FACULTEIT ECONOMIE EN BEDRIJFSKUNDE

THE EUROPEAN FISCAL FRAMEWORK

A CRITICAL ANALYSIS OF POLICY RULES

Aantal woorden: 15910

Stijn Vermeulen
Stamnummer : 01300185

Promotor: dr. Ewoud Quaghebeur

Masterproef voorgedragen tot het bekomen van de graad van:

Master of Science in de economische wetenschappen

Academiejaar: 2017 - 2018

UNIVERSITEIT GENT

Acknowledgements

Writing this thesis is the highlight of my degree and has been possible thanks to several people.

First of all, I would like to thank my promoter dr. Ewoud Quaghebeur for giving me the opportunity to write my master thesis about this particular subject and for all the feedback and assistance he provided over the year.

Second, I want to thank my parents for all the support they have given me over the past five years as without them I would not have made it this far. I'm very grateful for all the opportunities they have given me to study and pursue my degree.

Lastly, I would also like to thank my girlfriend, flatmates, family and friends for all support they've given and all the joy experienced during my time in Gent. These memories will be something I'll always cherish.

Stijn Vermeulen, June 2018.

Nederlandse samenvatting

De Europese economie lijkt zich te herstellen. In het jaarlijkse groeirapport voorspelt de Europese Commissie stijgende groei, minder werkloosheid, herstellende investeringen en een lichte verbetering van openbare financiën. Ondanks het goede nieuws lijken problemen zich te blijven opstapelen: de vluchtelingenproblematiek, het verlaten van het Verenigd Koninkrijk uit de Unie, de verkiezing van een Eurosceptische regering in Italië, de aanhoudende hoge overheidsschuld, et cetera.

Deze thesis zal zich focussen op dit laatste probleem: de hoge overheidsschuld en de rol van de Stabiliteit en Groeipact hierin. Meer bepaald zullen er 4 vragen behandeld worden, elk in een eigen hoofdstuk.

In hoofdstuk 1 zullen we kijken waarom begrotingsregels nodig zijn en hoe ze welvaart en fiscale verantwoordelijkheid kunnen promoten. We zullen aantonen dat argumenten zoals over-optimisme, tijd-inconsistent beleid, risico op default en neiging tot inflatie gebruikt kunnen worden om begrotingsregels op supranationaal niveau te verantwoorden.

In hoofdstuk 2 lichten we toe hoe de huidige Stabiliteit en Groeipact begrotingsdiscipline oplegt aan de lidstaten en welke procedures hierbij komen kijken. We zullen zien dat de Pact uit twee armen: de preventieve arm met de middellange-termijn doelstelling (MTO) en de correctionele arm met de buitensporige tekortprocedure (EDP) centraal.

Het derde hoofdstuk gaat verder met de beschrijving van de kritiek op de huidige staat van de Stabiliteit en Groeipact. Argumenten van overmatige complexiteit, verkeerde keuze in doelstellingen en gebrek aan het nakomen van de regels roepen op tot hervorming.

Hoofdstuk 4 sluit af met een analyse van de huidige Pact in een Nieuw-Keynesiaans model met prijsrigiditeit en maakt een vergelijking met een alternatieve regel met meer focus op schuld. Hier zullen we besluiten dat de keuze van de betere regel zal afhangen van de relatieve voorkeur tussen de monetaire overheid en de fiscale overheid.

Table of contents

List of abbreviations

AGS: Annual Growth Survey

CSR: Country Specific Recommendations

DBP: Draft Budgetary Plans

EC: European Commission

ECB: European Central Bank

EDP: Excessive Deficit Procedure

ERM2: Exchange Rate Mechanism II

EU: European Union

GDP: Gross Domestic Product

IRF: Impulse Response Function

MTO: Medium-term Objective

ROG: Representative Output Gap

SCP: Stability and Convergence Programme

SDP: Significant Deviation Procedure

SGP: Stability and Growth Pact

TEU: Treaty on European Union

TFEU: Treaty on the Functioning of the European Union

TSCG: Treaty on Stability, Coordination and Governance in the Economic and Monetary Union

List of Figures

List of Tables

Introduction

The European economy seems to be recovering. In the European Commission's Annual Growth Survey of 2018 growth is reported to surpass expectations, unemployment will decrease, investments are recovering and public finances are slightly improving. It seems the worst of the financial crisis and the sovereign crisis that followed has passed. Despite the good news, the European Union still faces several issues: the United Kingdom leaving the Union, the rise of Euroscepticism in Italy and the remaining high sovereign debt levels are some of them. This dissertation will focus on this last issue: the continued persistence of high sovereign debt and the role of the current fiscal framework, the Stability and Growth Pact.

The inception of the Stability and Growth Pact dates back to the signing of the Treaty on European Union on 7 February 1992 in Maastricht. The then twelve members of the European Community committed themselves to creating an ever closer union and to strengthen the solidarity between the peoples of Europe (Treaty on European Union, 1992, Article A). To reach this goal, they pledged to further strengthen economic and social cohesion through establishing a common economic and monetary policy, ultimately including a single currency (Treaty on European Union, 1992, Article B). With these concepts as foundation, the European Council agreed on a resolution in the summer of 1997 in which it underlines the importance of safeguarding sound government finances to accomplish price stability and sustainable growth (European Council, 1997). This resolution would be known as the Resolution on Stability and Growth Pact and would later be incorporated in the Treaty on the Functioning of the European Union (Treaty on the Functioning of the European Union, 2007).

However, even after several reforms like the Six-Pack, Two-Pack and the Fiscal Compact, sovereign debt levels remain high and compliance to targets remains low. The Euro area debt-to-GDP ratio reached 88% in 2017, well above the target of 60%. Additionally, six countries, including France, Italy and Belgium, have been forecasted to be non-compliant with the Pact for 2018 (European Commission, 2017a). One can wonder if the Pact is succeeding in its intended goal of promoting sound budgetary discipline and whether or not another reform is needed.

In this Master thesis, four questions will be addressed concerning the state of the European fiscal framework today. The first chapter will address the question as to why a fiscal framework is needed, both in general and in a monetary union specifically. Arguments like over-optimism, time-inconsistency and inflationary pressure will suggest that a budgetary framework can promote prosperity. The second chapter will continue by describing how the current framework limits government debt and promotes sustainable public finances. The third chapter follows with a discussion of the criticism given on the current framework together with proposals for alternative rules or targets. The fourth and last chapter will conclude with an analysis of the Pact in a New-Keynesian model with price rigidity and make a comparison for an alternative, more debt-focused rule. The comparison will show that the better rule will be determined by the degree of preference between fiscal and monetary policy.

1. Why a common budgetary framework?

Before digging deeper in the specifics of the Stability and Growth Pact, we first have to understand why a common budgetary framework is necessary in the first place. We will discuss two different categories of arguments. Section 1.1 will discuss the need for a set of budgetary rules in general and why they might promote prosperity. Following this, section 1.2 discusses why fiscal rules are needed in a monetary union with a common currency.

1.1 The general need for budgetary rules

Besides the existence of market failure, so is there the possibility of government failure. When reading the economic literature on optimal policy, either fiscal, monetary, environmental or any other type, it is often presumed that policies are implemented by a benevolent social planner. A benevolent social planner is defined as an all-knowing, all-powerful, well-intentioned entity that aims to maximize the welfare of everyone in society (Mankiw, 2016 p.143). A government, however, is often not all-knowing, nor is it always all-powerful. Problems, like time-inconsistency, information asymmetry, impatience and political competition can lead to suboptimal policy and a bias towards deficits and debt accumulation. A few of these problems will be discussed in the following paragraphs.

1.1.1 Time-inconsistency of fiscal policy

Similar to the rules versus discretion debate in monetary economics, as in the paper of Kydland & Prescott (1977), fiscal policy can be faced with a time-inconsistency problem. Rational agents know when an announced policy decision is inconsistent and will adjust their expectations accordingly, leading to a suboptimal situation. If this inconsistency occurs, commitment to a rule instead of discretionary policy might then improve the outcome and lead to a second best situation.

A first illustration of this problem is given by Bianchi & Menegatti (2012) with the example of a government with two objectives: debt stabilization and output stabilization. An announcement of full debt stabilization won't be trusted by the public as the government would maximize its utility with a mix of both debt and output stabilization. Rational agents know this and adjust their expectations accordingly, leading to a suboptimal situation. Bianchi & Menegatti (2012) conclude that when debt is sufficiently high enough, a believable commitment to debt stabilization is preferable thus making the case for fiscal rules.

A second illustration of time-inconsistency of fiscal policy is given in a paper by Dixit & Lambertini (2003). They demonstrate that the interaction between a monetary and fiscal authority can lead to a suboptimal outcome when the monetary authority is more conservative than the fiscal authority. The outcome of the non-cooperative game between the two authorities can than lead to a situation with higher inflation and a lower output than is socially optimal. The policy recommendations that come forth from this paper are that either both authorities need to commit themselves to targets, both authorities need to focus on the same targets or the monetary authority should only care about inflation and the fiscal authority only

about output. Which of the three recommendations should be applied to the European Union is open for argument; however, two of the three proposals do imply a role for fiscal rules or targets.

Another issue which can be categorized under time-inconsistency is when a governing party would manipulate spending and create a deficit when it is likely to be replaced by an opposing party in the next election. The policy of the governing party is then inconsistent in the sense that it tries to influence the possibilities of the next government by running deficits and thus creating a suboptimal situation instead if it had stayed in office. This problem arises because a current government has influence over a decision variable for the next, i.e. the state of government balance or outstanding debt. This is even more amplified if there is a higher degree of political polarization and downward rigidity of spending (Alisa & Tabellini, 1987; Persson & Svennson, 1989). A fiscal framework can ensure the opportunities for this type of "backstabbing" policy are as limited as possible.

1.1.2 Common pool problem

A second argument in favour of fiscal discipline and rules, springs from the fact that the government budget is a common pool resource and a spending bias can arise by too many officials using that common resource. Similar to Garret Hardin's Tragedy of the Commons problem (1968), government officials do not fully internalize the true cost of one extra unit of spending or debt. The benefits of extra spending are usually carried by a particular group in society, while the costs are carried by all the taxpayers. This leads to an underestimation of the true cost by government officials, because, for example, a member of parliament only sees the extra tax burden of extra spending on its constituents (Von Hagen & Harden, 1995; Velasco, 2000).

Evidence from increased spending when there are more ministers in charge is found by Perotti & Kontopoulos (2002). More specifically, they find that government spending, transfers and investment are all significantly affected by the number of ministers in charge. Hallberg & Von Hagen (1997) also find evidence of a positive effect of a multi-party government on deficits and debt. Their suggestion for solving this common pool problem entails either having a strong finance minister or installing fiscal rules in order to limit the deficit bias.

1.1.3 Over-optimism in public finances

A third argument for a fiscal framework is the possibility of over-optimism in public finances. Government budgeting goes through several stages: planning, voting for the budget law, implementation and ex-post control (Beetsma, Giuliodori & Wierts, 2009). Especially in the first stage, the planning stage over-optimism in forecasting can have severe consequences as tax revenues are overestimated or projects are under-budgeted. Evidence of over-optimism in forecast is found by Beetsma et al. (2009) who find that the actual implemented adjustments often fall short of the planned adjustments. Additionally, they find that variability of fiscal outcomes is also dominated by implementation errors. Over-optimism is further more

supported by Frankel (2011) who finds that overall forecasts are often too optimistic, especially in times of high economic activity and even more so at longer horizons.

This can lead to overshooting deficit targets and a loss in credibility when it is a reoccurring phenomenon. Therefore, a credible, independent fiscal institution that would be responsible for budget forecasting can improve fiscal discipline and limit the deficit bias caused by over-optimism (Beetsma et al., 2009, Calmfors, 2011, Frankel, 2011).

1.1.4 Budget deficits, government debt and growth

While the previous paragraphs may have given a clear answer to why fiscal rules can be beneficial to implement, with the relation between government debt and growth the answer isn't as clear-cut. While some papers argue that government debt can be detrimental to growth, others are inconclusive about the relation and some even report a positive relation. We'll briefly discuss the different arguments used in the literature.

In neoclassical growth models, like Diamond (1965), there is a possibility that a dynamic inefficient situation occurs when there is overaccumulation of capital. This overaccumulation results in welfare losses for future generations. Therefore, an argument can be made in favour of public debt as it can bring the economy closer to the golden-rule optimum as debt crowds out investment. Saint-Paul (1992), however, counters the neoclassical growth models by showing that public debt has a negative effect on growth with the use of an endogenous growth model. In the endogenous growth model, public debt will reduce growth, implying that there will be a generation in the future that will have its welfare reduced.

Empirical evidence of the relationship between growth and public debt is ambiguous. Checherita-Westphal & Rother (2012) and Baum, Checherita-Westphal & Rother (2013) find evidence of an inverted U-shape relationship between debt and growth for 12 euro-area countries. Their findings suggest that for lower levels, debt can have a positive impact up. However, between a 90-100% debt ratio it turns over to a negative relation with growth. On the other side of the argument, estimates of Panizza & Presbitero (2014), Égert (2015) for example, find little evidence of any causal relation between debt and growth. Whether or not public debt has any relation with economic growth, and consequently if a fiscal framework promotes growth, is thus open for discussion.

1.2 The need for budgetary rules in a monetary union

The Treaty on European Union (1992) and its signatories made the commitment to more economic and monetary integration, ultimately introducing a common currency. The introduction of a common currency also meant a common monetary policy, which is carried out by the European Central Bank. The mandate of the ECB is to ensure price stability in the European Union and its member states and it pursues this goal by setting an inflation target of near but under 2% (ECB, 2018).

This mandate of price stability also has implications for fiscal policy and national debt. A national government can have a bias towards inflation, since unexpected higher inflation reduces the burden of repaying the debt. This can be shown using the following equation (Eijffinger & de Haan, 2000):

$$\Delta b_t + t_t = g_t + (r_t + \pi_t^e - \pi_t) b_{t-1} \qquad (1.1)$$

with b_t government debt at time t, g_t government spending, t_t tax income, r_t the real interest rate, π^e expected inflation and π_t the actual inflation rate. The left hand side represents the government's finances while the right hand side shows the total expenditures. It should be clear that if the actual inflation is higher than the expected inflation, the government has an easier time financing its expenditures. This would imply that government can have an inflationary bias, especially when debt levels are high (Eijffinger & de Haan, 2000). It can be argued, however, that since the European Central Bank is considered to be independent, no single national government can directly influence monetary policy. In other words, it is argued that this inflationary bias is limited at best suggesting fiscal rules wouldn't help as mush.

Another argument that can be brought up for the inflationary bias of national governments is the unpleasant monetary arithmetic from Sargent & Wallace (1981). This arithmetic states that if fiscal policy and monetary policy are set in a decentralised manner, strict monetary policy now would imply higher inflation later. As debt level reaches a certain point, debt can be perceived as unsustainable and therefore the only way to ensure debt is paid off, is higher induced inflation. If this occurs, the monetary authority has no longer any control over inflation. Davig & Leeper (2011) built further on this argument as for countries that enter an era of fiscal stress and have reached their limits on taxation, the monetary authority can lose control over inflation. If this is indeed the case, a framework in which limits government debt can promote prosperity.

A second implication of a monetary union on fiscal policy is the effect fiscal policy can have on interest rates. As fiscal conditions deteriorate in specific member states, contagion effects and the risk of default can increase and have negative consequences for other members. Estimates from Baum et al. (2013) find that long-term interest rates experience increased pressure with debt ratios above 70%. Arghyrou & Kontonikas (2012) found evidence of these contagion effects for the Greek debt crisis of 2010 which had a significant impact on the sovereign bond spreads. With regards to the risk of default, De Grauwe & Ji (2012) also suggest that government bond markets in a monetary union experience increased fragility. This fragility originates from the possibility of self-fulfilling liquidity and solvency crises as panic and fear create scenarios where insolvency and default are even more likely. If this is the case, the argument can be made that a fiscal framework can decrease the likelihood of these self-fulfilling crises to happen.

1.3 Concluding remarks regarding the need for a fiscal framework

While the previous paragraphs list several arguments for the need of a fiscal framework, it is not exhaustive. As of now, the consensus in the European Union is that a framework on union level is warranted. As of 1997 the Stability and Growth Pact is in effect and it aims to ensure fiscal sustainability of public finances in the European Union and its member states. The next chapter will dig deeper into the details of the Pact and will explain the specific rules in place to ensure national governments' finances are sustainable.

2. The Stability and Growth Pact

In 1997, the Stability and Growth Pact (SGP) was adopted as the budgetary pillar of the Economic and Monetary Union and applied to the whole European Union without exception. Central in this Pact are three EU wide rules: a public debt ceiling of 60% of GDP, a ceiling on the fiscal deficit of 3% of GDP and a commitment to a country-specific Medium-term Budget position. The first two rules are part of the corrective arm, while the third is key in the preventive arm of the Pact (European Commission, 2017c).

Two EU institutional bodies play a large role in the implementation of the Stability and Growth Pact. The first institution, the European Commission, has initiating authority and monitors and reports on the budgetary practices of national governments. These reports will be delivered to the Council of Ministers who, if necessary, will decide upon required follow-up actions, e.g. impose sanctions on non-complying member states (European Council, 1997).

The following sections will elaborate more on the structure of the Stability and Growth Pact. The Pact consists of an institutional framework, a preventive and corrective arm. Section 2.1 will elaborate on the preventive arm with the Medium-term objective as key component in ensuring sound public finances. Section 2.2 will follow with the corrective arm and its Excessive Deficit Procedure as centrepiece. Section 2.3 will conclude with the institutional context in which the Pact operates. These sections will be a thorough summary of the Vade Mecum on the Stability and Growth Pact (2017c) published by the Commission. The Vade Mecum aims to improve the transparency in the surveillance and enforcement of the Pact and the document presents the relevant procedures and methodologies used by the Commission (European Commission, 2017c).

2.1 The preventive arm

The preventive arm is the first of two stages in the Stability and Growth pact and has as main objective to promote sound budgetary discipline and ensure the sustainability of member states' public finances. Compliance with the preventive arm ensures that member states maintain sound budgetary positions and avoid the occurrence of excessive deficits or debt. To reach this healthy budgetary position the Commission uses a two-pillar approach. The country specific Medium-Term Objective (MTO) will be the centrepiece of the preventive arm, supplemented by an analysis of the growth rate of the government expenditures. Both pillars are taken in account when an overall assessment of public finances is made.

2.1.1 The Medium-Term Objective (MTO)

The Medium-Term Objective is the central concept of the preventive arm and it will be the main benchmark used in the Commission's assessment of the national budgets. The MTO ensures that member states stay compliant with the 3% of GDP deficit objective. A member state's compliance is assessed by comparing the MTO and the actual structural balance to see whether the target has been reached or, at the least, a proper adjustment path towards it is

being followed. If this is not the case, the Commission may take steps to initiate a Significant Deviation Procedure possibly accompanied by sanctions (cf. infra).

In the assessment of the MTO the Commission uses the structural balance, i.e. the cyclically-adjusted general government balance net of one-off and other temporary measures. Algebraically this result is achieved by first calculating the cyclically-adjusted general government balance (CAB):

$$CAB = \frac{BAL}{Y} - \varepsilon * OG \qquad (2.1)$$

with BAL as the public balance or general government net borrowing/spending (Eurostat, 2018), Y the GDP, ε the semi-elasticity of the budget balance to the business cycle and OG the output gap estimated on the basis of a production function method.

Once the cyclically-adjusted balance is estimated, one-off and temporary measures are removed to get an estimate of the structural balance. The advantage of using the structural balance over the cyclically-adjusted balance is that it filters out the temporary or one-off components that generally don't affect the underlying budgetary position.

The MTO is defined as the structural balance target that a member state needs to reach in order to be compliant with the preventive arm. The required value of the country-specific MTO is calculated by taking the largest value of the following equation:

$$MTO^{min} = \max\left(MTO^{MB}, MTO^{ILD}, MTO^{ERM2\backslash euro}\right) \qquad (2.2)$$

The minimum MTO is thus calculated by taking the maximum of three different targets or in other words the most restricting MTO. Each component is defined by its own principles such that all requirements of the Pact are met.

The first target taken into consideration is the minimum benchmark Medium-Term Objective (MTO^{MB}). This target ensures a safety margin with respect to the 3% of GDP deficit rule. The formula used is comparable to the estimation of the cyclically-adjusted balance:

$$MTO^{MB} = -3 - \varepsilon * ROG \qquad (2.3)$$

The minimum benchmark will be the difference between -3% of GDP deficit and a cyclical component. As before, ε is the semi-elasticity of the government budget to the business cycle. The difference in this formula, however, is that the representative output gap (ROG) is used instead of the regular output gap. The argument for using the representative output gap is that it also takes both the business cycle's volatility in the member state itself and in the whole union into account. If there is more volatility in the output, either in the member state or in the Union, then a larger effort has to be made by a national government to keep a sufficient safety margin. Compliance to this benchmark will ensure that a country won't breach the deficit rule in a normal, economic cycle.

The second target is the Medium-Term Objective with implicit liabilities and debt taken into consideration (MTO^{ILD}). The value of this target has to ensure that a member state stays or converges to a sustainable debt ratio while also taking the costs of ageing into account. The MTO^{ILD} consist of three components:

$$MTO^{ILD} = Budgetary\ Balance_{stabilizing\ 60\%\ Debt-to-GDP}(I) + \alpha * Ageing\ cost(II) + Effort_{debt\ reduction}(III) \qquad (2.4)$$

The first component (I) is the budgetary balance that needs to be achieved to stabilize the debt-to-GDP ratio at 60%. Based on the equation Heylen (2014, p.231) uses to describe debt stabilization, algebraically this can be written as:

$$\Delta b_t = Def_t + \frac{(R_{n,t} - g_{n,t})}{(1 + g_{n,t})} b_{t-1} = 0 \qquad (2.5)$$

$$Def_t = -\frac{(R_{n,t} - g_{n,t})}{(1 + g_{n,t})} b_{t-1} \qquad (2.6)$$

with Def_t the deficit or balance in % of GDP, $R_{n,t}$ the nominal interest rate on debt, $g_{n,t}$ the nominal growth rate and b_{t-1} the government debt in % of GDP and thus equal to 60%. Once a member state is at the 60% debt-to-GDP target, equation (2.6) gives the required deficit in order to keep the debt constant at that level.

The second component (II) brings the costs and the needed budgetary adjustment of ageing into consideration. It is estimated by taking the present value of the projected increase in age-related expenditures with α=33%.

The third and last component (III) adds a supplementary debt reduction to the MTO, which leads to larger efforts for countries with a higher debt level. This component follows a linear function:

$$Effort_{debt\ reduction} = 0.024 * debt - 1.24 \qquad (2.7)$$

If the debt level is at 60% the required additional effort to be made is equal 0,2%, while a member state with a debt-to-GDP of 100% will need to make an additional effort of 1,14%.

When all three components are found, they will be added into equation (4) and the result will be the Medium-Term Objective with implicit liabilities and debt taken into consideration. Compliance with this MTO ensures that a country converges or stays at a sustainable debt level while also taking into account the future increase in age-related expenditures.

The last Medium-Term Objective target is the $MTO^{ERM2\backslash euro}$ and is defined in by Regulation (EC) 1466/97 and the Treaty on Stability, Coordination and Governance in the Economic and Monetary Union (TSCG, 2012). The regulation states that ERM2 states have to make an additional effort to reach a target of -1% of GDP deficit. The same rule applies to euro area

countries, but only if their debt-to-GDP ratio is significantly below the 60% and if the risks in terms of long-run sustainability of public finance are low. If a euro-area member state does not meet these criteria then it has to make an additional effort to ensure its deficit does not exceed -0,5% of GDP.

The three Medium-Term Objective targets are combined into equation (2) and the result will be the lower bound for the structural balance. This results in the MTO that fulfils all the listed criteria and will be the MTO a member state will present in its Stability and Convergence Programme (SCP) (cf. infra).

2.1.2 The expenditure benchmark

Complementary to the MTO, compliance with the preventive arm is assessed with the use of an expenditure benchmark. The objective of this benchmark is to ensure that governments who are at their MTO stay on their target or, in the case they are not, that they follow an appropriate adjustment path towards it.

The country-specific expenditure benchmark will determine the maximum allowed growth rate of government expenditures. This benchmark is based on the government expenditure aggregate which consists of overall government expenditure net of interest payments, spending on EU programmes paid for by EU funds and cyclical components. In addition, national investments are spread out over a period of four years.

Once the expenditure aggregate is determined, the allowed growth rate will be set according to whether or not a member state is at their MTO. If they are at their MTO, the expenditures are not allowed to grow more than the medium-term growth rate of potential GDP. Adherence to this ensures that a country at their target stays at their target. If a country, however, is not at their target, the maximum expenditure growth rate will be set below the medium-term growth of potential GDP. When the expenditure growth is set below that of potential GDP, the structural balance will adjust so that the MTO is reached over time.

2.1.3 Assessment of compliance with the preventive arm

Both the Medium-term objective and the expenditure benchmark are used in the assessment whether each member state complies with the Pact. All member states need to present their Stability and Convergence Programmes (cf. infra) to the Commission. These reports contain their medium-term budgetary plans with supporting data. Whether a member state is meeting the criteria of the preventive arm or not, is based on the analysis of their respective SCP. The analysis is performed ex post, in-year and ex ante.

Out of this analysis, three different scenarios can follow. The first scenario is that a member state is compliant and has reached its MTO or is on an appropriate adjustment path towards it. The second scenario is that there is some deviation, but it isn't significant. The third and last option is that there is a significant deviation from the target.

In the first case, compliance could either mean that a country is at its MTO or that it is on an appropriate path towards it. A member state is considered to be at its MTO when the structural balance is within 0.25 percentage points of its target. This means some degree of uncertainty surrounding the estimation of the structural balance is taken into account. If the target is not reached, compliance is still possible as long as an appropriate adjustment path is being followed. The rate of this adjustment path depends on two factors: the business cycle and the fiscal position of the member state. The rationale behind the business cycle is simple: in good times greater effort must be made, while in bad times there is more leeway. Besides the business cycle, the debt position of a member state is also taken into account when determining the appropriate adjustment path. If a country exceeds the 60% debt-to-GDP ratio, it has to make an additional effort to ensure it adjust towards its target.

The second scenario occurs in case of a deviation from either the MTO or the expenditure benchmark. However, changes in the structural balance are considered insignificant if the deviation is smaller than 0.5% of GDP in a single year or smaller than 0.25% on average over two consecutive years. Similarly for the expenditure benchmark, an insignificant deviation means that the total impact on government balance is less than 0.5% of GDP in a single year or cumulatively in two consecutive years. An insignificant deviation will not lead to any further actions.

The third scenario occurs when the criteria mentioned in the previous paragraphs are not met and there is a significant deviation from either the MTO or the expenditure benchmark. If this is the case, then the Commission may initiate a Significant Deviation Procedure (cf infra).

To conclude the assessment procedure, three noteworthy exceptions apply to the previous rules. The first exception concerns the implementation of major structural reforms. Structural reforms, e.g. pension or healthcare reforms, can have negative budgetary effects in the short run, while in the long run it may improve public finances. Under the SGP these reforms are allowed under certain conditions. The general rule is that any deviation from the MTO a structural reform causes cannot exceed 0.5% of GDP and departing from the target is only allowed for three years. A second exception with the same prerequisites is made for national investments. The third exception concerns the impact of unusual events. If an unusual event outside the control of a member state takes place, e.g. a natural disaster or terrorist attack, a temporary deviation of the MTO is allowed as long as it does not endanger the medium-term fiscal sustainability. All three of these exceptions allow for additional flexibility in member states' finances while still ensuring the criteria of the preventive arm are met in the medium-term.

2.1.4 The Significant Deviation Procedure (SDP)

In case of non-compliance and the Commission's overall assessment suggests there may be a significant deviation from the target, the Commission will take additional action. For ex ante and in-year assessments, the Commission will report the findings of its forecasts to the member

state and steer the debate towards preventing the deviation. Important to note here is that no punitive action can be taken for ex ante or in-year deviations, as the Commission's findings are based on forecasts and not actual data.

Ex post, however, punitive action can be taken as any deviation from the target is observed. The Commission will initiate a Significant Deviation procedure (SDP) and send a warning through the Council of Ministers to the member state in question together with its recommendation on policy measures. The member state then must take appropriate action and report back to the Council. If no appropriate action is taken, the Commission will recommend the Council to adopt a decision that no effective action has been taken. This decision by the Council has to be taken by qualified majority. If this decision does not pass, the Commission can make a new recommendation to the Council to pass a decision of no effective action, this time by reverse qualified majority. This means that if there is no qualified majority, the decision is passed and sanctions can be enforced.

Sanctions under the SDP can only be imposed on Euro Area member states. The default sanction is an interest-bearing deposit equal to 0.2% of the member state's GDP, however the amount may vary. The deposit will be kept by the Commission and will only be returned when effective action is taken. In the case a country enters the Excessive Deficit Procedure (EDP), however, the deposit will be turned into a non-interest bearing deposit (cf infra).

2.2 The corrective arm

The second stage in the Stability and Growth pact is the corrective arm, with the Excessive Deficit Procedure (EDP) as centrepiece. This arm is centred around two criteria: a limit of 3% of GDP government deficit and an upper bound on the debt-to-GDP ratio of 60%. As long as a member state is compliant with the preventive arm, it should not violate any of these 2 criteria in all but the most extreme circumstances. The corrective arm is therefore not considered to be part of the normal budgetary procedure, but rather serves as a means to rectify previous made policy errors. If a member state, however, breaches one or both of the rules, the Commission will prepare a detailed report on the factors that led to the breach. This report is defined in Article 126(3) of the TFEU. The following sections will be a summary of the procedures under the corrective arm: establishing a breach, the Excessive Deficit Procedure and follow-up procedures.

2.2.1 Establishing non-compliance with the criteria

A member state will be judged non-compliant when it breaks one or both the deficit and debt criterion. A breach in these criteria, either by exceeding the 3% of GDP deficit or 60% debt-to-GDP ratio, has to be identified by the Commission. The identification of a breach can be based on outturn data, plans (see section 2.2.3) or forecast data. During this assessment the criteria will first be examined individually.

2.2.1.1 The deficit criterion

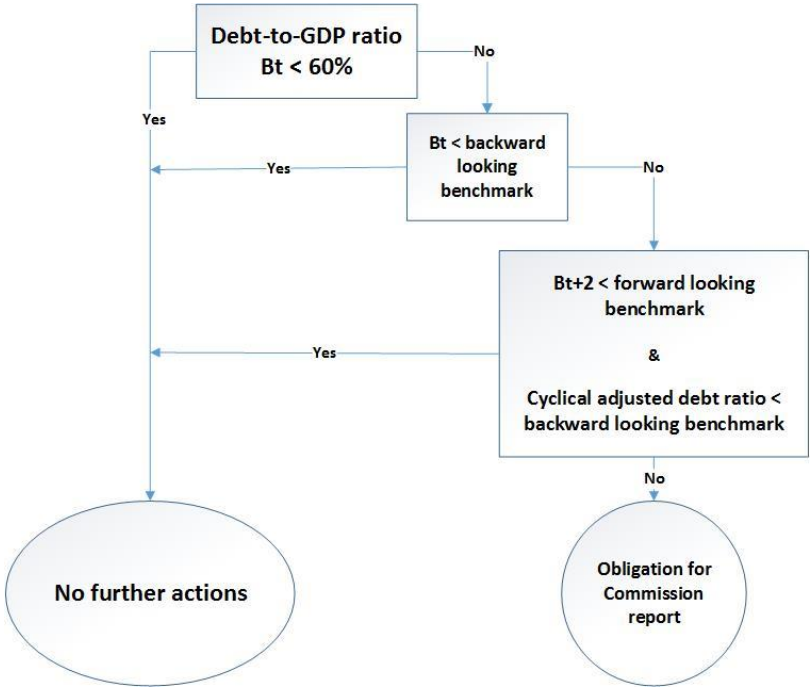
A member state is judged non-compliant with the deficit criterion if the general government deficit exceeds the 3% of GDP. No other factors are taken into account before producing the Commission's report based on this criterion.

2.2.1.2 The debt criterion

With the debt requirement a government needs to keep its debt-to-GDP ratio below 60% or be sufficiently adjusting towards it. If these conditions are not met and the debt ratio exceeds 60%, the Commission will take appropriate action depending on the particular case.

In the case the debt threshold is breached from below, e.g. from 55% to 62%, the Commission will always write the report and send it to the Council, unless the debt ratio goes back below the threshold within the forecast horizon. In all other cases, the breach will be put into perspective with three benchmarks: a backward-looking, a forward looking and a benchmark that takes the impact of the business cycle into account. Only if all three indicate that the debt ratio has increased too much the Commission will write its report to the Council. The specific procedure to judge compliance with the debt criterion is shown in figure 2.1.

Figure 2.1 the steps to assess compliance with the debt criterion in case of a breach from above the benchmark (Based on: Vade Mecum on SGP, European Commission, 2017)



The first step in the assessment procedure will be to check whether or not the debt ratio has met its requirement. If this is the case, no follow-up procedure is needed. If, however, the debt-to-GDP ratio is larger or equal to 60%, a comparison with the backward looking benchmark is made. The backward looking benchmark takes into account the fluctuation in debt. By doing so, the volatility of the debt ratio is taken into account. The backward looking benchmark is calculated as follows:

$$Backward\ looking\ benchmark = 60\% + \frac{0.95}{3}(b_{t-1} - 60\%) + \frac{0.95^2}{3}(b_{t-2} - 60\%) + \frac{0.95^3}{3}(b_{t-3} - 60\%) \quad (2.8)$$

with b_{t-1}, b_{t-2} and b_{t-3} the debt-to-GDP ratios of respectively one, two and three years ago. If a member state was non-compliant in year t-3, the debt ratio should have decreased at an average rate of 5% a year by year t. In other words, if the current debt ratio is smaller than the backward looking benchmark, then the member state is sufficiently adjusting towards the reference value of 60%.

If the current debt-ratio is not smaller than backward looking benchmark, two additional benchmarks are constructed. The first is the forward looking benchmark, which takes fluctuations into account and is constructed in a similar way to the backward looking:

$$Forward\ looking\ benchmark = 60\% + \frac{0.95}{3}(b_{t+1} - 60\%) + \frac{0.95^2}{3}(b_t - 60\%) + \frac{0.95^3}{3}(b_{t-1} - 60\%) \quad (2.9)$$

with b_{t+1}, b_t and b_{t-1} the debt-to-GDP ratios of one year ahead, the current year and one year ago. This benchmark will be compared with the debt ratio at time t+2. The debt ratios at time t+1 and t+2 are forecasted under the assumption of no-policy change. If the forecasted debt ratio at time t+2 is lower than the forward looking benchmark, the member state is judged compliant with the forward looking rule. In this case, the debt ratio will adjust appropriately to 60% without taking any policy measures thus no further action is required.

However, a member state has to be compliant with the second benchmark, the cyclically adjusted debt benchmark, as well. This benchmark has to prevent that a member state will not be subject to an EDP if the non-compliance is caused by the business cycle. The debt-to-GDP ratio is corrected for cyclical components of debt over the past three years and will then be compared to the backward looking benchmark. If the cyclically-adjusted debt ratio is lower than the backward looking benchmark, a member state is considered to be compliant. If this is not the case, the member state is judged non-compliant and the Commission will write the report defined under Article 126(3).

It is important to note that, while the previous few paragraphs describe the normal procedure for the assessment of the debt criterion, an exception exists for member states that already were in an EDP before the adoption of the Six Pack in November 2011. These countries are subject to a transition period three years after they will have corrected their excessive deficit or debt under the existing EDP. This is to ensure that they have time to adapt their structural adjustments to the level needed to comply with the debt reduction benchmark.

2.2.1.3 The Commission's report under Article 126(3)

When there is a breach in either the deficit criterion, the debt criterion or both the Commission will prepare the report defined under Article 126(3). In this report, the Commission examines the factors that caused the breach in more detail.

A negative assessment of deficit and/or debt criterion, however, will not automatically lead to an EDP as exceptions exist and other relevant factors are taken into account as well. Exceptions as temporary or exceptional deviations can count as mitigating circumstances. Other factors like the medium-term budgetary position or adherence to the MTO in case of a breach in the debt ratio will be taken into account as well before deciding on the launch of an EDP.

Once the report is finalized, the Commission will send it to the Economic and Financial Committee of the Council of Ministers (ECOFIN) who will have the final say on the decision of launching an Excessive Deficit Procedure.

2.2.2 Launching an Excessive Deficit Procedure

If the Council judges a member state non-compliant with the deficit and/or debt criteria, an Excessive Deficit Procedure is launched and the Commission will prepare a report with its recommendations for necessary actions to be taken by the member state in question. This report will be based on an analysis of the macro-fiscal situation and will decide on a timeframe within which the breach should be corrected. This report will always contain a deadline for correction, a defined adjustment path both in nominal and structural terms, an expenditure benchmark and a deadline for effective action.

The aim of the deadline for correction set in the recommendations' report is to present a credible path of adjustment towards healthy public finances. By default, the initial deadline is set one year after the breach was identified. However, longer deadlines are possible after a careful analysis, e.g. when the breach of the deficit or debt criterion is substantially high or when full adjustment in one year is not feasible.

The deadline for correction is complemented by a fiscal effort target path, both for an EDP based on the deficit criterion as one based on the debt criterion. This target is defined on the basis of an underlying macroeconomic scenario using the Commission's forecasts with a minimum target set at a 5% of GDP improvement of the structural balance. In the particular case of an EDP based on the debt criterion, compliance with the debt benchmark may require a larger deficit than allowed by the SGP. Such a higher deficit is allowed in the final year before correction as to make sure the debt will comply at the least with the forward looking benchmark.

The third component of the Commission's recommendation is an expenditure benchmark, similarly defined as in the preventive arm. The expenditure benchmark will be set at the value below the medium-term growth rate of potential GDP which is consistent with the fulfilment of the fiscal effort target.

The final component, the deadline of effective action, is set at a maximum of six months. In case of a serious breach, however, the deadline can be shortened to 3 months. The member state has to report the actions undertaken and the Commission will make sure compliance is met in a timely manner.

All four components are included in the Commission's recommendation and are sent to the Council for adoption. If the Council adopts the recommendation, the member state in question will have to take action according to the recommendations of the Commission.

Following the Commission's recommendation, if the Commission judges a member state seriously non-compliant, it can ask the Council to impose sanctions. The Council will then impose a non-interest bearing deposit of 0.2% of GDP by default and maximum value. If there was already an interest bearing deposit under the Significant Deviation Procedure, this will be directly converted in a non-interest bearing one. The decision for imposing sanctions is made by a qualified majority vote.

2.2.3 Monitoring under the Excessive Deficit Procedure

The Commission monitors the progress and judges whether or not effective action is taken. A member state under the EDP has to adopt the necessary measures to comply with the recommendations given by the Commission and this within the given deadline of three or six months. Any taken measures have to be reported to the Council and the Commission and this report has to include additional targets for expenditure and revenue. Furthermore, euro area countries are subject to additional reporting requirements, e.g. reporting an assessment of in-year budgetary execution every three or six months and reporting a roadmap for structural reforms.

When the Commission has received the reports from the member state under the EDP, it will perform a first assessment of compliance with the recommendations by checking a member state is forecast to meet the fiscal effort and expenditure targets within the given deadline. This assessment is preliminary and thus not final, but it will provide the Commission with the necessary information for subsequent action. If a member state meets the targets, the EDP will be put in suspension. If the targets are not met, a careful analysis is performed to determine whether the EDP has to be stepped up or failure to comply is caused by unexpected events.

2.2.3.1 Suspension of the EDP

In the case that a member state under an EDP meets the targets given by the Commission after the first assessment, the EDP will be suspended. It is important to note that this does not mean that the EDP has ended. What it does mean, is that the EDP will not be stepped up and the member state will be put under continuous monitoring. This monitoring procedure entails specific milestones and member states have to report every three or six months depending on the circumstances as listed in section 2.2.2.

Additionally, the Commission will perform regular forecasting exercises to ensure continuous compliance. If a member state is fully compliant, the monitoring process will continue until the EDP is abrogated (see section 2.2.3.5). If, however, non-compliance is identified, the suspension will be lifted and the same procedure is followed as in the initial assessment.

2.2.3.2 The careful analysis

If the initial assessment concludes the given targets were not met, the Commission will perform a careful analysis to determine if the policy commitments were uphold or not.

In this careful analysis the emphasis lies on the expenditure benchmark defined in the recommendation report. If the actual net expenditure growth rate exceeds the recommended rate, there is a presumption that the promised policy commitments are not delivered and vice versa. It has to be remarked that if a member state is found non-compliant in one year, the careful analysis will be made on a cumulative basis. This methodology ensures a front-loaded effort isn't unduly punished while compliance is still met after the correction period. The careful analysis will also include other considerations that might factor in the non-compliance of the recommended targets. Some of these considerations are, but are not limited to, unforeseen inflation developments or a high degree of uncertainty surrounding revenue measures.

After the analysis of the expenditure benchmark and all other relevant factors, the Commission judges if a member state has taken effective action or not. Depending on its findings, two possible scenarios can follow. Either the Commission judges that effective action is taken, but unforeseen circumstances are the cause of non-compliance or it judges that no effective action is taken and the EDP is stepped up.

In the first scenario the Commission can, but is not obligated to, extend the deadline or issue new targets to be met. The second scenario, however, will lead to a notice with revised recommendations accompanied by sanctions (see section 2.2.4).

2.2.4 Procedure following non-compliance with the Commission's recommendations

If the Commission judges that no effective action is taken and the Council adopts this conclusion, the member state under the EDP will receive a notice with revised recommendations. The procedure of assessing compliance with these new recommendations are the same as in section 2.2.2.3 with the difference that the recommended measures need to be adopted in four months, instead of three or six.

Together with the notice several sanctions can be imposed. For example, the Commission can undertake on-site monitoring missions and for euro area member states the Council can decide by qualified majority on a fine equal to 0.2% of GDP. If there was already a non-interest bearing deposit for non-compliance with the deficit or debt criterion, this deposit is converted into a fine and the difference is either returned or made up by the member state. Additionally,

member states can receive a suspension of commitments of the European Structural and Investment Funds.

After the issuance of the notice the member state has to adopt the measures and will be subject to the same assessment procedure as described in section 2.2.2.3. If a member state is found non-compliant again, sanctions will be intensified. A fine ranging between 0.2% and 0.5% of GDP will be imposed and can be supplemented additional restrictions surrounding issuing bonds and lending from the European Investment Bank. This fine should be paid every year until the EDP is either put in suspension or abrogated.

2.2.5 Abrogation of the Excessive Deficit Procedure

The Excessive Deficit Procedure will be concluded when a member state's public finances are back in a healthy condition. Abrogation will take place when the Commission concludes on the basis of observed data that both the deficit and the debt criterion are complied with and it is a lasting correction.

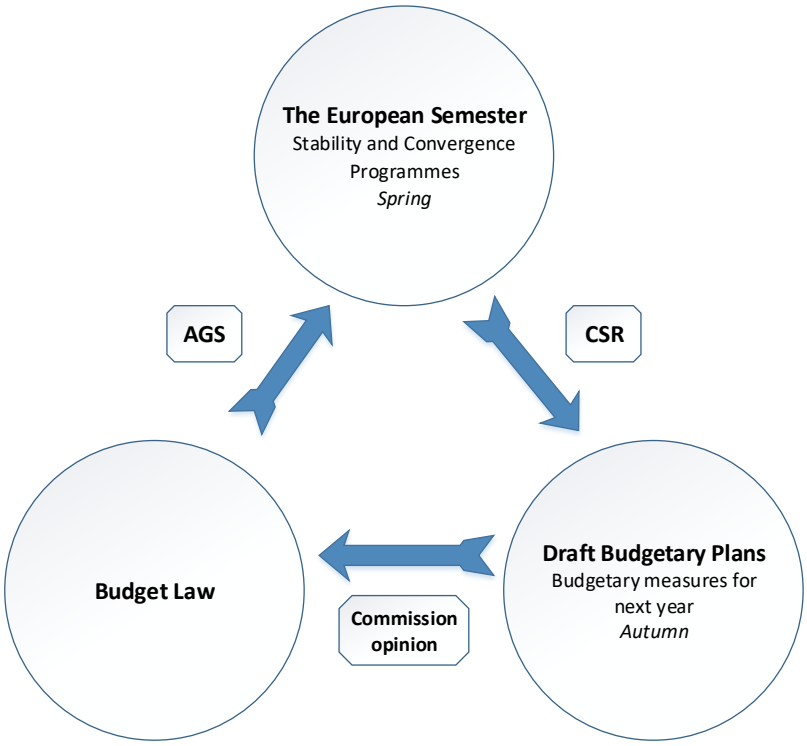
In case of the deficit criterion, this lasting correction is defined as a deficit below or close to 3% of GDP where the deficit has declined continuously and the forecasts indicate it will not exceed the 3% over the forecast horizon. For the debt ratio, a lasting correction is defined as a debt ratio below 60% of GDP or a ratio above 60% but compliant with the forward-looking benchmark based on forecasts (cf. supra). It is important to note that both the deficit as the debt criterion need to be complied with, irrespective of whether the EDP was launched on the basis of the deficit or debt criterion.

When the EDP is abrogated all the imposed sanctions are abrogated as well. The non-interest bearing deposit is returned and the suspensions of commitments of the European Structural and Investment Funds are lifted. Any paid fine, however, is not reimbursed.

2.3 The institutional context

While the Pact's primary goal is to promote sound public finances, it also plays a role in a wider economic surveillance process. The crisis years have led to significant reforms in the Union's economic governance structure, like the institution of the European Semester, the Six Pack, the Two Pack and the Fiscal Compact. All these reforms have led to an annual surveillance cycle which is summarized in Figure 2.2 and elaborated on in sections 2.2.3.1-2.2.3.3.

Figure 2.2 the annual cycle of economic surveillance (Based on: Vade Mecum on SGP, European Commission, 2017)



2.3.1 The European Semester

The annual surveillance cycle starts with the European Semester, which will take place in the first six months of every year. At the start of this semester, the Commission will present the assessment of the economic situation in Europe in its Annual Growth Survey (AGS). In this survey it sets out the economic and budgetary priorities of the Union for the upcoming year. These priorities are discussed and general guidance is given by the European Council to the member states.

Based on this guidance, each member state will submit their Stability and Convergence Programme (SCP) which elaborates on its medium-term budgetary plans. The Commission will evaluate the SCPs on compliance with the given guidance, the preventive arm and the corrective arm (cf. supra). Once the evaluation has been made, the Council will adopt the Commission's country specific recommendations (CSR) and will inform the member states of its performance. The CSRs contain policy guidelines for the following 12 to 18 months and are tailored to each country individually. They will be adopted by the national ministers of finance in July concluding the European Semester.

2.3.2 The Draft Budgetary Plans

Following the European Semester with its Country Specific Recommendations, the guidelines will be adopted into the Draft Budgetary Plans (DBP). Important to note is that while an SCP has to be submitted by each Union member, the DBP is only obligatory for euro area states. The goal of the DBPs is to translate the SCPs into concrete macro-fiscal projections and measures for the next year.

The DBPs will be evaluated in similar way as the SCPs (see section 2.2.1 and 2.2.2). After the evaluation, the Commission will form its opinion and inform the member state. In the case of serious non-compliance with the Pact, a revised plan will be requested which needs to be submitted as soon as possible.

2.3.3 National budgetary process

After the Commission has given its opinion on the DBP, either positive or negative, the member states need to adopt the plans into their national law. How this process is handled, can differ for each country.

The Six Pack, however, does impose several requirements this budgetary process has to conform to. For example, member states have to abide by accounting and fiscal statistics standards, standards on the preparation of forecasts and standards on the transparency of general government finances.

Additionally, the Fiscal Compact imposes two extra requirements for the national budgetary process on its signatories. The first requirement is that all signatories of the Compact should incorporate the Medium-Term Objective (MTO) in their national law and should impose an automatically-triggered correction mechanism in case of deviation. The second requirement imposed by the Fiscal Compact is that compliance with the fiscal rules and the preparation of forecasts should be done under the supervision of an independent institution.

3. Critical analysis of the framework

Now that we know how the European fiscal framework works, this section will discuss some of the criticism that has been given over the years since the SGP's inception. While some of the criticism has already been addressed in the several reforms, e.g. the transition from the use of a nominal towards a structural deficit target, other problems still exist.

3.1 Complexity for flexibility

A first argument used by critics of the current framework is that it is too complex and littered with conditions and exceptions, so much so that it is difficult to implement and comply with. While the several reforms of the Pact have allowed for more flexibility, it has also made it more complex. With more complexity comes more risk, as monitoring compliance and communication to the public becomes more difficult (Andrle et al., 2015). This increased complexity also creates more uncertainty surrounding the outcome of the Commission's decisions, as it holds a wide-range of discretionary power in its assessment (Claeys, Darvas & Leandro, 2016).

3.2 Choice of rules and targets

The current form of the Pact contains three rules: a deficit rule both in nominal (3% of GDP) and structural terms (minimum of 0,5% of GDP), an expenditures rule and a limit on debt of 60% of GDP. The Choice of the 3% deficit and 60% debt limit is based on the fact that under the condition of a minimum of 5% nominal growth, debt will automatically converge to 60%. This can be proven following Wickens (2008, p.103-105):

$$\frac{B_t}{Y_t} \geq \frac{1}{X_t}\frac{D_t}{Y_t} \quad (3.1)$$

with B_t/Y_t the debt-to-GDP ratio, D_t/Y_t the deficit-to-GDP ratio and X_t the nominal growth rate in percentages. If we fill in the numerical values of the SGP and solve for X_t, we get:

$$0.60 \geq \frac{1}{X_t}0.03 \Leftrightarrow 20 \geq \frac{1}{X_t} \Leftrightarrow X_t \geq 0.05 \quad (3.2)$$

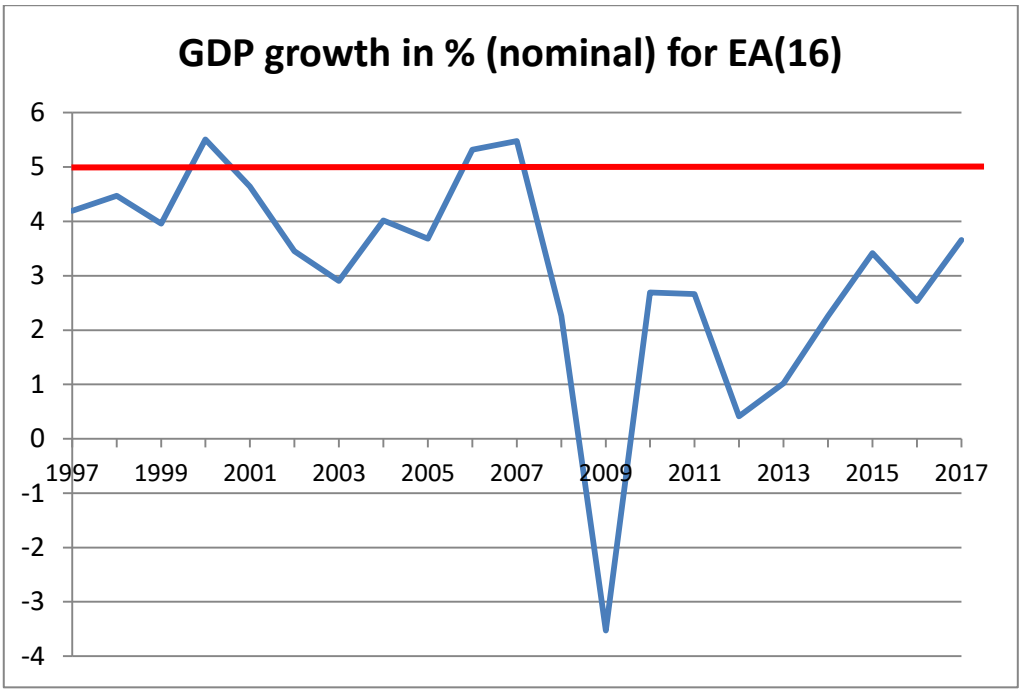
Nominal growth thus has to be larger or equal to 5% in order to be in a fiscal sustainable scenario. However, this 5% nominal growth is a strong conditional factor. As can be seen in figure 3.1, in the period from 1997 up until 2017, there have been only 3 occasions when nominal growth actually reached over 5%. The average growth rate for this time period was 3,1%. If we would repeat the previous exercise, but now with an average growth rate of 3,1%:

$$\frac{B_t}{Y_t} = \frac{1}{0.031}0.03 = 0.968$$

This means that even if the 3% deficit target would be adhered to, debt would converge to 96,8% under a nominal growth rate of 3,1%. This is a substantially higher debt ratio than the

SGP prescribes and which shows there is inconsistency in the fiscal targets for the current economic climate.

Figure 3.1 Nominal GDP growth in percentages for the Euro Area (Cyprus, Malta & Lithuania excluded) Source: OECD Economic Outlook No 102 – November 2017 Code: EA16.GDP_ANNPCT



A second concern surrounding the choice in targets is the large emphasis put on the structural deficit with the MTO. The structural deficit needs to be estimated and this can lead to inaccurate forecasts and reoccurring revisions. This inaccuracy is caused by the difficulty to measure the cyclically adjusted balance in real-time and estimates can be imprecise which can lead to misguided policy advice (Claeys et al., 2016).

Proposals to reform the current set of rules are given by Saraceno & Veroni (2004), Muscatelli, Natale & Tirelli (2012), Andrle et al. (2015), Claeys et al. (2016) and Bénassy-Quéré et al. (2018) to name some of them. While the proposals differ in complexity and implementation, they all have in common that they propose a larger focus on debt rather than deficits. Choosing a debt rule for fiscal sustainability has the advantage of being most effective at convergence to a sustainable debt level and is easier to communicate and monitor (Schaechter et al., 2012). Besides a debt rule, Andrle et al. (2015), Claeys et al. (2016) and Bénassy-Quéré et al. (2018) also propose an expenditure rule as it provides clear operational guidance and transparency if correctly implemented.

3.3 Compliance and credibility of sanctions

A last point of criticism to consider, is the issue with compliance to the targets and the credibility of sanctions imposed on the member states. As of today, only two member states, Sweden and Estonia, have never fallen under the Excessive Deficit Procedure. Every other member state has been subject to the EDP at least once, however, no fines or sanctions have yet been imposed (European Commission, 2018). Darvas & Leandro (2015) find an implementation rate of the Commission's recommendations under the SGP of 44% between 2012 and 2014, which signals low compliance with the Pact. These findings are supported by Andrle et al. (2015) who also find low compliance with the debt target, deficit target and MTO.

One can wonder how credible the sanctions provisioned in the SGP truly are. Financial sanctions may lack credibility in bad times, as they either exacerbate the troubles or, in case of severe hardship, are barely significant at all (Andrle et al., 2015; Claeys et al., 2016). Additionally, since the Council of Ministers has the final say on sanctions, game theory would suggest that sanctions are unlikely. Member states will be less inclined to sanction others since in the future they themselves may be under scrutiny. While this issue can be difficult to address, Andrle et al. (2015) propose that non-financial sanctions be considered, e.g. constraints on hiring by government. Claeys et al. (2015) propose that perception should change as the framework should be seen as economically sound guidance.

4. The Stability and Growth Pact in a New-Keynesian model

Concluding the critical analysis of the Stability and Growth Pact, this chapter will attempt to put the Pact in a New-Keynesian model with price rigidity. More specifically, in this chapter we will analyse the effects of government spending and debt has on the economy and make the link with the SGP and fiscal rules involved. Once our model is built, we will make a comparison between the current dominant fiscal rule, the MTO, and a rule which allows for more flexibility while still ensuring sustainability.

Before continuing, we first have to make several simplifications in order to make our analysis possible. First of all, our model will only consider a closed economy system. This assumption can be compared to a single European super state and while unrealistic, it provides us with a good starting point for our analysis. A second simplification we make, is a MTO of 0%, instead of -0,5% (or -1% depending on the debt-to-GDP ratio) which will allow us to make a clear distinction between a deficit rule and a debt rule.

Section 4.1 to 4.5 will describe the model by defining the behaviour of households, firms, the government sector and market clearing condition. Section 4.6 will continue with a quantitative analysis of a government spending shock under a deficit rule and a debt rule. Finally, section 4.7 will conclude by checking the robustness of the results of section 4.6.

4.1 The households problem

We start of our model by defining the households: how they behave and make their decisions. In general, the households' utility is defined by the following standard utility function:

$$U(C_t, N_t) = \log C_t - \zeta \frac{N_t^{1+\varphi}}{1+\varphi} \quad (4.1)$$

This function has two control variables, consumption C_t and labour hours N_t. Households will seek to maximize this utility function subject to several constraints. These constraints, however, differ between the types of households as we make a distinction between two types: First, we have the fully rational households who behave in a perfectly optimal and rational way. Second, we have rule-of-thumb households who are limited in their capabilities and consume their whole disposable income for each period. The following sections go into more detail of each type of household's specific behaviour.

4.1.1 The fully optimizing households

The first type of households is the fully optimizing or "Ricardian" households. These households behave in a perfectly rational way and have full access to capital markets. They will seek to maximize the following utility function for each period:

$$U(C_t^o, N_t^o) = E_0 \sum_{t=0}^{\infty} \beta^t (\log C_t^o - \zeta \frac{{N_t^o}^{1+\varphi}}{1+\varphi}) \quad (4.2)$$

In this maximization problem, these "Ricardians" face two constraints: the budget constraint and the capital accumulation constraint.

$$P_t C_t^o + P_t I_t^o + R_t^{-1} B_{t+1}^o \leq W_t P_t N_t^o + R_t^k P_t K_t^o + B_t^o - P_t T_t \quad (4.3)$$

$$K_{t+1}^o = (1-\delta) K_t^o + \Phi\left(\frac{I_t^o}{K_t^o}\right) K_t^o \quad (4.4)$$

In the first constraint, the left-hand-side shows the spending possibilities. A "Ricardian" can choose between buying consumption goods C_t or investment goods I_t both for the price P_t or buying government issued bonds valued at $R_t^{-1}B_{t+1}$ with R_t the gross nominal interest rate. On the right-hand-side we have the disposable income. Households provide hours of labour N_t for which they receive a nominal wage W_tP_t. They receive additional income from capital K_t rented out to the firms who remunerate them with interest R^k_t P_t. A third source of income is the government bonds issued at time t-1 who get paid back. Lastly, the government imposes a lump sum tax T_t, reducing the households' disposable income. We further assume that spending cannot exceed disposable or in other words there is no private debt.

The second constraint is the capital accumulation constraint. Capital stock is created from household investments. At time t the "Ricardians" decide upon how much they are willing to invest and by doing so they decide upon the capital stock for the next period. Additionally, we introduce that capital adjustment costs similar to Gali, Vallés & López-Salido (2007) with $\Phi\left(\frac{I_t^o}{K_t^o}\right) K_t^o$ representing the change in capital because of investment. We asumme this function to be an increasing, concave function and in equilibrium investment equals depreciating capital.

The utility function, budget and capital accumulation constraint combined result in the following Lagrange function:

$$\mathcal{L} = \sum_{t=0}^{\infty} E_0 \beta^t \Bigg(\log C_t^o - \zeta \frac{{N_t^o}^{1+\varphi}}{1+\varphi}) + \lambda_t (W_t P_t N_t^o + R_t^k P_t K_t^o + B_t^o - P_t T_t - P_t C_t^o - P_t I_t^o - R_t^{-1} B_{t+1}^o) + q_t ((1-\delta) K_t^o + \Phi\left(\frac{I_t^o}{K_t^o}\right) K_t^o - K_{t+1}^o) \Bigg)$$

If we solve this for the control variables C_t, C_{t+1}, N_t, K_{t+1}, I_t and B_{t+1} the first order conditions can be written as:

$$W_t = \zeta C_t^o N_t^{o\varphi} \quad (4.5)$$

$$E_t\left(\frac{C_{t+1}^o}{C_t^o}\right) = \beta \frac{1+r_t}{1+E_t \pi_{t+1}} \quad (4.6)$$

$$Q_t = E_t \left\{ \Lambda_{t,t+1} \left(R_{t+1}^k + Q_{t+1} \left[(1-\delta) + \Phi\left(\frac{I_{t+1}^o}{K_{t+1}^o}\right) - \Phi'\left(\frac{I_{t+1}^o}{K_{t+1}^o}\right)\left(\frac{I_{t+1}^o}{K_{t+1}^o}\right) \right] \right) \right\} \quad (4.7)$$

$$\frac{1}{\Phi'\left(\frac{I_t^o}{K_t^o}\right)} = Q_t \quad (4.8)$$

The equations are the labour supply function under perfect labour market conditions, the Euler equation, the shadow value of capital or Tobin's Q and its relation with respect to investment, respectively. The labour supply function describes the decision for hours supplied by the households at a given market wage W_t. The second equation, illustrates that consumption growth will be equal to the subjective discount factor β multiplied with the gross expected real interest rate. The third and fourth equations describe the optimal future capital holdings and optimal investment. The third equation specifically states that the consumption possibilities from holding capital now needs to be equal to the extra consumption possibilities created later (F. Heylen, personal communication, 2017), while the fourth shows the relation between Tobin's Q and investment.

4.1.2 Rule-of-thumb households

The second type of households is the rule-of-thumb consumer. Unlike the fully optimizing households, this group does not behave in a full "Ricardian" way. Instead, these households consume their full labour income in one period and they do not look further in the future. Gali et al. (2007) propose several reasons why this non-Ricardian behaviour might occur, like myopia, borrowing constraints or ignorance of intertemporal trading opportunities. These rule-of-thumb households will maximize the following utility function:

$$U(C_t^r, N_t^r) = \log C_t^r - \zeta \frac{N_t^{r\,1+\varphi}}{1+\varphi} \quad (4.9)$$

Similar to the maximization problem for the "Ricardian" households, they face a budget constraint. This budget constraint, however, does not contain any form of capital, investment or government bonds. All disposable labour income is spent on consumption.

$$P_t C_t^r = W_t P_t N_t^r - P_t T_t$$

Simplifying the previous equation leads us to:

$$C_t^r = W_t N_t^r - T_t \quad (4.10)$$

The Lagrange function for these households then becomes:

$$\mathcal{L} = \log C_t^r - \zeta \frac{N_t^{r\,1+\varphi}}{1+\varphi} + \lambda_t (W_t N_t^r - T_t - C_t^r)$$

With first order condition:

$$W_t = \zeta C_t^r N_t^{r\varphi} \quad (4.11)$$

Similar as in section 4.1.1 this is the labour supply equation under perfect labour market conditions for rule-of-thumb households.

4.1.3 Aggregation

Before continuing with the description of the firms and government, we first have to aggregate both types of households. We will assume that aggregate consumption in our economy is made up by a fraction λ of rule-of-thumb consumers and a fraction 1-λ of "Ricardians". This results in:

$$C_t = \lambda C_t^r + (1-\lambda) C_t^o \quad (4.12)$$

Similarly, we define the aggregate hours of supplied labour:

$$N_t = \lambda N_t^r + (1-\lambda) N_t^o \quad (4.13)$$

Finally, since only "Ricardians" have the possibility to save and invest, total investment and capital stock depends only on the fraction of "Ricardians" in our economy.

$$I_t = (1-\lambda) I_t^o \quad (4.14)$$

$$K_t = (1-\lambda) K_t^o \quad (4.15)$$

4.2 The firms problem

All goods are produced by the firms in our economy. Similar to our assumptions for households, we will assume there to be two types of firms: a representative final goods firm and a continuum of intermediate good firms. We will discuss both in more detail in section 4.2.1 and 4.2.2.

4.2.1 Final goods firm

The representative final goods firm operates in a perfectly competitive market and produces the final investment and consumption goods for the households and government spending. The production of the final good uses constant elasticity of substitution technology and the input is provided by the intermediate good firms:

$$Y_t = \left(\int_0^1 X_t(j)^{\frac{\phi-1}{\phi}} dj \right)^{\frac{\phi}{\phi-1}} \quad (4.16)$$

with $X_t(j)$ the intermediate good and ϕ the elasticity of substitution between intermediate goods. We further assume that $\phi \in]1, +\infty[$ which implies that the intermediate goods are imperfect substitutes. Since the final good firm operates in a perfectly competitive market, prices are given and profits are maximized as follows:

$$Profit = \max_{X_t(s)} P_t Y_t - \int_0^1 P_t(j) X_t(j)\, dj \quad \forall s \in [0,1]$$

Solving the previous equation, results in the demand function for the specific intermediate good. This demand will depend on the ratio of specific prices $P_t(j)$ compared to the general price level P_t, the elasticity of substitution ϕ and the level of output Y_t.

$$X_t(j) = \left(\frac{P_t(j)}{P_t}\right)^{-\phi} Y_t \quad (4.17)$$

A second implication of the perfect competitive market is that free entry is possible which will push prices down to production costs resulting in zero profits.

$$P_t Y_t = \int_0^1 P_t(j) X_t(j)\, dj$$

Rewriting this equation with $Y_t = X_t(j)\left(\frac{P_t(j)}{P_t}\right)^{\phi}$ results in the following price index:

$$P_t = \left[\int_0^1 P_t(j)^{1-\phi}\, dj\right]^{\frac{1}{1-\phi}} \quad (4.18)$$

4.2.2 Intermediate goods firm

Unlike the final goods firm, the intermediate good firms do not operate in a perfectly competitive market. However, we will assume that each of these firms is a monopolist of their own good. This implies that these firms do have some market power and are able to set their own prices. These prices, however, will be set in a staggered fashion like proposed by Calvo (1983).

First, we assume that the intermediate good firms produce according a Cobb-Douglas production function with constant returns to scale:

$$Y_t(j) = A_t K_t(j)^{\alpha} N_t(j)^{1-\alpha} \quad (4.19)$$

with A_t the available technology, K_t the capital stock and N_t labour hours provided by the households. Since these firms are monopolists of their own product, they will seek to minimize their cost given the constraint that they need to meet the demand of the final good firm. This results in the following Lagrange:

$$\mathcal{L} = W_t N_t(j) + R_t^k K_t(j) + \mu_t(j)[X_t(j) - A_t K_t(j)^{\alpha} N_t(j)^{1-\alpha}]$$

Solving the Lagrange gives the first order condition:

$$\frac{K_t(j)}{N_t(j)} = \left(\frac{\alpha}{1-\alpha}\right)\left(\frac{W_t}{R_t^k}\right) \quad (4.20)$$

Since wages and rental cost of capital are given and do not depend on the specific intermediate good j, this equation states that the capital-labour ratio will be the same for each intermediate good firm.

Next we can derive the real marginal cost function as well from the Lagrangian. Since the cost function is defined by the sum of total real labour cost and total real rental cost of capital, the real marginal cost function will be the derivative of this function. This results in:

$$MC_t{}^r = \frac{1}{A_t}\psi(R_t^k)^{\alpha}W_t{}^{1-\alpha} \quad (4.21)$$

with $\psi = (1-\alpha)^{-(1-\alpha)}\alpha^{-\alpha}$ and $MC_t{}^r$ the real marginal cost. Note that in order to get the nominal marginal cost we merely have to multiply this with P_t.

Next, we have to define the price index. As stated before we will assume that prices are set in a staggered fashion, like first proposed by Calvo (1983). Using equation 4.18 and assuming that a firm only can change its price to changing circumstances with probability (1-θ) we get:

$$P_t = \left[\theta P_{t-1}^{1-\phi} + (1-\theta)(P_t^{\#})^{1-\phi}\right]^{\frac{1}{1-\phi}} \quad (4.22)$$

Aggregate price is thus a weighted average of the prices of the previous period and the new optimal price chosen by firms who can adjust. $P_t^{\#}$ is also known as the reset price. The way firms choose this optimal reset price results from the following maximization problem:

$$\max_{P_t^{\#}} E_t \sum_{k=0}^{\infty}\left\{(\beta\theta)^k\left(\underbrace{Y_{t+k}(j)(P_{t+k})^{\phi-1}(P_t^{\#})^{1-\phi}}_{A} - \underbrace{(P_{t+k})^{-1}C\left[Y_{t+k}(j)(P_{t+k})^{\phi}(P_t^{\#})^{-\phi}\right]}_{B}\right)\right\}$$

Firms will seek to maximize the expected present discounted values of the real profits taking into account the probability they will be stuck with the current price. Here we have both the subjective discount rate β and θ in the discount factor. Factor A and B are the real profits and real costs, respectively with C(-) the nominal cost function. The maximization problem is solved by differentiating with respect to $P_t^{\#}$ and this results in the first order condition:

$$E_t \sum_{k=0}^{\infty}\left\{(\beta\theta)^k\left((1-\phi)Y_{t+k}(j)(P_{t+k})^{\phi-1}(P_t^{\#})^{-\phi} + \phi MC_{t+k}Y_{t+k}(j)(P_{t+k})^{\phi-1}(P_t^{\#})^{-\phi-1}\right)\right\} = 0$$

Rewriting the first order condition gives us the optimal reset price:

$$P_t^{\#} = \frac{\phi}{\phi-1}E_t\left[\frac{\sum_{k=0}^{\infty}\left\{(\beta\theta)^k MC_{t+k}Y_{t+k}(j)(P_{t+k})^{\phi-1}\right\}}{\sum_{k=0}^{\infty}\left\{(\beta\theta)^k Y_{t+k}(j)(P_{t+k})^{\phi-1}\right\}}\right] \quad (4.23)$$

Interpreting equation 4.23, we can see that if prices would be perfectly flexible or θ=0 the reset price would be the product of the nominal marginal cost and a mark-up determined by the elasticity of substitution. This is the result we would expect in case of monopolistic competition. If prices are inflexible, the optimal price will be a mark-up over weighted average of expected future marginal costs. The discount factor $(\beta\theta)^k$ puts less weight on future marginal costs. The term $Y_{t+k}(j)(P_{t+k})^{\phi-1}$, however, represents aggregate factors affecting the demand for the intermediate good and will somewhat mitigate the discount factor (Whelan, 2016).

4.3 The government sector

The third participant in our economy is the government sector. Within this government we have two authorities: the monetary authority and the fiscal authority. Our assumption is that both are independent from each other, which is reasonable since in Europe the European Central Bank is considered to be highly independent (ECB, 2017). Both are discussed in more detail below.

4.3.1 The monetary authority

The nominal interest rate in our economy is controlled by the central bank. In the European Union the European Central Bank is considered to be independent from any government and its main goal is maintaining price stability in Europe (Treaty on the Functioning of the European Union, 2016, Article 127). To maintain this price stability, the ECB will set the nominal interest rate according to the following rule:

$$r_t = r^* + \phi_\pi \pi_t \quad (4.24)$$

with r_t the nominal interest rate, r^* the nominal interest rate in equilibrium and $\phi_\pi \pi_t$ the inflation dependent component. In order to ensure a stable outcome, we need to assume that $\phi_\pi > 1$ otherwise inflation could not be controlled by the central bank. This is also known as the Taylor Principle (Taylor, 1999). This rule is can also be seen as a special case of the Taylor rule proposed by John B. Taylor (1993) with the coefficient of response to the output gap set to zero.

4.3.2 The fiscal authority

The next actor in our economy is the fiscal authority or the government. The government raises revenue by levying lump sum taxes $P_t T_t$ and issuing debt at price $R_t^{-1} B_{t+1}$. This revenue is spent on government spending $P_t G_t$ and repaying its debt B_t. This results in the government budget constraint 4.25:

$$P_t G_t + B_t = P_t T_t + R_t^{-1} B_{t+1} \quad (4.25)$$

Government spending is assumed to be determined by an AR(1) process with $0 < \rho_g < 1$ and $\varepsilon_{g,t}$ an exogenous shock with constant variance.

$$G_t = \rho_g G_{t-1} + \varepsilon_{g,t} \quad (4.26)$$

Our analysis in section 4.6 will make a comparison between two fiscal rules: a deficit rule and a debt rule. While the Stability and Growth Pact contains both, however, more emphasis is put on the deficit rule as previously stated in section 3.2. Making the distinction between these rules allows us to see how the economy responds under the different scenarios.

We define the deficit rule by imposing that for each increase in spending, a one-for-one increase in taxes is needed to ensure balance. Although this is more restrictive than the current fiscal rules in place in the SGP, it is still a reasonable simplification since the MTO's lower bound is set at 0.5% of GDP. Algebraically this rule is defined as:

$$G_t = T_t \quad (4.27)$$

The second rule we'll be analysing is a debt rule. This rule does allow spending to exceed taxes; however, taxes will still need to adjust over time to ensure fiscal sustainability. An algebraic notation of this rule is given by equation 4.28:

$$T_t = \phi_b \frac{B_t}{P_{t-1}} + \phi_g G_t \quad (4.28)$$

With a debt rule taxes thus adjust to debt issued in the previous period and government spending in the current period with ϕ_b and ϕ_g as positive constants.

4.4 Market clearing

In order to close the model we have to put a few more assumptions in place. The first two are that the summation of both labour input and capital stock used by the intermediate firms equals the supplied labour and capital of the households. This is shown is equation 4.29 and 4.30. The last assumption is the market clearing condition, which states that production Y_t equals the sum of household consumption C_t and investment I_t and government spending G_t. This is equation 4.31.

$$N_t = \int_0^1 N_t(j)dj \quad (4.29)$$

$$K_t = \int_0^1 K_t(j)dj \quad (4.30)$$

$$Y_t = C_t + I_t + G_t \quad (4.31)$$

4.5 Final set of equations

Before introducing our model in Dynare, we are going to log-linearize the equations such that any deviation shown in our results is a deviation from the steady state values. For notation purposes, we will indicate the log-linearization around this steady state with a tilde. We start with linearizing the households' equations 4.6, 4.10 and 4.12. Similar as in Gali et al. (2007) we will assume that the steady state value of consumption is the same for both "Ricardian" and Rule-of-thumb consumers, thus $C_t^* = C_t^{o*} = C_t^{r*}$.

$$-\widetilde{C_t^o} = -\widetilde{C_{t+1}^o} + \widetilde{R_t} - E_t\widetilde{\pi_{t+1}}$$

$$\widetilde{C_t^r} = \frac{W^* N^{r*}}{C^*}\left(\widetilde{W_t} + \widetilde{N_t^r}\right) - \frac{Y^*}{C^*}\widetilde{t_t}$$

$$\widetilde{C_t} = \lambda\widetilde{C_t^r} + (1-\lambda)\widetilde{C_t^o}$$

With some rewriting the Euler equation for consumption can be reduced to an aggregate equation (for full derivation, see the appendix):

$$\widetilde{C_t} = E_t\widetilde{C_{t+1}} - \frac{1}{\sigma_C}\left(\widetilde{R_t} - E_t\widetilde{\pi_{t+1}}\right) - \Theta_n E_t\Delta\widetilde{N_{t+1}} + \Theta_t E_t\Delta\widetilde{T_{t+1}}$$

Using equation 4.5, 4.11, 4.12 and 4.13 we get the log-linearized equation for aggregate labour supply. Since we assume that the steady state consumption value is the same for each type of consumer, the same is implied for the steady state value for labour hours N_t.

$$\widetilde{W_t} = \widetilde{C_t} + \varphi\widetilde{N_t}$$

Log-linearizing the capital accumulation, Tobin's Q and its relation with investment gets us:

$$\widetilde{K_{t+1}} = (1-\delta)\widetilde{K_t} + \delta\tilde{I}$$

$$\widetilde{I_t} - \widetilde{K_t} = \eta\widetilde{Q_t}$$

$$\widetilde{Q_t} = -\left(\widetilde{R_t} - E_t\widetilde{\pi_{t+1}}\right) + (1-\beta(1+\delta))E_t\widetilde{R_{t+1}^k} + \beta\widetilde{Q_{t+1}}$$

with $\eta = \frac{1}{\Phi''(\delta)\delta}$.

The key equations for firms are 4.19, 4.20 and 4.21 which can be linearized to get the following three results:

$$\widetilde{Y_t} = \widetilde{A_t} + \alpha\widetilde{K_t} + (1-\alpha)\widetilde{N_t}$$

$$\widetilde{W_t} + \widetilde{N_t} = \widetilde{R_t^k} + \widetilde{K_t}$$

$$\widetilde{MC_t}^r = \alpha\widetilde{R_t^k} + (1-\alpha)\widetilde{W_t} - \widetilde{A_t}$$

The determination of the optimal reset price and general price dynamics can be rewritten to get the New Keynesian Philips curve.

$$\widetilde{\pi_t} = \frac{(1-\theta)(1-\beta\theta)}{\theta}(\widetilde{MC_t}^r) + \beta E_t\widetilde{\pi_{t+1}}$$

The log-linearized Taylor rule, the government budget constraint and the AR(1) process of government spending are:

$$\widetilde{r_t} = \phi_\pi \widetilde{\pi_t}$$

$$\widetilde{b_{t+1}} = (1 + r^*)(\widetilde{b_t} + \widetilde{g_t} - \widetilde{t_t})$$

$$\widetilde{g_t} = \rho \widetilde{g_{t-1}} + \varepsilon_{g,t}$$

Note that government debt, government spending and taxes are not linearizeπd around their own steady state, but around steady state output, i.e. $\widetilde{b_t} = \frac{B_t \backslash P_{t-1} - B^* \backslash P^*}{Y^*}, \widetilde{g_t} = \frac{G_t - G^*}{Y^*}, \widetilde{t_t} = \frac{T_t - T^*}{Y^*}$. Next, both types of fiscal rules are linearized:

$$\widetilde{g_t} = \widetilde{t_t} \quad (Deficit\ rule)$$

$$\widetilde{t_t} = \phi_b \widetilde{b_t} + \phi_g \widetilde{g_t} \quad (Debt\ rule)$$

In order to ensure debt is non-explosive in case of a debt rule, we need to put this rule in the government budget constraint (Gali et al., 2007). The result shows that in order for debt to be non-explosive $\phi_b$needs to be large enough, or algebraically:

$$\widetilde{b_{t+1}} = (1 + r^*)(1 - \phi_b)\widetilde{b_t} + (1 + r^*)(1 - \phi_g)\widetilde{g_t}$$

$$(1 + r^*)(1 - \phi_b) < 1$$

Lastly, we log-linearize the market clearing condition. Note that here again we log-linearize government spending around the steady state value of output:

$$\widetilde{Y_t} = \frac{C^*}{Y^*}\widetilde{C_t} + \frac{I^*}{Y^*}\widetilde{I_t} + \widetilde{g_t}$$

4.6 Quantitative analysis

The last step to be taken before putting our model in Dynare is to define our parameters and several key steady state expressions. We start with the output elasticity of capital α and, consequently, the output elasticity of labour (1-α). We assume a capital share of 33,33% which implies a value of 1/3 for α. To the subjective discount factor β we attribute a value of 0,99 which implies a steady state annual interest rate around 4%. Next, we assume capital to depreciate at a rate of 2,5% each quarter or 10% a year, giving us a δ of 0,025 (Gali et al., 2007; Leeper, Plante & Traum, 2010; Smets & Wouters, 2002). The inverse of the Frish elasticity φ is given a value of 0.2, as used in e.g. Gali et al. (2007). The fraction of rule-of thumb consumers λ is set at 0,5 and the elasticity of the investment-capital ratio η is set at 1 (Gali et al., 2007). On the firms' side, we have to attribute values to the elasticity of substitution between goods ϕ and the Calvo parameter for price stickiness θ. For ϕ we follow Gali et al. (2007) and attribute a value of 6 to it, which implies that the mark-up on the marginal costs of the intermediate goods is equal to 1,2. Additionally, the Calvo parameter is set at 0,75 based on our assumption that prices remain unchanged for one year on average. For the government institutions we attribute a value of 1,5 and 0.9 to the inflation response of monetary policy and the persistence of government spending, respectively. Lastly, the fiscal responses to debt and government spending we start with values of 0,33 and 0,1 (Gali et al, 2007).

Table 4.1 Parameterization of baseline model

Parameter	Value
α	1/3
β	0.99
δ	0.025
φ	0.2
λ	0.5
η	1
ϕ	6
θ	0.75
ϕ_π	1.5
ρ_g	0.9
ϕ_b	0.33
ϕ_g	0.1

Besides these initial parameters we also need to define a few steady state expressions in order to run our simulation. Since several of these are rewritten forms of our equations, we will only discuss the most important expressions. The first expression worth highlighting is g^* or the government spending-to-GDP ratio. We assume that in steady state government spending is a fixed fraction of total output and we fix this value at 0,2. Next, in steady state the marginal

costs are equal to the inverse of the mark-up. This results from the fact that in the long run prices are fully flexible implying a Calvo parameter θ of 0.

Table 4.2 Steady state expressions used in baseline model

Steady state expressions
$r^* = \frac{1}{\beta} - 1$
$g^* = 0.2$
$MC^* = \frac{\phi - 1}{\phi}$
$\frac{C^*}{Y^*} = 1 - \frac{\delta\alpha}{\left(\frac{r^* + \delta}{MC^*}\right)} - g^*$
$\frac{I^*}{Y^*} = 1 - \frac{C^*}{Y^*} - g^*$

In the next sections, we will simulate the impulse response functions to a government spending shock. The reason we choose to analyse a government spending shock is to better understand which effect the two fiscal rules have on our economy and how effective they are to discourage spending and debt. The next paragraphs will first discuss the impulse response functions under a deficit rule, followed by a discussion of the alternative debt rule.

4.6.1 IRFs under a deficit rule

The first analysis we make is the scenario under a deficit rule. A lot of emphasis is put on the structural balance with the Medium-term Objective as centrepiece in the preventive arm of the Stability and Growth Pact. As discussed in chapter 2, the structural balance cannot be lower than -0,5% (or -1%) of GDP. However, for convenience purposes we will assume the MTO cannot be lower than 0% or in other words, there can be no debt accumulation because of structural deficits. All structural spending has to be financed by taxes, which in our case is lump sum taxation.

The impulse response functions are shown in figure 4.1 and 4.2. Our analysis starts with evaluating the evolution of output. Under the parameterization we've chosen, output rises, however not in a one-for-one fashion with government spending. As we know from the market clearing condition, this implies that either consumption or investment or both decrease. In this scenario, we see a decrease in both with a negative wealth effect on consumption, while investment decreases because of crowding out.

Because of the deficit rule in place, an increase in government spending has to be financed by an equal increase in taxation. The burden of this increase in taxation will be carried by both "Ricardians" as well as rule-of-thumb households. This causes them to feel poorer which leads to less consumption and higher work effort. The optimizing households will smooth out their decrease in consumption as they optimize their utility over multiple periods. Rule-of-thumb households, however, don't take the future into account and will thus reduce their consumption relatively more than the "Ricardians". The negative wealth effect also leads to an increase in labour supply. This increase in supply, however, is not met with an equal increase in labour demand, resulting in a drop of the real wage.

Besides the wealth effect government spending has on our economy, it also affects investment through a marginal productivity effect and a crowding out effect. The increase in hours worked causes the marginal productivity of capital to increase which increases investment. However, the negative effect of the increasing interest rate will dominate, resulting in a drop in investment. Lower investment eventually leads to a lower capital stock, which can be clearly seen in figure 4.1.

On the firm's side of the story, the combination of increased demand, increased capital rental costs and a slight mitigation of decreased real wages eventually leads to higher marginal costs. Because increased marginal costs makes the intermediate good firms re-evaluate their prices, the optimal reset price will increase and this causes rising inflation. Following the increased inflation the monetary authority will respond by increasing the nominal interest rate which discourages consumption, and by consequence demand, even more.

The first thing that should be clear from this analysis is that households' utility is negatively affected by the increase in government spending because consumption decreases and work effort increases. In addition to this, investment and capital also decrease over an extended period of time. A fiscal authority thinking about increasing its spending will thus have to consider whether or not the benefits of increased spending weigh up against the costs. We also see that increased government spending increases inflation. Since the European Union's monetary policy is conducted by the ECB and the ECB has the explicit goal to maintain price stability, this increase in inflation might be undesirable.

Figure 4.1 Impulse response functions to a one standard deviation government spending increase under a deficit rule

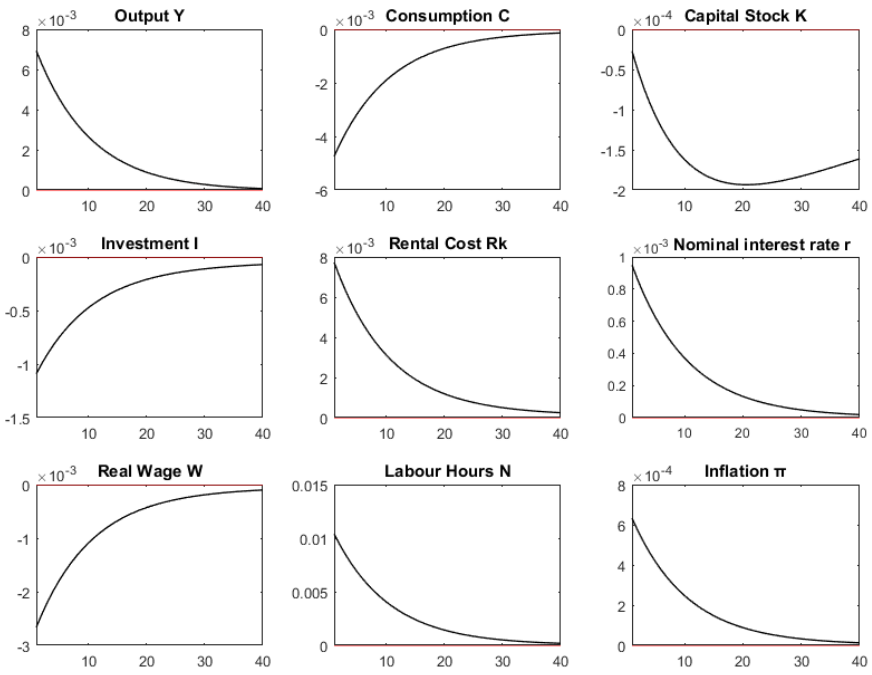
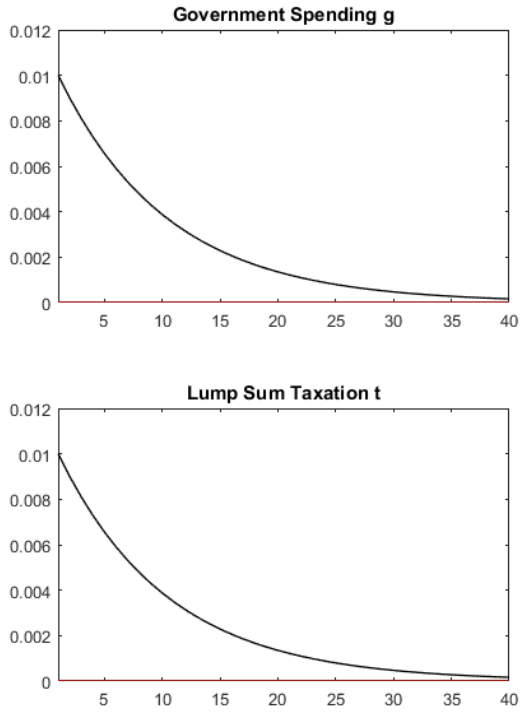


Figure 4.2 Impulse response functions to a one standard deviation government spending increase under a deficit rule



4.6.2 IRFs under a debt rule

Now that we have discussed what happens after a government spending shock with a deficit rule in place, we take a look at what happens if a debt rule is put in place. The goal of a debt rule is to ensure fiscal sustainability in the long run while still allowing for some short-run flexibility in choice of financing. The results are shown in figure 4.3 and 4.4. At a first glance the results seem to be very similar as under the deficit rule, albeit with difference in intensity.

Output increases following the government spending shock, though again not in a one-for-one fashion. Both consumption and investment decrease, caused by the negative wealth effect and crowding out effect respectively. The main difference with the deficit rule is the allowance of debt to accumulate meaning taxes won't initially increase in the same amount as government spending. For the "Ricardians" this doesn't change anything, since they foresee that the increase in debt leads to higher taxation later. They will thus behave in the same manner and smooth out their consumption over time. Rule-of-thumb households, however, do change their behaviour in comparison to the deficit rule scenario. They will consume more in the first few quarters relative to the deficit rule scenario, since these households consume their whole disposable income and taxes don't immediately increase as rapidly. This behaviour explains the wave-shaped pattern in both consumption and real wage, as in the first few periods rule-of-thumb households will not lower their consumption as much, resulting in a lower marginal utility of consumption which in turn translates into a lower increase in labour supply. However, since the debt-to-GDP ratio needs to be sustainable, debt needs to be repaid and taxes will have to increase eventually. Higher taxation will force rule-of-thumb households to decrease its consumption and increase their labour supply. To finish our story, just like in the deficit rule scenario, marginal costs increase leading to higher inflation. Higher inflation forces the central bank to set the interest rate at a higher level in order to maintain price stability.

Just as in the deficit rule scenario, we see a decrease in consumption and an increase in labour hours which both negatively impact households' utility. Next to that, investment and capital also drop and inflation also increases causing pressure on the monetary authority. The difference here, however, is that while the sign is the same as in the previous scenario, the intensity differs. In the next section, we will make a comparison between the deficit and debt rule scenarios to illustrate this difference in intensity.

Figure 4.3 Impulse response functions to a one standard deviation government spending increase under a debt rule

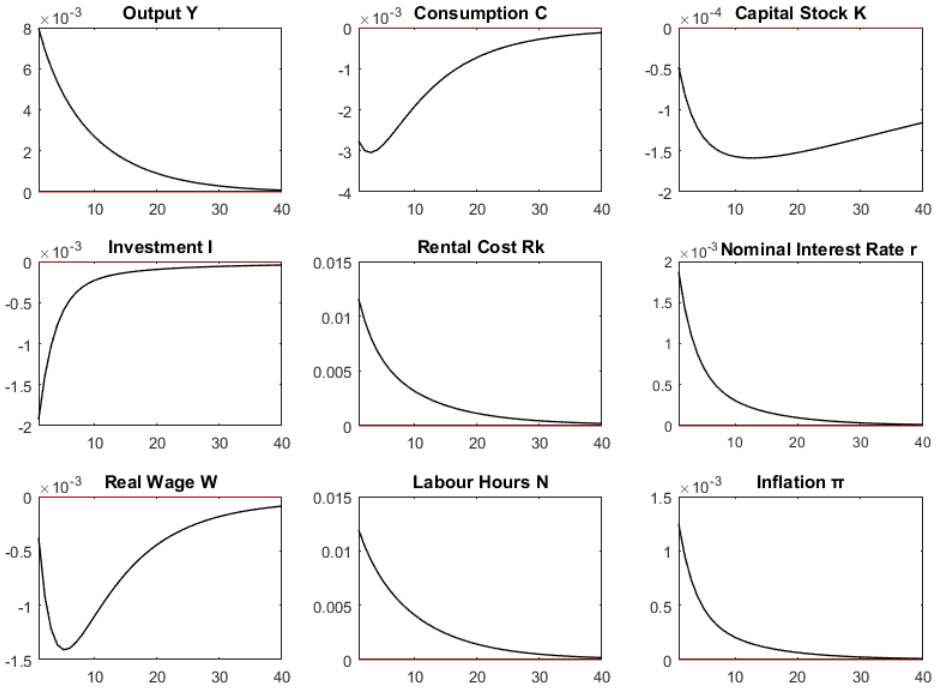
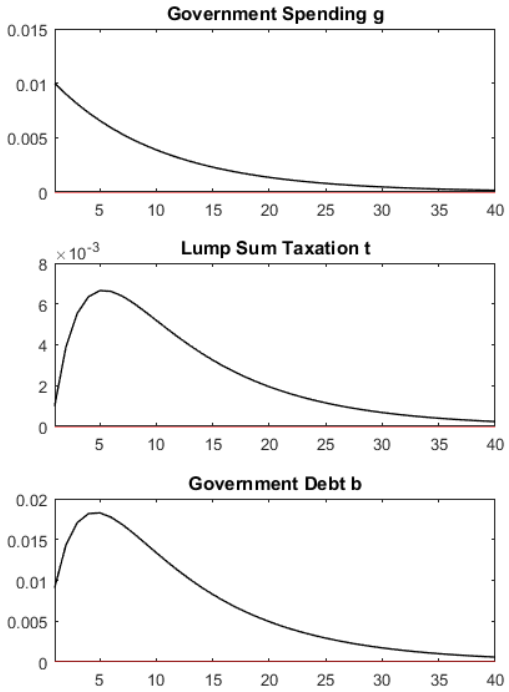


Figure 4.4 Impulse response functions to a one standard deviation government spending increase under a debt rule



4.6.3 A comparative analysis

In this section we will make a quick comparison between the IRFs under both rules. Starting off with the evolution of output following a government spending shock, we see in figure 4.5 a larger increase in output under a debt rule compared to a deficit rule scenario. However, output evolution under both rules rather quickly converges as after 6 to 7 quarters both are barely distinguishable.

The difference in IRFs between the two fiscal rules can be explained by three factors. First of all, consumption decreases less if the fiscal authority is allowed to accumulate debt as can be seen in figure 4.5. This is the result of the fraction of rule-of-thumb consumers who don't take the future tax increase into account and thus reduce their consumption less than they would have if government spending was fully tax financed. A second factor is the increase in nominal interest rate set by the central bank to combat the higher inflation. As seen in the fourth graph in figure 4.5, inflation is higher under a debt rule than under a deficit rule. A higher increase in rental costs and lower decrease in real wage under the debt rule causes marginal costs and consequently inflation to increase more. The central bank pursues price stability and will thus respond setting the nominal interest rate higher. A third and last important factor at play here is the larger decrease in investment under the debt rule. The cause of this larger decrease can be linked with the previous factor: as interest rates rise more, so does the user cost of capital and therefore investing becomes less attractive. The negative interest rate effect will thus dominate even more over the increased marginal productivity of capital effect under a debt rule.

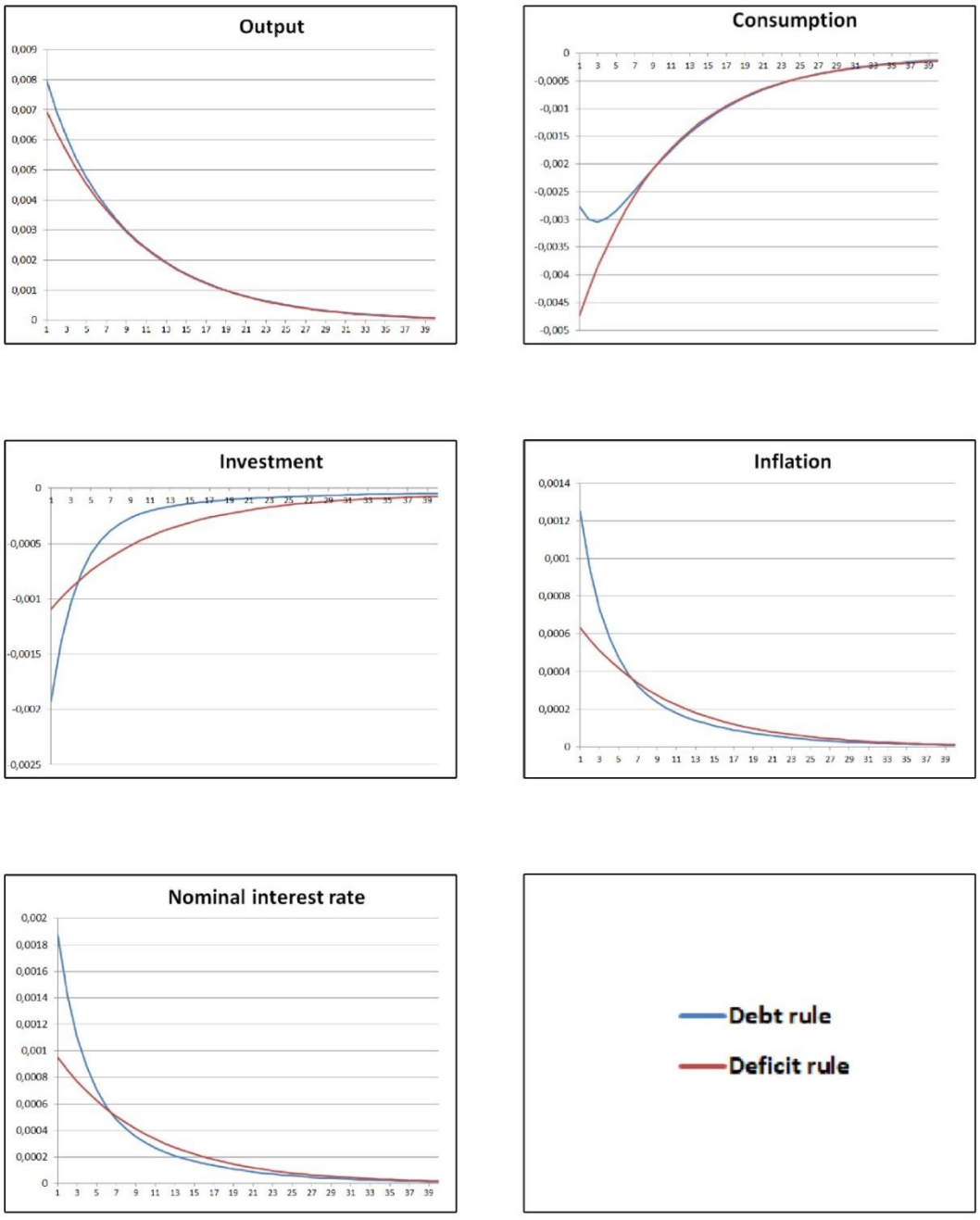
The outcome of these factors results in the slightly larger increase in output under the debt rule. This does not mean we can conclude the debt rule is superior, however. Following the definition of a fiscal rule by Schaechter et al. (2012): *"a fiscal rule aims at correcting distorted incentives and containing pressures to overspend" (p. 5).* If we would follow this definition, we should not look at the most preferable outcome following a government spending shock, but at the scenario that disincentivizes government spending the most.

A quick analysis of figure 4.5 shows that in our model a deficit rule creates the most disincentives for increased government spending. Under the deficit rule, output increases less and consumption decreases more causing households' utility to decrease more. Additionally, inflation increases less which also means that monetary policy has to increase the nominal interest rate less drastically. Less pressure on monetary policy can be a strong argument to why a deficit rule is preferred over a debt rule, especially in a monetary union. This can also be an explanation as to why so much emphasis is put on the MTO in the current form of the SGP.

While the deficit rule may disincentivize government spending the most, the debt rule can do the same. Under the debt rule consumption also drops significantly causing household's utility to decrease. An advantage the debt rule has, is that while investment drops significantly more than under the deficit rule, it does return at a faster pace to its steady state. If investment restores faster, than so does capital stock. Following the reasoning of Romer's growth model, higher capital accumulation leads to higher knowledge accumulation which leads to higher growth (Romer, 1986). This would imply that a debt rule would mitigate the negative effect of public spending on growth more so than a deficit rule would. The downside of the debt rule is the higher inflation caused by increased demand and marginal costs which results in the need for a higher nominal interest rate to ensure price stability.

To summarize, which rule is superior over the other depends of the chosen perspective and preference. If a larger preference is given to fiscal policy, a debt rule is preferable since it ensures the largest positive output effect and smallest negative household utility effect. A larger preference for monetary policy, however, implies preference for the deficit rule since it creates the least amount of pressure to raise the interest rate.

Figure 4.5 Impulse response functions to a one standard deviation government spending shock under a debt rule (blue) and a deficit rule (red)



4.7 Robustness check

To finalize our analysis, we check if our results are robust under a different selection of parameters. More specifically, in this section we will check the impulse response functions for different values of the persistence of government spending ρ_g, the fiscal response to government debt ϕ_b and the fiscal response to government spending ϕ_g.

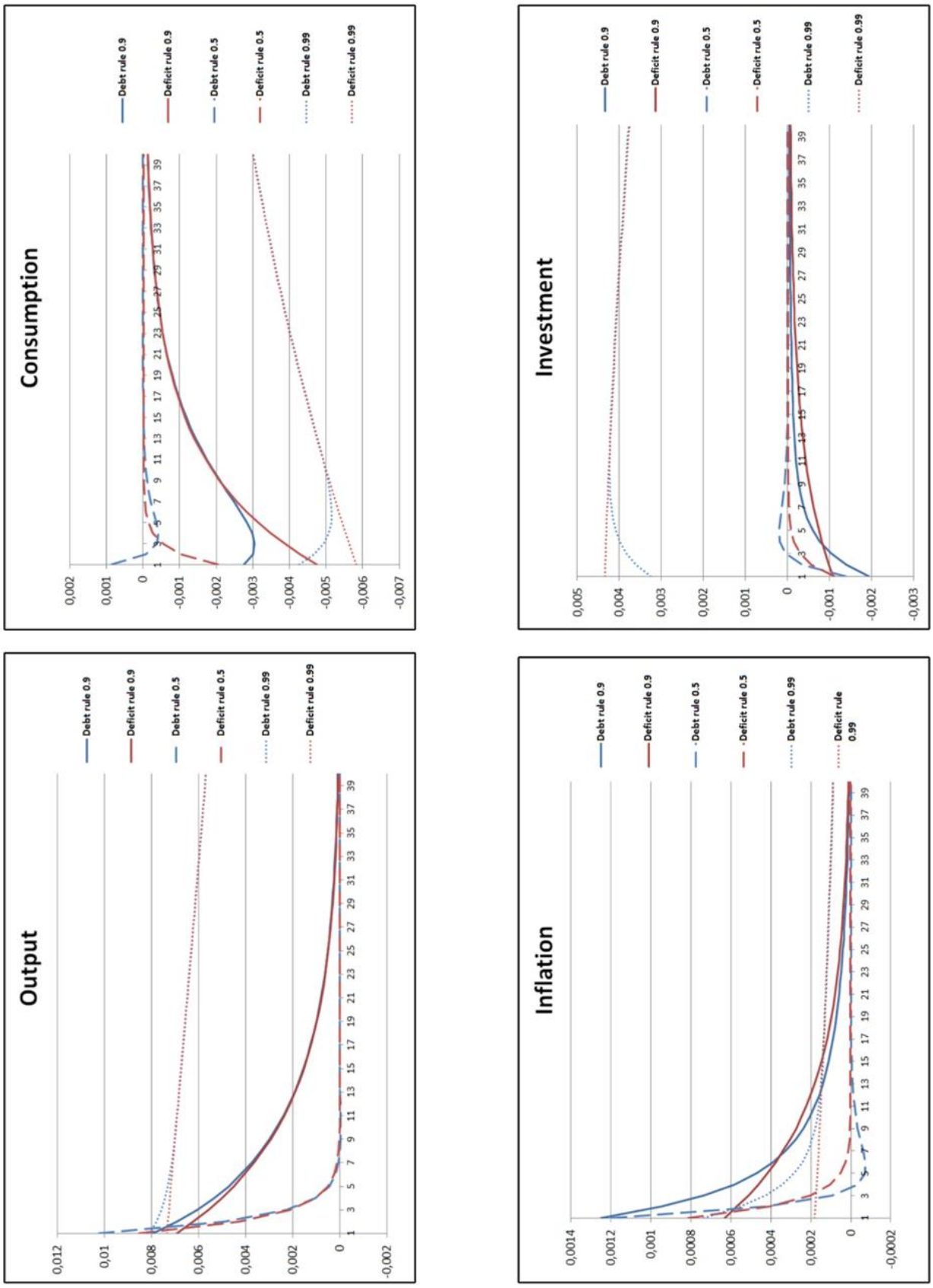
4.7.1 Persistence of government spending

First, figure 4.6 reports the IRFs for different values of persistence of government spending. We simulate the IRFs for one lower (striped line) and one higher (dotted line) value of ρ_g. The analysis is done for both the debt rule (blue) and deficit rule (red). The lower value is set at 0,5 and the higher value of ρ_g is set at 0,99.

Starting our analysis with the evolution of output, we see very similar results as in our baseline model. Both under lower and higher persistence, the debt rule still has a stronger output effect over the deficit rule. However, a value of ρ_g of 0,5 makes output return much more quickly to its steady state and vice versa for a higher persistence of 0,99. For consumption, the negative wealth effect of government spending is more limited with low persistence as lower total taxation will be needed to finance spending. More so, under a debt rule consumption even increases resulting from the rule-of-thumb households' behaviour. In case of high persistence, the reverse is true: consumption decreases even more as total taxation will be higher. Next, the evolution of investment knows a strong positive response if spending persistence is high. This can be explained by the lower inflation, and consequently lower interest rate. Because of the higher drop in consumption, there is less demand for goods and thus lower inflation. This is followed by a lower interest rate which causes the positive marginal productivity effect of capital to dominate, making investments more interesting.

In general, the conclusion of section 4.6 does not change if we let government spending persistence fluctuate. The deficit rule still shows the most disincentives for increased spending and will thus be preferred by the monetary authority. The debt rule will still be preferred for fiscal policy as it still causes the largest output effects and in case of low persistence it even may increase household consumption. The only noteworthy change is the increased investment if persistence is high. In this scenario the deficit rule even allows for a larger increase as the negative interest rate effect will be more limited compared to under the debt rule.

Figure 4.6 Impulse response functions to one standard deviation government spending shock under a debt rule((blue) and a deficit rule (red) for different values of ρ_g



4.7.2 Fiscal response parameters

In a second robustness check, we will simulate several additional impulse response functions for different values of the fiscal responses to debt and spending, ϕ_b and ϕ_g respectively. We will look at five different sets: the baseline model, a lower and higher value for ϕ_b with ϕ_g fixed, a higher value for ϕ_g with ϕ_b fixed and a higher value for both parameters. The different scenarios are listed in table 4.3.

Table 4.3 Scenarios for different parameterization of fiscal response to government debt φ_b and government spending φ_g

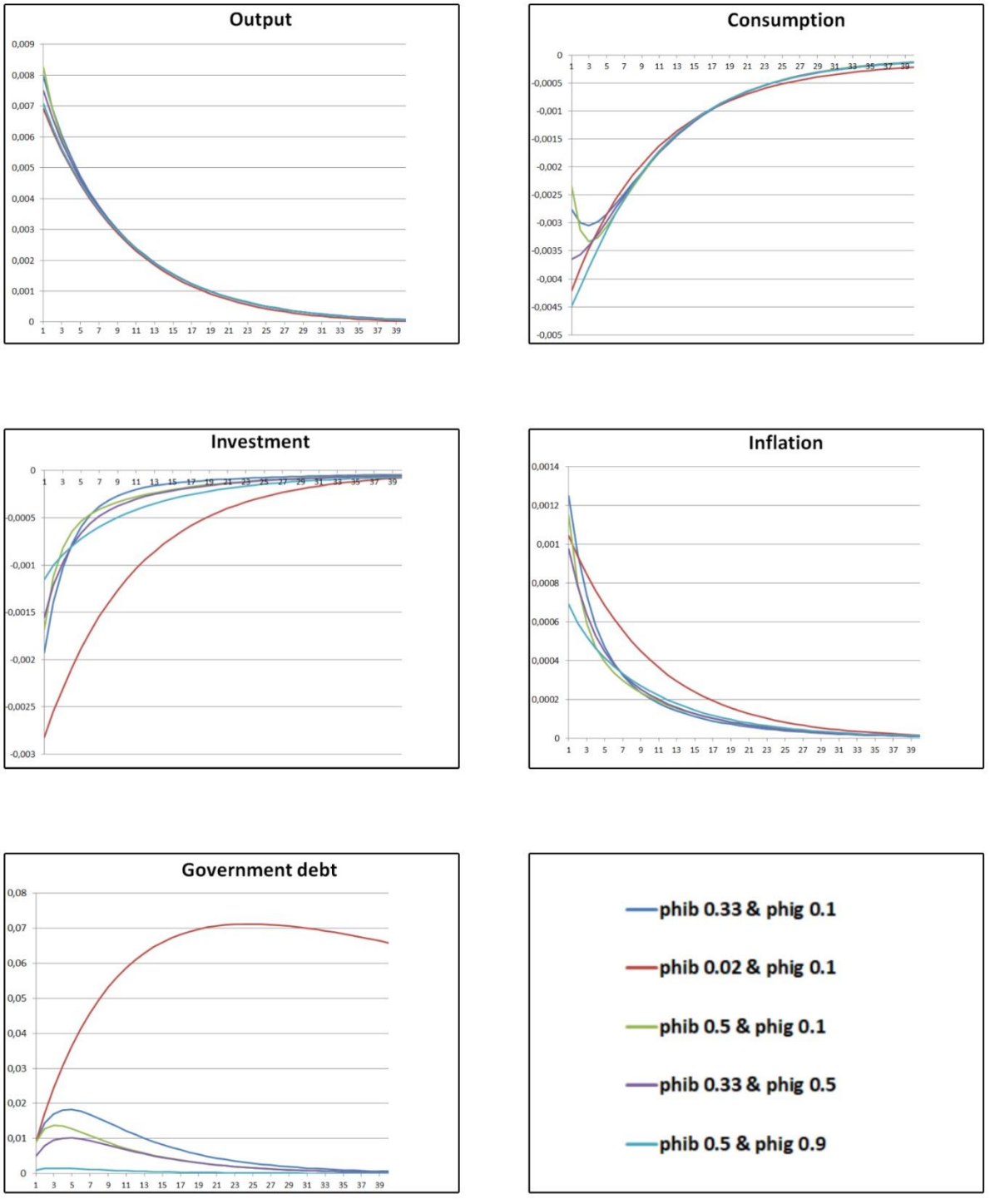
$\boldsymbol{\phi_b}$	$\boldsymbol{\phi_g}$
0.33	0.1
0.02[1]	0.1
0.5	0.1
0.33	0.5
0.5	0.9

Figure 4.7 shows the impulse response functions under the different scenarios. Starting with the IRF for output, we see very little variation between the different scenarios. Putting a larger weight on the response to debt seems to produce larger output effects, while a larger weight on the response to spending produces the opposite effect. This is a reasonable outcome, since putting more weight on spending will push the debt rule in the direction of a deficit rule. For consumption as well we conclude the same: the larger the response to debt, the less negative consumption will respond and the larger the response to spending, the more negative consumption responds. For investment and inflation, there exist different responses which all depend on the size of the negative interest rate effect and positive marginal productivity effect.

Special attention needs to be but on the fifth graph, showing the evolution of debt under each different specification. While all scenarios ensure fiscal sustainability, it is clear they ensure this in a different timeframe. In case of the second rule, debt increases more drastically and for a much longer duration than the other scenarios. As all of these rules can be implemented to ensure sustainability, choosing the best fitting rule is a matter of preference of how fast we want debt to be paid off. In general, letting the fiscal responses vary, does not change our analysis from section 4.6.3.

[1] The condition for non-explosive debt is $(1+r^*)(1-\phi_b)<1$ which implies a lower bound of 0,01 for ϕ_b. Any lower value will result in continuous debt accumulation.

Figure 4.6 Impulse response functions to one standard deviation government spending shock under different values of fiscal response to debt and government spending



5. Conclusion

The goal of this dissertation was to answer four questions concerning the state of today's European fiscal framework. First, a fiscal framework can be beneficial if problems like over-optimism, time-inconsistent policy, risk of default or inflationary pressure are prevalent. Next, we continued by elaborating how the current framework works and what targets are chosen to ensure sustainability and fiscal discipline. The third question addressed in section 3 was what the points of critique are on the current framework and how to address them. Here, arguments as too much complexity, wrong or inconsistent choice of targets and lack of compliance were brought up. Lastly, we ran a simulation of the Stability and Growth Pact in a New-Keynesian model and made a comparison between the dominant deficit rule of the Pact and a more debt-focused rule. The last chapter concluded that the better rule is chosen on the basis of relative preference between the monetary authority and fiscal authority.

However, several remarks need to be made concerning our results. First of all, the model used for the analysis of section 4 is largely based on the paper of Gali et al. (2007). Unlike their paper, however, our model does not contain any form of wage rigidity. This causes a large deviation between results, especially concerning the impulse response of consumption which increases even under relative high persistence of government spending. This has serious implications for our comparison between the deficit rule and debt rule. Under a debt rule consumption would increase making it much less punishing for a government to increase its spending and debt.

A second remark, concerns the implications of our closed-economy, single super state model. It is clear that this is a very restrictive and unrealistic condition on our model. A more realistic approximation for the European Union would be to impose a multi-country model with trade. This can alter the outcome of our results though as, for example, since intra-EU trade accounts for 64% of all EU trade, inflation spillovers are of much more concern (Eurostat, 2017).

A last remark concerns the choice of fiscal rules in the comparison. In setting the numerical target of the deficit rule at zero, the comparison between the alternative debt rule was simplified. This is again a very restrictive condition since the structural deficit target in practice is set at -0.5% or -1%. A possible remedy to this is by setting the fiscal responses ϕ_b and ϕ_g sufficiently high such that government does not exceed 0.005 or 0.01% similar to our fifth scenario in section 4.7.2. Additionally, papers like Andrle et al. (2015), Claeys, Darvas & Leandro (2016) and Bénassy-Quéré et al. (2018) also propose an operational rule focused on expenditures rather than deficits or debt. A comparative analysis including an expenditure rule might thus be a good addition to this debate.

While the European economy seems to be recovering and forecasts for 2018 are optimistic, it still faces some issues. The Stability and Growth Pact is built on sound principles, but its complexity, choice of rules and lack of compliance may be hampering progress towards building off sovereign debt. A call for reform may thus not be unreasonable, especially when in times of economic recovery. However, to conclude with a quote from Jean Monnet, an influential architect of European Unity: *"People only accept change when they are faced with necessity, and only recognize necessity when a crisis is upon them. (Barroso, 2012)"* Launching a debate for reforming the Pact can be difficult in time of recovery, but nonetheless it can lead to greater prosperity and unity in the European Union.

References

Alesina, A., & Tabellini, G. (1987). A Positive Theory of Fiscal Deficits and Government Debt in a Democracy. *NBER Working Paper Series*.

Andrle, M., Bluedorn, J., Eyraud, L., Kinda, T., Brroks, P. K., Schwartz, G., et al. (2015). Reforming Fiscal Governance in the European Union. *IMF Staff Discussion Note SDN/15/09*.

Arghyrou, M. G., & Kontonikas, A. (2012). The EMU sovereign-debt crisis: Fundamentals, expectations and contagion. *Journal of International Financial Markets, Institutions & Money*, 658-677.

Barroso, J. M. (2012, September 4). *European Commission Press Release Database.* Retrieved June 2, 2018, from European Commission: http://europa.eu/rapid/press-release_SPEECH-12-585_en.htm

Baum, A., Checherita-Westphal, C., & Rother, P. (2013). Debt and growth: New evidence for the euro area. *Journal of International Money and Finance 32*, 809-821.

Beetsma, R., Giuliodori, M., & Wierts, P. (2009). Planning to cheat: EU fiscal policy in real time. *Economic Policy, Volume 24, issue 60*, 753-804.

Bénassy-Quéré, A., Brunnermeier, M., Enderlein, H., Farhi, E., Fratzscher, M., Fuest, C., et al. (2018). Reconciling risk sharing with market discipline: A constructive approach to euro area reform. *Centre for Economic Policy Research Policy Insight No. 91*.

Bianchi, C., & Menegatti, M. (2012). Rules versus Discretion in fiscal policy. *The Manchester School Vol 80 No. 5*, 603-629.

Calmfors, L. (2011). The Role of Independent Fiscal Policy Institutions. *CESifo Working Paper No. 3367*.

Calvo, G. A. (1983). Staggered Prices in a Utility-Maximizing Framework. *Journal of Monetary Economics 12*, 383-398.

Checherita-Westphal, C., & Rother, P. (2012). The impact of high government debt on economic growth and its channels: An empirical investigation for the euro area. *European Economic Review 56*, 1392-1405.

Claeys, G., Darvas, Z., & Leandro, Á. (2016). A proposal to revive the European fiscal framework. *Bruegel Policy Contribution issue 2016/07*.

Davig, T., & Leeper, E. M. (2011). Temporarily unstable ogvernment debt and inflation. *NBER Working Paper Series no. 16799*.

De Grauwe, P., & Ji, Y. (2012). Mispricing of Sovereign Risk and Multiple Equilibria in the Eurozone. *CEPS Working Document no. 361*.

Diamond, P. A. (1965). National Debt in a Neoclassical Growth Model. *The American Economic Review, Vol. 55, No. 5, Part 1*, 1126-1150.

Dixit, A., & Lambertini, L. (2003). Interactions of Commitment and Discretion in Monetary and Fiscal Policies. *The American Economic Review*, 1522-1542.

Égert, B. (2015). Public debt, economic growth and nonlinear effects: Myth or reality? *Journal of Macroeconomics 43*, 226-238.

Eijffinger, S., & de Haan, J. (2000). *European Monetary and Fiscal Policy.* Oxford: Oxford University Press.

European Central Bank. (2017, January 12). *Why is the ECB Independent?* Retrieved May 3, 2018, from European Central Bank - Eurosystem: https://www.ecb.europa.eu/explainers/tell-me-more/html/ecb_independent.en.html

European Central Bank. (n.d.). *The definition of price stability*. Retrieved May 28, 2018, from Europen Central Bank - Eurosystem: https://www.ecb.europa.eu/mopo/strategy/pricestab/html/index.en.html

European Commission. (2017a). *2018 Draft Budgetary Plans: Overall Assessment.* Brussels.

European Commission. (2017b). *Annual Growth Survey 2018.* Brussels.

European Commission. (2017c). *Vade Mecum on the Stability and Growth Pact.* Directorate-General for Economic and Financial Affairs. European Commission.

European Commission. (2018, May 23). *Excessive deficit procedures - overview*. Retrieved May 30, 2018, from European Commission: https://ec.europa.eu/info/business-economy-euro/economic-and-fiscal-policy-coordination/eu-economic-governance-monitoring-prevention-correction/stability-and-growth-pact/corrective-arm-excessive-deficit-procedure/excessive-deficit-procedures-overview_en

European Council. (1997, June 17). Resolution of the European Council on the Stability and Growth Pact. Amsterdam.

Eurostat. (2017, January). *Intra-EU trade in goods - recent trends*. Retrieved May 25, 2018, from Eurostat Statistics Explained: http://ec.europa.eu/eurostat/statistics-explained/index.php/Intra-EU_trade_in_goods_-_recent_trends#Intra-EU_trade_in_goods_balance

Frankel, J. (2011). Over-optimism in forecasts by official budget agencies and its implications. *Oxford Review of Economic Policy, Volume 27, number 4*, 536-562.

Galí, J., Vallés, J., & López-Salido, J. D. (2007). Understanding the Effects of Government Spending on Consumption. *Journal of the European Economic Association*, 227-270.

Hallerberg, M., & Von Hagen, J. (1997). Electoral Institutions, Cabinet Negotiations, and Budget Deficits in the European Union. *NBER Working Paper Series*.

Hardin, G. (1968, December 13). The Tragedy of the Commons. *Science*, pp. 1243-1248.

Heylen, F. (2017). Macroeconomics: Business Cycles, Innovation and Growth. Ghent.

Heylen, F. (204). *Macroeconomie.* Antwerpen-Apeldoorn: Garant Uitgevers nv.

Kydland, F. E., & Prescott, E. C. (1977). Rules rather than Discretion: The Inconsistency of Optimal Rules. *The University of Chicago Press Journals*, 473-492.

Leeper, E. M., Plante, M., & Traum, N. (2010). Dynamics of fiscal financing in the United States. *Journal of Econometrics 156*, 304-321.

Mankiw, N. G. (2016). *Principles of Economics.* United States of America: Cengage Learning.

Member States of the European Union. (1992, July 29). Treaty on European Union. Maastricht.

Member States of the European Union. (2007, December 13). Treaty on the Functioning of the European Union. Lisbon.

Muscatelli, V. A., Natale, P., & Tirelli, P. (2012). A simple and flexible alternative to Stability and Growth Pact deficit ceilings. Is it at hand? *European Journal of Politcal Economy*, 14-26.

OECD. (2017, November). Economic Outlook No 102.

Panizza, U., & Presbitero, A. F. (2014). Public debt and economic growth: Is there a causal effect? *Journal of Macroeconomics 41*, 21-41.

Perotti, R., & Kontopoulos, Y. (2002). Fragmented Fiscal Policy. *Journal of Public Economics*, 191-222.

Persson, T., & Svensson, L. E. (1989). Why a Stubborn Conservative would run a Deficit: Policy with Time-Inconsistent Preferences. *The Quarterly Journal of Economics, vol. 104, No. 2*, 325-345.

Saint-Paul, G. (1992). Fiscal Policy in an Endogenous Growth Model. *The Quarterly Journal of Economics, Vol. 107, No. 4*, 1243-1259.

Saraceno, F., & Veroni, P. (2004). A Simple Proposal for a Debt Related Fiscal Rule. *Quarterly Journal of Economic Research 73*, 471-480.

Schaechter, A., Kinda, T., Nina, B., & Weber, A. (2012). Fiscal Rules in Response to the Crisis - Toward the "Next-Generation" Rules. A New Dataset. *IMF Working Paper WP/12/187*.

Smets, F., & Wouters, R. (2002). An estimated stochastic dynamic general equilibrium model of the euro area. *ECB Working Paper No. 171*.

Taylor, J. B. (1993). Discretion versus Policy Rules in Practice. *Carnegie-Rochester Conference Series on Public Policy 39*, 195-214.

Taylor, J. B. (1999). A Historical Analysis of Monetary Policy Rules. *NBER Monetary Policy Rules*, 319-348.

Velasco, A. (2000). Debts and Deficits with Fragmented Fiscal Policymaking. *Journal of Public Economics*, 105-125.

Von Hagen, J., & Harden, I. J. (1995). Budget Processes and Commitment to Fiscal Discipline. *European Economic Review 39*, 771-779.

Whelan, K. (2016). Retrieved April 5, 2018, from Karl Whelan: http://www.karlwhelan.com/MAMacro/nkpc-details.pdf

Wickens, M. (2008). *Macroeconomic Theory A Dynamic General Equilibrium Approach.* Princenton: Princeton University Press.

Appendix

A) Log linearization of the equations:

Tobin's Q:

$$\ln(Q_t) = \ln(\frac{1}{\beta R_t} E_t\left(\frac{P_{t+1}}{P_t}\right)) + \ln(E_t R^k_{t+1} + Q_{t+1}\left[(1-\delta) + \Phi\left(\frac{I^o_{t+1}}{K^o_{t+1}}\right) - \Phi'\left(\frac{I^o_{t+1}}{K^o_{t+1}}\right)\left(\frac{I^o_{t+1}}{K^o_{t+1}}\right)\right])$$

$$\ln(Q_t) = -\ln(\beta) - \ln(R_t) + \ln(E_t P_{t+1}) - \ln(P_t) + \ln(E_t R^k_{t+1} + Q_{t+1}\left[(1-\delta) + \Phi\left(\frac{I^o_{t+1}}{K^o_{t+1}}\right) - \Phi'\left(\frac{I^o_{t+1}}{K^o_{t+1}}\right)\left(\frac{I^o_{t+1}}{K^o_{t+1}}\right)\right])$$

$$\widetilde{Q_t} = -\left(\widetilde{R_t} - E_t\widetilde{\pi_{t+1}}\right) + \left(\frac{1}{R^{k*} + Q^*\left((1-\delta) + \Phi\left(\frac{I^*}{K^*}\right) - \Phi'\left(\frac{I^*}{K^*}\right)\left(\frac{I^*}{K^*}\right)\right)}\right)(E_t R^k_{t+1} - R^{k*}) + \left(\frac{1}{R^{k*} + Q^*\left((1-\delta) + \Phi\left(\frac{I^*}{K^*}\right) - \Phi'\left(\frac{I^*}{K^*}\right)\left(\frac{I^*}{K^*}\right)\right)}\right)(E_t Q_{t+1} - Q^*)$$

With: $R^{k*} = \frac{1}{\beta} - 1 + \delta,\ Q^* = 1\ , \frac{I^*}{K^*} = \delta\ , \Phi\left(\frac{I^*}{K^*}\right) = \delta\ and\ \Phi'\left(\frac{I^*}{K^*}\right) = 1$

$$\widetilde{Q_t} = -\left(\widetilde{R_t} - E_t\widetilde{\pi_{t+1}}\right) + \frac{\frac{1}{\beta} - 1 + \delta}{\frac{1}{\beta}} E_t\widetilde{R^k_{t+1}} + \frac{1}{\frac{1}{\beta}}\widetilde{Q_{t+1}}$$

$$\widetilde{Q_t} = -\left(\widetilde{R_t} - E_t\widetilde{\pi_{t+1}}\right) + (1 - \beta(1+\delta))E_t\widetilde{R^k_{t+1}} + \beta\widetilde{Q_{t+1}}$$

Investment:

$$-\ln(\Phi'\left(\frac{I^o_t}{K^o_t}\right)) = \ln(Q_t)$$

$$-\frac{\Phi''\left(\frac{I^*}{K^*}\right)}{\Phi'\left(\frac{I^*}{K^*}\right)}(\Phi'\left(\frac{I^o_t}{K^o_t}\right) - \Phi'\left(\frac{I^*}{K^*}\right)) = \widetilde{Q_t}$$

LHS: $* \frac{\delta}{\delta}\ and\ with \frac{I^*}{K^*} = \delta, \frac{1}{\Phi''(\delta)\delta} = \eta\ and \widetilde{\Phi'\left(\frac{I^o_t}{K^o_t}\right)} = \widetilde{I_t} - \widetilde{K_t}$

$$\widetilde{I_t} - \widetilde{K_t} = \eta\widetilde{Q_t}$$

Capital accumulation:

$$\ln(K_{t+1}) = \ln((1-\delta)K_t + \Phi\left(\frac{I_t^o}{K_t^o}\right)K_t^o)$$

With $\Phi\left(\frac{I_t^o}{K_t^o}\right)K_t^o = I_t$

$$\ln(K^*) + \frac{1}{K^*}(K_{t+1} - K^*)$$
$$= \ln\big((1-\delta)K^* + I^*\big) + \frac{(1-\delta)}{(1-\delta)K^* + I^*}(K_t - K^*) + \frac{1}{(1-\delta)K^* + I^*}(I_t - I^*)$$

$$\widetilde{K_{t+1}} = (1-\delta)\tilde{K}_t + \delta\tilde{I}$$

Labour supply:

$$\ln(W_t) = \ln(\zeta) + \ln(C_t) + \varphi\ln(N_t)$$

$$\ln(W^*) + \frac{1}{W^*}(W_t - W^*) = \ln(C^*) + \frac{1}{C^*}(C_t - C^*) + \ln(N^*) + \frac{\varphi}{N^*}(N_t - N^*)$$

$$\widetilde{W_t} = \tilde{C}_t + \varphi\tilde{N}_t$$

Euler equation:

$$E_t\left(\frac{C_{t+1}}{C_t}\right) = \beta\left(\frac{R_t}{E_t\left(\frac{P_{t+1}}{P_t}\right)}\right)$$

$$\ln(C_{t+1}) - \ln(C_t) = \ln(\beta) + \ln(R_t) - (\ln(E_t(P_{t+1})) - \ln(P_t))$$

$$-\widetilde{C_t^o} = -\widetilde{C_{t+1}^o} + \widetilde{R_t} - E_t\widetilde{\pi_{t+1}}$$

Rule-of-thumb consumption:

$$\ln(C_t^r) = \ln(W_t N_t^r - T_t)$$

$$\widetilde{C_t^r} = \frac{N^{r*}}{W^*N^{r*} - T^*}(W_t - W^*) + \frac{W^*}{W^*N^{r*} - T^*}(N_t^r - N^{r*}) - \frac{1}{W^*N^{r*} - T^*}(T_t - T^*)$$

$$\widetilde{C_t^r} = \frac{W^*N^{r*}}{W^*N^{r*} - T^*}\big(\widetilde{W_t} + \widetilde{N_t^r}\big) - \frac{Y^*}{W^*N^{r*} - T^*}\widetilde{T_t}$$

$$\widetilde{C_t^r} = \frac{W^*N^{r*}}{C^*}\big(\widetilde{W_t} + \widetilde{N_t^r}\big) - \frac{Y^*}{C^*}\widetilde{T_t}$$

Production function:

$$\ln(Y_t) = \ln(A_t) + \alpha \ln(K_t) + (1-\alpha)\ln(N_t)$$

$$\ln(Y^*) + \frac{1}{Y^*}(Y_t - Y^*) = \alpha\left[\ln(K^*) + \frac{1}{K^*}(K_t - K^*)\right] + (1-\alpha)\left[\ln(N^*) + \frac{1}{N^*}(N_t - N^*)\right]$$

$$\widetilde{Y_t} = \widetilde{A_t} + \alpha\widetilde{K_t} + (1-\alpha)\widetilde{N_t}$$

Cost minimization:

$$\ln(\alpha) + \ln(W_t) + \ln(N_t(j)) = \ln(1-\alpha) + \ln(R_t^k) + \ln(K_t(j))$$

$$\widetilde{W_t} + \widetilde{N_t} = \widetilde{R_t^k} + \widetilde{K_t}$$

Marginal cost:

$$\widetilde{MC_t}^r = \alpha\widetilde{R_t^k} + (1-\alpha)\widetilde{W_t} - \widetilde{A_t}$$

Price dynamics:

$$\widetilde{P_t} = \theta\widetilde{P_{t-1}} + (1-\theta)\widetilde{P_t^\#}$$

Rearrange:

$$\widetilde{P_t^\#} = \frac{1}{1-\theta}(\widetilde{P_t} - \theta\widetilde{P_{t-1}})$$

$$k\varepsilon_p E_t\Big(\sum_{k=0}^{\infty}\{(\beta\theta)^k MC_{t+k}Y_{t+k}(j)(P_{t+k})^{\varepsilon_p-1}(P_t^\#)^{-\varepsilon_p-1}\}\Big)$$

$$= -k(1-\varepsilon_p)E_t\left(\sum_{k=0}^{\infty}\{(\beta\theta)^k Y_{t+k}(j)(P_{t+k})^{\varepsilon_p-1}(P_t^\#)^{-\varepsilon_p}\}\right)$$

$$\text{part 1: } \ln(MC_{t+k}) + \ln\big(Y_{t+k}(j)\big) + \big(\varepsilon_p - 1\big)\ln(P_{t+k}) - (\varepsilon_p + 1)P_t^\#$$

$$part\ 2\text{: } \ln\big(Y_{t+k}(j)\big) + \big(\varepsilon_p - 1\big)\ln(P_{t+k}) - \varepsilon_p P_t^\#$$

$$E_t\left[\sum_{k=0}^{\infty}(\beta\theta)^k(\widetilde{P_t^\#} - \widetilde{MC_{t+k}})\right] = 0$$

Simplify:

$$\widetilde{P_t^{\#}} = (1-\beta\theta)\sum_{k=0}^{\infty}(\beta\theta)^k\, E_t\widetilde{MC_{t+k}}$$

Reverse engineer:

$$\widetilde{P_t^{\#}} = (1-\beta\theta)\widetilde{MC_t} + (\beta\theta)E_t\widetilde{P_{t+1}^{\#}}$$

Fill in $\widetilde{P_t^{\#}}\ and\ \widetilde{P_{t+1}^{\#}}$:

$$\frac{1}{1-\theta}(\widetilde{P_t} - \theta\widetilde{P_{t-1}}) = (1-\beta\theta)\widetilde{MC_t} + \frac{\beta\theta}{1-\theta}(E_t\widetilde{P_{t+1}} - \theta\widetilde{P_t})$$

$$(\widetilde{P_t} - \theta\widetilde{P_{t-1}}) = (1-\theta)(1-\beta\theta)\widetilde{MC_t} + \beta\theta(E_t\widetilde{P_{t+1}} - \theta\widetilde{P_t})$$

Rearrange:

$$(1+\beta\theta^2)\widetilde{P_t} - \theta\widetilde{P_{t-1}} = (1-\theta)(1-\beta\theta)\widetilde{MC_t} + \beta\theta E_t\widetilde{P_{t+1}}$$

Divide both sides with θ:

$$\frac{(1+\beta\theta^2)}{\theta}\widetilde{P_t} - \widetilde{P_{t-1}} = \frac{(1-\theta)(1-\beta\theta)}{\theta}\widetilde{MC_t} + \beta E_t\widetilde{P_{t+1}}$$

Subtract $\beta\widetilde{P_t}$ on both sides:

$$\frac{(1-\beta\theta+\beta\theta^2)}{\theta}\widetilde{P_t} - \widetilde{P_{t-1}} = \frac{(1-\theta)(1-\beta\theta)}{\theta}\widetilde{MC_t} + \beta E_t\widetilde{\pi_{t+1}}$$

Rewrite while knowing: $\frac{(1-\beta\theta+\beta\theta^2)}{\theta} = 1 + \frac{(1-\theta)(1-\beta\theta)}{\theta}$

$$\widetilde{\pi_t} = \frac{(1-\theta)(1-\beta\theta)}{\theta}(\widetilde{MC_t} - \widetilde{P_t}) + \beta E_t\widetilde{\pi_{t+1}}$$

New Keynesian Phillips curve:

$$\widetilde{\pi_t} = \frac{(1-\theta)(1-\beta\theta)}{\theta}(\widetilde{MC_t^{\,r}}) + \beta E_t\widetilde{\pi_{t+1}}$$

Market clearing:

$$\ln(Y_t) = \ln(C_t + I_t + G_t)$$

$$\ln(Y^*) + \frac{1}{Y^*}(Y_t - Y^*) = \ln(C^* + I^* + G^*) + \frac{1}{(C^* + I^* + G^*)}(C_t - C^*) + \frac{1}{(C^* + I^* + G^*)}(I_t - I^*) + \frac{1}{(C^* + I^* + G^*)}(G_t - G^*)$$

$$\widetilde{Y_t} = \frac{C^*}{Y^*}\widetilde{C_t} + \frac{I^*}{Y^*}\widetilde{I_t} + \widetilde{G_t}$$

Government spending:

$$\ln(G_t) = \rho \ln(G_{t-1}) + \varepsilon$$

$$\ln(G^*) + \frac{1}{G^*}(G_t - G^*) = \rho \ln(G^*) + \frac{1}{G^*}\rho(G_{t-1} - G^*) + \varepsilon$$

Simplify and log linearize around Y^*:

$$\frac{1}{Y^*}(G_t - G^*) = \frac{1}{Y^*}\rho(G_{t-1} - G^*) + \varepsilon$$

$$\widetilde{g_t} = \rho\widetilde{g_{t-1}} + \varepsilon_{g,t}$$

Government budget constraint:

$$B_{t+1} = R_t P_t G_t + R_t B_t - R_t P_t T_t$$

$$\frac{B_{t+1}}{P_t} = R_t \frac{B_t}{P_{t-1}} + R_t G_t - R_t T_t$$

$$b_{t+1} = R_t b_t + R_t G_t - R_t T_t$$

$$\ln(b_{t+1}) = \ln(R_t b_t + R_t G_t - R_t T_t)$$

$$\frac{1}{b^*}(b_{t+1} - b^*) = \frac{R^*}{R^* b^* + R^* G^* - R^* T^*}(b_t - b^*) + \frac{R^*}{R^* b^* + R^* G^* - R^* T^*}(G_t - G^*) - \frac{R^*}{R^* b^* + R^* G^* - R^* T^*}(T_t - T^*)$$

Simplify with $G^* - T^* = 0$ *and* $R^* = 1 + r^*$ and log linearize around Y^*

$$\widetilde{b_{t+1}} = (1 + r^*)(\widetilde{b_t} + \widetilde{g_t} - \widetilde{t_t})$$

Aggregate Euler equation:

Using the log-linearized forms of equation 4.5 and 4.11 and combining them with 4.12 and 4.13 results in:

$$\widetilde{W_t} = \widetilde{C_t} + \varphi \widetilde{N_t}$$

If we log-linearize equation 4.11 and rearrange it, we get:

$$\widetilde{N_t^r} = \varphi^{-1}(\widetilde{W_t} - \widetilde{C_t^r})$$

We combine the previous two results in the log-linearized form of equation 4.10:

$$\widetilde{C_t^r} = \frac{W^* N^{r*}}{C^*}\left(\widetilde{C_t} + \varphi \widetilde{N_t} + \varphi^{-1}(\widetilde{C_t} + \varphi \widetilde{N_t} - \widetilde{C_t^r})\right) - \frac{Y^*}{C^*}\widetilde{T_t}$$

$$\widetilde{C_t^r} = \frac{W^* N^{r*}}{C^*}\left((1+\varphi^{-1})\widetilde{C_t} + (1+\varphi)\widetilde{N_t} - \varphi^{-1}\widetilde{C_t^r})\right) - \frac{Y^*}{C^*}\widetilde{T_t}$$

$$(1+\varphi^{-1})\widetilde{C_t^r} = \frac{W^* N^{r*}}{C^*}\left((1+\varphi^{-1})\widetilde{C_t} + (1+\varphi)\widetilde{N_t}\right) - \frac{Y^*}{C^*}\widetilde{T_t}$$

$$(\varphi+1)\widetilde{C_t^r} = \frac{W^* N^{r*}}{C^*}\left((\varphi+1)\widetilde{C_t} + (1+\varphi)\varphi\widetilde{N_t}\right) - \varphi\frac{Y^*}{C^*}\widetilde{T_t}$$

$$(\varphi+1)\widetilde{C_t^r} = \frac{(1-\alpha)MC^{r*}Y^*}{C^*}\left((\varphi+1)\widetilde{C_t} + (1+\varphi)\varphi\widetilde{N_t}\right) - \varphi\frac{Y^*}{C^*}\widetilde{T_t}$$

$$\left(\frac{\varphi C^*}{MC^{r*}Y^*} + (1-\alpha)\right)\widetilde{C_t^r} = (1-\alpha)\left((\varphi+1)\widetilde{C_t} + (1+\varphi)\varphi\widetilde{N_t}\right) - \varphi\frac{1}{MC^{r*}}\widetilde{T_t}$$

Next, we apply a lag operator ($1\text{-}L^{-1}$) for the log-linearized form of equation 4.12:

$$\widetilde{C_t} - E_t\widetilde{C_{t+1}} = \lambda\left(\widetilde{C_t^r} - E_t\widetilde{C_{t+1}^r}\right) + (1-\lambda)\left(\widetilde{C_t^o} - E_t\widetilde{C_{t+1}^o}\right)$$

Finally, using the Euler equation for optimizing households and the result form our last solution in the previous equation gets us:

$$\widetilde{C_t} = E_t\widetilde{C_{t+1}} - \frac{1}{\sigma_C}\left(\widetilde{R_t} - E_t\widetilde{\pi_{t+1}}\right) - \Theta_n E_t\Delta\widetilde{N_{t+1}} + \Theta_t E_t\Delta\widetilde{T_{t+1}}$$

With:

$$\frac{1}{\sigma_C} = (1-\lambda)\Gamma\left(\frac{\varphi C^*}{MC^{r*}Y^*} + (1-\alpha)\right)$$

$$\Theta_n = \lambda\Gamma(1-\alpha)(1+\varphi)\varphi$$

$$\Theta_t = \frac{\lambda\Gamma\varphi}{MC^{r*}}$$

$$\Gamma = \frac{1}{\left(\frac{\varphi C^*}{MC^{r*}Y^*} + (1-\alpha)\big(1-\lambda(1+\varphi)\big)\right)}$$

B) Dynare code:

Deficit_rule:

```
var y k c n w r rk i g mc_r pi a q t;  //Endogenous variables & AR processes
varexo epsilon_g;            //Exogenous shocks

parameters alpha beta delta varphi phi phi_pi sigmaC thetaN thetaT Gamma rhog rhoa sigma theta eta
lambda phi_b phi_g
gy_ss r_ss cy_ss iy_ss;  // Parameters

//--- Parameterization ---//
alpha=1/3;
beta = .99;
delta = .025;
varphi = 0.2;
rhog=.9;
rhoa=0.9;
sigma=0.01;
theta=0.75;
phi=6;
phi_pi=1.5;
eta=1;
lambda=0.5;
phi_b=0.33;
phi_g=0.1;

//--- Steady state expressions ---//
gy_ss=.20;
r_ss=(1/beta)-1;
mc_ss=(phi-1)/phi;
cy_ss= 1-gy_ss-((delta*alpha)/((r_ss+delta)/mc_ss));
iy_ss=1-cy_ss-gy_ss;
Gamma=1/((1/mc_ss)*varphi*cy_ss+(1-alpha)*(1-lambda*(1+varphi)));
sigmaC=(1-lambda)*Gamma*((1/mc_ss)*varphi*cy_ss+(1-alpha));
thetaN=lambda*Gamma*(1-alpha)*(1+varphi)*varphi;
thetaT=lambda*Gamma*(1/mc_ss)*varphi;
//--- Equations of the model (in log-linear approximation) ---//
model(linear);

  %% Household
        % Aggregate Euler equation
        c = c(+1) -sigmaC*(r-pi(+1))-thetaN*(n(+1)-n)+thetaT*(t(+1)-t);
        % Labour supply
        w = c + varphi*n;
         % Tobin's Q
```

```
        q=beta*q(+1)+(1-beta*(1-delta))*rk(+1)-(r-pi(+1));
        % Investment
         i-k(-1)=eta*q;
        % Capital law of motion
        k = (1-delta)*k(-1) + delta*i;

%% Intermediary firms
        % Production function
        y = a+ alpha*k(-1) + (1-alpha)*n;
        % Real marginal cost
        mc_r=-a +alpha*rk+(1-alpha)*w;
        % Cost minimization
        w + n = rk + k(-1);
        % Price dynamics NKPC
        pi = beta*pi(+1) + (((1-theta)*(1-theta*beta))/theta)*mc_r;

%%Government
         g = t;

%% Market Clearing
        y = cy_ss*c + iy_ss*i + g;

%% monetary policy
        r = phi_pi*pi;

%% Exogenous shocks
        g = rhog*g(-1) + epsilon_g;
        a = a(-1);

end;
check;
steady;

//--- Shocks ---//
shocks;
var epsilon_g; stderr sigma;
end;

//--- Simulation ---//
stoch_simul;
```

Debt_rule:

```
var y k c n w r rk i g mc_r pi a q t b;  //Endogenous variables & AR processes
varexo epsilon_g;            //Exogenous shocks

parameters alpha beta delta varphi phi phi_pi sigmaC thetaN thetaT Gamma rhog rhoa sigma theta eta
lambda phi_b phi_g
gy_ss r_ss cy_ss iy_ss;  // Parameters

//--- Parameterization ---//
alpha=1/3;
beta = .99;
delta = .025;
varphi = 0.2;
rhog=.9;
rhoa=0.9;
sigma=0.01;
theta=0.75;
phi=6;
phi_pi=1.5;
eta=1;
lambda=0.5;
phi_b=0.33;
phi_g=0.1;

//--- Steady state expressions ---//
gy_ss=.20;
r_ss=(1/beta)-1;
mc_ss=(phi-1)/phi;
cy_ss= 1-gy_ss-((delta*alpha)/((r_ss+delta)/mc_ss));
iy_ss=1-cy_ss-gy_ss;
Gamma=1/((1/mc_ss)*varphi*cy_ss+(1-alpha)*(1-lambda*(1+varphi)));
sigmaC=(1-lambda)*Gamma*((1/mc_ss)*varphi*cy_ss+(1-alpha));
thetaN=lambda*Gamma*(1-alpha)*(1+varphi)*varphi;
thetaT=lambda*Gamma*(1/mc_ss)*varphi;

//--- Equations of the model (in log-linear approximation) ---//
model(linear);

  %% Household
        % Euler Ricardian
        c = c(+1) -sigmaC*(r-pi(+1))-thetaN*(n(+1)-n)+thetaT*(t(+1)-t);
        % Labour supply
        w = c + varphi*n;
        % Tobin's Q
         q=beta*q(+1)+(1-beta*(1-delta))*rk(+1)-(r-pi(+1));
```

```
        % Investment
        i-k(-1)=eta*q;
        % Capital law of motion
        k = (1-delta)*k(-1) + delta*i;

%% Intermediary firms
        % Production function
        y = a+ alpha*k(-1) + (1-alpha)*n;
        % Real marginal cost
        mc_r=-a +alpha*rk+(1-alpha)*w;
        % Cost minimization
        w + n = rk + k(-1);
        % Price dynamics NKPC
        pi = beta*pi(+1) + (((1-theta)*(1-theta*beta))/theta)*mc_r;

%%Government
        %Budget constraint
        b =(1 + r_ss)*(b(-1) + g - t);
        %Fiscal policy rule
        t = phi_b*b(-1) + phi_g*g;

%% Market Clearing
        y = cy_ss*c + iy_ss*i + g;

%% monetary policy
        r = phi_pi*pi;

%% Exogenous shocks
        g = rhog*g(-1) + epsilon_g;
        a = a(-1);

end;
check;
steady;

//--- Shocks ---//
shocks;
var epsilon_g; stderr sigma;
end;

//--- Simulation ---//
stoch_simul;
```