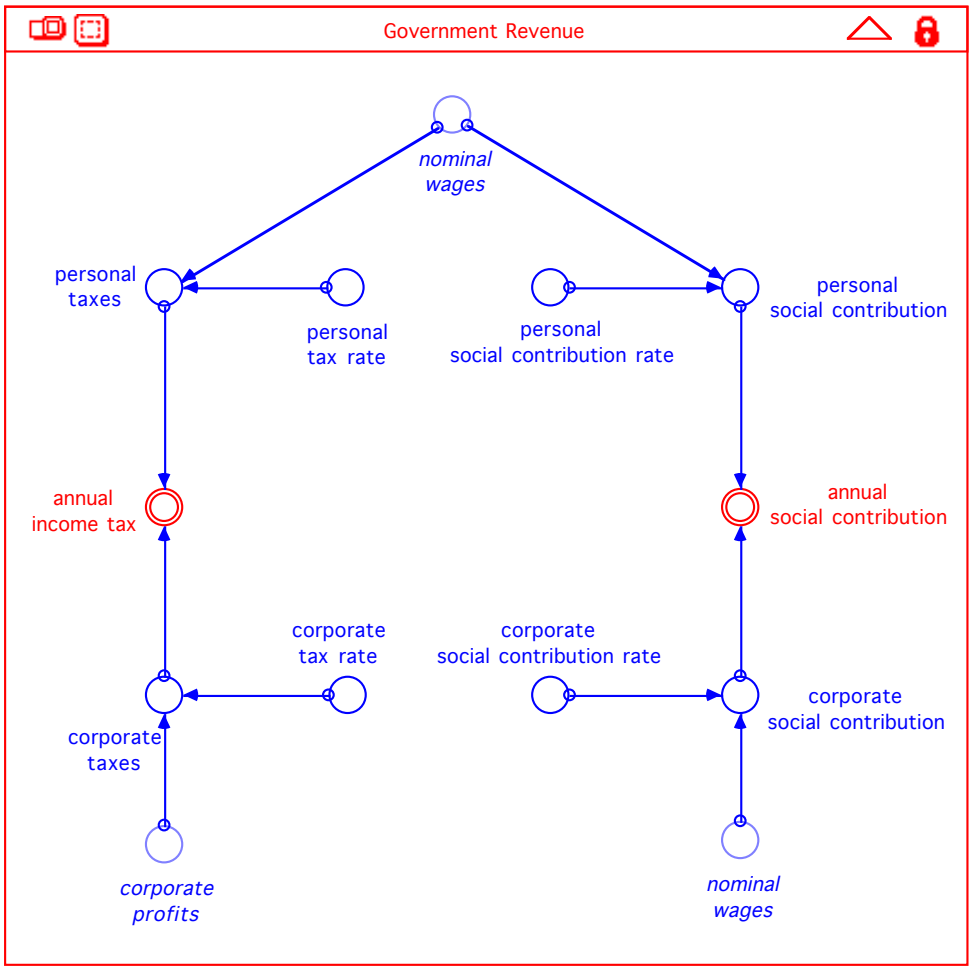


Figure 4.10: Stock and Flow Diagram 2 of Taxation System

Annual tax income is the sum of personal taxes and corporate taxes. Personal tax rate is a weighted 24% and corporate tax rate is 24%. Employers are also asked to deduct social contribution from the source of employees' wages and make extra social contribution according to wages. It's noted that the tax bases of personal taxes and corporate taxes are different but the one of

social contribution is the same – nominal wages, what different are only the social contribution rates.

4.4.3. Pension System Module

Pensioners have 14 months' pensions for each year. Normally, pensions will be delivered to pensioners monthly, so each pensioner can have 12 months' pensions every year. But Greek pensioners can enjoy 2 more months' pensions, totally 14 months' pensions. The pension base is the average of last 5 years wages before retirement. In order to sample the last 5 years wages before retirement, a conveyor is introduced, transit time is 5 years (Figure 4.11), which means that the sum of last five years wages at the end of each simulation year is on the conveyor. Pension base is the sum divided by transit time – 5 years.

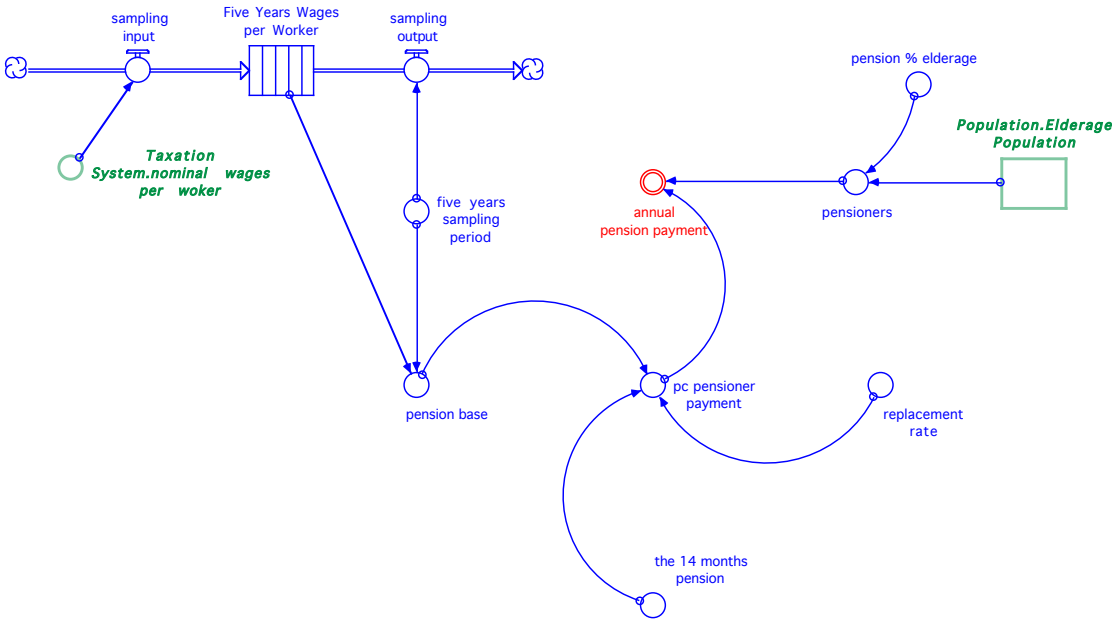


Figure 4.11: Stock and Flow Diagram of Pension System

For labor-market entrants from 1993, the pension is 2% of earnings for each year of contributions up to 35 years. There is therefore a maximum replacement rate of 70% for people retiring at the normal age or earlier.

However, for working after the age of 65 and a contribution period of 35 years, there is a higher accrual of 3.3% per year, for a maximum of three years, while there is no accrual rate for those working after this period (maximum replacement rate of 80%). Then taking supplement pension into account, a replacement around 90% is used in the model.

4.4.4. Healthcare System Module

Healthcare system is extremely complex than what we imagine. Total healthcare spending includes public expenditure and private payment. In order to know the finance of healthcare system, we can simplify the system as what Figure 4.12 shows.

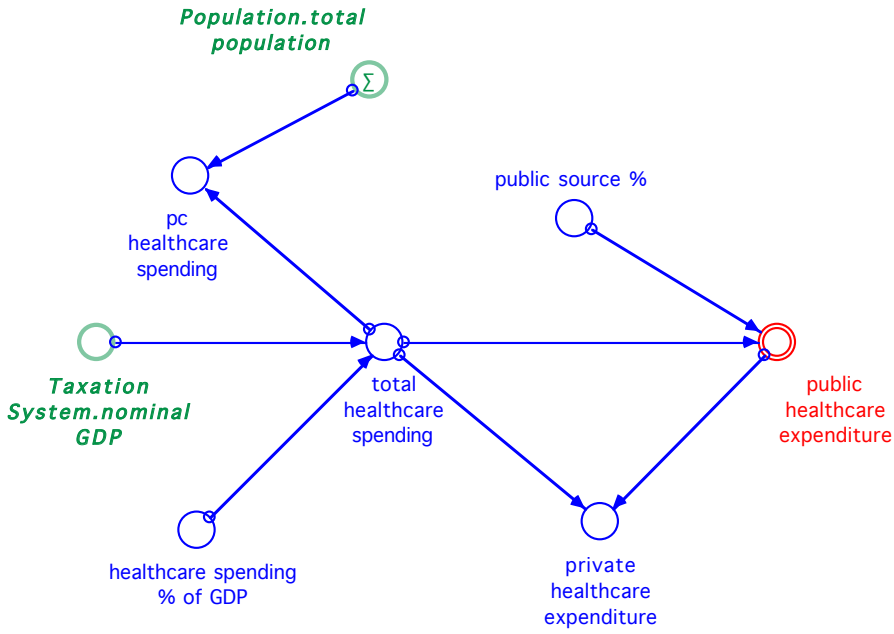


Figure 4.12: Stock and Flow Diagram of Healthcare System

$$total\ healthcare\ spending = nominal\ GDP * healthcare\ spending\ \%\ of\ GDP$$

$$public\ healthcare\ expenditure = total\ healthcare\ spending * public\ source\ \%$$

Public healthcare expenditure is what government pays on healthcare, which contributes to government expenditure then budget deficit.

4.4.5. Civil Servants System Module

The finance of civil servants system shares the same principle with pension system. We need know civil servants population and average wages of civil servants. Figure 4.13 shows how we formulate the two variables.

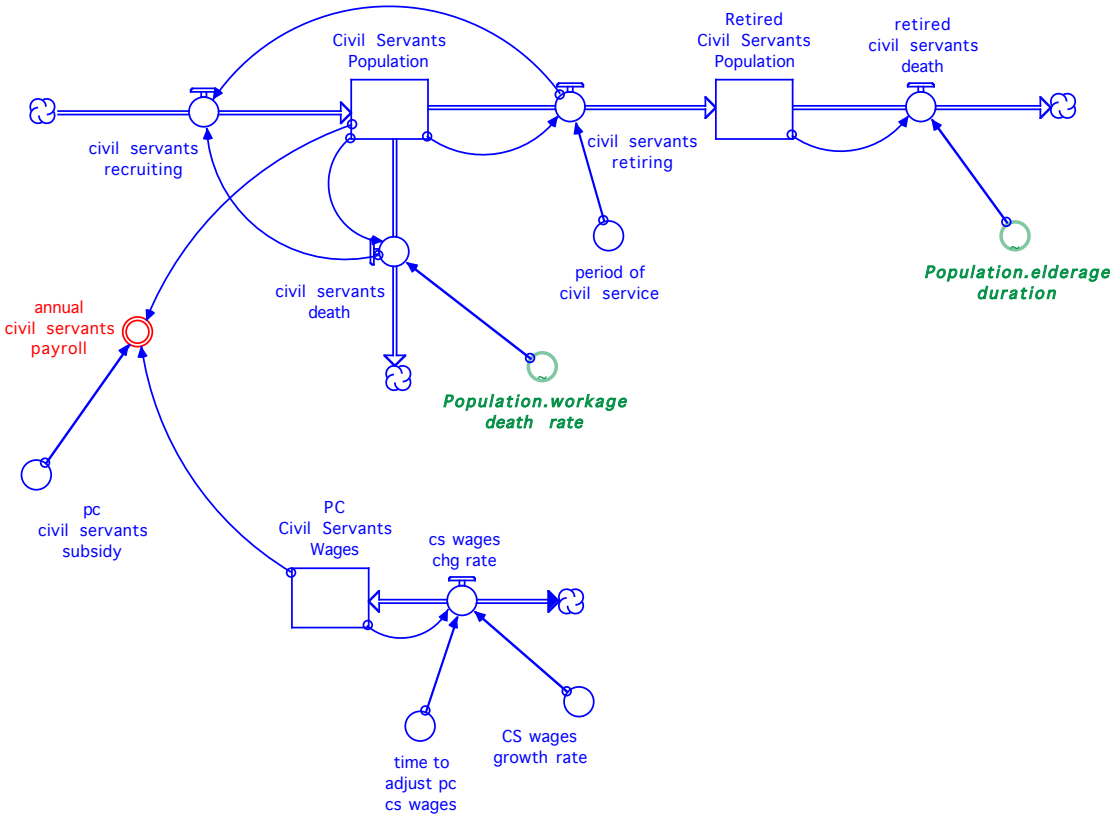


Figure 4.13: Stock and Flow Diagram of Civil Servants System

The civil servants have been redundant with low productivity, but with higher wages. Government tries to maintain the civil servants population, but there is a delay between retiring/death and recruiting.

Pc civil servants wages is higher than nominal wages per worker, and it grows steadily each year. In addition to wages, civil servants can get extra subsidies due to various reasons, such as using a computer, speaking foreign language, arriving on position on time and so on. They can also get 14 months' wages each year.

4.4.6. Government Debt

Now we are getting to the top-level model. All modules are integrated into this model. Figure 4.14 offers a big picture for it. The five modules we talked above are shown on the low left, they coordinate with each other and produce the government revenue and expenditure. Only three main kinds of expenditures are considered in the model, others excluding debt related expenditure (interest payments and repayments) is represented by other expenditure.

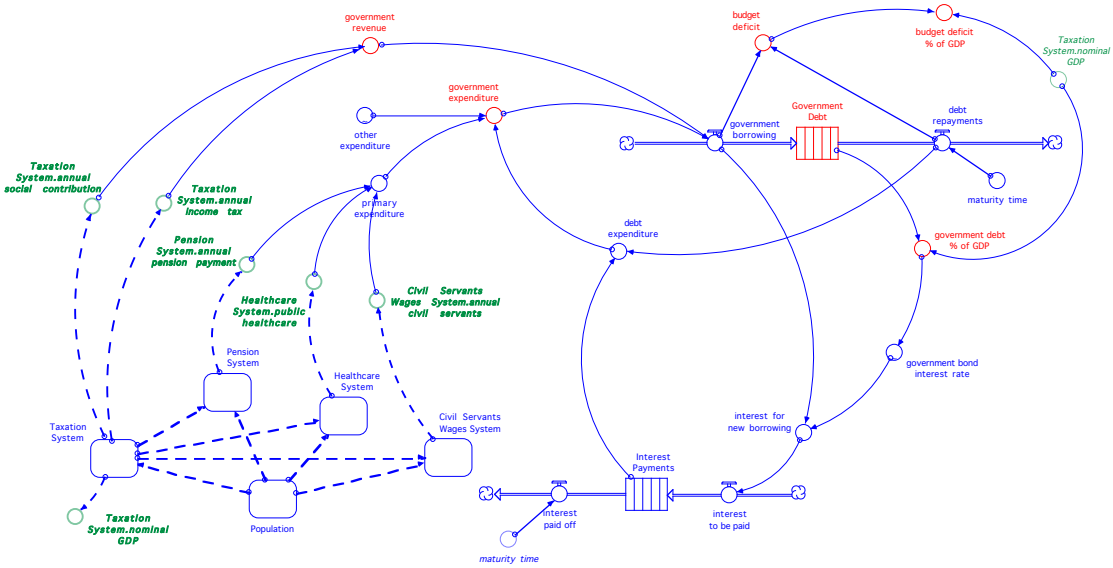


Figure 4.14: Stock and Flow Diagram of Government Debt

What the government needs to borrow is the gap between the government expenditure and the revenue. The main part of the whole model comes the right side of the diagram. The conveyor conception is again adopted here. As is shown, both government debt and interest payments use conveyor

conception, which is more similar with the real world. The conveyor is a material delay, material will stay on the conveyor for a fixed period of time. For the case we are discussing, the government borrowing is the material which will go onto conveyor; debt repayments is the material which will get down from conveyor. Once the government borrowing is occurred, it goes onto the conveyor and stays on it until it is due then get down from the conveyor, meaning that this sum of debt borrowed 7 years (weighted maturity time is 7 years) ago is repaid. All the government borrowings on the conveyor are the total government debt.

The working mechanism of interest payments is the same with government. Assuming all the debt is fixed interest rate debt, the interest for new government borrowing is calculated once government borrowing occurred. This interest to be paid then goes onto the conveyor of interest payments. The government will pay this interest to its creditor for 7 years until it is due, then both the principal and interests for principal are paid off. Interest payments conveyor holds the total interests the government need pay for the single year.

Both interest payments and debt repayments constitute the debt expenditure of the government. The debt expenditure adds up to government expenditure for a lager gap, and then results in more government borrowing.

The budget deficit is the net government borrowing, it is the gap between the government expenditure and the revenue excluding debt repayments.

5. Model Validation

No model has ever been or ever will be thoroughly validated… "Useful", "illuminating", "convincing", or "inspiring confidence" are more apt descriptors applying to models than "valid" (Greenberger, 1976).

All models are limited, or simplified representations of the real world (Sterman, 2000). But policymakers need models to help them to make decisions. The objective of model validation is to build the confidence of the model.

The time span for model simulation is from beginning of 2001 to end of 2009, the model validations are also in the same time span. In all graphs below, I name the behavior simulated from the model formulation (without any policies) the Base Run. And the

5.1. Reference Mode Replication Test

Reference mode replication is the most direct method to build the confidence to the model. Because the research emphasis is on the government debt, I take historic government debt as the reference mode and include the model simulation results to compare with reference mode. Figure 5.1 displays both the simulated result of government debt and its reference mode.

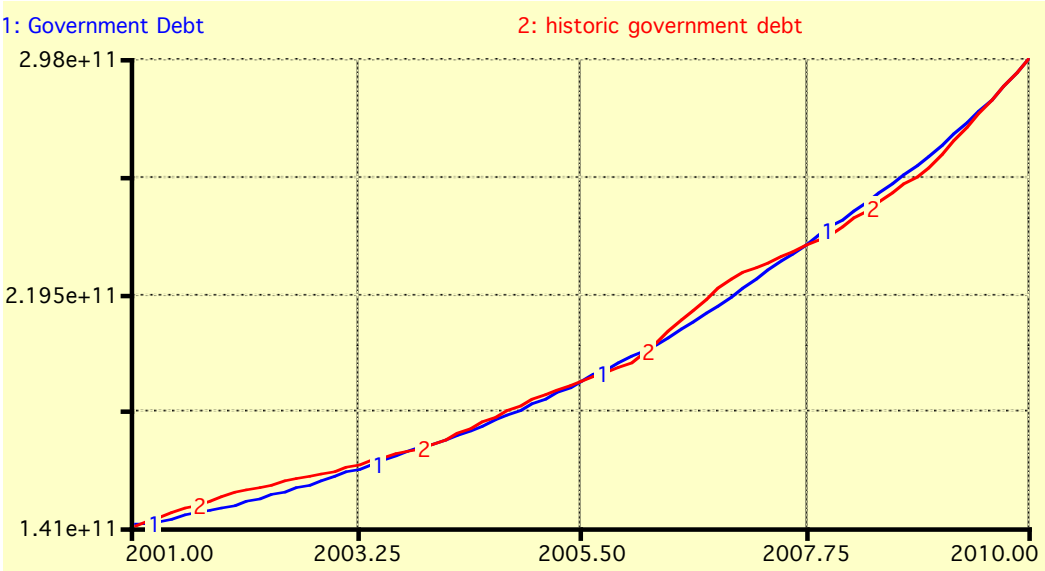


Figure 5.1: Comparison between Simulated Behavior and Reference Mode of Government Debt
Scenario 1: Simulated Behavior of Government Debt
Scenario 2: Historic Data of Government Debt

Figure 5.2 displays the comparison of government debt as a percentage of GDP.

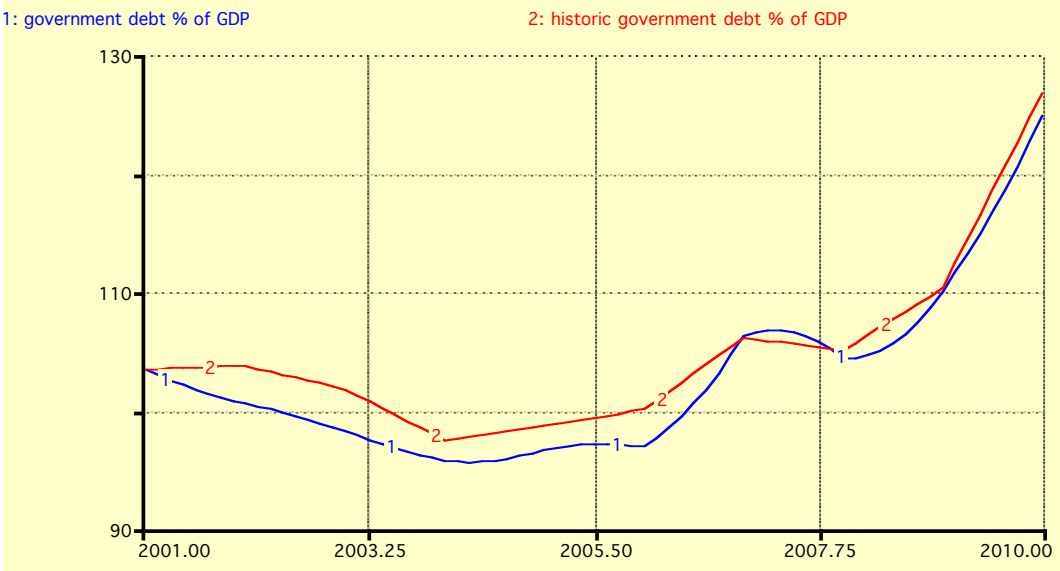


Figure 5.2: Comparison between Simulated Behavior and Reference Mode of Government Debt as a Percentage of GDP

Scenario 1: Simulated Behavior of Government Debt as a Percentage of GDP
Scenario 2: Historic Data of Government Debt as a Percentage of GDP

From Diagrams above, the simulated behaviors roughly replicated the reference mode, especially the trends of simulations.

5.2. Extreme Condition Test

From reference mode replication test, we have built basic confidence to the model, but we don't know if the structure is robust enough – robust under extreme conditions. In order to confirm that and fix flaws in the model, extreme condition test becomes necessary.

Referring Figure 4.14, taxation system is a very important module of the model. It is the source of government revenue and some of its outputs have influence on almost all main branches of government expenditure at the same time and as well as government debt. Labor share is selected to implement this test.

Labor share is the percentage that how much of GDP distributes to the labor force. The initial value for labor share is 0.6, meaning that 60% of GDP will distribute to the labor force, which is set as the base run. Then labor share will be change to extreme values – 0 and 1. Main simulation results (numbered by 2) will be compared with the ones in base run (numbered by 1) to see if the model under extreme conditions is reasonable.

Labor share=0

When labor share=0, all GDP will go into corporates other than labors. As a result, nominal wages is 0, there is no social contribution, no personal income tax. The only tax revenue of government is from corporate income tax. So government revenue will be less, the expenditure in pension and civil servants wages are all 0, the government will pay all healthcare bills for people.

Figure 5.3 shows that annual income tax overlaps with each other in simulations, that's because the tax rates both for personal and corporate are the same, however GDP distributes between labor and corporate, the tax for income is always the same.

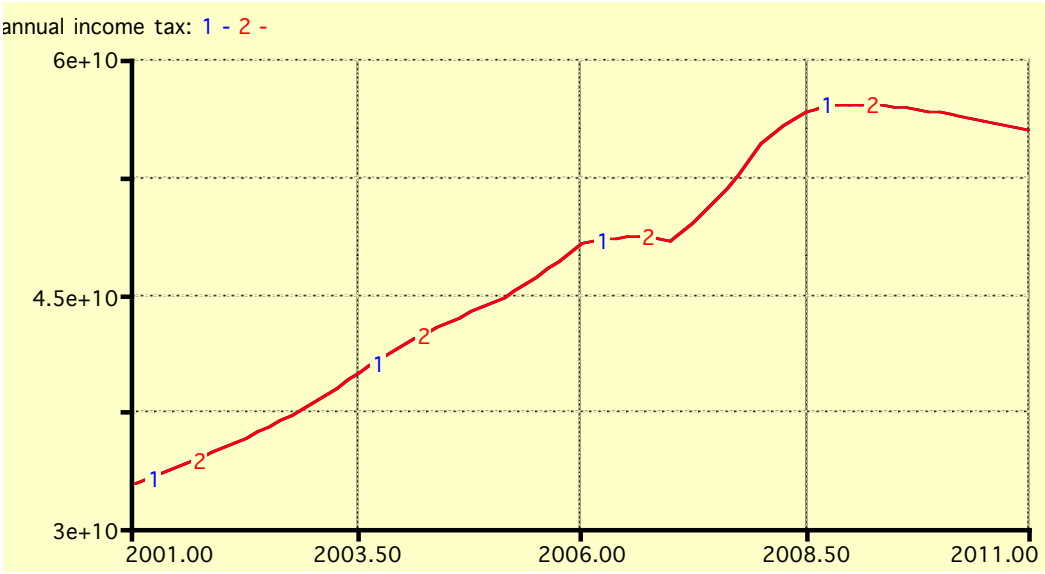


Figure 5.3: Annual Income Tax

Scenario 1: Base Run
Scenario 2: Behavior When Labor Share=0

Social contribution includes personal social contribution and corporate social contribution which are all based on nominal wages, it turns to 0 when labor share=0, as shown in Figure 5.4.

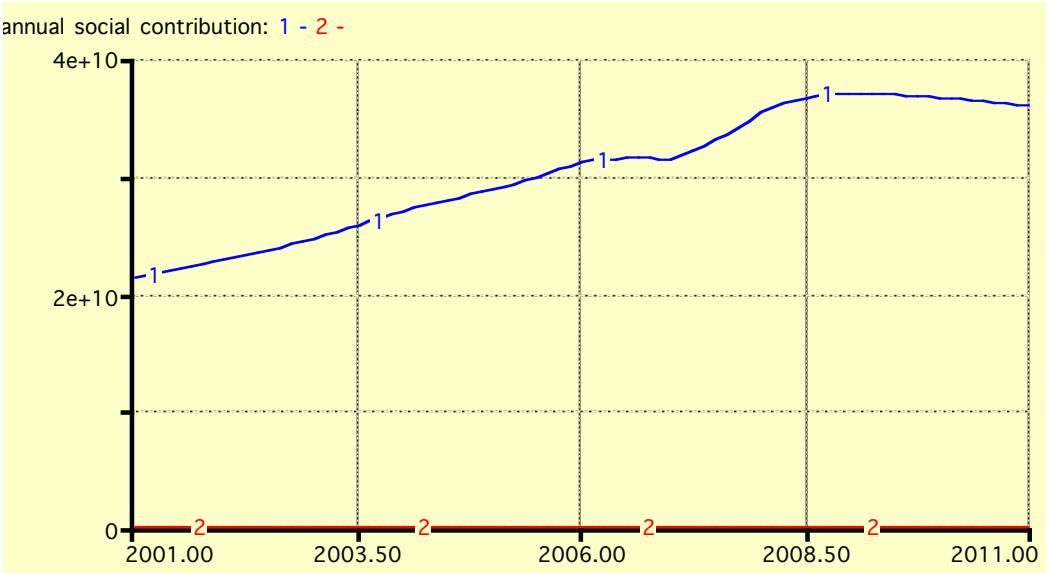


Figure 5.4: Annual Social Contribution

Scenario 1: Base Run
Scenario 2: Behavior When Labor Share=0

Figure 5.5 displays that annual pension payment turns to 0 when labor share=0, because pension derives from nominal wages.

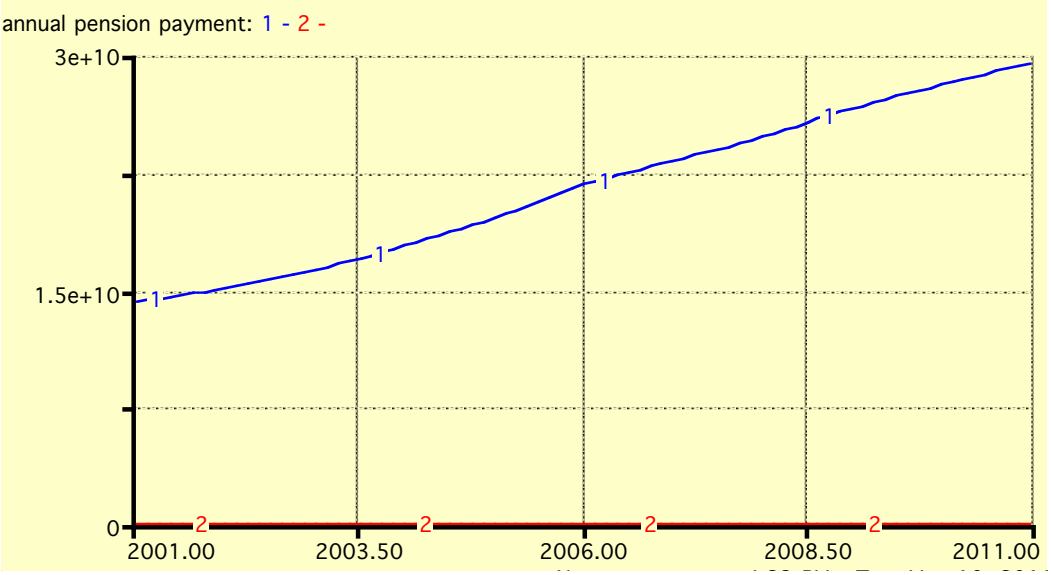


Figure 5.5: Annual Pension Payment

Scenario 1: Base Run
Scenario 2: Behavior When Labor Share=0

Figure 5.6 shows civil servants payroll is 0, because labor share=0, none of personals can get wages.

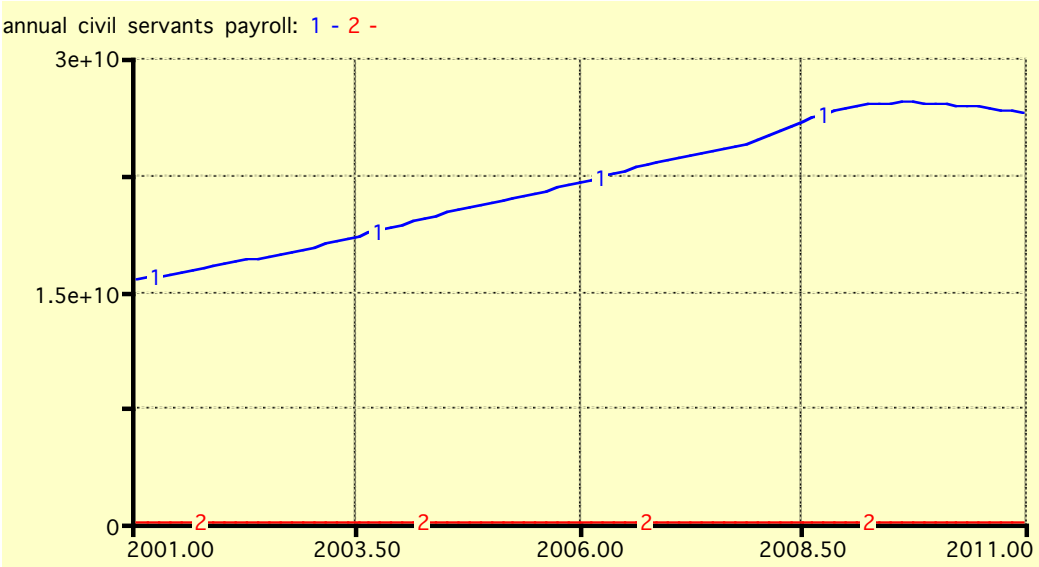


Figure 5.6: Annual Civil Servants Payroll

Scenario 1: Base Run
Scenario 2: Behavior When Labor Share=0

Figure 5.7 shows that public healthcare expenditure is higher than base run, that's because people have no money pay bills at all, the private payment in base run need be paid by government also.

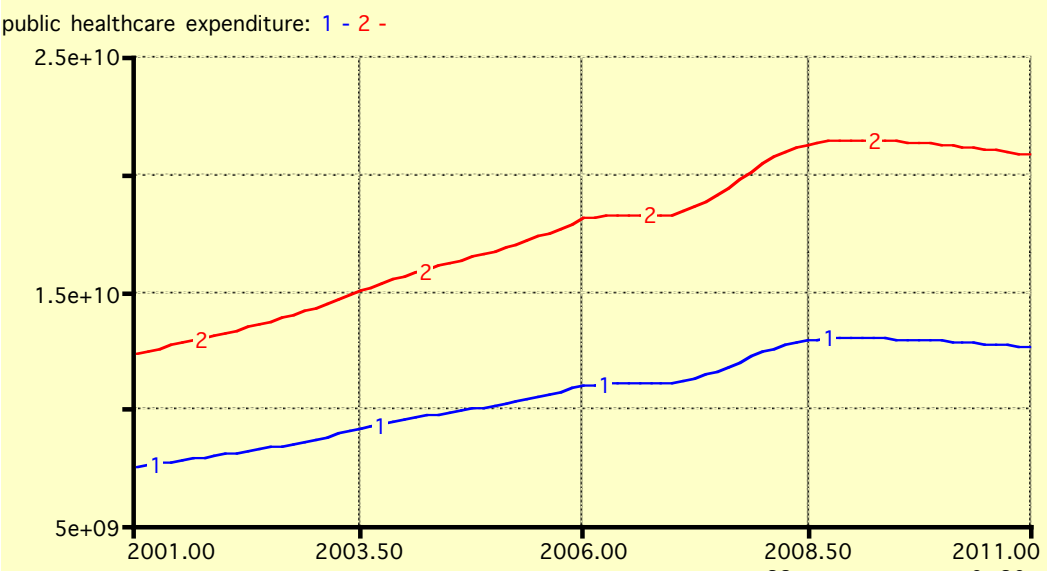


Figure 5.7: Public Healthcare Expenditure

Scenario 1: Base Run
Scenario 2: Behavior When Labor Share=0

Labor share=1

When labor share=1, all GDP will go into the labor force other than corporates. As a result, nominal wages is the whole GDP, there is no corporate social contribution, no corporate income tax. The tax revenue of government is from personal income tax and personal social contribution. So government revenue will be less, while the expenditure in pension and civil servants wages are much higher.

Figure 5.8 ~ Figure 5.12 give simulation results on condition that labor share=1. All these simulations below are corresponding with the ones (Figure 5.3 ~ Figure 5.7) on condition that labor share=0.

Figure 5.8 shares the same result with Figure 5.3, because both personal and corporate tax rate are 24%. Under extreme conditions, annual income tax is all from either nominal wages or corporate profits – the whole GDP.

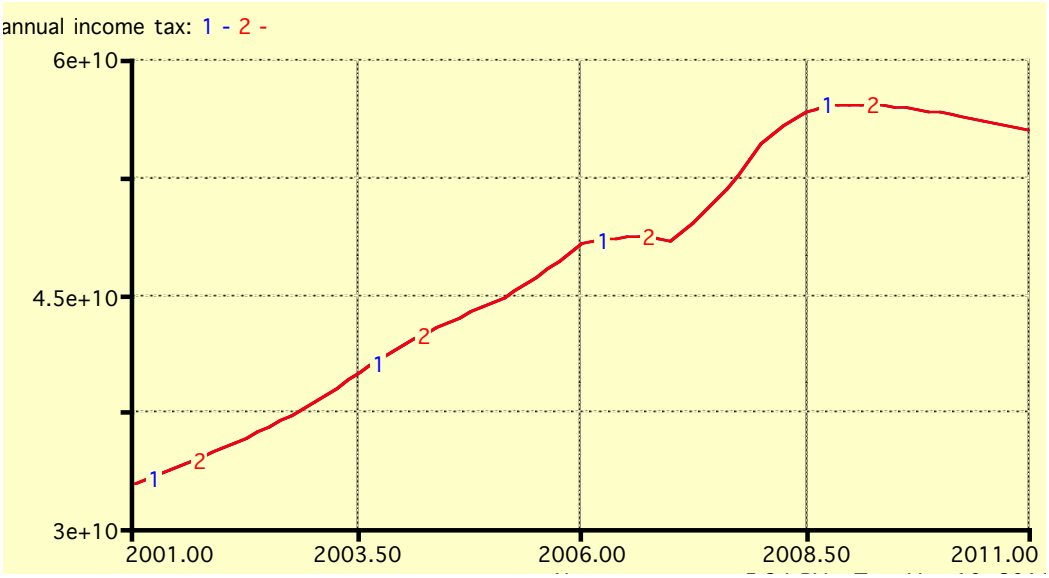


Figure 5.8: Annual Income Tax

Scenario 1: Base Run
Scenario 2: Behavior When Labor Share=1

When labor share =1, the whole GDP becomes nominal wage of labor force, corporate profits is 0. Corporate social contribution is paid by corporates according to labors' wages, so it becomes 0 on condition that labor share=1 in order that annual social contribution is lower than base run. Figure 5.9 displays the comparison.

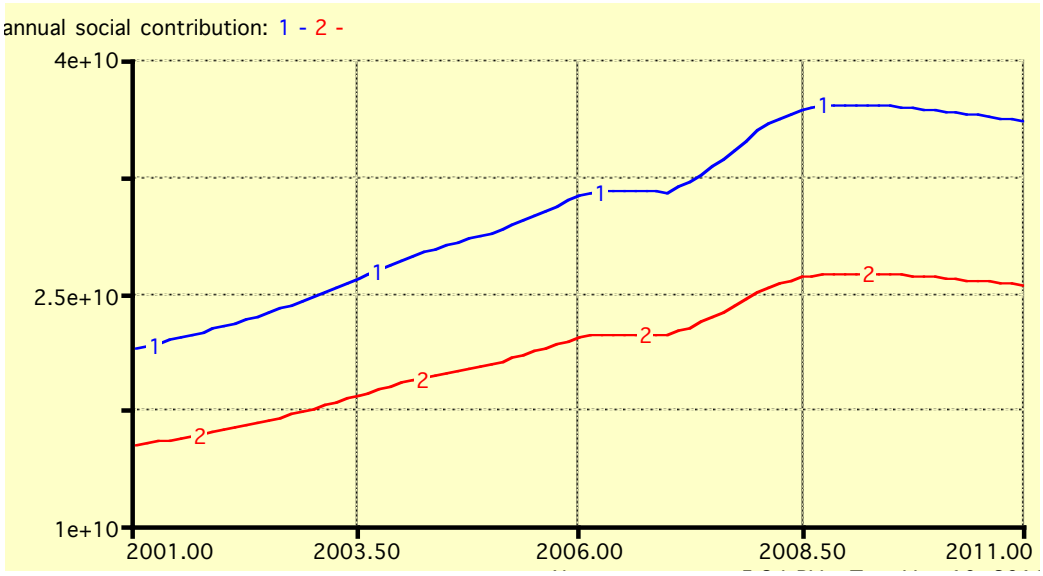


Figure 5.9: Annual Social Contribution

Scenario 1: Base Run
Scenario 2: Behavior When Labor Share=1

Pension and civil servants wages are all derived from nominal wages, the government spending on these two functions will be higher if the whole GDP becomes nominal wages. Figure 5.10 and Figure 5.11 show the changes.

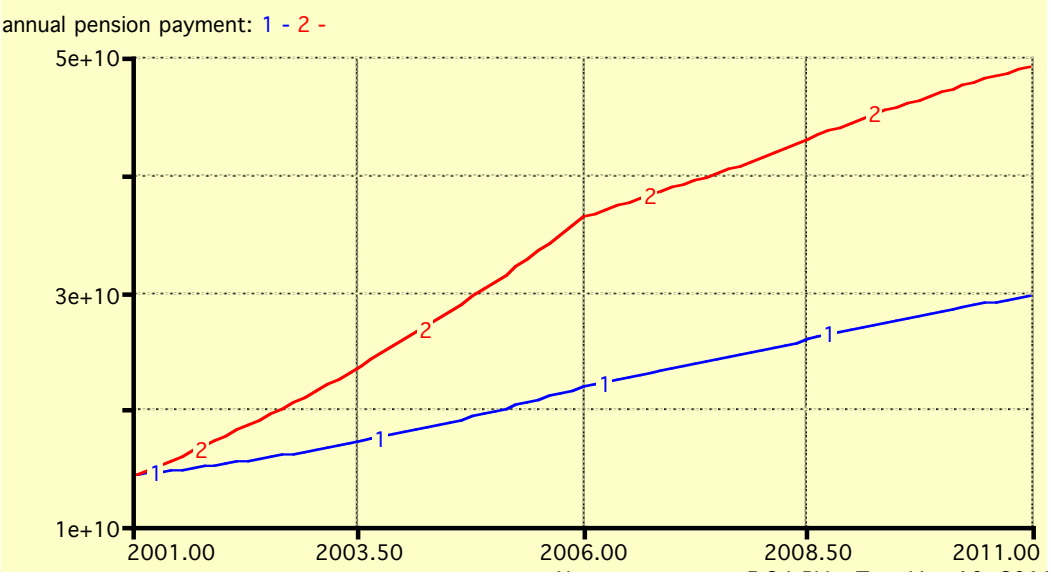


Figure 5.10: Annual Pension Payment

Scenario 1: Base Run
Scenario 2: Behavior When Labor Share=1

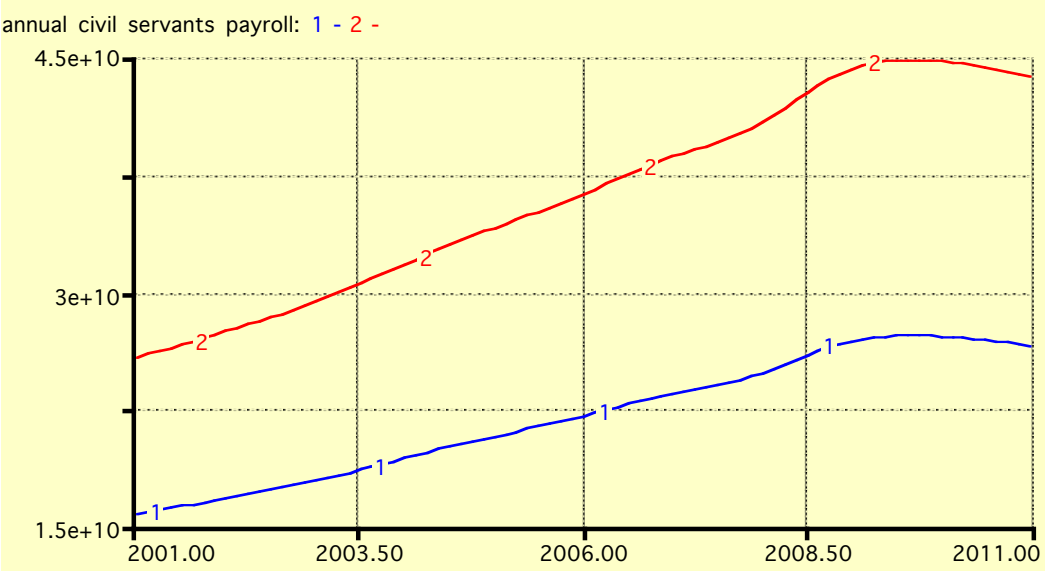


Figure 5.11: Annual Civil Servants Payroll

Scenario 1: Base Run
Scenario 2: Behavior When Labor Share=1

Healthcare expenditure is paid both by public and private, on condition that labor share=1, nominal wages and social contribution are all insured, that's why public healthcare expenditure has no change between the comparison.

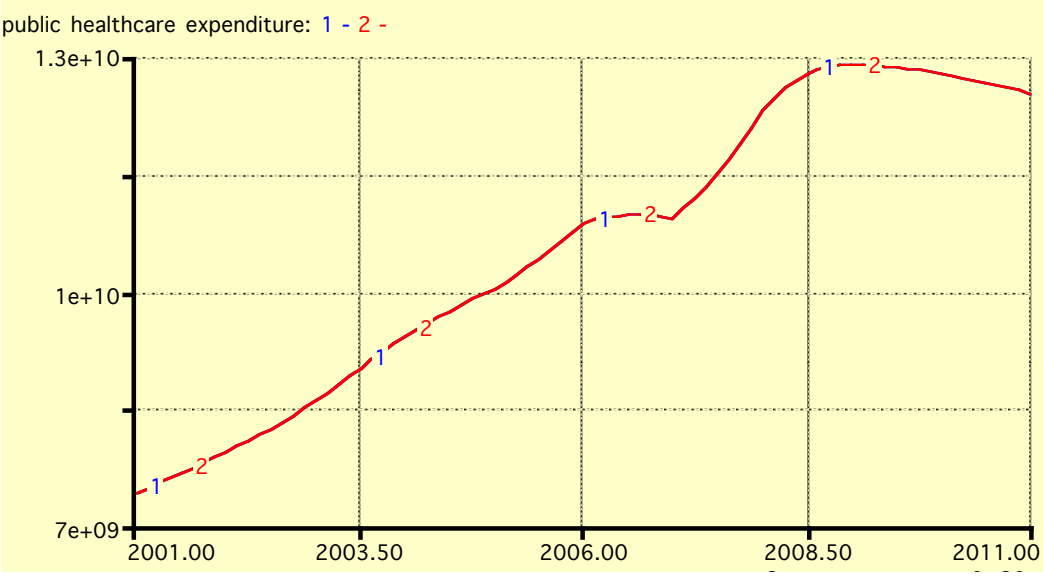


Figure 5.12: Public Healthcare Expenditure

Scenario 1: Base Run
Scenario 2: Behavior When Labor Share=1

Based on all simulations above, the model can generate reasonable results under extreme conditions, which contributes robustness to the model. The confidence to the model is also confirmed again by extreme condition test.

5.3. Structure-Behavior Test

The entire model is aggregation of five modules and a modules embedded top-level model (Figure 4.14). Structure-Behavior test could verify whether the model consists with the realism of real logic. In this section, we will go through these modules and main feedback loops to see whether they work reasonably, how they would work in the model, what the effects of the modules and feedback loops.

The test is implemented into two parts – modules-cut test and feedback loops-cut test.

5.3.1. Modules-Cut Test

The model includes five modules which have been described in section 4.4 Stock & Flow Diagram – population, taxation system, pension system, healthcare system and civil servants system. Thereinto, population takes a basic role to provide mandatory data to other modules such as the labor for employment, the base for pension population; taxation system is the main source of government revenue, it generates nominal wages, the reference frame both for pension system and civil servants system, and the most important – government revenue; pension system gives annual pension payment from the government; healthcare outputs public healthcare expenditure; and civil servants system produces annual civil servants payroll. These modules are main departments for government revenue and expenditure.

The test will be implemented by adding modules one by one – but population module and top-level model are run all the time – to see if the simulations are reasonable. The sequence is as below:

1). Population module + top-level model

2). Adding taxation system module

3). Adding pension system module

4). Adding healthcare system module

5). Adding civil servants system module

In Scenario 1, only population module and top-level model are run. Government revenue and government expenditure modules only offer the initial values for their outputs; After taxation system module is activated, the behavior of Scenario 2 may be very different with the one in Scenario 1, because government borrowing would be much less along with tax revenue taking effect while government expenditures are still keeping the initial values. Scenario 3 to Scenario 5 will show the behaviors adding government expenditure modules one by one. Because government expenditures are activated in these scenarios, there would be more budget deficit, and the government debt in each scenario would be bigger one by one.

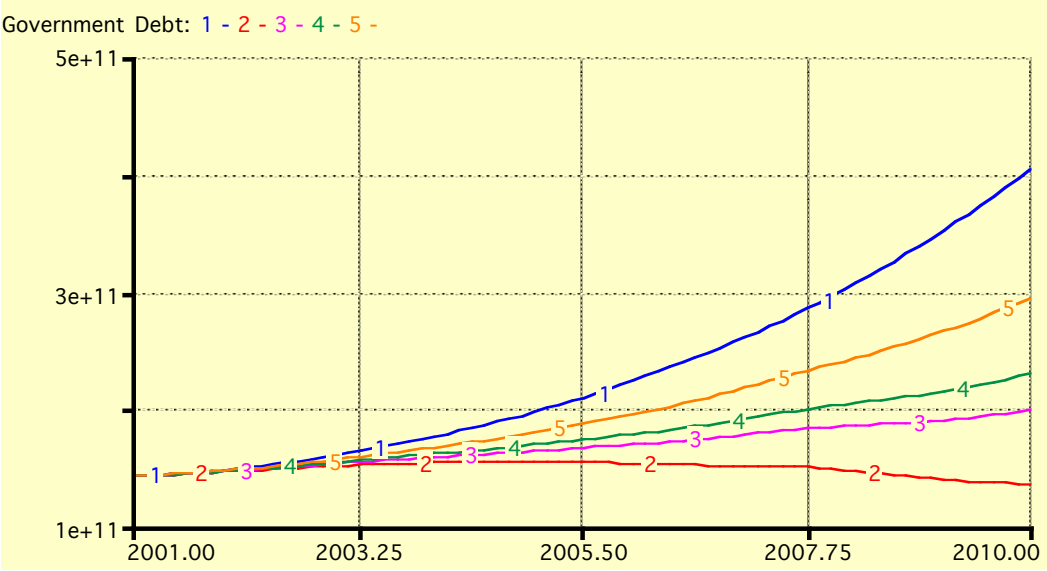


Figure 5.13: Modules-Cut Test

Scenario 1: Top-level Model + Population Simulation
Scenario 2: Top-level Model + Population/Taxation System Simulation
Scenario 3: Top-level Model + Population/Taxation/Pension System Simulation
Scenario 4: Top-level Model + Population/Taxation/Pension/Healthcare System Simulation
Scenario 5: Top-level Model + Population/Taxation/Pension/Healthcare/Civil Servants System Simulation

The results are shown in Figure 5.13. Scenario 1 has the highest level of debt among all simulations.

When taxation system is added to the system, government debt climbs for a while and then goes down. Due to the increasing in government revenue while government expenditure keeps low – because primary expenditure departments are inactive, the government borrowing decreases. And net borrowing of government debt decreases and then government debt takes a trend of decreasing.

Primary government expenditure modules are added to the system one by one in Scenario 3 to Scenario 5. The more expenditure modules are added, the higher the government debt. Scenario 5 is the running result of the entire model. From the comparison of Figure 5.13, the adding of pension system (Scenario 3) and civil servants system (Scenario 5) make two biggest increments to the government debt, which explains that these two expenditures play an important roll in government expenditure.

5.3.2. Feedback Loops-Cut Test

The feedback loops in the top-level model will be mainly discussed in this section. Figure 4.7 shows the feedback loops that have influences on government debt. As we can see, there are three reinforcing feedback loops, all these loops will be cut one by one to test the effect of each loop.

R1 is cut

Government debt as a percentage of GDP will not be influenced by government debt any more after R1 is cut (Figure 5.14). The government debt as the numerator in the percentage will keep its initial value all the time so that the interest rate would be lower after cutting R1. So the government debt may grow much more slowly compared with base run scenario.

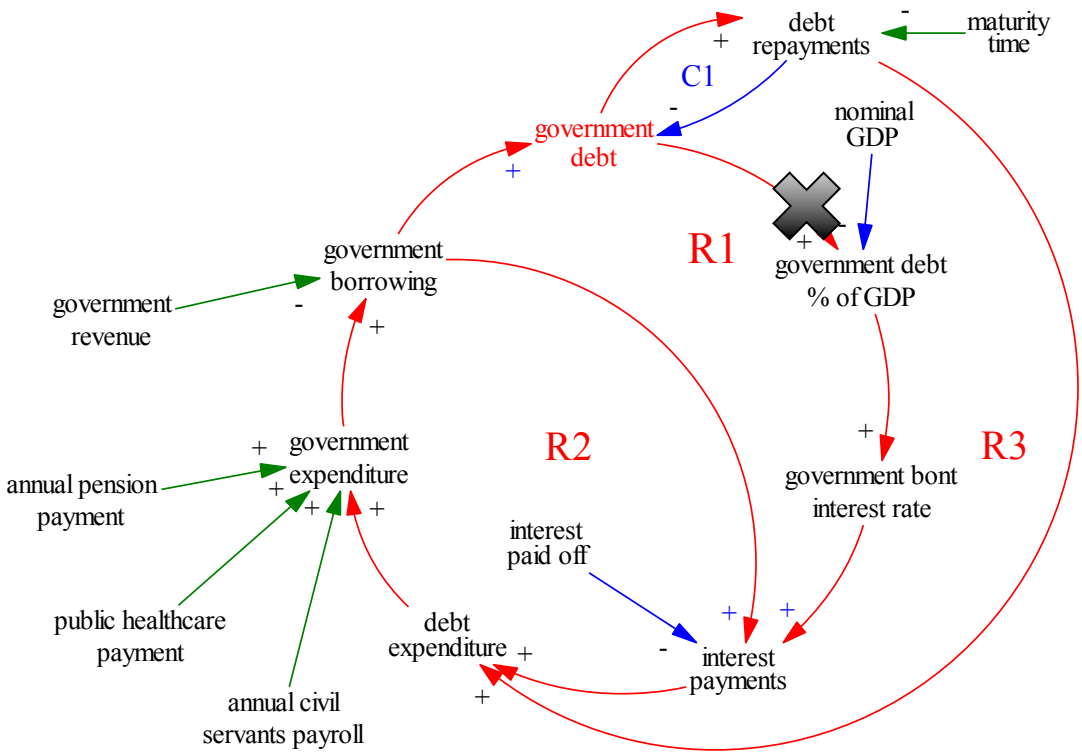


Figure 5.14: Cutting R1

From Figure 5.15 we can see that government debt in Scenario 2 is much smaller than the one in base run. When government debt as a percentage of GDP is not high, the government could finance itself through issuing new government bonds with lower interest rate. But when the percentage goes high, the government financing cost also goes high, it couldn't finance itself successfully unless it issues higher interest rate bonds. The higher interest payments, the bigger the government borrowing and then the government debt.

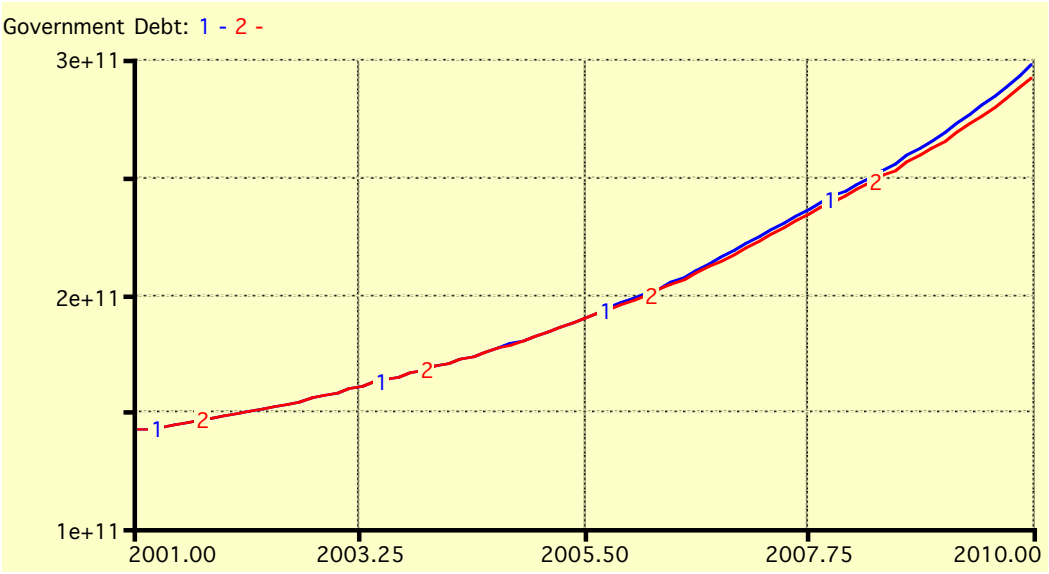


Figure 5.15: Cutting R1 Simulation

Scenario 1: Base Run
Scenario 2: Behavior after Cutting R1

R2 is cut

The increasing in government borrowing wouldn't increase the new interest after R2 is cut. Government borrowing in the equation of new interest will keep its initial value. Because the interest payments wouldn't be increased by the increasing in government borrowing, that less interest payments than it would be before R2 is cut could result in less government borrowing in following feedbacks. As a result, the government debt would be less than its behavior before cutting R2.

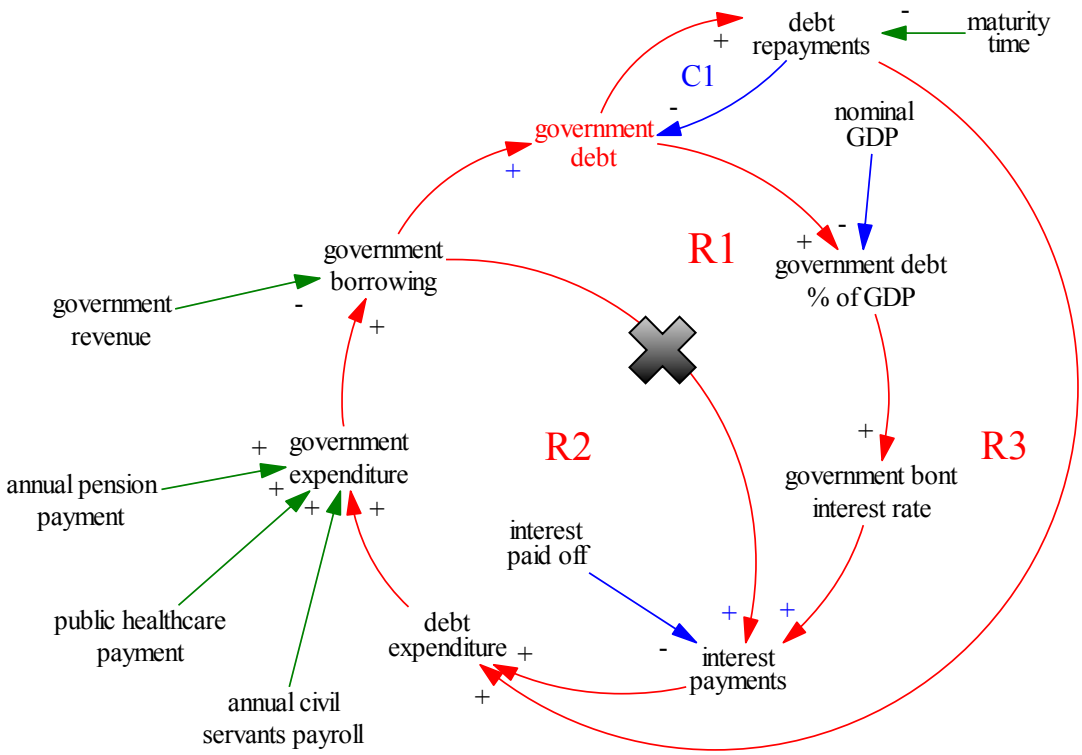


Figure 5.16: Cutting R2

Figure 5.17 shows the simulation result after R2 is cut. The government debt gets lower compared with the simulation in normal status, which is coincident with our expectation. Comparing Figure 5.17 with Figure 5.15, we can also find that the effect of reinforcing loop R2 is stronger than that of R1. The behavior difference is apparent in Figure 5.17 for medium-term period.

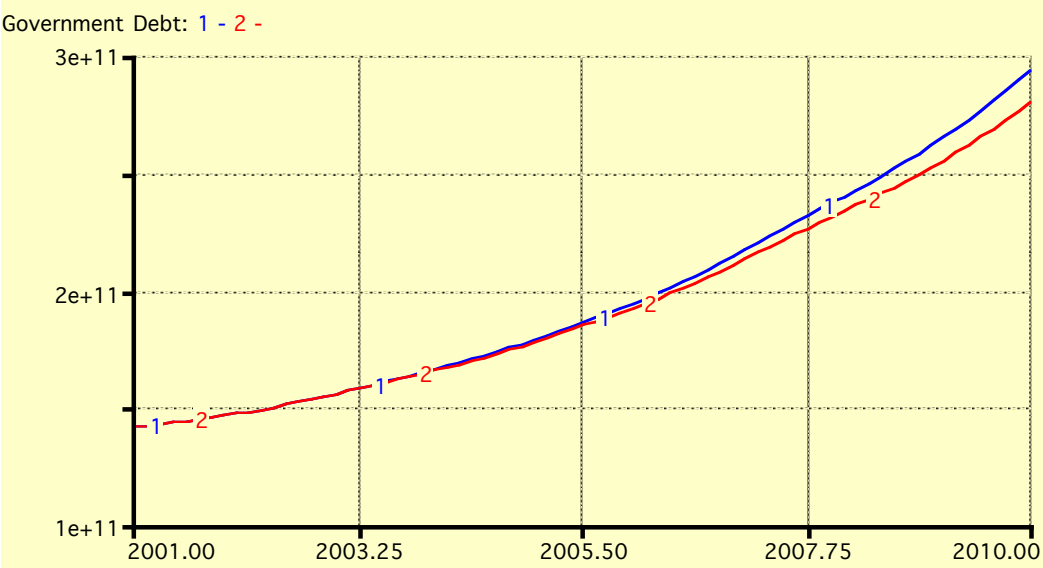


Figure 5.17: Cutting R2 Simulation

Scenario 1: Base Run
Scenario 2: Behavior after Cutting R2

R3 is cut

As discussed above in section 4.2.6 Government Debt, R3 and C1 fully counteract with each other, so debt repayments itself actually has no effect on government debt and budget deficit. In order to cut loop R3, we can set debt repayments as its initial value in the equation of debt expenditure, after which C1 wouldn't be balanced by the feedback from debt repayments to government borrowing, the government debt could grow more slowly than the its behavior before.

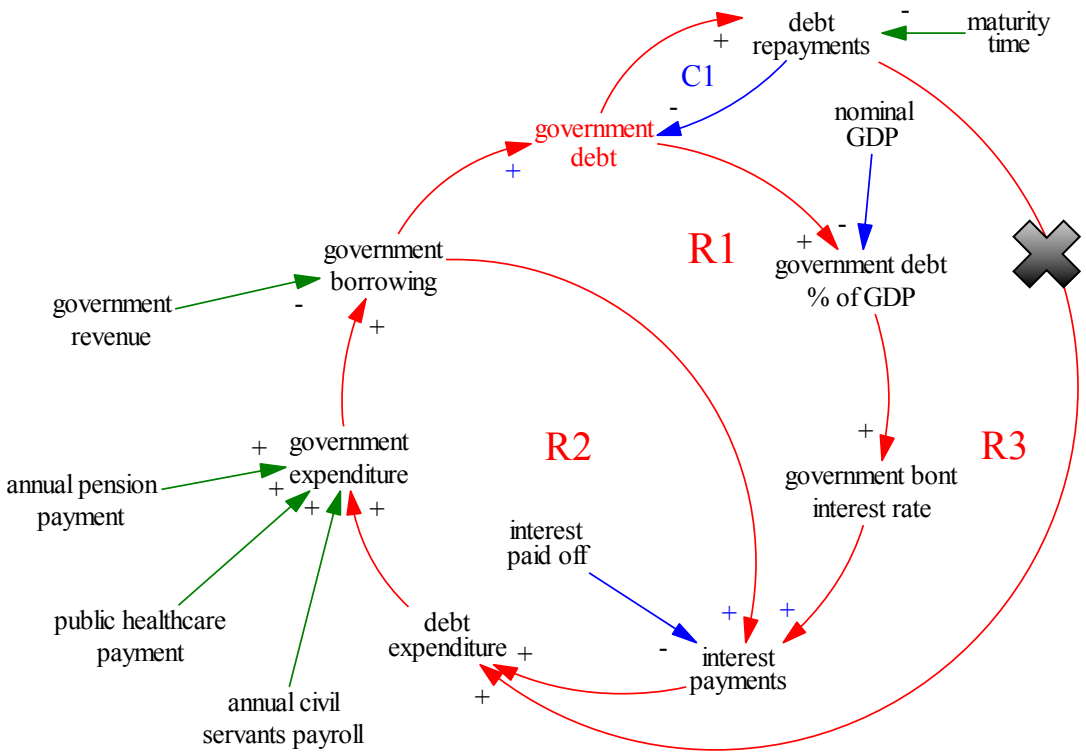


Figure 5.18: Cutting R3

Figure 5.19 shows the government debt base run and its behavior after cutting R3. It coincides with our expectation but there is something interesting that the 2 scenarios overlap in the first 7 years. That's because the maturity time is 7 years and the debt repayments in these 7 years are the same with its initial value.

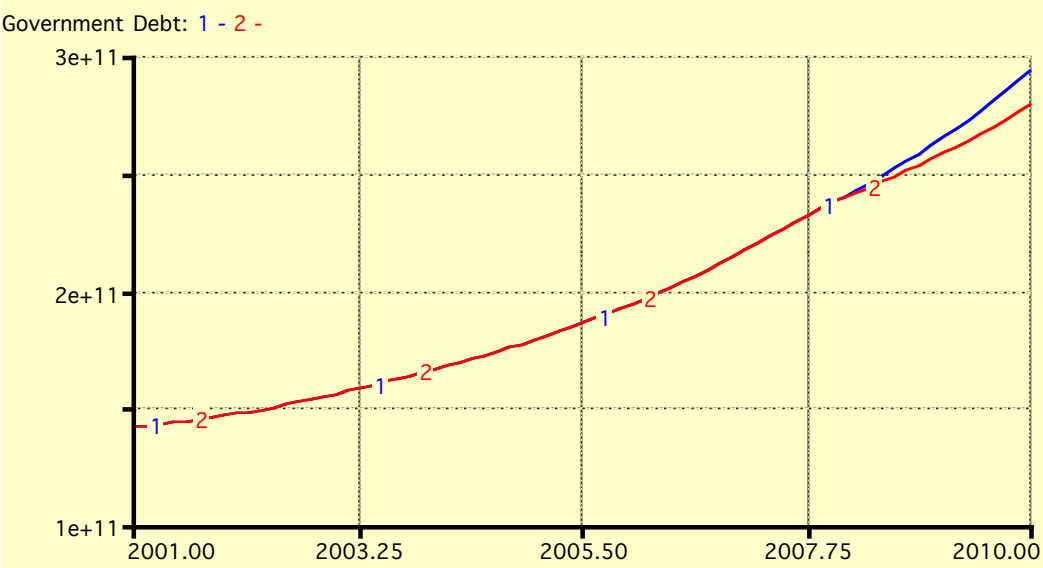


Figure 5.19: Cutting R3 Simulation

Scenario 1: Base Run
Scenario 2: Behavior after Cutting R3

From the feedback loop-cut test above, we found that the feedback of interest payments takes apparent effect in government debt. Both reinforcing loop R1 and R2 loop interest payments and government debt in. These interest payments feedback loops in top-level model are responsible for the problematic behavior. But interest payments is only one of factors which contribute to high-level of government debt. As what we know from introduction, the Greek welfare system is a demand-driven system. The public expenditure is all based on demand and with no consideration on supply, so that no feedbacks to public expenditure is another reason why government debt could be driven so high. From the module-cut test, pension system and civil servants system are two bigger consuming systems. The expenditures on these systems will eventually contribute to more government borrowing and then high government debt.

5.4. Parameter Sensitivity Test

Through the tests above, we feel comfortable about and have built enough confidence to the model. Parameters or variables are necessary for a model, but the function and effects are different. The sensitivity of parameters can provide support when formulating policies. For the model on which the paper is based, there are some parameters that are possible for government to control by administrative methods, then these methods could be potential policies to solve the problem which the government is facing.

5.4.1. Black Economy As a Percentage of GDP

Black economy, also called parallel economy, shadow economy, or underground economy, is usually untraceable, and hence untaxable. In other words, they are business dealings that are not reflected in a country's GDP computations. An integral part of most third-world and many first-world economies, it is a cash-based system in which transaction records are kept in secret account books (called “number two” accounts). Black economy and black money go hand in hand. Though it employs illegal (and even criminal) methods, it is a survival practice in repressive tax regimens or where legitimate expression of entrepreneurial activity is made unnecessarily difficult by a maze of regulations.

In Greece, black economy accounts for a large ratio of its economy, reaching 25% of GDP. This is a big number compared with other Eurozone members. The presence of black economy decreases revenue of government directly. In this section, the sensitivity of black economy as a percentage of GDP will be tested.

In the test, the model will be run three times, values of candidate parameter in three runs are different. These values are design to be incremental from 20% off to 20% up. So the values of candidate parameter

will be 0.2, 0.25 and 0.3 corresponding to the Scenario 1 to Scenario 3. Scenario 2 is actually the Base Run.

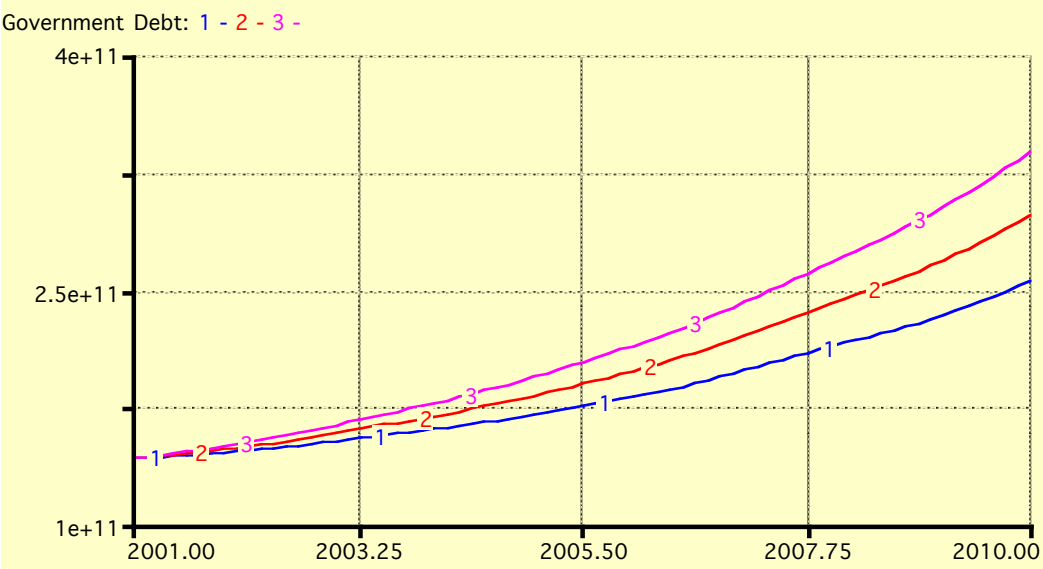


Figure 5.20: Sensitivity Test of Black Economy As a Percentage of GDP
Scenario 1: Black Economy As a Percentage of GDP=20%
Scenario 2: Black Economy As a Percentage of GDP=25% (Base Run)
Scenario 3: Black Economy As a Percentage of GDP=30%

Figure 5.20 shows the test result. Scenario 1 is the result when candidate parameter is set to 0.2, meaning that 5% of GDP's amount of black economy is moved back to legal market, which increases the government revenue. Scenario 2 is reference mode and simulation 3 is the result when candidate parameter is set to 0.3, which means 5% of GDP is transferred to black economy. We can see that the black economy sensitivity to government debt is high. The government debt changes a lot given 20% change in black economy.

5.4.2. Replacement Rate

As explained before, replacement rate is the percentage of a worker's pre-retirement income that is paid out by a pension program upon retirement. The higher the replacement rate, the more pension the pensioners can get.

In reference mode replication simulation, replacement rate is 60%, so in sensitivity test, its values will be set to 0.48, 0.6, 0.72.

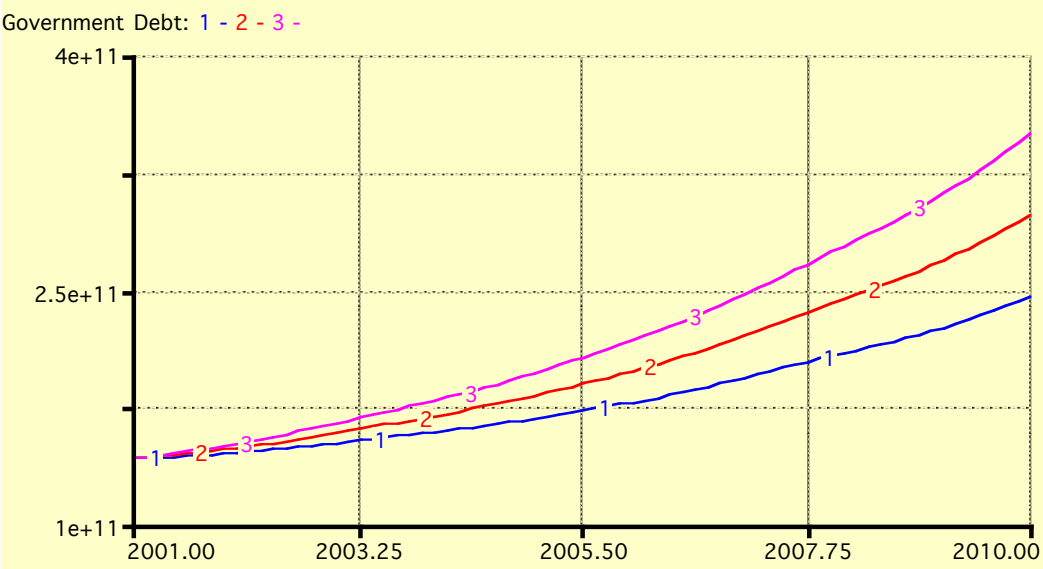


Figure 5.21: Sensitivity Test of Replacement Rate

Scenario 1: Replacement Rate=48%
Scenario 2: Replacement Rate=60% (Base Run)
Scenario 3: Replacement Rate=72%

Referred to Figure 5.21, replacement rate to government debt is more sensitive than black economy rate.

5.4.3. Healthcare Spending As a Percentage of GDP

Healthcare spending is the total spending of Greece on healthcare without considering who pays the bills. Greece, like most of European countries, the government pays healthcare bills for people who have social insurance, while others will pay bills out of pockets. Based on the 2011 report of OECD, the healthcare spending as a percentage of GDP is 9%, ranking ahead among OECD countries.

In this test, the percentage is set to 0.072, 0.09, 0.108 and simulation results are displayed in Figure 5.22.

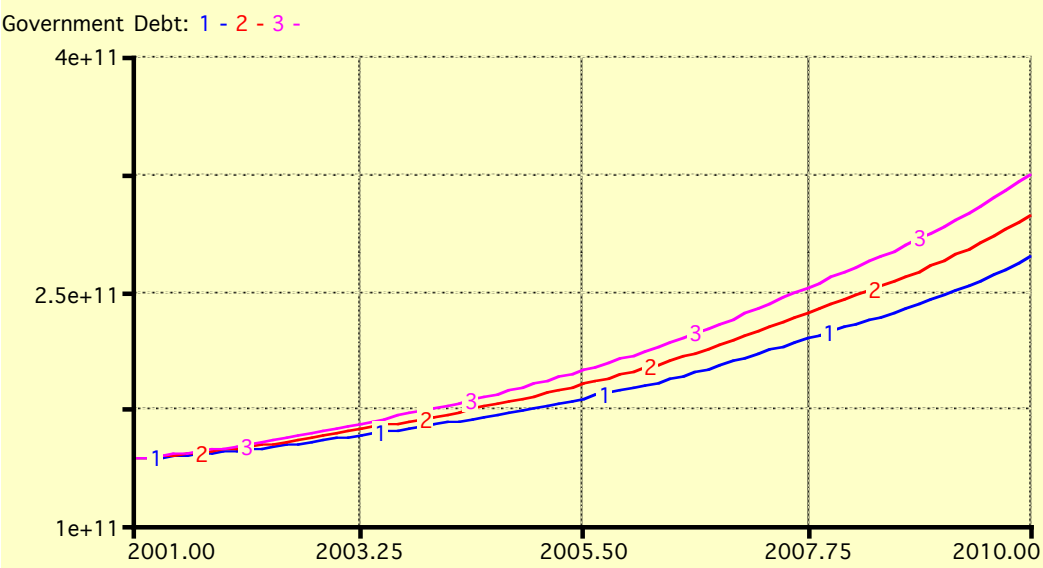


Figure 5.22: Sensitivity Test of Healthcare Spending As a Percentage of GDP
Scenario 1: Healthcare Spending As a Percentage of GDP=7.2%
Scenario 2: Healthcare Spending As a Percentage of GDP=9% (Base Run)
Scenario 3: Healthcare Spending As a Percentage of GDP=10.8%

The sensitivity of healthcare spending rate is less than those two parameters discussed above.

5.4.4. PC (Per Capita) Civil Servants Subsidy

Part of Greek civil servants can have subsidies because of speaking a foreign language, using a computer or getting to work on time. The subsidy is €10,000. Considering the 20% change in the value of candidate parameter, the values will be set from €8,000 to €12,000.

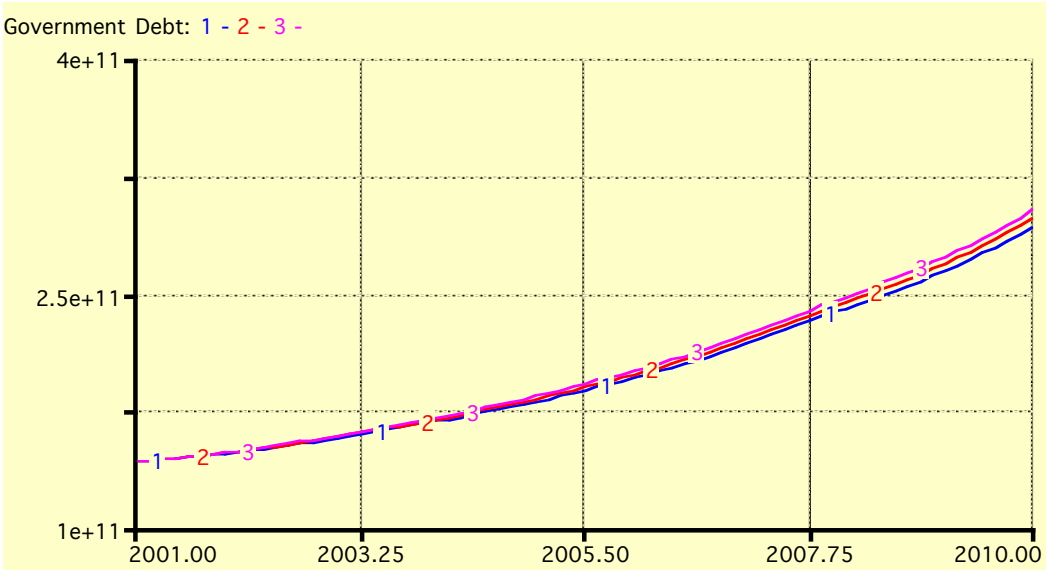


Figure 5.23: Sensitivity Test of PC Civil Servants Subsidy

Scenario 1: PC Civil Servants Subsidy=8,000 Euros
Scenario 2: PC Civil Servants Subsidy=10,000 Euros (Base Run)
Scenario 3: PC Civil Servants Subsidy=12,000 Euros

Figure 5.23 displays that the sensitivity of pc civil servants subsidy to government debt is the least among all parameters in the test, which indicates that change in pc civil servants subsidy has little influence on government debt.

5.4.5. CS (Civil Servants) Wages Growth Rate

From 2001, civil servants wages grew at a high and stable rate from which the nominal wages growth rate is a far cry. But civil servants wages are all paid by government who will bear the whole burden of quick growing in civil servants wages.

In the test, the growth rate will be set to 0.048, 0.06 and 0.072.

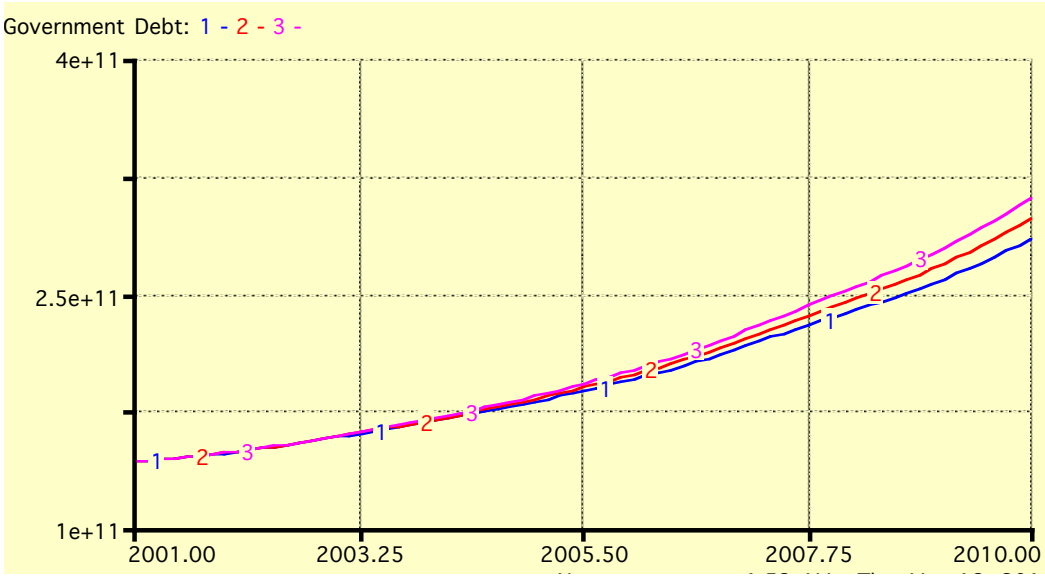


Figure 5.24: Sensitivity Test of CS Wages Growth Rate

Scenario 1: CS Wages Growth Rate=4.8%
Scenario 2: CS Wages Growth Rate=6% (Base Run)
Scenario 3: CS Wages Growth Rate=7.2%

The same with the sensitivity of pc civil servants subsidy, the sensitivity of civil servants wages growth rate is low.

Summing up the above, black economy as a percentage of GDP, replacement rate and healthcare spending as a percentage of GDP are the most sensitive parameters for the government debt. They distributes in both government revenue and government expenditure modules. These parameters may be discussed again in policy analysis chapter, because they are the most important parameters for government to control for the sake of regulating the high-level of government debt.

6. Policy Analysis

Greece today faces a double challenge: to consolidate the country's fiscal position through effective fiscal and structural policies aimed at reducing the budget deficit and lowering the public debt to GDP ratio; and to secure the conditions for economic development in the years to come through addressing long-standing structural weaknesses and thereby putting the economy on a new and sustainable growth path (Hellenic Governemnt, 2010).

The former constitutes a necessary condition for the latter. Successful fiscal consolidation creates a stable economic environment, which allows for a more efficient deployment of public resources, while also reducing "crowding out" of private sector funds.

To these twin challenges is added a third: to address the credibility deficit which the country's economic policy currently faces. The recent large revisions in deficit figures, coupled with previous failed attempts at fiscal consolidation make it increasingly difficult for Greece to continue funding its public deficits and large stock of debt in international capital markets. Addressing this problem calls for institutional reform which will restore credibility in data, the budgeting process and the operation of the public sector more generally.

The size of the fiscal adjustment requires a series of structural measures that directly reduce public expenditures and improve government revenues, while also addressing long-standing structural weaknesses. It involves initiatives to control public spending and completely overhaul the way the budget is prepared and executed, as well as broaden the tax base and reform the tax system. This task has to be implemented in the context of unfavorable domestic and international economic conditions. The latter are marked by uncertainty and weak growth and financial institutions. On the domestic front, the sources of the prolonged rapid growth that Greece experienced for more than a decade, mostly credit expansion that followed the EMU entry, have run their course.

The government's fiscal policy strategy is based on five key pillars, which incorporate the lessons learned to date. The strategy is further discussed on the quality of public finances and includes actions to:

- Restore credibility in fiscal statistics by making the National Statistics Service an independent legal entity and phasing in, during the first quarter of 2010, all the necessary checks and balances that will improve the accuracy and reporting of fiscal statistics.
- Improve transparency in fiscal management, by changing the process of budgeting, monitoring and evaluating its implementation, and moving towards a program-based budget.
- Reform the tax system in order to make it simple, stable, transparent and fair, and to effectively fight tax evasion by improving auditing activities and exchanging of information between auditing agencies.
- Achieve control of primary expenditures by containing personnel and other current outlays and reallocating expenditures more effectively.
- Implement the necessary structural reforms to enhance competitiveness and the efficient functioning of the economy.

The following sections introduce the policies formulated by the Greek government for the country's primary revenue and expenditure systems, which are also the condition of exchanging the bailout package from other member states and IMF. These policies are mainly designed for taxation system, pension system, healthcare system and civil servants system. Other possible policies would also be discussed afterwards.

In simulations with policies, the time scope is set between 2001 and end of 2030, which could give results of the policies in both medium-term period and relative long-term. The effects of the policies or the combinations of policies are intuitionistic through diagrams which show comparisons of the simulation results in base run without policies and the ones with policies. Figure 6.1 displays the projections without fiscal austerity policies and reforms, which is simulated to 2030 with the same structure used in Base Run. The government debt as a percentage of GDP goes

from 126.29% in 2009 to a dramatic level – 2,249% in 2030, and the volume of government debt gets from "only" €297 billion in 2009 to €15,119 billion in 2030. In all diagrams below, there is an indicator called "government debt ceiling 60%". It is the ceiling or upper limit for the "government debt as a percentage of GDP", which is the stipulation both in the Maastricht Treaty and in Stability and Growth Pact. The simulated result will be compared with the ceiling, which can give you an intuitionistic view. So the simulation in Figure 6.1 is the new Base Run, all simulations in this section will be compared with the Base Run in order to have a direct sense of the effect of policies.

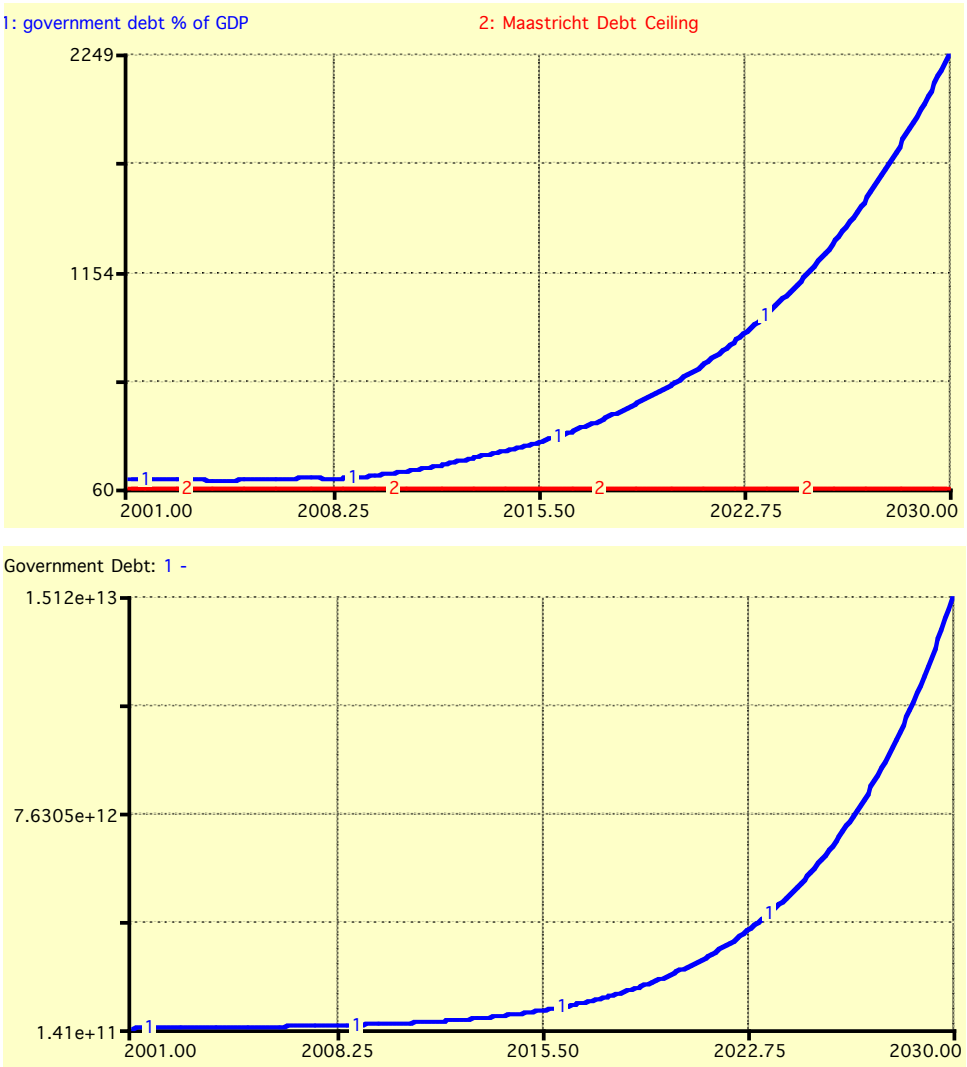


Figure 6.1: Projections to 2030 without Policies

6.1. Taxation Reform

According to the Greek tax system, if you stay and work in the country you have to pay taxes. However, you may be eligible for certain tax allowances, depending on your family situation, which are taken into account when calculating your taxable income, as well as the amount of tax you are liable to pay. If you are employed, your employer will deduct income tax from your wages, daily allowances or other remuneration. Table 6.1 shows the individual income tax rate of 2009. For salary not exceeding €12,000 are tax-exempt.

Table 6.1: Individual Income Tax Rate of Greece

Tax %	The Tax Base (EURO)
0	1 - 12,000
25	12,001 - 30,000
35	30,001 - 75,000
40	75,001 and over

Also liable to tax are general and limited partnerships, associations of civil law engaged in business or exercising a profession, civil associations of a profit-making or non-profitmaking nature, participating companies and joint venture.

Social security contribution is another main part of government revenue besides income tax. An employer is obligated to deduct tax at source from an employee and to make additional contributions.

Till the debt crisis burst out, tax evasion and tax avoidance were popular. It's estimated that black economy in Greece accounts for 25% of GDP, which is not taxed.

The individual income tax imposed on the income of employees has different levels, for the sake of simplifying the model, a weighted tax rate for individual income is used and set to 24%. Corporate tax rate is also 24%, while social contribution rates for individual and corporate are 11% and 15%.

The significant deterioration in the deficit of the general government in 2009, which can only partly be attributed to the unprecedented global crisis, uncovered the weaknesses of tax policy and the tax collection mechanisms, issues that must be effectively tackled in order to establish a sustainable fiscal environment. The budgetary process and inefficiencies in the tax collection mechanism are of significant importance. In this context the government had already launched a comprehensive tax reform effort towards a fairer, more transparent and legitimate system to facilitate compliance and increase revenues. Some of the measures will further develop elements already introduced in the 2010 budget (such as efforts to simplify the system and broaden the tax base through eliminating exemptions, thus contributing to revenues and facilitating tax).

The tax reform initiative will also be complemented by a sustained effort to strengthen capacities to detect and effectively fight widespread tax avoidance and tax evasion, including increasing collection effectiveness, limiting corruption, improving self-compliance.

Corresponding to our model, the percentage of black economy is reduced to 20% of GDP. The tax rates for both employers and employees are assumed to increase by 1 percentage. During the year of 2010, we can see lots of riots in Greek streets after the fiscal austerity came out. The government is also considering lifting tax rates directly but it has no result yet.

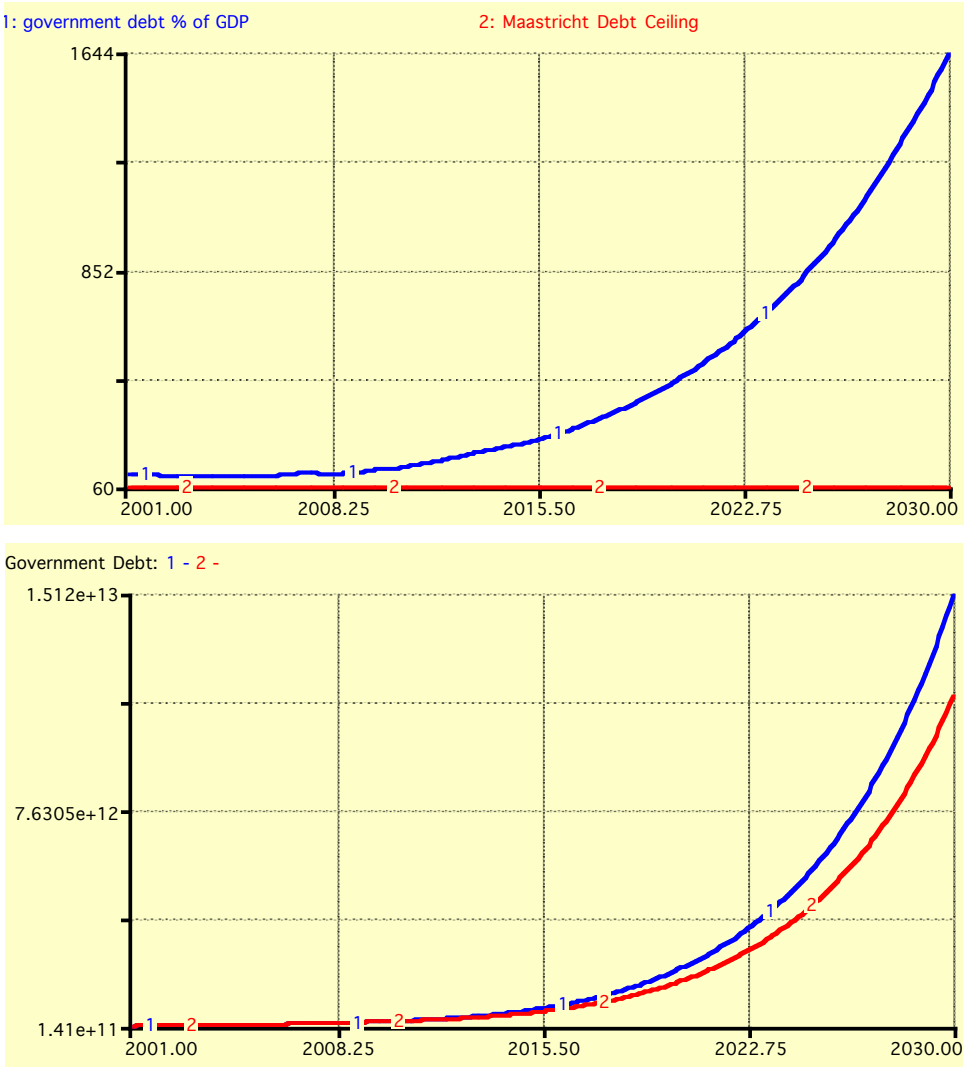


Figure 6.2: Tax Reform

Scenario 1: Base Run
Scenario 2: Projections to 2030 with Tax Reform

Figure 6.2 offers the projections with tax reform (Scenario 2). The government debt becomes €11,604 billion, 1,644% of GDP. And budget deficit goes to 327% of GDP, while the ceiling for it is only 3%.

6.2. Pension Reform

The pension system of Greece is a representative case of the "Mediterranean welfare state", which is characterized by extensive segmentation, very high payroll tax rates, and yet inadequate pension benefits(Nektarios, 2009).

The normal pension age is 65 for both men and women. A pension from this age requires a minimum of 4,500 days of contributions (equivalent to 15 years). Workers with a contribution record of 11,100 working days (37 years) can retire on a full benefit regardless of age. There are concessions for people who work in arduous or unhygienic occupations and for women with dependent or disabled children. For labor-market entrants from 1993, the pension is 2% of earnings for each year of contributions up to 35 years. There is therefore a maximum replacement rate of 70% for people retiring at the normal age or earlier. However, for working after the age of 65 and a contribution period of 35 years, there is a higher accrual of 3.3% per year, for a maximum of three years, while there is no accrual rate for those working after this period (maximum replacement rate of 80%). In the model, a weighted replacement rate of 60% takes effect. The earnings measure is the average over the last five years before retirement. Each pensioner can have 14 months' pension every year.

Left unchanged, public pension expenditures under the existing system would have doubled from around 11% of GDP in 2010 to 24% in 2060. This situation is clearly unsustainable.

The Greek Parliament in July of 2010 passed sweeping pension reforms that overhaul the country's existing private and public pension systems and bring its viability in line with the EU average. This ensures the system's medium and long-term sustainability, as well as a long-term actuarial balance. The pension reform includes:

- Merges existing pension funds into three and introduces a unified new system for current and future employees

- Introduces a unified statutory retirement age of 65 years by December 2013, increasing in line with changes in life expectancy
- Increases the minimum early retirement age to 60 by 2011
- Increases the minimum contribution period for retirement on a full pension from 35-37 to 40 years by 2015
- Cuts pension benefits by 6 percent a year for people retiring between the ages of 60 and 65 with less than 40 years of pension contributions
- Eliminates the 13th and 14th monthly pensions
- Extends the calculation of the pensionable earnings from the current last five years to the entire lifetime earnings
- Redistributes pensions in favor on lower ones by imposing a monthly tax on pensions above 1,400 euros from August 2010

In the model, the pension is decided mainly by four parameters: pension base, replacement rate, 12/14 months decision and pensioners. When time beyond 2010, most of pension reforms take effect. Pension base will be extended to whole lifetime earnings instead of the last 5 years; replacement rate could be kept the same but there will be only 12 monthly pensions.

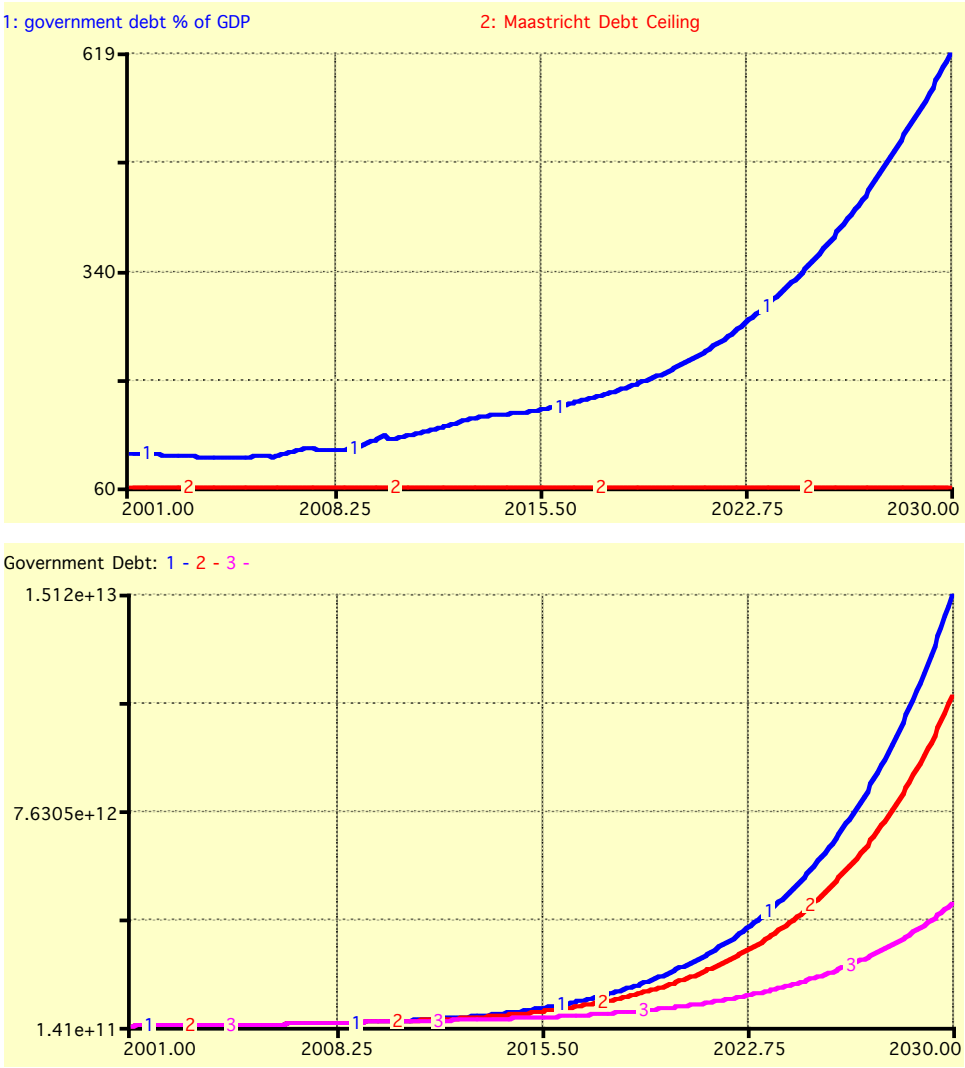


Figure 6.3: Tax/Pension Reform

Scenario 1: Base Run
Scenario 2: Projections to 2030 with Tax Reform
Scenario 3: Projections to 2030 with Tax/Pension Reform

Figure 6.3 shows the projections with tax/pension reforms. Scenario 3 in the lower diagram is the behavior under the tax and pension reform. It is decreased a lot compared with the other 2 projections. The government debt is 4,370 billion Euros, accounting for 619% of GDP and 115% for budget deficit.

6.3. Healthcare Reform

The containment of health care expenditures will be achieved mainly through the re-introduction of restrictions in the list of medicines provided by the health care branches of the social insurance funds.

Total health spending accounted for 9.7 % of GDP in Greece in 2007, above the 2008 average of 9.0% in OECD countries. Greece ranks below the OECD average in terms of health spending per capita, with spending of 2687 USD in 2007 (adjusted for purchasing power parity), compared with an OECD average of 3060 USD in 2008. Between 2000 and 2007, health spending per capita in Greece increased, in real terms, by 6.9 % per year on average, a growth rate higher than the average in OECD countries (4.2%) between 2000 and 2008. The public sector is the main source of health funding in all OECD countries. In Greece, 60.3% of health spending was funded by public sources in 2007. The average across OECD countries in 2008 is 72.8%. The guiding principles of health reform are as follows:

- Strengthen public regulation. Government will set overall cash limits and allocate resources in a transparent fashion, consistent with objective criteria. It will reorganize public procurement with a view to getting better value for public money. It will recruit hospital staff and other managers on merit, and devolve them the responsibility for running provider units. It will not be involved in day-to-day management of hospitals and other providers.

- Reinforce accountability. Once agreed, budget constraints will be inflexible. Public providers, including hospitals, will be instructed to operate under fixed budgets. Managers will not be allowed to authorize budget overspends, and will be accountable for failing to do so. Consultants and other medical personnel will be encouraged to participate in drawing up plans for ensuring a more efficient use of hospital resources.

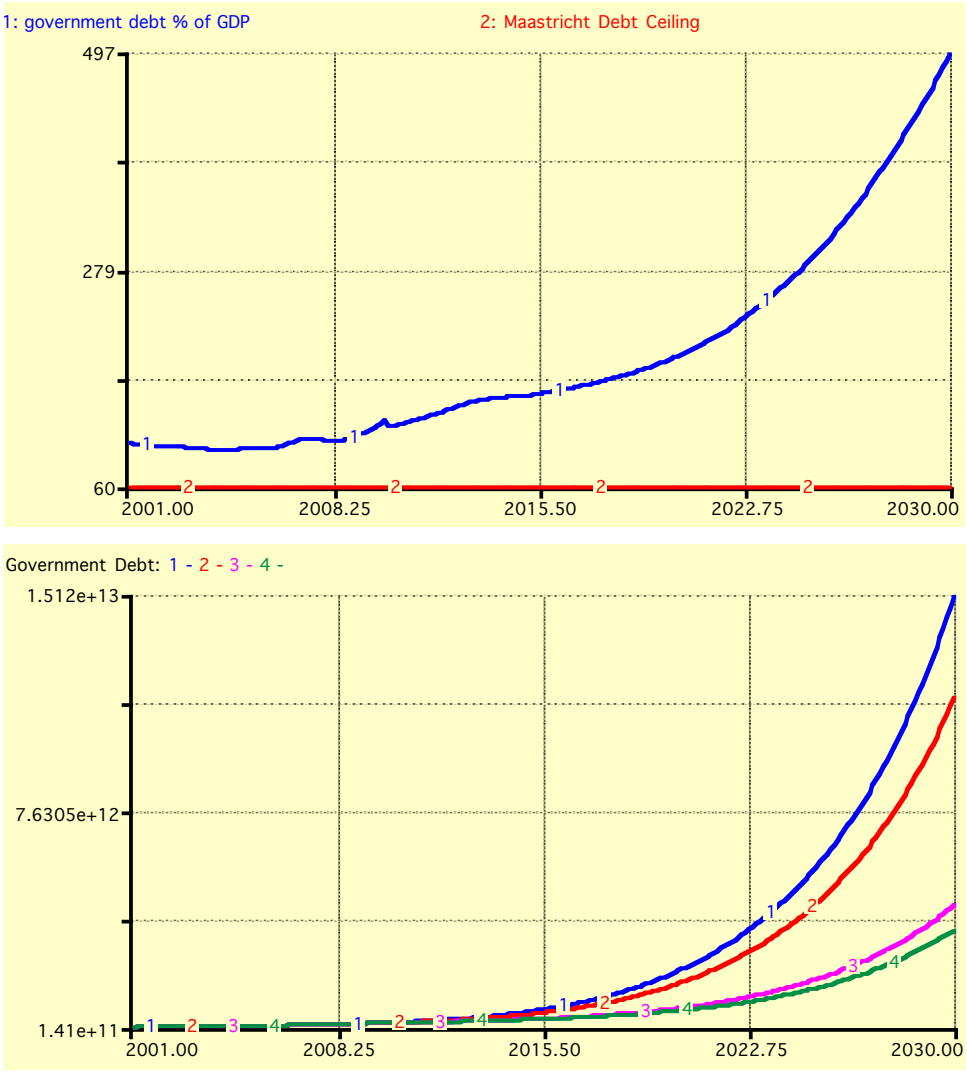


Figure 6.4: Tax/Pension/Healthcare Reform

Scenario 1: Base Run
Scenario 2: Projections to 2030 with Tax Reform
Scenario 3: Projections to 2030 with Tax/Pension Reform
Scenario 4: Projections to 2030 with Tax/Pension/Healthcare Reform

In simulation, healthcare spending as a percentage of GDP is adjusted to 8%. Scenario 4 in Figure 6.4 depicts the behavior of new projection adding healthcare reform.

6.4. Civil Servants Reform

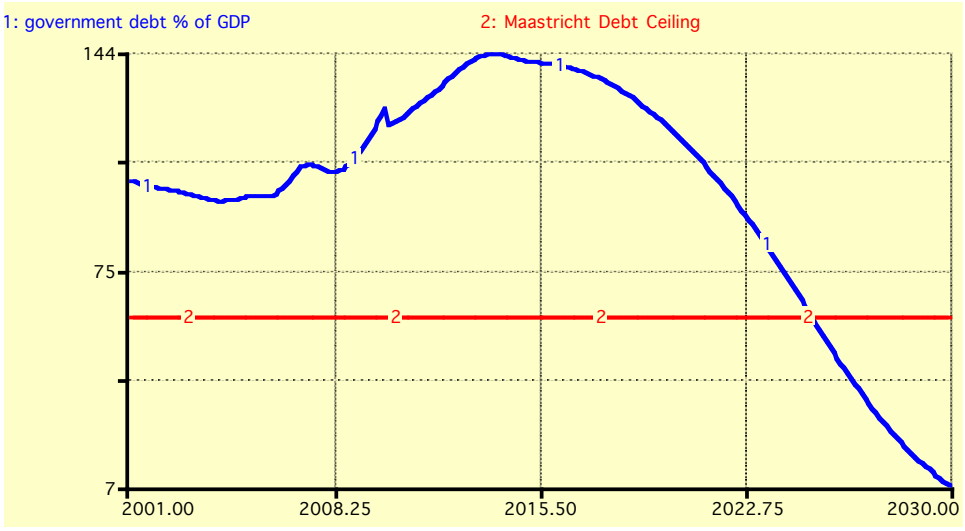
The main parameter of the "Greek problem" is the functioning of the state and of the wider public sector. The excessive growth in the operational cost of the state can be attributed mainly to the management of the human resources of the public sector, especially personnel recruitment, which leads to an enormous growth in wage cost in the public sector. To this is added mismanagement of financial resources, waste of resources in the state budget and the budgets of public sector organizations. Together they lead to high deficits and the accumulation of debt.

As far as recruitment in the public sector is concerned, the past few years saw the proliferation of project contracts or fixed-term contracts with no objective criteria, growing in total to more than 100.000 per year. To this was added the improper use of the "stage" contracts, leading to the recruitment of more than 60.000 people in the "wider" public sector. Finally, numbers hired increased in all cases where personnel categories in the wider public sector were not supervised by the Council for Civil Personnel Selection (ASEP), the independent authority guaranteeing recruitment with objective and fair criteria.

The new government after the elections stopped all new recruitment, and adopted a new bill according to which all recruitments in the "wider" public sector are subordinated to the procedures of ASEP. No recruitment can be made without its approval and without the implementation of the objective examination procedure. The "stage" system has been abolished in the public sector and no project contract can be formed without the explicit authorization by ASEP. Finally, all recruitment exceptions are abolished, and they are all subordinated to the procedures of ASEP. These fundamental changes of a structural nature already have a significant impact on the public sector wage bill and will significantly affect its medium-term development when combined with the decisions announced by the government, namely:

- A hiring freeze in 2010, excluding limited hiring in the health, security and education sectors (in schools only to fill vacancies).
- A rule limiting hiring to one new hire for every five retirements as of 2011.
- A reduction in short-term contracts of up to one-third in most government areas.
- A reduction in subsidies from 10,000 Euros to 5,000 Euros for those who work with computer, speaking foreign language or arriving on position on time.
- A wages freeze in in medium-term and 3% growth rate in long-term, which is 6% currently.

Figure 6.5 displays an extra behavior (Scenario 5) with civil servants reform. The substantial difference is that the trend of government debt is curved down. We can also see from the upper diagram that government debt as a share of GDP begins to bend down around 2015 and it goes through the ceiling around 2025. Observed intuitively from the diagram above, Civil servants system is another big expenditure for government besides pension system. The government debt is decreased to 47 billion Euros dramatically, accounting only 2.5% of GDP.



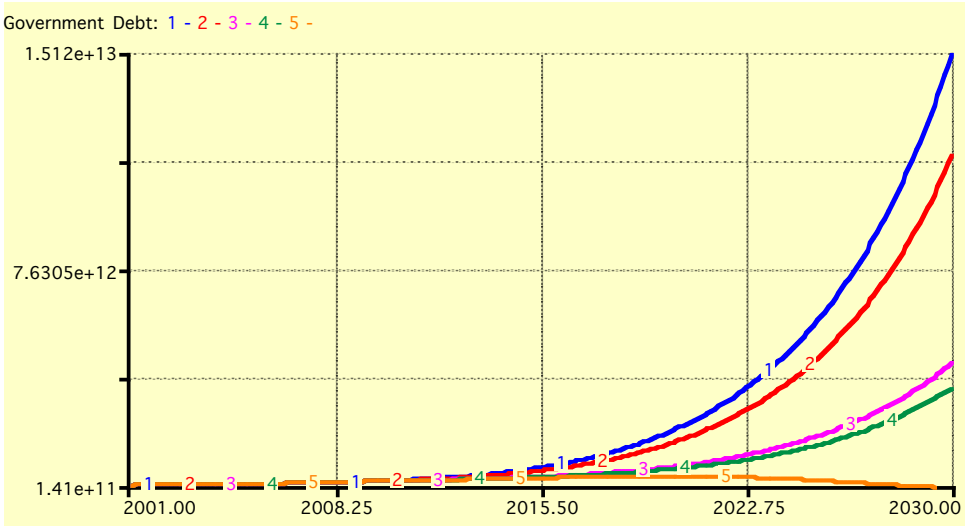


Figure 6.5: Tax/Pension/Healthcare/Civil Servants Reform

Scenario 1: Base Run
Scenario 2: Projections to 2030 with Tax Reform
Scenario 3: Projections to 2030 with Tax/Pension Reform
Scenario 4: Projections to 2030 with Tax/Pension/Healthcare Reform
Scenario 5: Projections to 2030 with Tax/Pension/Healthcare/Civil Servants Reform

6.5. Privatization and State Asset Management

The Greek government has unveiled a wide-ranging privatization and state asset management (SAM) program, spanning the state's holdings in rail, road transport, airports, ports, utilities, the gaming industry, and public real estate. The program leverages private investment so as to restructure the economy, foster economic growth, contribute to fiscal consolidation and raise the overall quality of life.

The program puts to use the know-how of the private sector through outright sales, concession agreements, initial public offerings, strategic public-private partnerships, and the establishment of new holding companies. State shareholdings will range from minority stakes of less than 34%, to controlling stakes of 51% or more. In a number of cases the government will divest fully from its holdings.

It is estimated that the program will reap significant revenues of 15 billion Euros during the period 2011~2013, which will contribute to low the debt burden both in medium-term and long-term period.

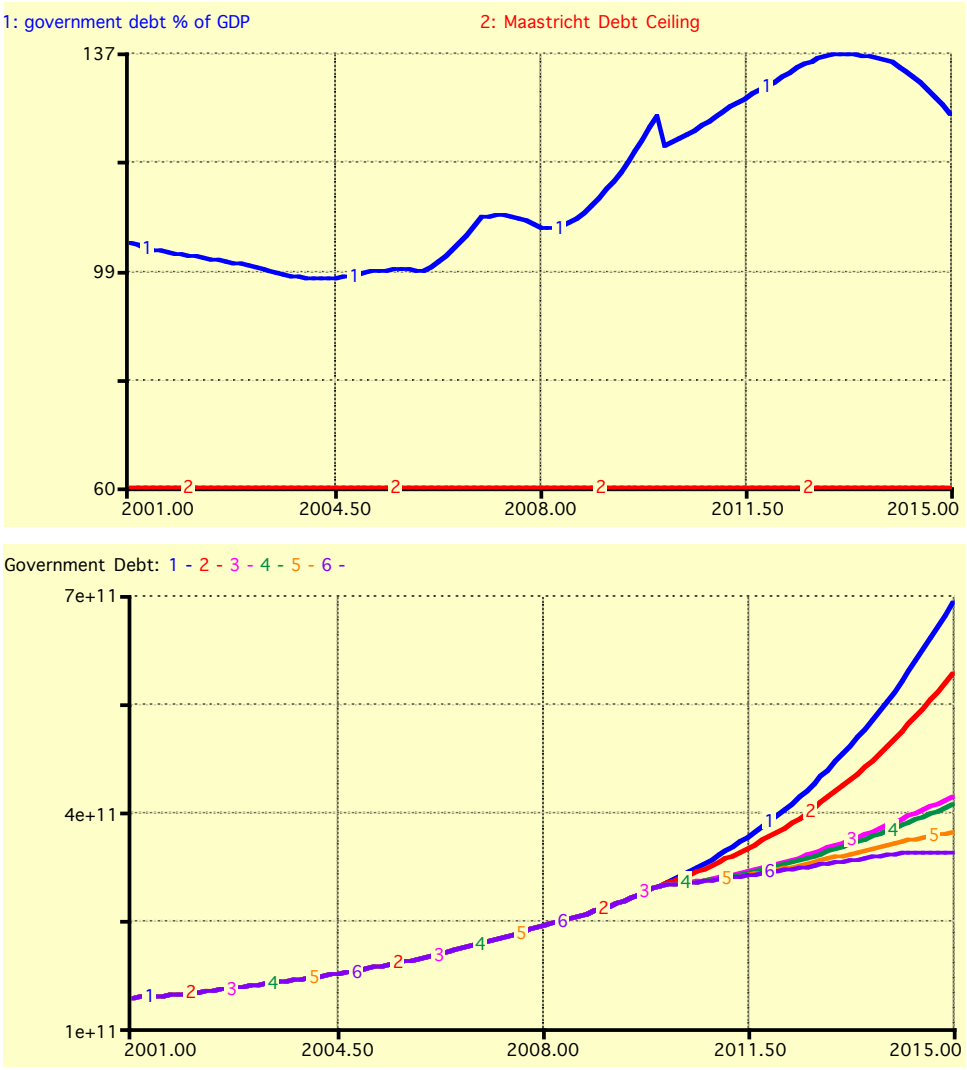


Figure 6.6: Tax/Pension/Healthcare/Civil Servants/SAM Reform (medium-term)

Scenario 1: Base Run
Scenario 2: Projections to 2015 with Tax Reform
Scenario 3: Projections to 2015 with Tax/Pension Reform
Scenario 4: Projections to 2015 with Tax/Pension/Healthcare Reform
Scenario 5: Projections to 2015 with Tax/Pension/Healthcare/Civil Servants Reform
Scenario 6: Projections to 2015 with Tax/Pension/Healthcare/Civil Servants/SAM Reform

Figure 6.6 displays the behaviors with different scenarios within a medium-term period. The wages for civil servants are frozen. These revenues from the program can be used to make the debt burden sustainable by reducing it by 12.5 percentage points of GDP until 2015 and reducing significantly the burden on the Greek taxpayer for interest payments.

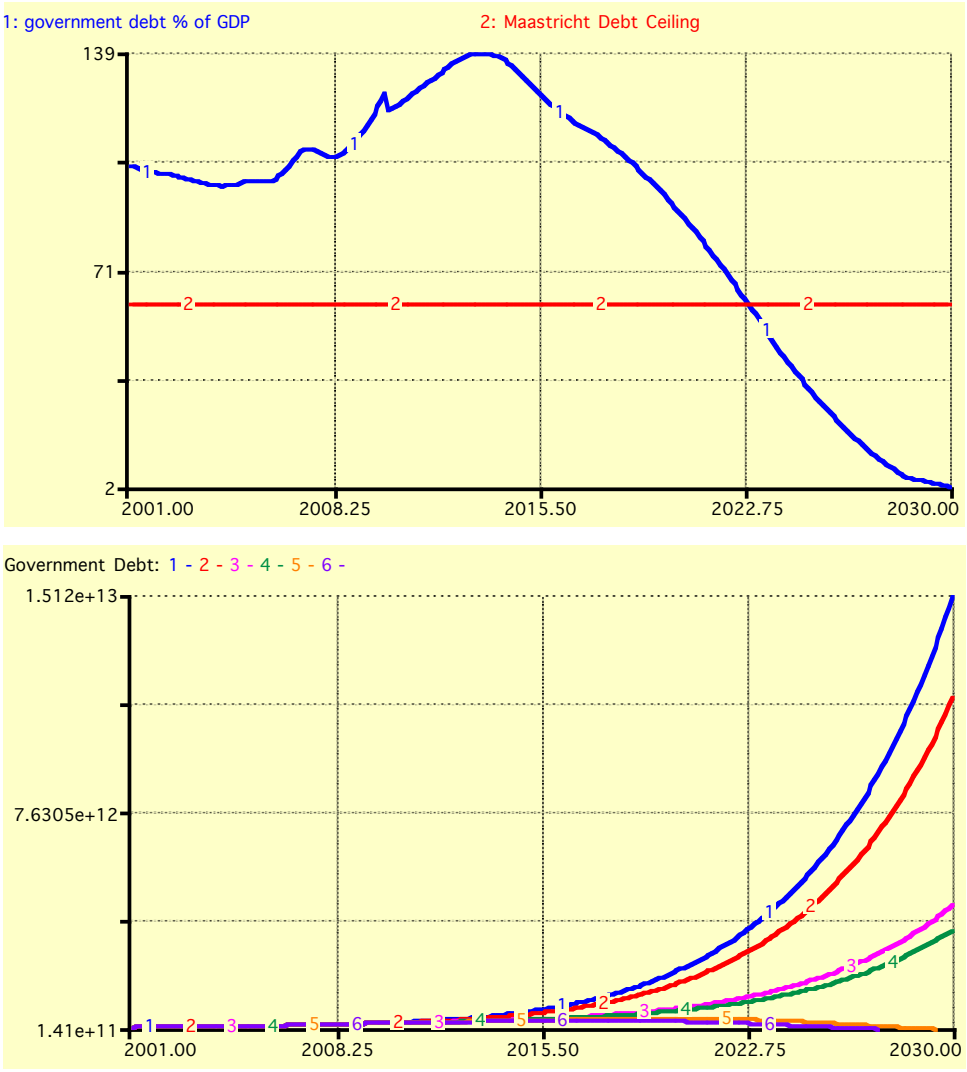


Figure 6.7: Tax/Pension/Healthcare/Civil Servants/SAM Reform (long-term)

Scenario 1: Base Run
Scenario 2: Projections to 2030 with Tax Reform
Scenario 3: Projections to 2030 with Tax/Pension Reform
Scenario 4: Projections to 2030 with Tax/Pension/Healthcare Reform
Scenario 5: Projections to 2030 with Tax/Pension/Healthcare/Civil Servants Reform
Scenario 6: Projections to 2030 with Tax/Pension/Healthcare/Civil Servants/SAM Reform

Figure 6.7 displays the behaviors with different scenarios within a long-term period. Government debt as a share of GDP goes down across the ceiling at 2022, 3 years before the scenario 5 in Figure 6.5 without SAM policy.

6.6. Policy Conclusions

Nearly all policies analyzed above are from modules of government revenue and government expenditure. Those policy parameters are the very parameters that should be regulated by the feedback from government debt and budget deficit, lacking of which is the important reason why the Greek debt crisis broke out. In the model that the paper is based on, I test these parameters exogenously without building the feedback loops. But in the real world, they need to be monitored during the whole process in order to be adjusted to optimal values through information feedback.

The fiscal consolidation program and reform measures discussed above are from a perspective of long-term period on condition that the bundle of policies is executed strictly. Table 6.2 shows simulation results with different scenarios until 2030. Reforms on pension and civil servants systems play important roles in decreasing the government debt burden. Policies for the same area in long-term may be different with the ones in medium-term. Pensions and payrolls of public sectors are froze in medium-term fiscal consolidation program, but eventually will keep increasing properly in a long-term period. Although the policies didn't take Greece to its expectations mainly due to the larger than projected recession, budget deficit in 2010 was beat to 10.5% of GDP, which is nearly 5 percentage points reduction just in one year, ranking first in EU countries.

Table 6.2: Simulation Results with Different Scenarios

	Debt (Billion Euros)	Debt (% of GDP)	Budget Deficit (Billion Euros)	Budget Deficit (% of GDP)
Base Run	15,119	2,248	2,720	451
Tax Reform	11,604	1,644	2,069	327
Pension Reform	4,370	619	729	115
Healthcare Reform	3,511	497	572	89.8
Civil Servants Reform	47	6.75	-45	-6.19
SAM	17	2.5	-10	-1.76

Nevertheless, most of reforms are closely related with people's welfare, such as pensions, wages, subsidies, etc. Therefore, there have been lots of riots in streets since the fiscal austerity was introduced after the crisis exploded. So another problem the government needs to figure out is how to build good public relations between the government and the citizens. The citizens need to know clearly what their country is actually suffering.

Besides, all reforms are based on a premise that the government could finance its budget deficit through issuing new government bonds every year successfully, because budget deficit would be present for more than 10 years in accordance with simulations. Following twice downgraded for government bonds from rating agencies in 2011, the possibility of debt defaulting is discussed by researchers and reporters. Asked about default speculation at a news conference in May 2011, President of European Central Bank, Mr. Trichet said, "It is not in the cards." So far, Greek and European officials have said consistently that a debt restructuring that would cause bondholders to suffer a haircut, or a loss on their holdings, was out of the question. But that stance may not preclude a softer option in which bondholders might be persuaded to exchange their shorter maturity debt for securities with longer maturities and perhaps even a lower interest rate.

7. Conclusions

This paper unmasks the veil of the sovereign debt crisis in Greece, offering a general structure combining budget deficit and government debt. But the government revenue and expenditure also has Greek characteristics. Greece, holding one of the most generous welfare systems in the world, spends quite a lot on public affairs like pensions and public sectors payrolls while earns little from its weak taxation system. Moreover, the membership of Eurozone makes it easy for Greece to finance its budget from member countries with low interests. After the new voted government went onto the stage, they modified the budget deficit twice then followed by the downgrades from rating agencies, which triggered the crisis in the end. All in all, the demand-driven welfare system and the absence of feedback from national account to budget deficit accumulate the sovereign debt crisis in Greece.

One of research findings is that the weak government revenue and extravagant expenditure are the chief culprits in high budget deficit and government debt, and then the high interest payments of the government debt contribute to high budget deficit in return. The weak government revenue results from high tax evasion and tax avoidance. The shadow economy of Greece, which contributes nothing to the government, ranks top in EU countries. On expenditure side, the pension payment, civil servants payroll, interest payments and healthcare expenditure all push the government expenditure to a very high level. The model built to represent the crisis replicates the evolving history of the crisis and at the same time provides a useful tool to analyze the dedicated policies used for solving its crisis.

In exchange for bailout from Eurozone member states and IMF, and also for a sustainable debt, Greek government put in place a series of related policies and reforms. These policies and reforms almost cover all government revenue and expenditures such as formulating laws and regulations to decrease the tax evasion and tax avoidance in order to cut down the share of shadow economy, freezing the pension and civil servants payroll for a medium-term period to reduce the government expenditure and so on. These policies and reforms are quantized and tested on the model for a long-term period. And we found that they do take big effect in the

government debt, especially the policies for pension system (Figure 6.3) and civil servants system (Figure 6.5), which could be seen in Table 6.2, under the modeling assumption that they are executed strictly. Any policies have their dual character, on one hand, they make more tax revenue and less government expenditure; on the other hand, they directly decrease the life quality of Greek who have been accustomed to high standard of life for a long time. That's the reason why various riots are full of streets since the government declared the fiscal austerity. If without fiscal austerity policies, Greece cannot finance itself to repay the matured government debt, defaulting would be true at that time. Once Greece defaults, investors would lose confidence, which could bring about a wave of panic selling of Euros. And there would be a risk of contagion to other PIGS countries and trigger a much larger scale of panic. The Inflation in Eurozone would not be prevented then.

On another side, what ensures the policies implemented without a hitch in the model is that the government can finance successfully to fund the budget deficit. But in return, the Greek government need implement these fiscal consolidation policies rigorously even need more deflationary policies in order to acquire more funds in the future. In a medium-term, the government need recover the investors' confidence in order to make the government debt sustainable, otherwise the government either defaults or restructures its debt or EU continues to fund Greece, which will induce more resistance in "healthier" countries. Just a few days before the paper is finished, end of May 2011, European leaders were negotiating a deal that would lead to unprecedented outside intervention in the Greek economy, including international involvement in tax collection and privatization of state assets, in exchange for new bail-out loans for Greece.

EMU member states share the same monetary policies but implement their own fiscal policies, so that sometimes their strengths don't match their ambitions, when handling intractable economic problems. It has been estimated that the reintroduction of a national currency, while giving the Greek government an extra instrument for macroeconomic stability, would imply a new Drachma falling by 80 per cent against the new Deutschmark; this gap would be around 50 per cent for the new Irish, Portuguese or Spanish currencies (Tilford, 2010).It is unlikely that this would be less

painful for their citizens and their economies than the present austerity plans. But this would also deal a serious blow to Germany's trade balance and growth as much of its export goes to EU countries (Soros, 2010).

The only and final way to solve this crisis is to depend on the citizens of Greece themselves. It's time for both Hellenic Government and Hellene to be all of one mind to bend their efforts in a single direction. It's time for all Hellene to "ask not what your country can do for you, ask what you can do for your country (John F. Kennedy)".

Appendix

Equations

Top-Level Model:

Government_Debt(t) = Government_Debt(t - dt) + (government_borrowing - debt_repayments) * dt

INIT Government_Debt = 141e9

TRANSIT TIME = varies

INFLOW LIMIT = ∞

CAPACITY = ∞

INFLOWS:

government_borrowing = max(0,government_expenditure-government_revenue)

OUTFLOWS:

debt_repayments = CONVEYOR OUTFLOW

TRANSIT TIME = maturity_time

Interest_Payments(t) = Interest_Payments(t - dt) + (interest_to_be_paid - interest_paid_off) * dt

INIT Interest_Payments = 5.64e9

TRANSIT TIME = varies

INFLOW LIMIT = ∞

CAPACITY = ∞

INFLOWS:

interest_to_be_paid = interest_for_new_borrowing

OUTFLOWS:

interest_paid_off = CONVEYOR OUTFLOW

TRANSIT TIME = maturity_time

budget_deficit = government_borrowing-debt_repayments

budget_deficit_%_of_GDP = budget_deficit/Taxation_System.total_nominal_GDP*100

budget_deficit_ceiling_3% = 3

debt_expenditure = Interest_Payments+debt_repayments

government_debt_%_of_GDP =
Government_Debt/Taxation_System.total_nominal_GDP*100
government_debt_ceiling_60% = 60
government_expenditure =
primary_expenditure+other_expenditure+debt_expenditure
government_revenue =
Taxation_System.annual_social_contribution+Taxation_System.annual_income_tax+
state_asset_management_decision
interest_for_new_borrowing =
init(government_borrowing)*government_bond_interest_rate
maturity_time = 7
primary_expenditure =
Civil_Servants_Wages_System.annual_civil_servants_payroll+Healthcare_System.pu
blic_healthcare_expenditure+Pension_System.annual_pension_payment
state_asset_management_decision = if (time>2011 and time<2017 and
state_asset_management_policy_switch=1) then state_asset_management_income
else 0
state_asset_management_policy_switch = 0
government_bond_interest_rate =
GRAPH(government_debt_%_of_GDP/init(government_debt_%_of_GDP))
(0.5, 0.035), (0.65, 0.037), (0.8, 0.04), (0.95, 0.043), (1.10, 0.047), (1.25, 0.055),
(1.40, 0.089), (1.55, 0.16), (1.70, 0.174), (1.85, 0.184), (2.00, 0.199)
historic_budget_deficit = GRAPH(TIME)
(2001, 5.1e+09), (2002, 6.5e+09), (2003, 7.5e+09), (2004, 9.7e+09), (2005, 1.4e+10),
(2006, 1e+10), (2007, 1.2e+10), (2008, 1.4e+10), (2009, 2.2e+10), (2010, 3.6e+10)
historic_government_debt = GRAPH(TIME)
(2001, 1.4e+11), (2002, 1.5e+11), (2003, 1.6e+11), (2004, 1.7e+11), (2005, 1.8e+11),
(2006, 2e+11), (2007, 2.2e+11), (2008, 2.4e+11), (2009, 2.6e+11), (2010, 3e+11)
historic_government_debt_%_of_GDP = GRAPH(TIME)
(2001, 103), (2002, 104), (2003, 102), (2004, 97.4), (2005, 98.6), (2006, 100), (2007,
106), (2008, 105), (2009, 110), (2010, 127)
historic_government_expenditure = GRAPH(TIME)

(2001, 6.4e+10), (2002, 6.6e+10), (2003, 7.1e+10), (2004, 7.7e+10), (2005, 8.4e+10), (2006, 8.6e+10), (2007, 9.5e+10), (2008, 1.1e+11), (2009, 1.2e+11), (2010, 1.2e+11)
historic_government_revenue = GRAPH(TIME)
(2001, 5.9e+10), (2002, 6e+10), (2003, 6.3e+10), (2004, 6.7e+10), (2005, 7.1e+10), (2006, 7.5e+10), (2007, 8.3e+10), (2008, 9e+10), (2009, 9.4e+10), (2010, 8.9e+10)
other_expenditure = GRAPH(TIME)
(2001, 1.6e+10), (2002, 1.9e+10), (2003, 2.4e+10), (2004, 2.6e+10), (2005, 3e+10), (2006, 3.3e+10), (2007, 3.7e+10), (2008, 4e+10), (2009, 4.5e+10), (2010, 4.9e+10), (2011, 5.1e+10), (2012, 5.3e+10), (2013, 5.5e+10), (2014, 5.6e+10), (2015, 5.6e+10), (2016, 5.7e+10), (2017, 5.7e+10), (2018, 5.8e+10), (2019, 5.9e+10), (2020, 5.9e+10), (2021, 6.1e+10), (2022, 6.2e+10), (2023, 6.2e+10), (2024, 6.3e+10), (2025, 6.4e+10), (2026, 6.6e+10), (2027, 6.7e+10), (2028, 6.8e+10), (2029, 7e+10), (2030, 7.1e+10)
state_asset_management_income = GRAPH(TIME)
(2011, 0.00), (2012, 3e+09), (2013, 7e+09), (2014, 5e+09), (2015, 2e+10), (2016, 1.5e+10), (2017, 0.00)

Civil Servants Wages System:

Civil_Servants_Population(t) = Civil_Servants_Population(t - dt) + (becoming_civil_servants - civil_servants_retiring - civil_servants_death) * dt
INIT Civil_Servants_Population = 6.5E5
INFLOWS:
becoming_civil_servants = smth1(civil_servants_recruiting_policy_decision*(civil_servants_retiring+civil_servants_death),0.5)
OUTFLOWS:
civil_servants_retiring = Civil_Servants_Population/period_of_civil_service
civil_servants_death = Civil_Servants_Population*Population.workage_death_rate
PC_Civil_Servants_Wages(t) = PC_Civil_Servants_Wages(t - dt) + (cs_wages_chg_rate) * dt
INIT PC_Civil_Servants_Wages = Taxation_System.nominal_wages_per_woker
INFLOWS:

cs_wages_chg_rate =
PC_Civil_Servants_Wages*smth1(CS_wages_growth_rate_decision,time_to_adjust_pc_cs_wages)
Retired_Civil_Servants_Population(t) = Retired_Civil_Servants_Population(t - dt) + (civil_servants_retiring - retired_civil_servants_death) * dt
INIT Retired_Civil_Servants_Population = 1.5e5
INFLOWS:
civil_servants_retiring = Civil_Servants_Population/period_of_civil_service
OUTFLOWS:
retired_civil_servants_death =
Retired_Civil_Servants_Population/Population.elderage_duration
annual_civil_servants_payroll =
Civil_Servants_Population*(PC_Civil_Servants_Wages/12)*14+0.3*Civil_Servants_Population*(if (Taxation_System.labor_share>0) then
civil_servants_subsidy_policy_decision else 0)
civil_servants_recruiting_policy_decision = if(time>2010) and (CS_system_policy_switch=1) then civil_servants_recruit_retire_ratio else 1
civil_servants_recruit_retire_ratio = 1/5
civil_servants_subsidy_policy_decision = if(time>2010) and (CS_system_policy_switch=1) then pc_civil_servants_subsidy else
pc_civil_servants_subsidy_till_2009
CS_system_policy_switch = 0
CS_wages_growth_rate = 0.06
CS_wages_growth_rate_decision = if(time>2010) and (CS_system_policy_switch=1) then CS_wages_growth_rate else CS_wages_growth_rate_till_2009
CS_wages_growth_rate_till_2009 = 0.06
pc_civil_servants_subsidy = 10000
pc_civil_servants_subsidy_till_2009 = 10000
period_of_civil_service = 32.4
time_to_adjust_pc_cs_wages = 1

Healthcare System:

healthcare_policy_switch = 0

healthcare_spending_%_of_GDP = 0.09
healthcare_spending_%_of_GDP_decision = if (time>2010) and (healthcare_policy_switch=1) then healthcare_spending_%_of_GDP else healthcare_spending_%_of_GDP_till_2009
healthcare_spending_%_of_GDP_till_2009 = 0.09
pc_healthcare_spending = total_healthcare_spending/Population.total_population
private_healthcare_expenditure = total_healthcare_spending-public_healthcare_expenditure
public_healthcare_expenditure = total_healthcare_spending*public_source_%
public_source_% = if (Taxation_System.labor_share>0) then 0.603 else 1
total_healthcare_spending = Taxation_System.total_nominal_GDP*healthcare_spending_%_of_GDP_decision

Pension System:

Five_Years_Wages_per_Worker(t) = Five_Years_Wages_per_Worker(t - dt) + (sampling_input - sampling_output) * dt
INIT Five_Years_Wages_per_Worker = 80000
    TRANSIT TIME = varies
    INFLOW LIMIT = ∞
    CAPACITY = ∞
INFLOWS:
sampling_input = Taxation_System.nominal_wages_per_woker
OUTFLOWS:
sampling_output = CONVEYOR OUTFLOW
    TRANSIT TIME = five_years_sampling_period
Whole_Life_Wages_per_Worker(t) = Whole_Life_Wages_per_Worker(t - dt) + (sampling_input_2 - sampling_output_2) * dt
INIT Whole_Life_Wages_per_Worker = 140000
    TRANSIT TIME = varies
    INFLOW LIMIT = ∞
    CAPACITY = ∞
INFLOWS:
sampling_input_2 = Taxation_System.nominal_wages_per_woker

OUTFLOWS:
sampling_output_2 = CONVEYOR OUTFLOW
TRANSIT TIME = whole_life_sampling_period
annual_pension_payment = if (Taxation_System.labor_share>0) then
pensioners*(pc_pensioner_payment/12*14) else 0
five_years_sampling_period = 5
pc_pensioner_payment =
pension_base_decision*replacement_rate_decision*the_12_months_pension_decision
pensioners = Population.Elderage_Population*pension_%_elderage
pension_%_elderage = 0.6
pension_base_decision = if (time>2010) and (sampling_policy_switch=1) then
Whole_Life_Wages_per_Worker/whole_life_sampling_period else
Five_Years_Wages_per_Worker/five_years_sampling_period
replacement_rate = 0.6
replacement_rate_decision = if(time>2010) and (replacement_rate_policy_switch=1)
then replacement_rate else replacement_rate_till_2009
replacement_rate_policy_switch = 0
replacement_rate_till_2009 = 0.6
sampling_policy_switch = 0
the_12_months_pension = 12/12
the_12_months_pension_decision = if(time>2010) and
(the_12_months_pension_policy_switch=1) then the_12_months_pension else
the_14_months_pension
the_12_months_pension_policy_switch = 0
the_14_months_pension = 14/12
whole_life_sampling_period = 35

Population:

Elderage_Population(t) = Elderage_Population(t - dt) + (becoming_elderage +
elderage_migration - elderage_death) * dt
INIT Elderage_Population = 1.815E6
INFLOWS:
becoming_elderage = Workage_Population/workage_duration

elderage_migration = Elderage_Population*net_migration_rate

OUTFLOWS:

elderage_death = Elderage_Population/elderage_duration

Workage_Population(t) = Workage_Population(t - dt) + (becoming_workage + workage_migration - becoming_elderage - workage_death) * dt

INIT Workage_Population = 7.432E6

INFLOWS:

becoming_workage = Youth_Population/youth_duration

workage_migration = Workage_Population*net_migration_rate

OUTFLOWS:

becoming_elderage = Workage_Population/workage_duration

workage_death = Workage_Population*workage_death_rate

Youth_Population(t) = Youth_Population(t - dt) + (youth_migration + birth - becoming_workage - youth_death) * dt

INIT Youth_Population = 1.67E6

INFLOWS:

youth_migration = Youth_Population*net_migration_rate

birth = women_in_fetile_age*total_fertility_rate/fertility_period

OUTFLOWS:

becoming_workage = Youth_Population/youth_duration

youth_death = Youth_Population*youth_death_rate

elderage_% = Elderage_Population/total_population*100

fertility_period = 35

total_population = Elderage_Population + Youth_Population + Workage_Population

women_in_fetile_age = Workage_Population*proportion_of_fertile_age_women_in_workage_population

workage_duration = 50

youth_% = youth_population/total_population*100

youth_duration = 15

average_life_expectancy = GRAPH(TIME)

(2001, 78.0), (2002, 78.5), (2003, 78.7), (2004, 78.9), (2005, 79.1), (2006, 79.3), (2007, 79.6), (2008, 79.7), (2009, 79.7), (2010, 79.7), (2011, 79.9), (2012, 79.9), (2013, 79.9), (2014, 80.3), (2015, 80.6), (2016, 80.8), (2017, 80.8), (2018, 81.2),

(2019, 81.6), (2020, 81.9), (2021, 82.3), (2022, 82.7), (2023, 82.9), (2024, 83.3), (2025, 83.6), (2026, 84.2), (2027, 84.6), (2028, 85.4), (2029, 85.9), (2030, 87.0)

elderage_duration = GRAPH(average_life_expectancy)

(78.0, 13.0), (78.5, 13.5), (79.0, 14.0), (79.5, 14.5), (80.0, 15.0), (80.5, 15.5), (81.0, 16.0), (81.5, 16.5), (82.0, 17.0), (82.5, 17.5), (83.0, 18.0), (83.5, 18.5), (84.0, 19.0), (84.5, 19.5), (85.0, 20.0), (85.5, 20.5), (86.0, 21.0), (86.5, 21.5), (87.0, 22.0)

historic_population = GRAPH(TIME)

(2001, 1.1e+07), (2002, 1.1e+07), (2003, 1.1e+07), (2004, 1.1e+07), (2005, 1.1e+07), (2006, 1.1e+07), (2007, 1.1e+07), (2008, 1.1e+07), (2009, 1.1e+07), (2010, 1.1e+07)

net_migration_rate = GRAPH(TIME)

(2001, 0.00266), (2002, 0.00347), (2003, 0.00346), (2004, 0.00327), (2005, 0.00371), (2006, 0.00351), (2007, 0.00359), (2008, 0.00357), (2009, 0.00357), (2010, 0.00357)

proportion_of_fertile_age_women_in_workage_population = GRAPH(TIME)

(2001, 0.553), (2002, 0.549), (2003, 0.546), (2004, 0.539), (2005, 0.542), (2006, 0.535), (2007, 0.528), (2008, 0.479), (2009, 0.465), (2010, 0.413)

total_fertility_rate = GRAPH(TIME)

(2001, 1.27), (2002, 1.26), (2003, 1.27), (2004, 1.29), (2005, 1.31), (2006, 1.34), (2007, 1.40), (2008, 1.43), (2009, 1.46), (2010, 1.49), (2011, 1.46), (2012, 1.47), (2013, 1.47), (2014, 1.45), (2015, 1.45), (2016, 1.44), (2017, 1.44), (2018, 1.43), (2019, 1.43), (2020, 1.43), (2021, 1.43), (2022, 1.40), (2023, 1.40), (2024, 1.40), (2025, 1.39), (2026, 1.38), (2027, 1.37), (2028, 1.36), (2029, 1.35), (2030, 1.34)

workage_death_rate = GRAPH(TIME)

(2001, 0.00055), (2002, 0.000575), (2003, 0.000575), (2004, 0.000525), (2005, 0.00055), (2006, 0.000525), (2007, 0.00055), (2008, 0.00055), (2009, 0.000525), (2010, 0.0005)

youth_death_rate = GRAPH(TIME)

(2001, 0.0058), (2002, 0.00571), (2003, 0.0058), (2004, 0.00562), (2005, 0.00508), (2006, 0.00499), (2007, 0.0049), (2008, 0.00481), (2009, 0.00477), (2010, 0.00472), (2011, 0.00436), (2012, 0.00432), (2013, 0.00405), (2014, 0.004), (2015, 0.00396), (2016, 0.00396), (2017, 0.00378), (2018, 0.00364), (2019, 0.00364), (2020, 0.0036), (2021, 0.0036), (2022, 0.00342), (2023, 0.00337), (2024, 0.00333), (2025, 0.00324), (2026, 0.00319), (2027, 0.00319), (2028, 0.00319), (2029, 0.00315), (2030, 0.00315)

Taxation System:

Real_GDP(t) = Real_GDP(t - dt) + (real_GDP_change) * dt

INIT Real_GDP = 136.281E9

INFLOWS:

real_GDP_change = Real_GDP*real_GDP_change_rate/100

annual_income_tax = corporate_taxes+personal_taxes

annual_social_contribution =

corporate_social_contribution+personal_social_contribution

black_economy = total_nominal_GDP-nominal_GDP

black_economy_%_of_GDP = 0.25

black_economy_%_of_GDP_decision = if (time>2010) and

(tax_evasion_reduction_policy_swith=1) then black_economy_%_of_GDP else

black_economy_%_of_GDP_till_2009

black_economy_%_of_GDP_till_2009 = 0.25

corporate_profits = max(0,total_nominal_GDP-nominal_wages)

corporate_social_contribution = if (labor_share<1) then

nominal_wages*corporate_social_contribution_rate_decision else 0

corporate_social_contribution_rate = 0.15

corporate_social_contribution_rate_decision = if(time>2010) and

(taxation_system_policy_switch=1) then corporate_social_contribution_rate else

corporate_social_contribution_rate_till_2009

corporate_social_contribution_rate_till_2009 = 0.15

corporate_taxes = corporate_profits*corporate_tax_rate_decision

corporate_tax_rate = 0.24

corporate_tax_rate_decision = if(time>2010) and (taxation_system_policy_switch=1)

then corporate_tax_rate else corporate_tax_rate_till_2009

corporate_tax_rate_till_2009 = 0.24

employment = Population.Workage_Population*employment_rate

employment_in_black_economy = total_employment-employment

labor_share = 0.6

nominal_GDP = Real_GDP*GDP_deflator/100

nominal_wages = total_nominal_GDP*labor_share

nominal_wages_per_woker = nominal_wages/total_employment

personal_social_contribution =
nominal_wages*personal_social_contribution_rate_decision
personal_social_contribution_rate = 0.11
personal_social_contribution_rate_decision = if(time>2010) and
(taxation_system_policy_switch=1) then personal_social_contribution_rate else
personal_social_contribution_rate_till_2009
personal_social_contribution_rate_till_2009 = 0.11
personal_taxes = nominal_wages*personal_tax_rate_decision
personal_tax_rate = 0.24
personal_tax_rate_decision = if(time>2010) and (taxation_system_policy_switch=1)
then personal_tax_rate else personal_tax_rate_till_2009
personal_tax_rate_till_2009 = 0.24
taxation_system_policy_switch = 0
tax_evasion_reduction_policy_swith = 0
total_employment = employment*(1.25-black_economy_%_of_GDP_decision)
total_nominal_GDP = nominal_GDP*(1.25-black_economy_%_of_GDP_decision)
employment_rate = GRAPH(TIME)
(2001, 0.565), (2002, 0.563), (2003, 0.575), (2004, 0.587), (2005, 0.594), (2006,
0.601), (2007, 0.61), (2008, 0.614), (2009, 0.619), (2010, 0.612), (2011, 0.596)
GDP_deflator = GRAPH(TIME)
(2001, 100), (2002, 103), (2003, 107), (2004, 111), (2005, 114), (2006, 120), (2007,
117), (2008, 127), (2009, 129), (2010, 132), (2011, 135), (2012, 139), (2013, 140),
(2014, 144), (2015, 148), (2016, 150), (2017, 153), (2018, 157), (2019, 162), (2020,
166), (2021, 170), (2022, 175), (2023, 179), (2024, 183), (2025, 188), (2026, 192),
(2027, 197), (2028, 200), (2029, 206), (2030, 212)
real_GDP_change_rate = GRAPH(TIME)
(2001, 4.20), (2002, 3.44), (2003, 5.94), (2004, 4.62), (2005, 2.24), (2006, 4.90),
(2007, 0.00), (2008, 8.10), (2009, -2.50), (2010, -3.97), (2011, -4.50), (2012, -3.00),
(2013, 1.00), (2014, 4.00), (2015, 4.00), (2016, 4.00), (2017, 4.00), (2018, 4.00),
(2019, 4.00), (2020, 4.00), (2021, 4.00), (2022, 4.00), (2023, 4.00), (2024, 4.00),
(2025, 4.00), (2026, 4.00), (2027, 4.00), (2028, 4.00), (2029, 3.90), (2030, 3.90)

References

Alichi, A 2008 A Model of Sovereign Debt in Democracies.

Arghyrou, M G & Tsoukalas, J D 2010 The Greek Debt Crisis: Likely Causes, Mechanics and Outcomes. *The World Economy* 34 173-91.

Das, S B 2010 European Debt Crisis: Implications and Lessons for ASEAN.

Greenberger, M, M. Crenson, and B. Crissey 1976 Models in the Policy Process.

Greiner, A 2011 Economic Growth, Public Debt and Welfare: Comparing Three Budgetary Rules. *German Economic Review* 12 205-22.

Hellenic Governemnt, M o F 2010 Hellenic Stability and Growth Programme.

MAMADOUH, V & WUSTEN, H V D 2010 FINANCIAL, MONETARY AND GOVERNANCE CRISIS: AN OUTLOOK ON THE EURO(ZONE).

Nektarios, M 2009 Greece: Proposed Reform of the Pension System.

Nelson, R M, Belkin, P & Mix, D E 2010 Greece's Debt Crisis: Overview, Policy, Responses, and Implications.

Skouloudis, A, Evangelinos, K, Nikolaou, I & Filho, W L 2011 An overview of corporate social responsibility in Greece: perceptions, developments and barriers to overcome.

Soros, G 2010 The Crisis and the Euro.

Sterman, J D 2000 *Business Dynamics: Systems Thinking and Modeling for a Complex World* McGraw-Hill Higher Education.

Tilford, S 2010 How to save the euro.

Velandia, A 2002 A Risk Quantification Model for Public Debt Management.

Wheat, I D 2007 The Feedback Method: A System Dynamics Approach to Teaching Macroeconomics.

WHO 1996 Health Care Systems in Transition.

Wyplosz, C 2006 European Monetary Union: the dark sides of a major success. *Economic Policy* 21 207-61.