The Stability and Growth Pact: Why, why not and what are the alternatives?

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Abstract

The aim of this paper is to analyze the interaction between multiple fiscal policies and a single monetary policy in the context of the European Union (EU). The paper outlines the coordination failures arising from the free riding problems, which give rise to the need for rules constraining the debt and deficit levels. Excessive deficits make the task of maintaining price stability difficult for the monetary policy. It explores the need for the Stability and Growth Pact (SGP) and its continuation in its current avatar. The paper however finds that the SGP, as incorporated in the Maastricht Treaty, is not the optimum solution and has given rise to various other problems in the wake of a single monetary policy and multiple fiscal policies. In particular, the paper finds that the lack of coordination between the fiscal and monetary policies engendered by the SGP in its current form could be one of the reasons for depressed demand and slow growth in the EU. The paper presents some alternatives such as tradable deficit permits to the SGP and some changes to the pact, which could rid it of the coordination failures and other identified drawbacks and make the rules constraining the fiscal policies more optimum.

Contents

List of Figures

List of Tables

List of Abbreviations

BEPG:	Broad Economic Policy Guidelines
ECB:	European Central Bank
ECOFIN:	European Council of Finance Ministers
ECT:	European Council Treaty
EDP:	Excessive Deficit Procedures
EMS:	European Monetary System
EMU:	European Monetary Union
EU:	European Union
FPC:	Fiscal Policy Committee
GDP:	Gross Domestic Product

1 Introduction

Since January 2001, the European Monetary Union is a reality. The Euro, as a common currency, has bound the 12 participating countries into a common monetary policy. However, there is a fear that coordination failures might arise due to interaction of a common monetary policy for the Euro zone, interacting with multiple fiscal policies, with each participating country laying down its fiscal policy, pretty much independently. The severe problem of free riding by accumulation of excessive debt, the full impact of which is shared among the member countries of the common currency, was sought to be countered by the "Stability and Growth Pact"(SGP). The objective of the pact is to discipline the fiscal policies of the member countries by imposing a ceiling on budget deficit at 3% of the national GDP and close to balance in the long run (debt not exceeding 60% of GDP). An independent central bank, the European Central Bank (ECB), set up by the Maastricht Treaty, is committed only to the goal of price stability. It was envisioned that the ECB would therefore respond to only cost-push shocks, leaving the national fiscal authorities to respond to demand shocks (Uhlig 2002).

Recently, however, SGP has been a source of heated debate among academics and policy makers alike, particularly in the light of the recent slowdown in Europe and the observation that many countries are near the limit of permissible deficit or have already crossed it. As a matter of fact, Germany and Portugal were both issued warnings in 2001 for breaching the pact. Measures and alternative rules, to those currently in force, have been designed and put forth by both academics and policy makers alike; including radical suggestions to do away with the pact, in an attempt to get rid of the problems it has imposed on member countries. The Pact has been criticized on a variety of other grounds as well, which are also discussed in this paper. In the light of all the criticisms that it faces, the need for a pact like SGP sometimes appears to be hazy.

This paper discusses the motivation for a ceiling on the individual debt of participating countries in a monetary union. It finds that a monetary union could result in excessive debt, which gets magnified due to myopic governments (Beetsma and Bovenberg (1999)). A ceiling on the debt that governments can incur then enhances the central bank's goal of price stability. A ceiling on debt also makes "Ricardian Equivalence" hold, whereby fiscal shocks have no effect on real

variables. This is important because variations in the present value of current and future primary government budgets result in price instability. (Woodford, (1996)).

The paper finds that a ceiling on the individual debts of participants in a monetary union is needed. The paper however finds that the provisions in the pact to achieve balanced budgets in the long term could do with 'tweaking.

The paper discusses the reasons as to why the SGP in its present form is not optimal. The reasons are due both to the inherent strict objective of balanced budget in the long run and the institutional arrangements currently in place. The latter translate in political implementation that leads to situations where the fines and warnings may not be imposed. Also, the pact provides no incentive for member countries to keep their budget in check in times of economic boom, giving rise to excessive deficits in times of economic slowdown, when the SGP limits become binding. In this respect, it has an asymmetrical effect over the economic cycle.

The answer to the problems created by the pact may be a new pact or altogether different mechanisms to control the deficits and debts of the member countries. The latter could take form of "Tradable Deficit Permit", as proposed by Casella (1999), wherein countries would be allocated permits up to the amount equivalent to 3% of their national GDP and would only be allowed incur as much deficit. At the time of accounting, they would have to produce permits to cover the deficit they have incurred during the year. For any extra deficit, they would have to produce extra permits. In such a system, countries would be allowed to trade in their permits and incur deficits by equalizing the cost of incurring this extra deficit to its benefits. An outline of how such a mechanism could function is presented in Section 5. Another way out, when such a drastic measure as a change in rules governing member countries does not find favor, would be a modification of the pact to take into account its current deficiencies, such as asymmetric effect over the cycle, political implementation, voting mechanism for Excessive Deficit Procedures (EDP), arbitrary ceilings, impossibility of imposing fines and one-size-fits-all approach. Some of the modifications, as discussed later, can be implemented at not too great a cost and without the pact losing its credibility. Other modifications or alternatives, such as a Fiscal Policy Committee as proposed by Wyplosz (2002) or the introduction of the Debt Sustainability Rule, might however require a change in the basic formulation of the Pact and thereby change the rules. Modification of the existing SGP or a change in rules governing the fiscal policies of member countries

might make the implementing authorities lose credibility. This could happen because it would convey the impression that the rules governing the behavior of the member countries are being changed in light of the current problems being faced by some of them. It may also lead other participating countries to think that it may be possible to maneuver their way out, as and when times are hard, by more modifications. A change of rules may also be problematic in the light of the not too distant enlargement of the EU into Central and Eastern Europe. The newly acceding countries might rightly feel that the incumbent countries are trying to make the pact and the conditions difficult for candidate's entry into the EU. The paper also analyses some of the criticisms in light of the impending enlargement.

The remainder of this paper is organized as follows. Section 2 discusses the state of existing knowledge in the area. It highlights the main works and the discussions so far. Section 3 builds up the model, the reason that a pact of the form of the SGP is needed. It uses the model outlined in Woodford (1996) and Beetsma and Bovenberg (1999) to address this issue. It reproduces the results of Woodford (1996) model using the 'Toolkit' (Uhlig, 1995) and 'gensys.m' (Sims) and then tries to implement the deficit criteria of the SGP. The following section then outlines the drawbacks in the present formulation of the pact as widely discussed in literature. It tries to support this with available data on EU countries and check if these perceptions of the drawbacks are justified. Section 5 presents the alternatives and modifications to the pact. Section 6 concludes.

2 Motivation and Literature Review

This paper is motivated by recent debate in literature over the suitability of the SGP The EU, consisting of 15 members, decided to adopt a common currency to not only enhance trade amongst its members, but also to be able to emerge as the other competent and large economy in the world. The SGP was adopted at the Amsterdam Summit in June 1997 and laid out the convergence criteria for public debt and fiscal levels that member countries were required to meet. The European Monetary System (EMS) gave way to the EMU, the European Monetary Union, in 1999. EMU was governed by the Maastricht Treaty and consisted of only 12 of the 15 members, with the UK, Denmark and Sweden opting to stay out of it. The Maastricht Treaty, which was based on the Delors Report (1989), laid down the framework in which the fiscal policy of the member countries was to be conducted.

The limit on public debt and fiscal deficit level, as specified by the SGP, even though criticized widely (e.g. Buiter and Kletzer (1990), Eichengreen and Wyplosz etc.) has also been shown to be necessary (Beetsma and Bovenberg (1998, 1999), Beetsma and Uhlig (1999), Woodford (1996) etc.). Beetsma and Uhlig (1999) show that policy makers, since they have terminable stay in office, are often tempted to raise additional debt due to this short-term perspective. It becomes attractive for them to raise debt to pay for expenditures, which may benefit the constituency in power, leaving the successor to repay the debt, using a mix of inflation and taxes to deal with the problem. In the light of such myopic governments, a ceiling on the debt and deficits, which individual governments can incur, becomes necessary to constrain a government's temptation to raise excessive debt. The SGP does just that by requiring governments to have only 3% deficit and close to surplus in the long run and debt not exceeding 60% of GDP. Beetsma and Bovenberg (1999) show that a monetary unification boosts excessive debt accumulation since each individual government does not fully internalize the cost of additional inflation due to its higher stock of debt because part of these costs are borne by the residents of other countries in the monetary union. If monetary policy is discretionary, then debt ceilings play a useful role in alleviating this free rider problem. A conservative central banker, who attaches higher priority to price stability, can offset monetary distortions due to lack of commitment. However, in

the presence of myopic governments, a conservative central banker also needs to be supplemented by debt ceilings to establish the second best (i.e. Pareto optimum in the absence of lump-sum taxes.).

Woodford (1996) argues that, "variations in the governments' budget can be an important source of macroeconomic instability and that the instability is not eliminated when the central banker follows a monetary policy rule that is completely unresponsive to the size of public debt." If nominal rigidities are present, then this variation in governments' budget and fluctuations in the level of aggregate demand resulting from fiscal shocks can cause variations in the level of real economic activity, real interest rates and rates of inflation, even though rational expectations are assumed. A Rational Expectations Equilibrium, not involving stable prices and output, may result when shocks that change the expected present value of current and future government budgets occur. This occurs as the fiscal policy regime is 'non-Ricardian' and therefore changes the households' intertemporal budget constraints. In the context of a common monetary policy, this is important for member countries, since a path of unsustainable debt, followed by any government, will impose price level instability in the union overall, even if the other governments adhere to a sustainable debt path. The only way that other governments could ensure price level stability would be to vary their own budget surplus in the opposite way, so that the public debt of the monetary union remains on a steady path. Since this would amount to financing the fiscally irresponsible government's budget deficit, no government would want to extend such a favor. A ceiling on debt, as imposed by the SGP, would then ensure that the path of debt of all governments in the union is on a sustainable path.

The analysis in this paper is based on the model by Woodford (1996) and it shows that a ceiling on debt of individual governments alleviates the free riding problem.

As mentioned already, the SGP has been criticized on a variety of grounds by a number of academicians (Eichengreen and Wyplosz, Paul deGrauwe (2002), Irlenbusch and Sutter (2000), Eichengreen (1996), Giavazzi (2001), Benoît Coeuré and Jean Pisani-Ferry (2003) to name a few. Wyplosz (2002) criticizes the pact on its arbitrary ceiling on debt of 3%, its political implementation, the political impossibility of imposing fines and the asymmetric effect over the cycle. Benoît Coeuré and Jean Pisani-Ferry (2003) criticize the pact for its one-size fits-all

approach and the fact that there appears to be no rationale to impose a common target for countries whose debt levels differ and whose future liabilities are different. This paper analyses these criticisms in the light of the available data on deficits and debt levels in the EMU countries. It also provides a critical review of these criticisms.

In the light of the various criticism of the SGP, a number of alternatives have been put forth in literature. The tradable deficit permits approach proposed by Casella (1999) involves a system, where countries are allocated permits for the deficits they are allowed to incur. It is modeled on the basis of the environmental market for pollution permits for sulphur emissions in the U.S. Though the proposal does away with many of the drawbacks of the pact, such as a fixed fine and asymmetric effect by providing incentives to countries to keep budget in surplus in good times, its implementation is perceived to be problematic. In particular, it appears difficult to determine firstly**,** who should be able to trade in these permits, local or national governments, and secondly, how a situation, where all countries keep their deficits close to the 3 % limit knowing that in case of a shock, the supply of permits will be increased, would be resolved. The Fiscal Policy Committee (FPC) proposal put forth by Wyplosz (2002) would require a fiscal body in each country to coordinate the fiscal policy. Other alternatives and modifications are discussed in section 5.

This paper takes the view that some modifications can be incorporated in the SGP without a loss of credibility, such as the provision of incentive to keep budget in balance when nominal economic growth is above 5%. Institutions that implement the policy/recommendations in case of EDP should be made independent and their agendas clearly defined. Implementation of non-partisan application of rules whereby the finance ministers responsible for drafting national fiscal policy, as members of ECOFIN, are not allowed to decide if a country's deficit breaches the SGP defined criteria. The paper, in short, espouses the view that with a few modifications, the existing SGP can be allowed to function. The paper finds that the modelling of the rules in SGP is not the problem as they are transparent, well defined, easy to monitor and simple. The problem however lies in their implementation. The difficulty of non-partisan implementation and the confusion regarding allocation of responsibility, the fact that peer pressure is the main source of governmental compliance with the rules, make their working almost impossible.

Amendment of SGP to take into account these factors will ensure its smooth working by not only making it implementable, but would also let automatic stabilizers work in times of economic slowdown.

3 The need for the Stability and Growth Pact

This section discusses the need for rules of the form of the SGP, which impose a limit on the growth of public debt and deficit, as a requirement for price stability.

From a monetarist point of view, the Central Bank controls the money supply and through that, the rate of inflation, in the economy. This happens via the 'Quantity Theory of Money' equation, $M_t = \kappa Y_t P_t$, where 'κ' is assumed to be the constant velocity of money, M_t, the nominal money supply in the economy, P_t, the price level and Y_t, the nominal GDP. Inflation in the economy would increase as the difference between the rates of growth of money supply and output. . If money supply increases by 'λ' and output increases by 'μ', then inflation in the economy will increase by a factor 'λ-μ'.

However, this argument is flawed because the household's demand for money also depends upon their expectation of future inflation. This dependence of money demand on future inflation causes a large number of equilibrium paths of inflation rate[1]. The constraint on fiscal policy instruments, such as debt and deficit, can then ensure that the prices remain on a stable path.

From a fiscal policy point of view, also known as the 'fiscal theory of price level' (FTPL)[2], price level is set to equate the real value of total initial government indebtedness to the present value of the net-of –interest government surplus, including seinorage revenues.[3] According to Woodford, households have to satisfy their intertemporal budget constraints at all times, while governments may not do so. Governments can follow non-Ricardian fiscal policy under which their budget constraint may be satisfied for some, but not all price paths. The non-Ricardian fiscal policy of the government can thus influence inflation rates.

When one takes the monetarist view, then monetary policy is 'active', i.e. monetary policy (interest rate) reacts strongly to changes in inflation and output and fiscal policy is assumed to take a 'passive' stance, in that the governments adjust debt and deficit levels accordingly. In such a scenario, a limit or constraint on fiscal authorities ensures that the monetary authority moves first and that the fiscal policy has no incentive to work towards surprise inflation (to reap benefits, as their debt is

[1] Obstfeld and Rogoff, 1983 show this.
[2] Michael Woodford proposes the fiscal theory of price level.
[3] Lars Ljinquist and Thomas Sargent, chapter 17,

nominally denominated). Limits on debts and deficits may also be needed since the 'no-bailout' clause of the 'Maastricht Treaty' does not appear to be credible as it appears unlikely that the ECB would not monetise part of the debt of the defaulting government in the wake of a banking crisis in Europe.[4] A limit on the debt and deficits level may also be necessary to avoid a debt crisis in Europe, which could lead to a banking crisis.

Beetsma and Bovenberg (1999) put forth this point, where they argue that a monetary union would result in excessive debt accumulation. They argue that this could happen because the individual governments do not fully internalize the consequences of their excessive debt accumulation on the union-wide inflation as a whole because they face only part of the costs, the remainder being borne by the residents of other member countries of the monetary union. They argue that if monetary policy is discretionary, a debt ceiling of the form stipulated by the SGP alleviates this free rider problem. In the case where governments are myopic, which may be because they do not expect to be in power for an extended period and therefore their rate of discount is higher than that of the society, debt ceilings can play a useful role in addressing government's myopia.

A lower stock of debt implies a lower interest liability in the next period and therefore a lower financing requirement. This could imply lower tax rates and higher public spending so that the central bank would not need to use unanticipated inflation as an instrument to alleviate tax distortions. This would help achieve price stability, which is stipulated as the goal of the European Central Bank.

As the monetary union grows larger, the cost faced by each individual country of its excessive debt accumulation starts to decrease because there are more countries to share in that externality. In such a case, a debt ceiling outlining the debt that each member government can incur, helps in alleviating the free riding problem and restores the credibility of the central bank to maintain price stability. It does not put unnecessary pressure on the Central Bank to use unanticipated inflation as an instrument to align the preferences of the fiscal authorities with that of the society.

In the other case where fiscal policy is 'active', real primary surpluses react weakly to changes in real debt. In such a case, monetary authorities are second

[4] A default by a government on its debt, which has reached unsustainable proportions, could trigger a banking crisis in Europe. This would be because main tool in hands of ECB for conducting monetary policy in the EMU is open market operations via repurchase agreements. (Uhlig, 2002)

movers. A fiscal shock changes the equilibrium path of inflation, real money growth and output. The limits on debts and deficits that governments can incur, in this case, ensure that the policy is on a 'Ricardian' path so that the present value of government liabilities equals the expected present value of future primary surpluses.

The model below is based on the Woodford (1996), which takes the FTPL approach. This is because when fiscal policy is non-Ricardian, the number of equilibriums, involving stable or unstable prices, is many. A limit on debts and deficits to bring back the policy on 'Ricardian' path just reduces the number of possible equilibrium paths. The set of equilibriums then obtained are necessarily the same as that obtained under the monetarist view[5].

Below I use the Woodford (1996) model and implement it in MATLAB using the 'Toolkit for analyzing non-linear Dynamic Stochastic models easily' (Uhlig, 1995) and 'System for solving Linear Difference Equations' (Sims)[6]. The model shows that a kind of fiscal shock that makes the present value of consumption greater than the present value of expected income necessarily results in inflation and price level instability. In the base case, it plots impulse responses for a shock in deficit. It shows that even if the monetary policy rule of the central bank is irresponsive to the level of public debt, a shock in deficit causes an increase in inflation, output and nominal interest rates so that the households can afford a present value of consumption greater than the present value of income. Put differently, it implies that the present value of government liabilities is greater than that of its income so that governments can consume today without having to pay for it. This would lead to a trivial solution wherein all is consumed today. When the monetary policy rule is more responsive to the size of public debt and inflation, both variables (inflation and public debt) and seen to increase more and remain above steady state for a longer period and this makes the situation worse, not better.

The model then introduces limits on public deficit and debt levels, as stipulated by the SGP and plots impulse responses. It shows that in such a case, the deficit and debt movements of the individual governments are constrained so that debt growth is on a "Ricardian" path and hence sustainable. Output, inflation and interest rates in this case do not increase very much and do not have long lasting effects.

[5] Lawerence J. Christiano and Terry J. Fitzgerald, "Understanding the Fiscal Theory of Price level".
[6] This is done using the program, 'gensys.m' written by Christopher Sims.

3.1 The Model

Woodford argues that a variation in the present value of current and future primary government budgets, results in price level instability, so that there exists no possible monetary policy that results in equilibrium with stable prices. A limit on the debt that the governments can incur, as stipulated by the SGP, can eliminate this by bringing the debt levels on sustainable paths, so that "Ricardian Equivalence" holds. In such a case a monetary policy rule, as envisioned in the Maastricht Treaty, can ensure price stability.

The effects of fiscal shocks upon inflation, interest rates and output are analyzed using a closed-economy general equilibrium macroeconomic model based on the general equilibrium model with nominal price rigidities by Woodford (1996). The model assumes a continuum of identical infinitely lived households, indexed by $j \in [0,1]$, each of which specializes in the production of a single differentiated good each period, indexed by $z \in [0,1]$ with $z = j$ denoting the good supplied by household j. Each household consumes all of the goods and its own purchases are only an infinitesimal share of total demand for any of the good that it produces. The prices it sets make only an infinitesimal contribution to the overall cost of obtaining consumption goods. A Calvo type price distortion is introduced in the economy. It is assumed that in each period only a fraction '1-α', ($\alpha < 1$), of good suppliers get to set a new price and the remaining α must continue to sell at their previously posted prices. The suppliers that get to set new prices are chosen randomly in each period. Thus the probability of price change is independent of the time that has elapsed since the last price change and the degree to which costs and other market conditions have changed. An arbitrary degree of price stickiness is thus introduced into the system, with $\alpha = 0$ symbolizing complete price flexibility and $\alpha = 1$, complete price stickiness.

Each household j is assumed to maximize lifetime objective function

$$E\left\{\sum_{t=0}^{\infty}\beta^t\left[u(C_t^j + G_t) + v(M_t^j / P_t) - w(y_t(j))\right]\right\},$$

where u and v are increasing concave functions, w is an increasing convex function, and β is a discount factor between 0 and 1. v indicates the existence of liquidity services from wealth held in form of money, increasing in the real purchasing

power of money.[7] $y_t(j)$ is the household's supply of its product and C_t^j is an index of household's consumption defined by[8]

$$C_t^j = \left[\int_0^1 c(z)^{\frac{\theta-1}{\theta}} dz \right]^{\frac{\theta}{\theta-1}},$$

where $c_t^j(z)$ indicates household j's consumption of good z in period t. $\theta > 1$ is the constant elasticity of substitution among alternative goods. The additive way in which G_t enters the utility function implies that public goods are a perfect substitute for private consumption. M_t^j is the household's money balances at the end of period t and P_t is an index of good prices at t defined by

$$P_t \equiv \left[\int_0^1 p_t(z)^{1-\theta} dz \right]^{1-\theta},$$

$p_t(z)$ is the price of good z at date t. It is the minimum expenditure required to consume a consumption basket of goods defined by C_t^j.

The households in each period can trade in a range of securities that are large enough to completely span all states of nature and thus allows them to insure against idiosyncratic risks, such as those specified by the times when they are not able to change the prices of goods they supply. The budget constraint of the household can then be written as

$$\int_0^1 p_t(z) c_t^j(z) dz + M_t^j + E_t\left[R_{t,t+1} B_{t+1}^j\right] \leq W_t^j + p_t(j) y_t(j) - T_t$$

where, B_{t+1}^j denotes the nominal value of a bond portfolio at '$t+1$' that households hold in period 't', $R_{t,T}$ denotes the stochastic discount factor. T_t denotes the nominal tax obligations of the household during period 't'. W_t^j denotes the nominal value of household's financial wealth at the beginning of period 't' and is defined as

$$W_t^j = M_{t-1}^j + B_t^j$$

'Ponzi games' are ruled out so that households cannot borrow indefinitely to finance a scheme of consumption greater in present value than income.

The monopolistically competitive household can sell quantity $y_t(j)$ in each period but is able to set prices only after random intervals of time, the probability of

[7] This is as modelled in Sidrauski (1967) and Brock (1974)
[8] First Order Conditions here are derived in Appendix I of the paper.

choosing a new price in period '*t*' is given by α. The households as suppliers of the differentiated product therefore choose price '*p*' to maximise

$$\sum_{k=0}^{\infty} \alpha^k \left\{ \Lambda_t E_t \left[R_{t,t+k} p y_{t+k}(p) \right] - \beta^k E_t \left[w(y_{t+k}(p)) \right] \right\}$$

where '$y_T(p)$' denotes demand at date 'T', Λ_t denotes the marginal utility for the household of additional money income at date '*t*' and can be defined as

$$\Lambda_t = u'(Y_t) / P_t$$

The price index evolves according to the equation

$$P_t = \left[\alpha P_{t-1}^{1-\theta} + (1-\alpha) p_t^{1-\theta} \right]^{\frac{1}{1-\theta}}$$

It is the weighted average of prices that have been changed in the present period and the old prices, at which the households that could not change the price during this period continue to sell their goods.

The real primary deficit is assumed to follow an exogenous stochastic process and the accumulated level of public debt, rate of inflation or level of interest rates do not have any effect on it. W_t and B_t are predetermined state variables.

The central monetary authority is assumed to follow a feedback rule of the type

$$i_t = \Phi(\pi_t, Y_t)$$

It is independent of the size of public debt or any other fiscal variable and reacts only to the level of real economic activity, Y_t and changes in rates of inflation, π_t. The Central Bank thus does not demonstrate any intention to "monetise" the public debt or meet seignorage targets of the government.

To see that such a policy mix is consistent with Rational Expectations Equilibrium, only those equilibriums will be considered in which all state-variables follow paths that are close to their steady states or their deterministic equilibrium. This will exist only when the stochastic disturbances are small. The system of equations presented above is linearized around the stationary values of the state variables, which represent equilibrium in absence of the stochastic disturbances. Since real primary deficit is assumed to follow a stochastic process, under deterministic equilibrium, it would be, at some constant level (a constant primary surplus).

The linearization of equations[9] around their steady states gives rise to the following aggregate demand equations.

The equation specifying the evolution of real money balances denoted as a percentage deviation from its stationary value of m_t is given by

$$\hat{m}_t = \chi\left[\sigma^{-1}\hat{Y}_t - (\beta/1-\beta)\hat{i}_t\right]$$

The evolution of real economic activity is specified by the rule

$$\hat{Y}_t = E_t\hat{Y}_{t+1} - \sigma(\hat{i}_t - E_t\hat{\pi}_{t+1})$$

The gross nominal interest rate, specifying the monetary policy rule is given by

$$\hat{i}_t = \phi_\pi\hat{\pi}_t + \phi_y\hat{Y}_t$$

Where ϕ_π denotes the elasticity of the monetary policy function, Φ, with respect to inflation and ϕ_y denotes its elasticity with respect to output.

The evolution of government debt takes place according to the following equation

$$\hat{b}_{t+1} = \hat{i}_t + \beta^{-1}(\hat{b}_t - \hat{\pi}_t) + (\beta^{-1} - 1)\hat{\Delta}_t + \gamma(\hat{m}_{t-1} - \hat{m}_t - \hat{\pi}_t),$$

where, $\hat{\Delta}_t$ is the real primary deficit of the government and $\hat{\Delta}_t \equiv (\Delta^* - \Delta_t)/\Delta^*$ and Δ^* denotes the steady state value of this deficit, which is assumed to be greater than zero. That is, in absence of shocks, there is a constant primary surplus.

The coefficient σ denotes the measure of elasticity of substitution between consumption at different dates and χ measures the elasticity of demand of money with respect to the cost $i_t/1+i_t$ of holding money balances. They are respectively defined as

$$\sigma \equiv -\frac{u'(Y^*)}{u''(Y^*)Y^*}, \qquad \text{and} \qquad \chi \equiv -\frac{v'(m^*)}{v''(m^*)m^*}$$

The parameter γ indicates the relative importance of money and bonds in overall financial wealth and is defined as

$$\gamma \equiv \frac{m^*}{\beta b^*}$$

The 'Fisher Equation' defines the real interest rate, as

$$\hat{r}_t = \hat{i}_t - E_t\hat{\pi}_{t+1}$$

[9] Derivation of log linearisation of equations is done in Appendix II.

The aggregate supply block is defined by the expected- augmented "Phillips Curve", determining the equilibrium path of inflation associated with a given path of deviation of output from potential output.

$$\hat{\pi}_t = \beta E_t \hat{\pi}_{t+1} + \kappa \hat{Y}_t$$

where, $$\kappa \equiv \frac{(1-\alpha)(1-\alpha\beta)}{\alpha} \frac{\omega+\sigma}{\sigma(\omega+\theta)}$$

and $\omega \equiv \frac{\omega'(Y^*)}{\omega''(Y^*)Y^*}$ indicates what the elasticity of supply of a price-taking household would be to a change in the price at which it could sell one of the good it produces. 'α' is the degree of price stickiness and '$\frac{\theta}{\theta-1}$' is the 'mark-up' factor, the factor by which price exceeds marginal revenue as a result of the household's market power.

The disturbance follows a stochastic exogenous process given by a first-order autoregressive process

$$\hat{\Delta}_t = \rho \hat{\Delta}_{t-1} + \upsilon_t$$

Where υ_t is an independently and identically distributed variable with mean zero and bounded support. $|\rho| < 1$.

3.2 Parameterization

The model is calibrated using values for β = 0.95. This implies a rate of time preference of about 5% a year, which is consistent with observed real rates of return. κ = 0.3 is consistent with econometric estimates of Robert (1995). Alternatively, κ could be calculated by using values for α, ω and θ. The markup of firms is usually between 10-20% of the marginal cost, which implies a value for θ as 6 or 11[10]. 'α', as the degree of price stickiness can range from 0, for perfect price flexibility to 1, for perfect price stickiness. 'ω' as the elasticity of price–taking households to a change in price at which they could sell one of the goods they produce. The value of σ =1 is one that would result if *u(C) =log C* and implies an

[10] $\mu = \frac{\theta}{\theta-1} = 1.1 \Rightarrow \theta = 6$

$\mu = \frac{\theta}{\theta-1} = 1.2 \Rightarrow \theta = 11$

intertemporal elasticity of consumption of 1. χ =1 is a value that would result if *v (m) = log m* and implies an income elasticity of money demand of 1 and is consistent with the studies of money demand especially ones that emphasize low-frequency movements in money demand. 'γ'= 0.1 is consistent with the relative size of monetary base and government debt of U.S. The serial correlation coefficient for the autoregressive deficit process ρ is assumed to be 0.6.

The standard deviation of fiscal policy shock is assumed to be 0.5. This assumes that the standard deviation of government expenditure is 2% and that the share of government expenditure in output is 25%. (Bakhus, Kehoe and Kydland, 1991).

A pure interest rate peg implying $\phi_\pi = \phi_y = 0$ involves a moderate response of nominal interest rates to changes in the rate of inflation and output. The parameters of monetary policy rule ϕ_π, ϕ_y are here assumed to be $\phi_\pi = \phi_y = 0.1$. This implies that the monetary policy gives equal weight to inflation and output and is equally sensitive to both. The case when monetary policy is more responsive to inflation is also considered and uses monetary policy parameter values to be $\phi_\pi =$ 0.9 and $\phi_y = 0.5$.

The existence of a unique bounded solution for the state variable given an arbitrary bounded forcing process for the evolution of deficit depends on number of eigenvalues that lie inside the unit circle. (Blanchard and Kahn, 1980)

3.3 Model Analysis

The impulse responses[11] of real output, inflation, nominal interest rates, real interest rates and public debt to a shock in deficit is shown below. The horizontal axis represents the time axis, with '0' indicating the year in which the innovation to the deficit process occurs. The vertical axis indicates the percentage deviation of the variable from its steady state level.

In the first set of graphs, it is assumed that the monetary policy, or interest rate rule is equally sensitive to inflation and output ($\phi_\pi = \phi_y = 0.1$). A one percent

[11] The MATLAB codes are provided in Appendix III.

increase in deficit stimulates aggregate demand temporarily increasing output and inflation.

FIGURE 1: IMPULSE RESPONSE OF DEFICIT (1% INCREASE IN DEFICIT FROM STEADY STATE)

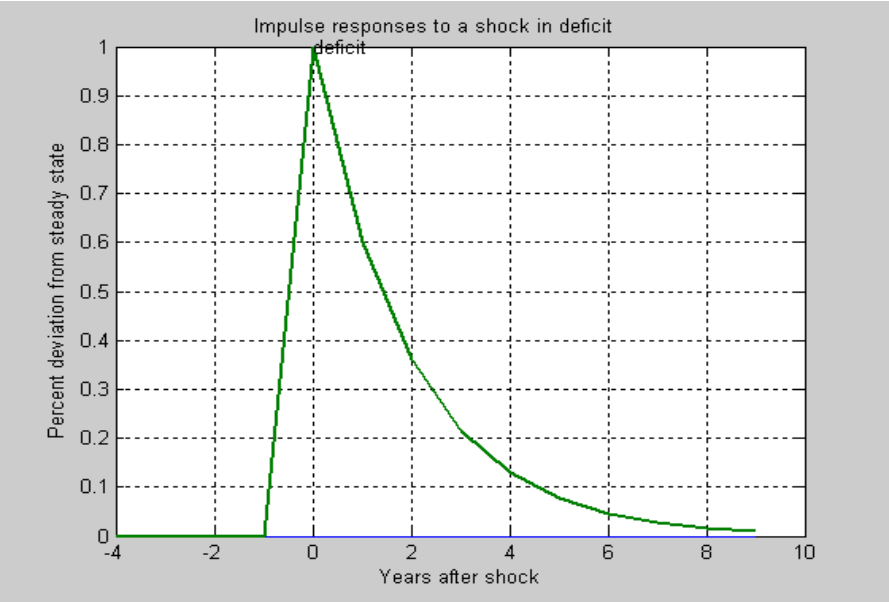
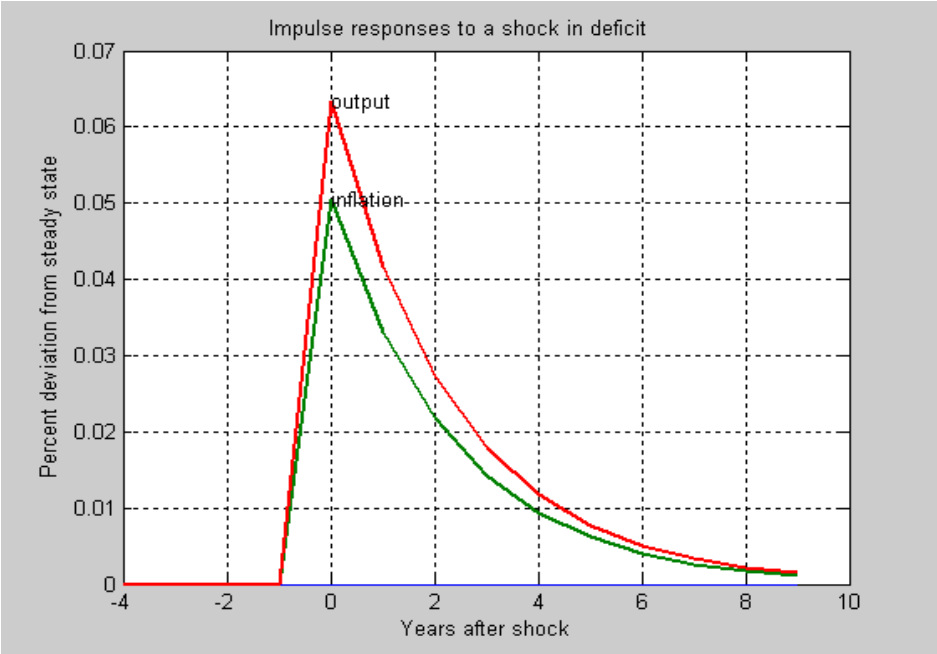


FIGURE 2: IMPULSE RESPONSE OF OUTPUT AND INFLATION TO A 1% SHOCK IN DEFICIT

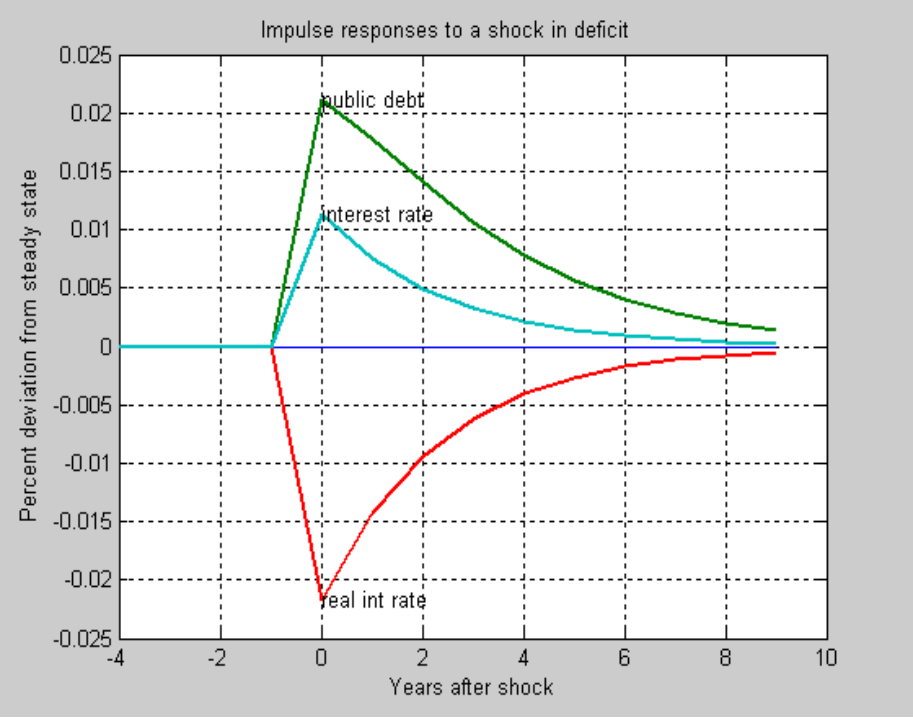


We see that since inflation and output are both forward looking, both begin to increase in the period before the innovation to the deficit process takes place in anticipation of it. The households that face the lucky Calvo draw get to choose new

prices and set them higher than the index of existing prices, resulting in inflation. Households that are stuck at the old prices, face increased demand at those prices. Output therefore increases to meet this increased demand.[12] The extent to which demand actually increases in equilibrium is exactly offset by the increase in inflation as it produces a capital loss.

An increase in the present value of government deficit increases the present value of consumption that the households can afford, if prices and interest rates do not change, and induces an increase in aggregate demand for those goods at given prices. Since prices increase, a part of the government debt is inflated away and real government debt increases by a smaller amount than the increase in deficit or inflation. The reduction in real interest rates suffices to prevent households from being able to afford more goods than the economy supplies. Thus 'Ricardian Equivalence" does not hold despite the assumption of rational expectations and that the monetary policy rule does not depend on fiscal variables.

FIGURE 3:IMPULSE RESPONSE OF PUBLIC DEBT, NOMINAL INTEREST RATES AND REAL INTEREST RATES TO A SHOCK IN DEFICIT



To restore equilibrium, prices and interest rates adjust to being about equality between the outstanding government liabilities and present value of future

[12] The model implicitly assumes that households satisfy the increased demand.

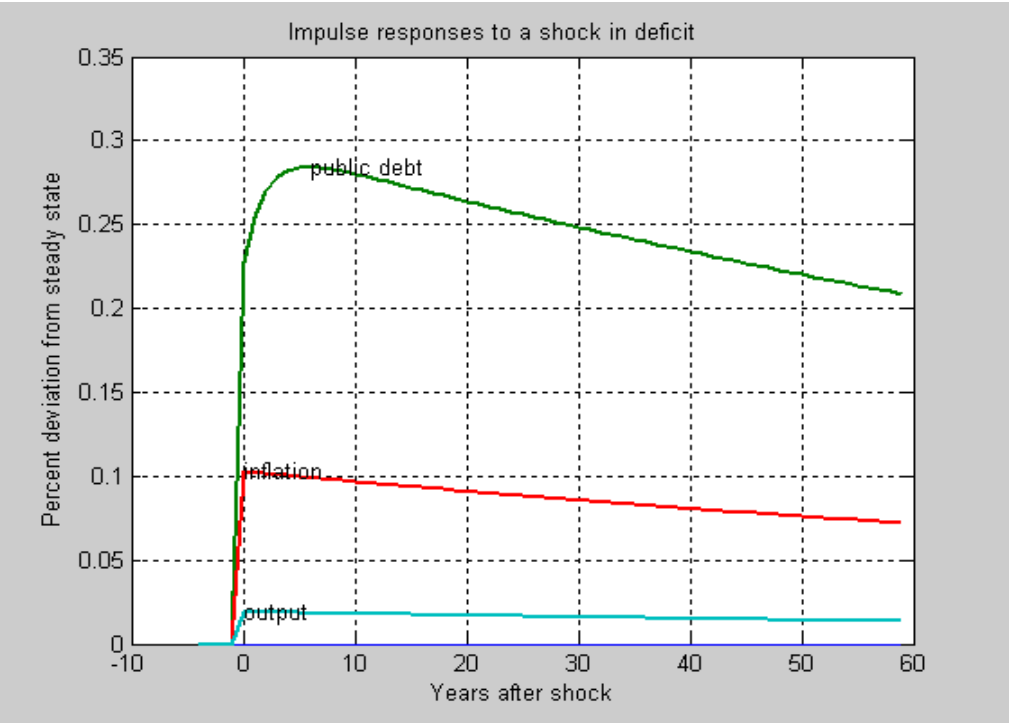
government surpluses. This can come about in three ways. One, seignorage revenues can be increased, as money supply increases to accommodate increased demand as a result of inflation. Two, unexpected inflation as a result of fiscal shock may reduce the real value of outstanding government liabilities, given that government debt is in nominal terms. Three, reduction in real interest rate can achieve the same objective because the now the government has to service its debt at lower interest rates and therefore with lower surplus. This occurs without a decrease in the real value of outstanding government liabilities.

The assumed monetary policy rule therefore implies higher nominal interest rates; due to higher output and increase in inflation. However the increase in nominal interest rates is less than the increase in inflation, as the real interest rate declines.

All these variables remain above steady state for a long time and for the 10 years period plotted, start to converge to steady state in the 9th year, assuming no innovation took place in the interregnum.

Below impulse responses are plotted for the case when the monetary policy rule is assumed to be more responsive to inflation than output ($\phi_\pi = 0.9, \phi_y = 0.5$).

FIGURE 4: IMPULSE RESPONSES OF OUTPUT, PUBLIC DEBT, AND INFLATION TO DEFICIT SHOCK ($\phi_\pi = 0.9, \phi_y = 0.5$)



The European Central Bank, whose main goal or objective is maintaining price stability, could be thought of in this perspective. Therefore in its objective function it gives more weight to inflation smoothening than to the output gap.

The figure shows the response of output, inflation and public debt, when the central bank is more aggressive about increasing nominal interest rates when inflation increases.

FIGURE 5: IMPULSE RESPONSE OF REAL INTEREST RATE TO A SHOCK IN DEFICIT

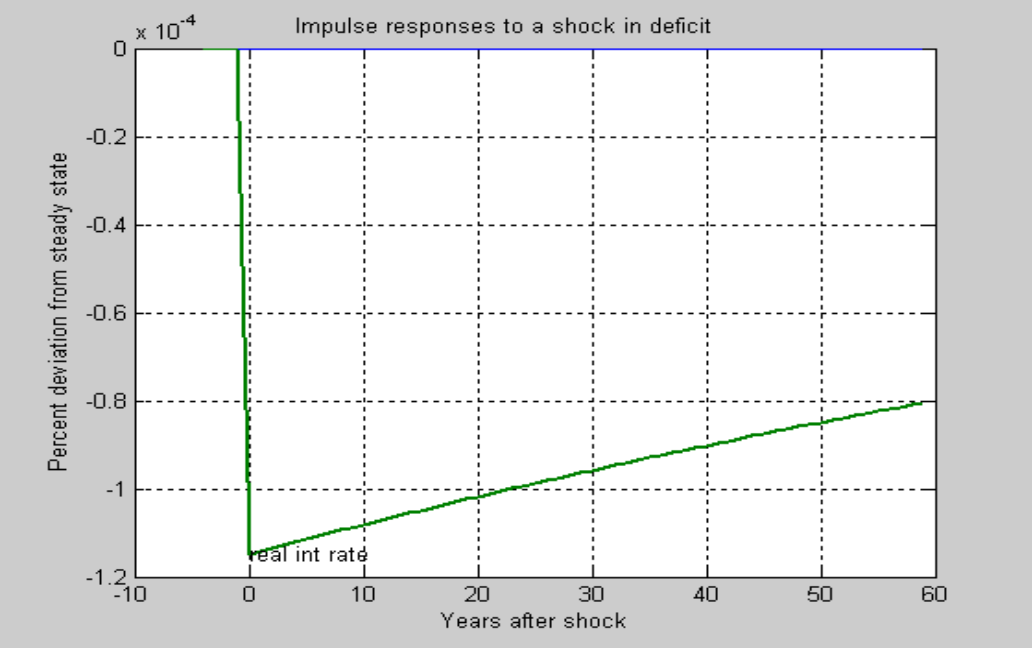
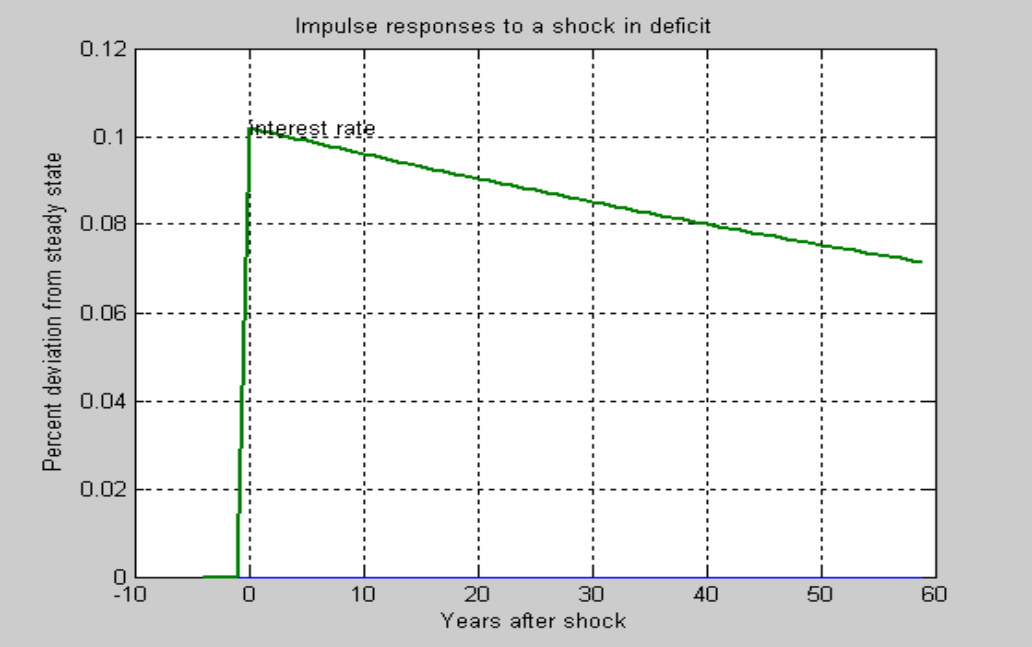


FIGURE 6: IMPULSE RESPONSE OF NOMINAL INTEREST RATE TO A SHOCK IN DEFICIT



Here we see that a increase in inflation firstly leads to only a small decline in real interest rates so that inflation increases to a greater extent and remains above steady state for a longer duration. The real government debt is also seen to increase by much more. This may happen since the real interest rate decline only minimally, the interest service of the debt increases. Also to increase nominal interest rates, more debt needs to be sold to the public. Since the real interest rate decreases only minimally, it takes a long time for real government debt to return to steady state. For a period of 60 years plotted above, all variable are seen to remain above steady state for the entire period.

We thus see that a shock in the deficit process, when the central bank cares only about price stability and not about any of the fiscal variables, leads to more rather than less increase in inflation and output. This occurs because the innovation in deficit process effects private spending decisions, even though the Central Bank is independent. Thus, a mere independence of Central Bank is not enough to guarantee price stability. Once the government can indicate that its debt is on a sustainable path, so that any increase in liabilities will be financed by increased future primary surpluses, no wealth effects would be observed.

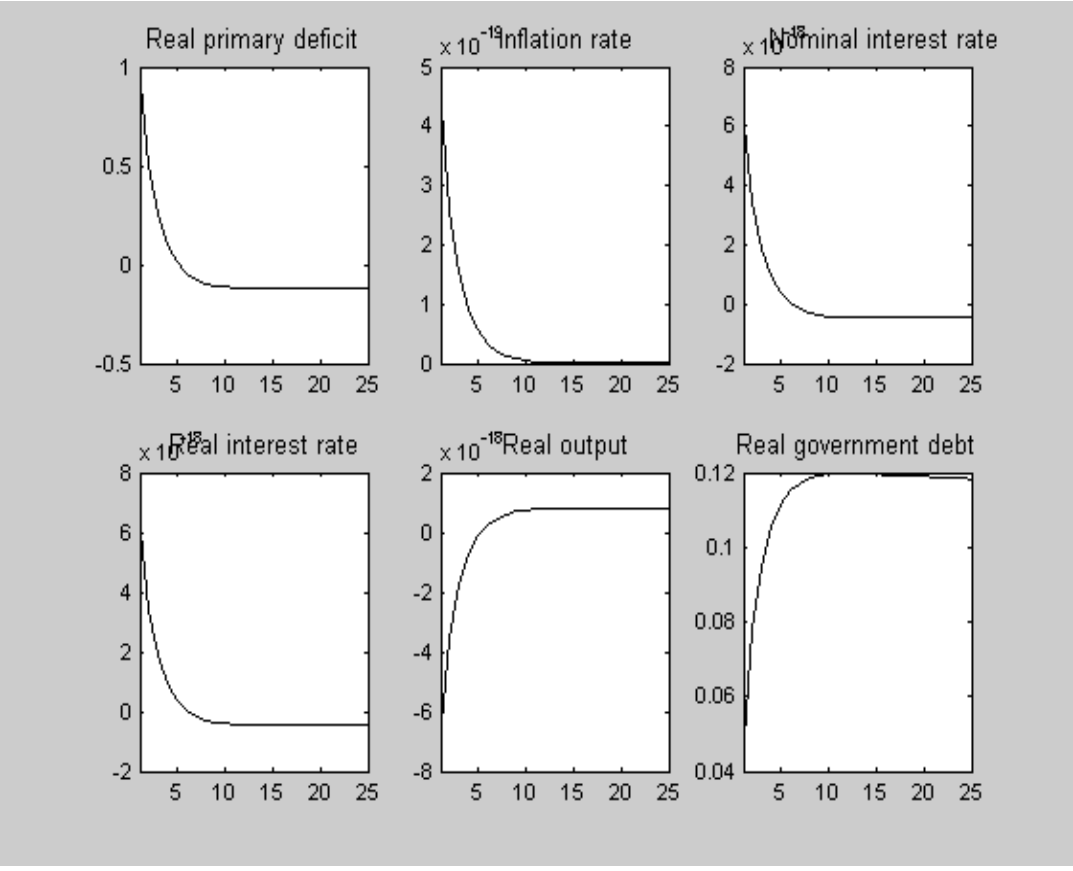
In context of a monetary union, an exogenous process for deficit has the same implications as that of the individual country, except that now the combined deficit of the union matters for the determination of inflation, output and interest rates, and not that of individual countries. In this case, if some countries do not follow a fiscally responsible policy, the variations in its budget deficit can lead to price level instability for the other countries in the union as well, even if the other countries' debt is on sustainable path. To ensure price level stability in this case, would require that that the deficit of the union be on a 'Ricardian' path. This can come about in two ways. Either all countries can commit to keep their deficits on a 'Ricardian' path, indicating that any increase in liabilities will be financed by increased future primary surpluses, or that the fiscally responsible members vary their deficit in the opposite way to that of the irresponsible country, so that debt of the union remains on a sustainable path. Since the second proposal amounts to financing the irresponsible governments' budgetary imbalance, no country would like to do that and would be vulnerable to inflation.

Governments, however, face problems committing to 'Ricardian' policy. This can be made credible to the public by committing to constrain the path of

deficit so that the public does not change its spending decisions. In this regard, a limit on the deficits that governments can incur achieves this end.

Shown below are the impulse responses when a limit of the type of SGP is imposed on governments. In the figure below[13], the deficit process is not exogenous, but is capped by the requirement of being below a certain limit (3% of GDP). $\Delta_t + b_t = \varphi Y_t + \upsilon_t$, where υ_t is the fiscal shock in any period and is given by a first order autoregressive process.'φ' = 0.03 caps the growth of deficit. The impulse responses are plotted for scenario where the interest rate rule is equally responsive to inflation and output (ϕ_π = ϕ_y = 0.1). As can be seen, all variables respond by a very small amount (in the order of 10^{-18}) and quickly return to steady state.

FIGURE 7: IMPULSE RESPONSES FOR A FISCAL POLICY SHOCK, WHEN DEFICIT IS CAPPED BY SGP REQUIREMENTS

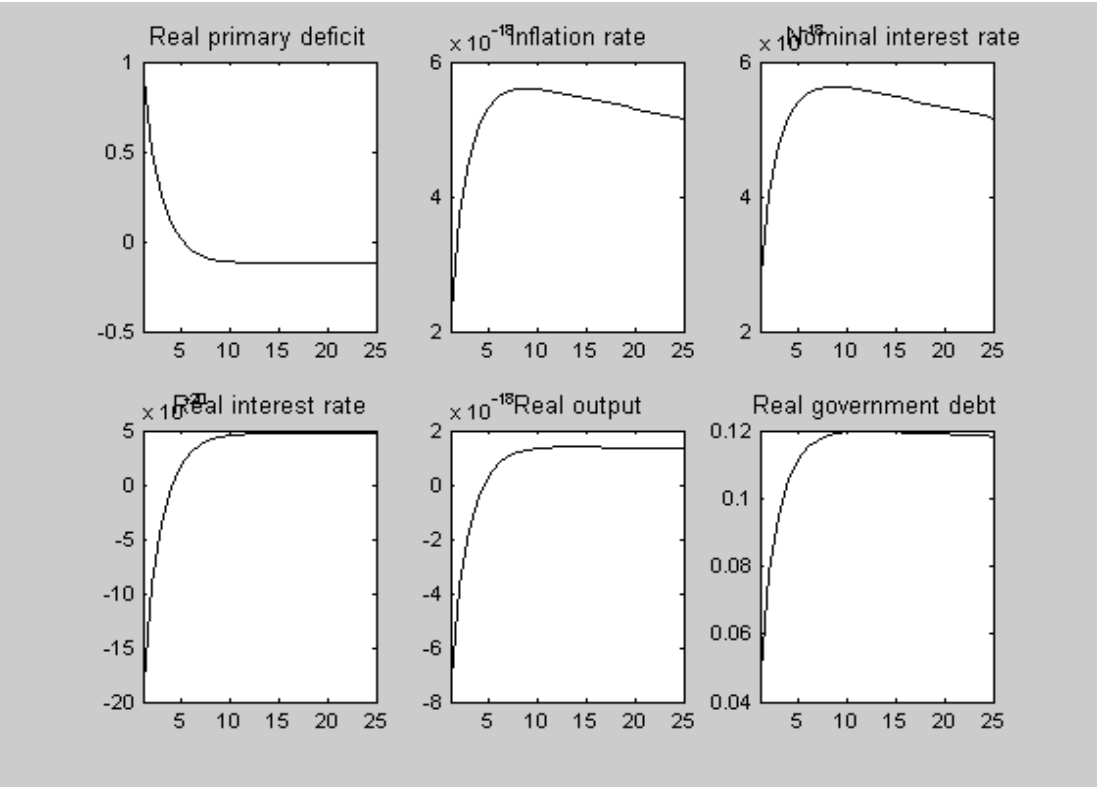


[13] The impulse responses are plotted using gensys.m. The results using 'Toolkit' are provided in Appendix IV. It is also argued there why a different system and methodology is used to get these results.

No wealth effects are observed because the households now know that any increase in liabilities of the government will be financed by future increase in taxes. They thus, do not feel richer at existing prices and interest rates.

The impulse responses for the case when interest rate rule is more responsive to inflation then output are also plotted below.

FIGURE 8: IMPULSE RESPONSES FOR A FISCAL POLICY SHOCK, WHEN DEFICIT IS CAPPED BY SGP REQUIREMENTS (ϕ_π = 0.9, ϕ_y = 0.5)



Thus, we see that the independence of central bank does not guarantee price stability, if government's deficit is on unsustainable paths, since this induces wealth effects for private individuals. The mandate of price stability of the government needs to be strengthened by the fiscal authorities. This ensures fiscal neutrality and makes fiscal policy 'Ricardian' or passive. This is also important in context of monetary union and also ensures that governments do not have incentive to free ride on fiscally responsible governments.

Therefore deficit limits of the SGP are necessary.

4 Why is the Stability Pact not optimum

This section delineates the reasons why a pact of the form of the Stability and Growth Pact may not be optimal. There is a vast discussion in literature as to why this may be the case. Eichengreen and Wyplosz (1998) discuss a situation where, they assume that, the governments will adjust fiscal policies to the extent that they will avoid incurring fines.

The reasons why the SGP is not optimal can be categorized into two main lines of reasoning. Most of the literature dealing with this issue can also be organized in these two streams. One stream argues that the SGP is not needed and that financial market can deal with the problems of externality arising out of each government's debt. This stream lobbies for the abolition of the pact as it exists and for changing the institutions that implement it. The alternative could be a new pact or a new system, which deals with the problems that led to the current situation. The next section deals with one of the approaches, the deficit permits approach, as an alternative to the SGP.

The other line of thought also discussed in literature is a modification of the extant SGP. As the last section brought out, there is undoubtedly a need for rules, which ensures that the path of government deficit and debt remain on 'Ricardian' path. Even when one takes the monetarist view, the need for such rules is clear, as discussed in the section above. What is however not clear is if the pact should be left to function, as it exists today or if there is a need to modify the pact.

This section first delineates the problems with the current functioning of the SGP. It discusses the problems that arise due to ineffective and political implementation, arbitrary ceilings on deficit, inadequacy of institutional set up, asymmetric effect over the cycle, political impossibility of imposing fines, excessive emphasis on deficit without much thought on the level of debt and its future consequences and other drawbacks that have been brought out in literature and that come to mind. It then goes on to discuss these problems in the light of the two lines of reasoning namely the abolition of the pact and the modification of the pact. This paper takes the view that limits on government incurrence of debts and deficits are needed. It however stresses that a modification of the pact may also be needed. The modification and the alternatives to the pact are discussed in the next section.

Problems with the pact

To counter the coordination failures giving rise to free riding problem as a consequence of the interaction of one monetary policy coordinating with 12 fiscal policies, the Stability and Growth Pact was formulated. The Pact requires that the national deficit level be maintained below 3% of national GDP (Article 104 of the Treaty) and be approaching "close to balance" in the medium term. This is clarified and speeded up by the Excessive Deficit Procedures (EDP), which consists of three elements.

- A political commitment by all parties involved in the SGP (European Commission, Member States, European Council) to the full and timely implementation of the budget surveillance process. This political commitment was expected to ensure that effective peer pressure is exerted on a Member State failing to live up to its commitments.
- Preventive elements, which through regular surveillance, aimed at preventing budget deficits going above the 3% reference limit. Council Regulation 1466/97 enforces the multilateral surveillance of budget positions and the co-ordination of economic policies. It foresees the submission by all Member States of stability and convergence programs, which the Council examines.
- Dissuasive elements, which, in the event of the 3% reference value being breached, require Member States to take immediate corrective action and, if necessary, allow for the imposition of sanctions. These elements are contained in Council Regulation 1467/97 on speeding up and clarifying the implementation of the excessive deficit procedure.[14]

The first criticism of the pact is that the reasoning for the 3% limit on deficit is arbitrary. It is argued that the 3% limit on deficit was imposed because public investment is not inflationary and European governments have historically undertaken public investment in the range of 3% of GDP. (Biuter, Corsetii and Roubini (1993)). Biuter (2003) argues that the 3% limit was not picked out of the air. In some countries, especially France, the 3% figure had won some political and public acceptance in the 1980s. Furthermore, it had some logical consistency with

[14] Economic and Financial Affairs of the European Union (http://europa.eu.int/comm/economy_finance/about/activities/sgp/edp_en.htm)

the longer-term objective of converging to a debt ratio of no more than 60%, provided - as was assumed at the time - that the denominator of the debt ratio, nominal GDP, would be rising at a trend rate of approximately 5% annually, 3% real growth plus 2% inflation. If member countries could achieve deficits hovering a bit below the 3% upper limit, their debt ratio would in the long run converge to just under 60% regardless of the point of departure. The objective for the debt ratio was seen as justified around 1990; that was the approximate average for the then 12 members and it also seemed to correspond roughly to the existing measures of the value of public sector assets. This comparison also suggests that it is in some sense normal to finance public investment by the issue of public debt, rather than by current revenue.

Another criticism is that the Pact, as pointed out by Alberto Alesina and Francesco Giavazzi[15], is that the pact concerns the overall level of deficit and not its components, namely taxes and public spending. Myopic governments may lead to excessive debt accumulation, by borrowing to finance spending to please their constituencies with little care about the implications of this deficit and leaving the next government to deal with the consequences. The current level of taxation in EU comes in the way of the incentive to individuals to work harder and invest more. The social security system, as it exists in Europe today, also provides little incentive for people to work hard. The implementations of the recommendations of the Social Security Committee at the European Union level may seem to be a burden when the candidate countries join.

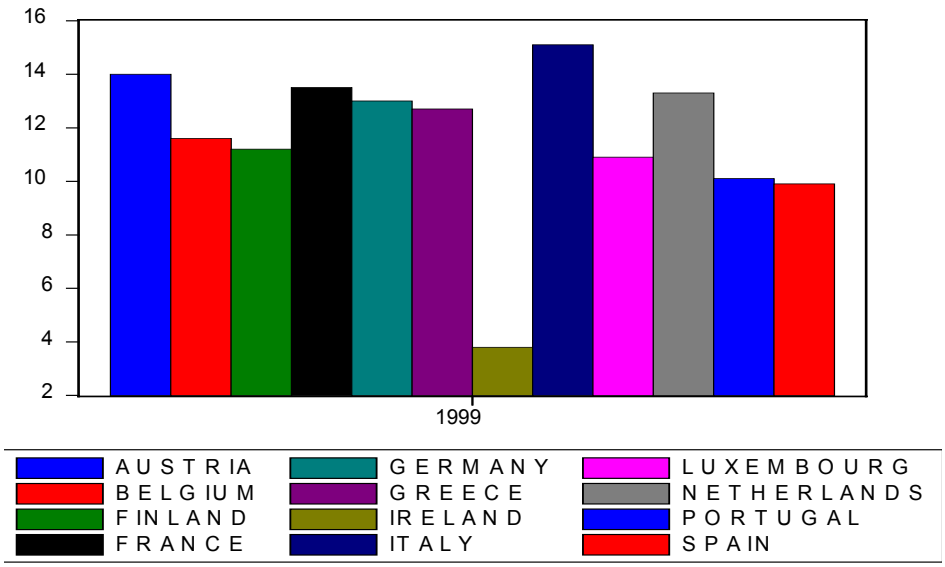
The pact lays too much emphasis on the level of deficit and not on debt and its future consequences, given the ageing population of the Euro zone. It fails to take into account that public debt is a governmental instrument for achieving intergeneration redistribution and insurance.

A close to balance or surplus budget in the long run implies that the government either finances current expenditure from current revenues or that it is a net creditor, which does not make sense. Also, for the Central European countries which are likely to join EMU, too much emphasis on deficits is dangerous given that they have low levels of debt and, at the same time, need to increase their public investment to converge with the present member countries, and therefore to have

[15]Project Syndicate, October 2002.

larger temporary deficits that can be financed by issuing more debt. On the other hand, for some of the present Euro Area member countries, which have higher debt levels than the rest of the members, debt sustainability is much more important than deficits, especially for those which are going to be more negatively affected by the ageing demographic trends. Debt sustainability is related to the GDP growth rate, to the real interest rate and to the primary budget balance and the real important measure of debt is net and not gross. None of these factors are included in the budgetary criteria of the SGP. As can be seen in the graph below, pension payments accounted for between 10-12% of GDP in 1999 in most EMU countries. This is especially important to keep into account in light of the debt and deficit restrictions of the SGP.

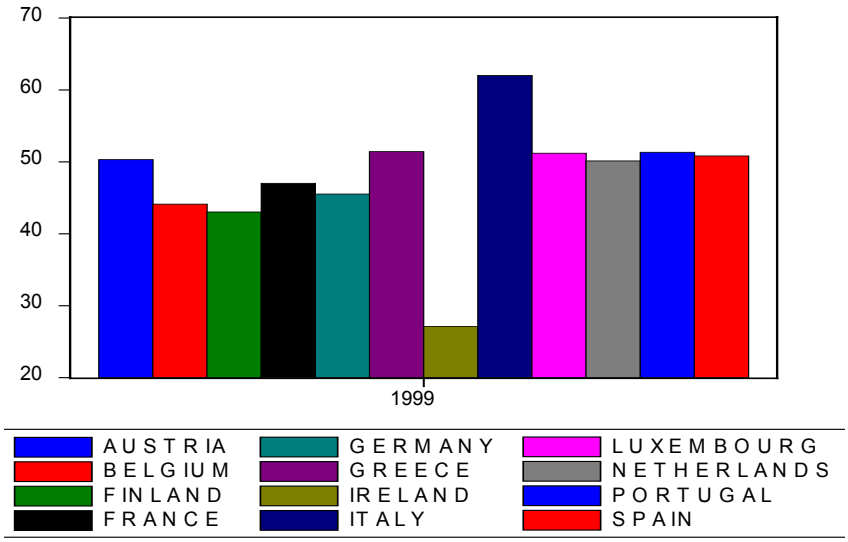
FIGURE 9: OLD AGE PENSIONS IN EMU AS A PERCENTAGE OF GDP[16]



As seen below, pension payments accounted for between 40-50% of the social expenditure. This is very high and with the adverse demographic trend being faced by most EMU countries, it is likely to increase. It therefore does not seem optimal to cut deficits sharply now for coping with future imbalances due to ageing populations, but it is more prudent to start tackling the issues head on through encouraging private pensions, increasing the age of retirement etc.

[16] Source of Data: Euro stat.

FIGURE 10: OLD AGE PENSIONS AS A PERCENTAGE OF SOCIAL EXPENDITURE[17]



With single monetary policy, exchange rates can no longer be used to adjust differential shocks. This leaves out a very important mechanism for shock adjustment and provides one less degree of freedom. This is especially true in light of the fact that not all countries in the union are at the same stage of economic development. Countries like Spain and Ireland, which have faster growing economies, cannot at present adjust the higher inflation rates, via the purchasing power parity, by appreciating their currencies. This puts inflationary pressure on the rest of the Union via the Harrod-Balassa-Samuelson effect. In such a case, these countries would be asked to curb growth because of the inflation they export to other countries in the Euro zone. The problem is likely to become more severe with the enlargement of the Monetary Union to the east, with the joining of the labor-intensive economies, which are likely to experience high growth rates for a few years, before their standards become at par with those of the western European countries.

The SGP as structured presently implies that the governments should run a budget surplus in good times so that they do not breach the limits of deficit during a recession. However, most countries have had to curb their economies to achieve the 3% deficit level to meet the criteria to enter the EMU. A recession would make this adherence impossible. The governments of the individual countries would no longer

[17] Source of Data: Euro stat.

be able to use deficits as a mechanism to increase public expenditure and stimulate demand. This may have the adverse effect that the recession may last longer than if demand could be stimulated via public expenditure. This could have longer-term implications for countries.

Benoît Coeuré and Jean Pisani-Ferry (2003) criticise the pact saying that it employs a one-size-fits-all approach. The fact that all the countries have to satisfy the same debt and deficit criteria can be justified only if the deficits of all countries give rise to the same externalities. In addition, there is no rationale to employ a common target to countries whose debt levels, implicit pension liabilities, potential growth rates, output gaps and future investment needs are widely different.

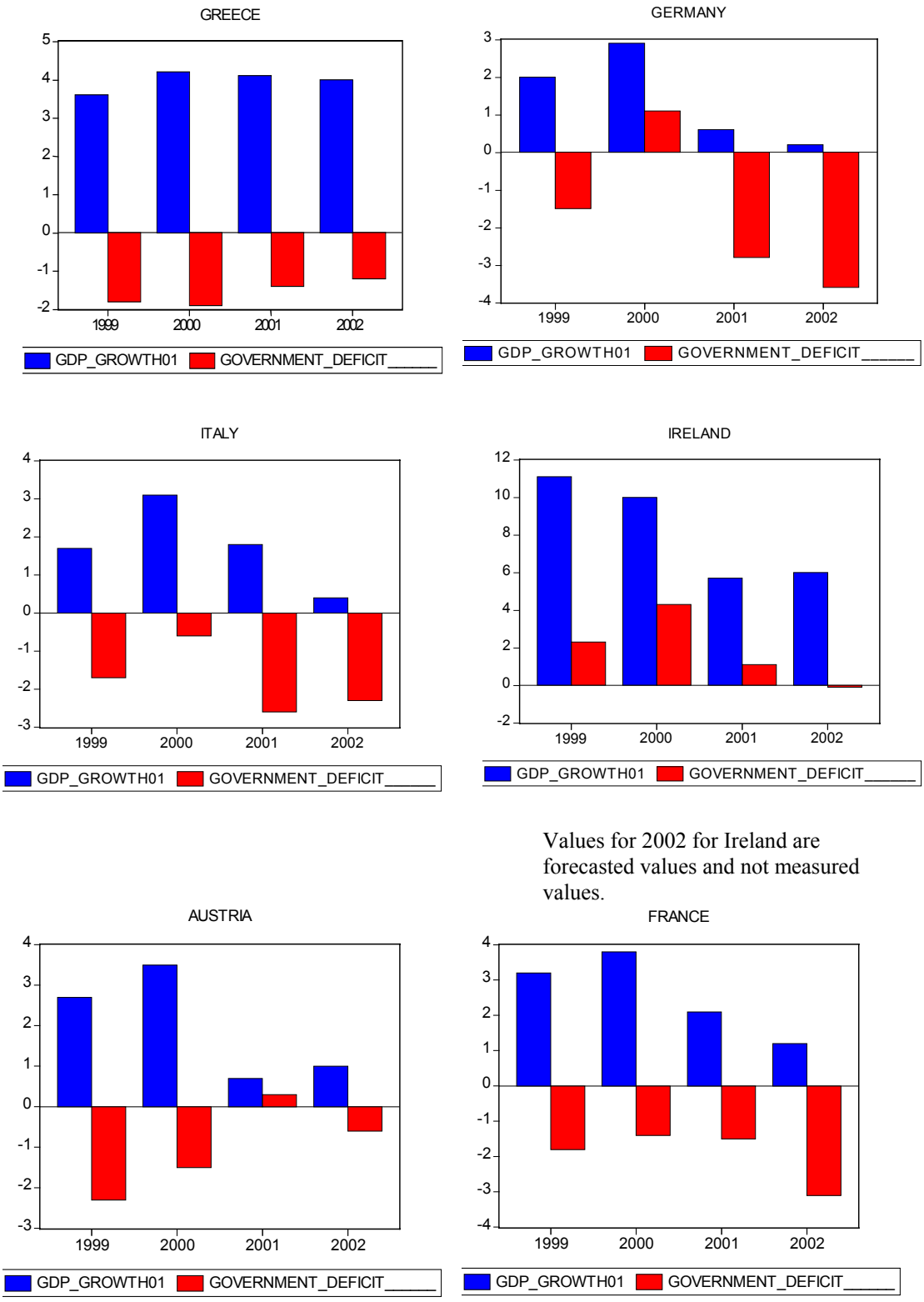
Another criticism of the SGP as pointed out by Buti (2001), Franco and Ongera (1997) is that the fiscal policy has turned procyclical. The SGP was supposed to improve things by making the fiscal policy at least neutral and possibly counter cyclical when automatic stabilizers are allowed to operate. However, this has not been the case and the fiscal policies have become even more procyclical. One reason for this could be that a government will be forced to increase taxes and curb public spending in downturns to satisfy the restrictions imposed by the SGP. Another reason could be that fiscal policy under the current SGP is a discretionary policy, which is often procyclical.

The present formulation of the SGP also does not give incentives to the governments to run a budget surplus in times of boom. In this way it treats deficit asymmetrically over the cycle. A surplus in good times would enable the automatic stabilizers to work in times of downturns. As argued by Eichengreen and Wyplosz (1998), if the budgets are kept in balance or surplus so that the automatic stabilizers can function, then there is no need for the SGP. This repeats in a vicious circle, because without the SGP, there would be no incentive for governments to keep their budgets in balance. An asymmetry of the pact in treating the deficit differently in times of boom and downturn is thus a strong drawback of the pact.

As can be seen from the graphs below, most countries did not align their deficit levels close to balance or in surplus in times of growth. For example, Greece had a real GDP growth rate of 4% in 2000 and even then the deficit was at 2% of GDP. Finland, The Netherlands, Luxembourg and Belgium were the only countries that brought their deficits into surplus during the high growth years of 1999-2000.

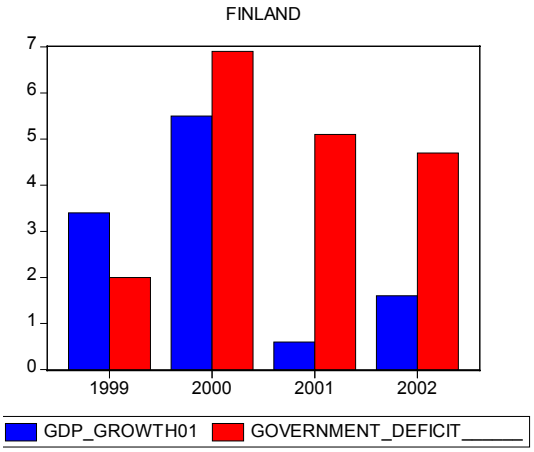
Belgium, as we can see, was just in surplus, while Finland had a budget surplus of nearly 7%.

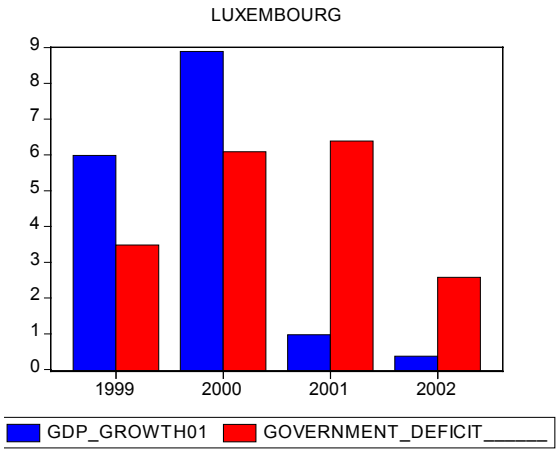
FIGURE 11: THE REAL GDP GROWTH AND DEFICIT OF THE 12 EMU COUNTRIES[18]



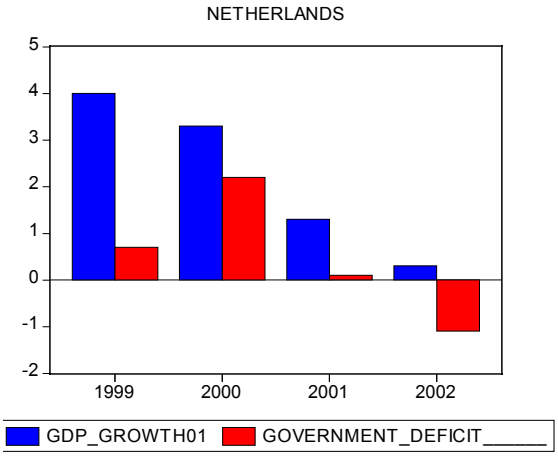
Values for 2002 for Ireland are forecasted values and not measured values.

[18] Source of Data: Euro stat. Graphs obtained using Eviews 4.1.

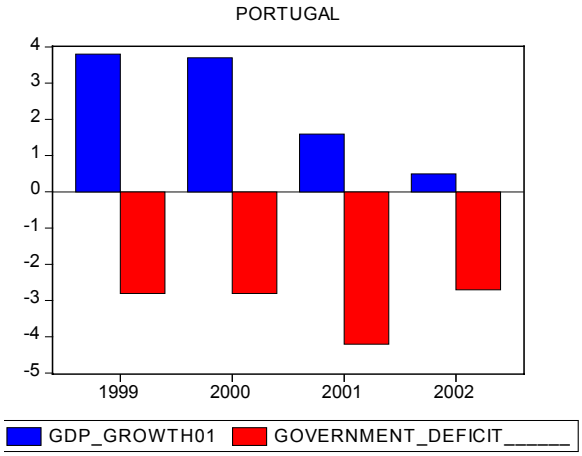




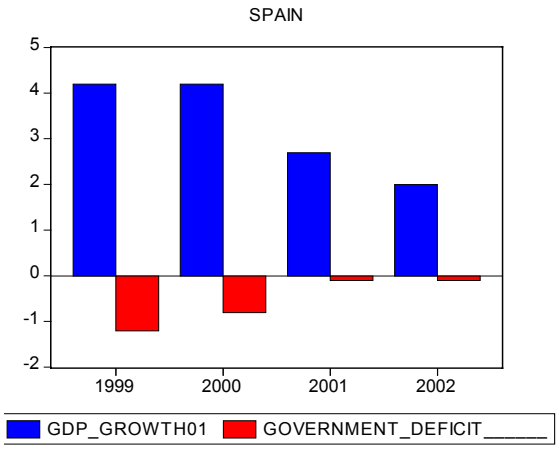
Data for real GDP growth rate in 2002 for Luxembourg is forecasted.



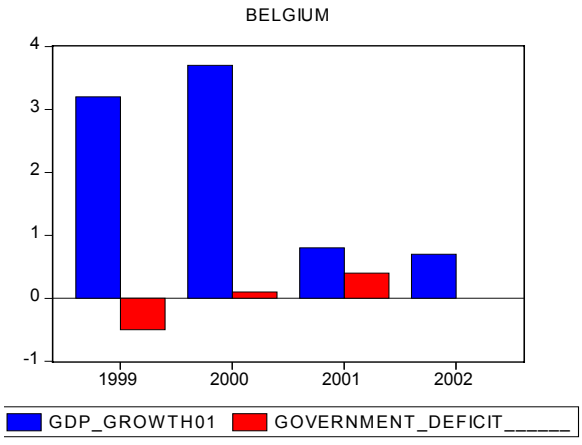
The graph uses forecasted values for real. growth of GDP for 2002 for The Netherlands



Data on government deficit in 2002 is forecasted and not measured for Portugal.



The graph uses forecasted data for real GDP Growth Rate for Spain for 2001 and 2002.



The government deficit of Belgium in 2002 was zero.

This shows that the reason for the high deficits presently incurred by the countries may not be the current slowdown in the economy but could be the inability of the SGP to force the governments to make use of the good state of the economy from 1998-2000, namely to bring the budget close to balance or in surplus. The countries did not improve their structural balances as they committed to do in the stability programs.

Ensuring that the automatic stabilizers can work and are not constrained by the SGP requires a faster pace of growth for Europe, which will endogenously close the deficit. This is because the equation determining net debt / GDP ratio can be calculated as a ratio of long-term financial deficit to the long run nominal income growth. The 60% ceiling on debt assumes that the long-term deficit will be below 3% and the nominal long-term growth in the Euro area would be 5%. Faster growth without inflation requires more labor markets and labor markets flexibility.

The tool in the hands of the central bank, namely the interest rates, to counter anti-inflationary pressure, may not always be the most effective method of dealing with inflationary pressures and can have adverse effects on different economies. In particular, a rise in interest rates may slow down economic activity in some countries.

The ECB was set up on the lines of the BundesBank, the German Central bank, partly because Germany was the strongest economy in the Euro zone. The ECB has therefore adopted the ethos of the BundesBank of maintaining price stability. It is, however, necessary that the ECB cares not only about price stability but also about unemployment as well. Whilst the BundesBank had a counterpart in fiscal policy, the ECB has no such counterpart and the fiscal policy is therefore uncoordinated. Whether the countries should coordinate their fiscal policies more closely or whether a monetary union entails a fiscal or political integration is a question that still remains undecided. The ECB and the member countries moreover have to decide on the relative importance of price stability for Europe as compared to the goals of growth, employment generation etc. Even Federal Reserve Bank of United States has these goals incorporated into its goals alongside the goal of price stability.

Abolition of the Pact

As seen above, a considerable body of literature brings out that the SGP, as it exists today, is not optimal and raises more questions than what it answers. This body of literature makes the case for a new pact or such reforms as would address these questions. The reasoning of this literature is based on the assumption that there is an inherent problem in that the SGP gives wrong incentives to the governments for adjusting fiscal policies. According to this reasoning, the SGP does not address the overall policy mix in the Euro zone and is based on the premise that interactions between various fiscal and economic policies are of little or no importance. It is assumed therein that a proper policy mix will be maintained as long that each policy maker does not breach the assigned limit. Monetary policy is assumed to play the active role while fiscal policy is there just to provide the right environment for former's working.

Another argument put forth for this theory is that the SGP monitors and imposes restrictions based on monitoring of the deficit and debt ratios, which do not provide sufficient assessment of the state of public finances. The "exceptional circumstances", cited as the only criterion where breaching the 3% limit does not lead to imposition of a fine, is not clearly defined and gives much room for maneuver. In particular, member countries have an incentive to under-report their GDP growth rate, when they are just on the limit of breaching it, to be able to avoid the fine. Also, the SGP does not take the cyclical factors sufficiently into account and is more concerned with the fiscal deterioration in a downturn while not giving enough incentives or motivation for governments to bring their houses in order during a boom. As the graphs in figure 11 above show, apart from four countries, all other EMU member nations had big deficits when growth in EMU area was high (1999-2001). These high deficits in times of boom do not provide sufficient room for automatic stabilizers to work in downturns. If the SGP also controlled the level of deficit in a boom and required it to be in surplus, then it would be able to ensure that during a downturn, enough room existed for the automatic stabilizers to work without having to breach the 3% deficit limit.

A related issue is that the imposition of fines on a country when it breaches the 3% limit leads to a further deterioration of its fiscal condition. The rule thus

ensures that the country is stuck in a period of low growth for a longer period, than if the automatic stabilizers could function.

Yet another perceived weakness of the pact is its political implementation. Charles Wyplosz (2002) argues that the main channel of implementation of the pact is peer pressure (Broad Economic Policy Guidelines). When a country is noticed to have breached the 3 % limit, the members of the ECOFIN, which consists of the finance ministers of the 12 member countries, decide on what restrictions are to be placed on the defaulting member. EU officials will be reluctant to levy fines on the member breaching the limits of deficit due to goodwill costs. Member states will be reluctant to incur fines due to the embarrassment it causes and will therefore adjust their fiscal policies enough so as not to incur the fines. Eichengreen (1997) has shown that the larger and stronger countries can get away without punishments, while the smaller countries may have to face the music. Also, the member countries have an incentive to vote in favor of a defaulting country, hoping that if and when they default, they will be supported likewise. In this way, a repeated cooperative game can be played amongst the members. This therefore requires a different framework for analysis than the one used, namely, non-repeated non-cooperative game.

The system of voting on whether sanctions need to be imposed on a country breaching the 3% limit is also questionable. As analyzed by Sutter, different weights to different countries in the EU council of ministers gives larger advantage to the larger countries, which can prevent the EDP working against them and have larger room for maneuver of fiscal policy. The voting mechanism has also been found to be unsatisfactory in that sinners pass judgment on other sinners.

The ex-post imposition of fines (not that they can be imposed ex- ante) is counterproductive and worsens the budgetary imbalances. They are ineffective as an ex ante anti- deterrent.

All these drawbacks support the case for the abolition of the SGP.

Amendment of the SGP

The other line of reasoning, which in present circumstances seems to be more appropriate, is one that advocates a change or amendment of rules of the SGP. This reasoning appears more pragmatic because attempts to abolish the pact would

lead to a situation where the pact is suspended, or is expected to be suspended. In such a situation, the policy makers would not have any incentive to abide by it. In the meantime, the lack of a policy would give rise to a period of greater uncertainty in the financial markets. This uncertainty would adversely affect the way markets price the risk for the European countries in the monetary union. It could also give rise to serious problems in the banking system.

Most of the problems with the current functioning of the SGP outlined above could be resolved if the SGP is amended to take into account the drawbacks. According to this reasoning, there is nothing wrong with the goals of the SGP and they are in fact needed for proper functioning of the common monetary policy interacting with many fiscal policies. However, the rules need to be better defined, transparent and implemented without partisan application.

Since the SGP, like any other pact or treaty, amended to take into account all the deficiencies outlined above could function well, a strong lobby exists advocating these changes. A major drawback in amending SGP at the time of a downturn is that the policy may appear to lose credibility. This could be a source of recurrent problems in the light of EU enlargement into Eastern Europe. This would also be a source of problem for financial markets.

The proposals for the modification of the SGP, as well as alternative rules, are outlined in the next section.

5 Alternatives

Abolition of the Stability and Growth Pact will give rise to serious problems as discussed in the previous section. Most suggested alternatives consider either a refinement of the Pact or an amendment to it.

This section first discusses the Deficit Permits approach advocated in Alessandra Casella's (1999) proposal with respect to the EU. It then discusses the other alternative to the SGP, namely an amendment of the Stability and Growth Pact to get it rid of the perceived problems of lack of political implementation and partisan nature. The voting mechanism in the EU Council, which decide whether a country is in breach of the deficit limit, is also discussed. The latter need special attention due to the expansion of the EU into Eastern Europe since these could give rise to a number of problems including non-satisfactory decisions by the council, in which the east European members will have a majority. This could lead to a divergence in opinion and objective of the few core "European Countries" from the rest of the Council. The SGP in that case would have to be modified at one go and not at differing times, (each time when the Council and member countries find its implementation unsatisfactory,) because this would lead to a loss of credibility of the pact and authorities.

5.1 The Deficits Permit Approach as alternative to SGP

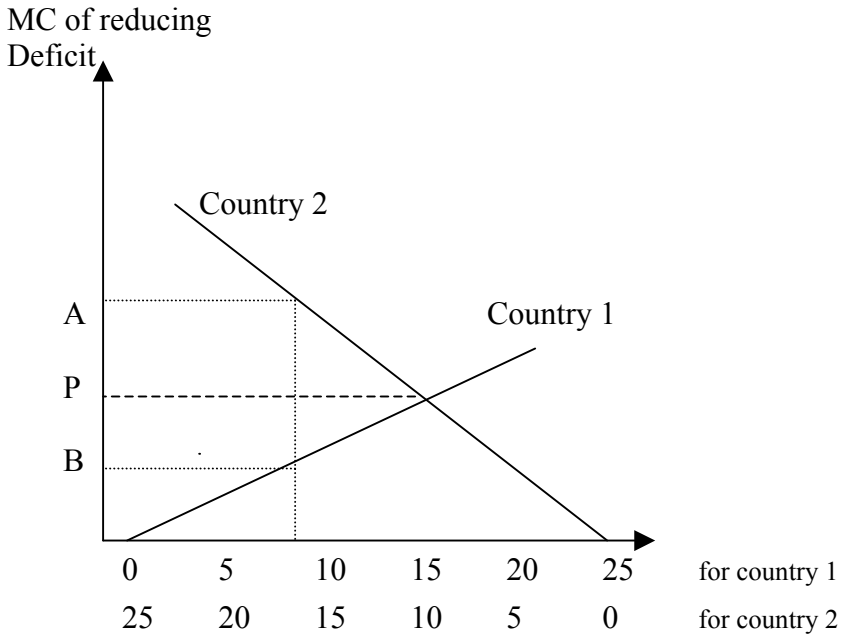
The model presented below is based on the model by Casella (1999) using tradable deficit permits as an alternative to the SGP to curb excessive debt accumulation and excessive deficit occurrence in member states of the EMU. It takes into account some of the drawbacks of the current scheme and brings out as to why the proposed scheme would be superior to the SGP. The model also takes into account the gamut of criticism, present in literature, to the model proposed by Casella (1999).

In the Casella (1999) model, each country would be allocated permits worth 3% of its GDP (as is the case in SGP) at the beginning of the year, which would be accounted for in a special register with the ECB. At the end of each accounting year, each country would be required to produce permits worth the amount of

deficit it has incurred during the year. These permits would then be withdrawn from the system. If a country finds that it has fewer permits than required for the debt it has incurred, it could buy the permit from other countries, which have a surplus and can therefore spare permits. It might not be advisable to allow countries to borrow permits for future use. The prohibition on borrowing may be understood in the light of myopic governments, which are too short sighted and may borrow permits to please their constituencies etc., leaving the next government to deal with the problem of keeping the budget in surplus or balance. Allowing countries to bank permits for future purposes may however allow room for intertemporal planning and smoothening of anticipated shocks.

A feature of this system is that the cost of issue of new debt increases. This is because to be able to issue new debt, a country would have to buy a permit to incur that debt and a part of the new debt would be devoted to purchase of the permit. If 'x' is the right to issue one euro of debt, the government can now only devote '1-x' euros to national expenditure. This drives a wedge between the total new debt and the borrowed funds that can be devoted to national expenditure and implies that the price of the right to issue 1 euro of debt must always be smaller than 1.

FIGURE 12: EFFICIENT ALLOCATION OF DEFICIT REDUCTION[19]



[19] Adapted from Tietenberg (1985:20)

An advantage of this scheme is that a country can actually measure the marginal cost and benefit of fiscal discipline and need not lower its debts if the costs of doing the same outweigh the benefits. This can be seen in the figure above.

While the representation, for simplicity, depicts the case of only two countries, it remains valid for many countries as well because it just depicts how different countries can have different costs of imposing fiscal discipline and therefore may not be constrained by the 'one size fits all' rule. Under the proposed scheme, the countries have the freedom to implement fiscal discipline in the most efficient manner. In the depiction shown above, the two countries produce differing levels of deficit because their GDP is different (deficits are assumed to be measured as a percentage of GDP).

The horizontal axis measures the reduction in deficit and is to be read from left to right for country 1 and right to left for country 2. The vertical axis measures the marginal cost of reduction in deficit in the two countries and thus both curves are zero when the deficits are unconstrained by the SGP or any other alternative rule. For each country, the total cost of achieving a desired level of deficit is below the marginal cost curve, up to the specified point. There is a unique allocation, where the marginal cost curves intersect, that minimizes the total cost.

Suppose that initial distribution required Country 1 to reduce deficit by 10 units and Country 2 to reduce deficit by 15 units. As long as the price of the permits was smaller than 'A', Country 2 would want to buy permits, and as long as the price was higher than 'B', Country 1 would want to sell. When the price equals 'P', both the countries have the required number of permits to bring them to the efficient point. The price cannot be different from 'P', since it would entail higher demand or supply depending on whether the price was higher than or lower than 'P'. This two-country logic can easily be extrapolated to a multiple-country scenario. It would be seen that any initial distribution of permits leads to the same equilibrium, although to different allocation of total costs.

One might observe that this, like the SGP, gives a strong incentive to governments to under-report their true deficit and in this way, it is not an alternative to the pact. However, any scheme that would measure the deficit and impose punishments on the defaulting governments would lead to a similar scenario.[20] One

[20] Remarked by Peter Birch Sorensen.

may however note that it would not be possible for governments to infinitely under-report and that such a scenario is most likely when the governments breach the 3% limit by a small amount.

The model I present below is based on the proposition by Casella (1999), but differs from the former in some respects. It builds and modifies the base model of Casella (1999). In the modified model, every country is allocated permits worth 3% of its GDP every year. This initial allocation could be dependent on the contribution of each country's GDP to total EMU GDP. These permits would however not accounted for by the ECB, but by a different body, which for instance, could be the Euro group or the Euro Commission. The ECOFIN would be debarred from the responsibility for the accounting of permits to solve the problem of partisan implementation of rules, which is presently a drawback under the SGP. The Euro group or Euro Commission would, in this case, be an autonomous body and decide on the fiscal stance of each government. Their task could also be interpreted as that of the regulator of the markets for permits.

Since countries comprising the EMU are of different sizes and financial strengths, the impact of each country's fiscal misbehavior imposes different externalities on other countries of the EMU and the EMU economy as a whole. To measure this impact, an index, "Index of Financial Impact", could be constructed, which would determine the weight of each country's GDP in the combined EMU GDP. This weight would determine the impact of each country's fiscally irresponsible behavior on the EMU as a whole. For instance, the impact of high deficits accumulated by Germany would be greater than the impact of Ireland exceeding the deficit limit by the same amount. Construction of an index, which measures the impact of each countries fiscal discipline, would make the deficits of the countries substitutable. This would be so because, in this case, Germany would be required to produce more number of permits for the same deviation of excessive deficit than Ireland, since it is a larger economy and thus affects the EMU more as compared to Ireland. Instead of denominating the permits in terms of the deficit of the country with the lowest contribution to the EMU GDP, the permits would be denominated in Euros. Therefore, each country would have a 3% limit on deficit, but in case of excessive accumulation, would require to furnish extra permits for the deficits in absolute Euro amounts. For example, if Ireland exceeds its deficit allocation by 0.5% and its GDP (as in 2002) is 125,562 million Euros, then it would

be required to furnish permits worth 627.81 million Euros.[21] This would not only make the rule and the value of permits clear, transparent and easy to calculate, but also ensure that as contribution of each country to the total EMU GDP changes, the denomination of permits does not have to be changed. It would also ensure that each year and every time, the ratio between countries, determining the relative financial impact does not have to be re-calculated.

At the end of each year, each member country would be required to produce the number of permits equivalent to the amount of deficit it has incurred. Countries would not be allowed to borrow against future allocations (*as proposed in the model by Casella (1999)*) to prevent the danger of misuse by myopic governments. The countries would however be allowed to save the permits for future use and allowed to call back permits to the extent saved in previous years. This would allow room for intertemporal smoothening of shocks.

The countries could also trade in their allocation of permits. For instance, if a country requires additional permits for the additional deficit it has incurred and does not have saved permits from previous years to call back, it could buy permits in the market. The price of the permit would then be determined by the demand and supply of permits. Such a situation would remove the rigidity of fixed fines, as in the SGP and bring an element of market dynamics into play. The price of the permit could therefore vary according to the then prevailing macro economic outlook in Europe. For instance, if a country needs the deficit to counter an asymmetric shock, then it would be the only or among the few countries affected by such a shock. Since other countries would not be in a crisis at the same time, it may be possible to obtain these permits at a reasonable cost. Also the relative number of demanding countries and suppliers of permits would determine the cost of the permit. In this way, a country can overcome an asymmetric shock at a lesser expense than currently mandated in the SGP. In case of a Europe- wide symmetric shock, which is the more likely scenario[22], the ECB would intervene and counter the shock using interest rates and other policy instruments. The "fiscal" authorities could also intervene to make more permits available, as the deficits could exceed the 3% limit. This increase in permits would only be made so that the deficit permits approach is

[21] 0.5% of 125 562 million

[22] A major motivation for the EMU was the fact that the EU faces mostly symmetrical shocks and therefore a common monetary policy can counter them. The asymmetric shocks faced by countries can be countered or addressed to by individual government fiscal policy and doesn't not need a union wide monetary intervention.

still valid and does not need be for the purposes of countering the shock, but rather would be used only for accounting purposes, as countries would still be required to furnish the permits in accordance with the deficit incurred. The ECB would remain the main body countering the asymmetric shock (as is the case now with SGP). In this way, a market would also be created for the situation when countries face asymmetric shocks, where they could trade and counter these shocks at least cost. There would be the clear rule in the case of a symmetric shock is encountered.

The intervention, to increase supply of permits, in this case (in case a Europe-wide negative shock is encountered), would be done by the central authority, such as the Euro Group or European Commission. This policy would prevent a situation wherein countries are able to revive their banked permits from previous years and sell them at high prices. A simple rule for the evolution of the supply of permits would be specified which focuses on indicators that the country cannot manipulate. Wyplosz (2002) has shown that for every 1% decrease in rate of growth GDP, deficit increases by 0.5%. This fact can be used as a basis for determining the rule for increase in supply of permits. Since this depends upon indicators that can be manipulated, countries may not be allowed to make use of the provision of calling back saved permits. The increase in supply of permits could occur in "exceptional circumstances" where a Europe-wide shock is encountered and growth in the Euro area falls below a certain specified level. These exceptional criteria could also be the same as specified presently in SGP. This rule of increasing permits would ensure that countries cannot sell their banked permits at higher prices and that they have to follow the guidelines of increased supply of permits. This provision should be kept in place until the rate of growth of GDP starts to increase at a faster rate. After this, the additional permits would be withdrawn from the system and the countries would once again be able to carry forward and call back their saved permits. If the committee (Euro Group or European Commission) meets twice a year to review the case, then the additional permits should be allowed to be in play for more than 6 months at a time once growth starts to increase, and then withdrawn. This would ensure that the countries are not exposed to a sudden requirement to start decreasing deficit as growth starts to increase, leading to a slower pace of growth and return to a slump. The common monetary policy would however, be the instrument that counters the shock, as was the main motivation of the EMU (shocks, which are symmetric, could be countered by a common monetary

policy). It may most likely be the case that the supply of permits need not be increased, as the automatic stabilizers would work and the growth rates returned to normalcy by the action of the Central Bank.

The automatic stabilizers would work because the governments would now have incentive to keep their budgets in check, also in times of economic boom. This would happen because a government could now either sell its excess permits, or store it for future use. In this way, the price of the permit always remains positive. One can therefore imagine a scenario where the national governments would try and keep the deficits close to balance or in surplus in times of economic boom. The advantage of such a system of permits is that it allows flexibility to individual countries at different times by imposing correct costs of fiscal measures to be taken and implemented, and providing the right incentives for fiscal cuts. Its major advantage in light of the SGP is that it gives the right incentives to governments to monitor their fiscal situation and to keep budgets in order in times of economic boom. The enhanced surveillance by governments at each time of their fiscal situation would let the automatic stabilizers work during periods of economic slowdown. This incentive arises from the fact that if countries can maintain a surplus or balanced budget over the cycle, they would be able to either sell their permits to other countries, which are on the brink of default or in default or can bank these surpluses for use in the future.

In case of a situation where most countries are at or near the 3% limit, some countries have exceeded their limit so that they need to buy extra permits and the situation does not qualify as an “exceptional circumstance”, the price of permits would be very high. This would provide incentives to other countries to try and further reduce their deficits to be able to sell the excess permits. As shown above, each country in this case could measure the cost of 1% reduction in deficit against the benefit, which in this case would be the high price of the permits. This scenario however, is unlikely to occur.

To span all possible scenarios, I also consider the situation when a country has excessive deficit and is not able to produce permits for this excess. In this case, permits would be relinquished from next year’s quota. (The country cannot borrow permits from next year’s allocation, but incase in fails to produce the required permits they would be relinquished. This would not be done in ratio of 1:1, rather a higher ratio. For instance, for every 1 Euro worth of extra deficit for which no

permit has been produced, 2 Euros worth of permits from next year's quota would be relinquished. This figure could be higher so that countries do not have incentive to make this intertemporal borrowing of permits.) In the case that this too cannot be done for the next year's permits have already been used, a strict measure needs to be imposed. It could take form of a warning to leave the EMU. The right incentive structure is difficult to formulate. However, as mentioned above, it is highly unlikely that such a situation would arise, since the system of permits is based on a market approach and at all times the countries can measure the costs and benefits of additional deficit incurred and can also smooth deficit and spending intertemporally.

5.1.1 Allocation of permits within governments

The majority of the debt in any country is not issued by the central government of the country but also by the states and local authorities. Once the permits are allocated to each country (they could be allocated as a proportion of GDP contribution, using the "Index of Financial Impact"), there arises the question, 'Should only the central government trade in it and thereby ensure that the local governments and states follow its directive'? The benefit of engaging local and state governments in the trading process is that it would make the market for permits more competitive and make it function like a real market. This would occur because the number of participants in the market would increase, since at present there are only 12 countries in the EMU. Once local and state governments are allowed to operate in the market, there will be many players so that each is an infinitesimally small part of the market and cannot affect quantities and prices. The permits approach in such a scenario would not only allocate the deficit efficiently between different governments, but also between different segments of a government (namely the state and local governments). The local governments would in this case be required to hold permits and thereby be able to borrow from the markets and raise capital. The central government would be allocated the permits from a Union wide authority and would then distribute it among the different local and state governments. They would trade in them to equalize their costs and benefits. Each state would now also be independent raising its own revenues and would only depend on the centre for the allocation of the initial permits.

The argument for the case allowing local authorities to trade in permits is however, flawed. Since states/ local bodies are not sovereign, they would expect the central government to bail them out when they incur debt for which they cannot furnish permits. This would distort their borrowing behaviour. Another drawback is that different states within a country have different revenue-raising capabilities and this could give rise to differentiated standards of living etc. Enforcing compliance with permits will not be sufficient to ensure that the market function smoothly and as envisioned. Therefore, in the model above, local governments should not be allowed to trade in permits at the Union-wide level.

However, there could be a directive whereby countries are required to also implement this deficit permits approach within the country, where local, state and municipal governments would trade. A market for tradable permits within each country would therefore be established. An existence of such a market in each country would ensure that the costs and benefits of fiscal borrowing are also equalised at a local and state level. This would not only increase the flexibility of these institutions in raising capital for investment purposes, but also ensure that the permits from the central government are allocated efficiently. It would help counter the present scenario where some states, due to their natural resources, or geographic location are better endowed and therefore richer and more capable of undertaking investment, than other states, or cities. Under the tradable deficit approach, each constituency could measure the cost of extra debt against the benefit and buy debt in the market. It would be a superior system, in the sense, that state and local bodies would not be at the mercy of the central governments discretionary power for availability of funds. This would be especially advantageous to the small constituencies.

The system would also ensure that the local governments have the same flexibility as the central governments. Since all constituencies and local bodies could trade, it would resemble a perfectly competitive market and costs would therefore be allocated correctly. The right to issue debt would also be allocated to the body that needs it most, since they would be willing to pay the most for it. The cost of regulation of such a system would also not be too high as the number of participants would be large.

5.1.2 Advantages of the deficit Permit Approach

I now focus on some of the reasons why this approach is criticised in literature and try to show that they are either not well founded or are minor problems.

One of the criticisms[23] of this approach is that it assumes that, like pollutants, that the public debts and deficits of different countries are perfect substitutes, thereby giving rise to the same externality. This gives rise to two interconnected criticisms. First, it is unlikely that the debts and deficits of each country are perfect substitutes. For instance, the deficit of the German fiscal authority is unlikely to be treated at par with that of the Italian authority. Thus externalities of differing extent are imposed on the neighbours. A default by the German government on its debt may be taken more seriously since it can cause a crisis in the banking system (as all banks in Europe are interlinked). This may not occur, if say Ireland, was to default on its debt. In such a case, not only the size of the country, measured by the size of its economy, matters, but the financial fragility of the country and government in question, is also of importance. As we have seen, this can be done away by constructing an "Index of Financial Impact", which takes into consideration the impact of each country's fiscal misbehaviour on the whole union and requires them to furnish permits in absolute Euro amounts, for the extra deficit they incur. For instance, Germany pays more for exceeding deficit by 1% than Ireland. This happens because the GDP of Germany is greater. In this sense, property rights could be created for the targeted externality, which controls the impact of each country's fiscal choices on the overall index, or the overall fiscal health of the EU. Even though the construction of the index does not represent an adequate treatment of differential default risk, as it ignores the capacity for generating primary surpluses, the growth rate and the interest rate as determinants of default risk, it is still better as an alternative. A different and more complicated index could also be constructed with many more features. I however think that even in its simplest implementation, the index takes all these factors into account. The same fine imposed by the SGP, namely 0.2% of GDP, irrespective of which country is in default, also assumes perfect substitutability of deficits in regard to the externality the deficit imposes.

[23] Buti, M., Eijffinger, S. and Franco, D (2002) and Buiter (2003)

Secondly, as has been correctly pointed out by Buiter(2003), it is difficult to draw a parallel between pollutants and deficit as has been assumed here. Pollutants are always a 'bad', never a 'good'; they impose negative externalities regardless of the quantity in the air. Public debt is not necessarily a bad, and the externalities imposed by one national government's debt on other national governments are not necessarily negative. While negative systemic fragility (default risk) externalities are, other things being equal, likely to increase uniformly with the amount of debt issued by a country, ordinary interest spillovers are not. Higher (risk free) interest rates are not automatically worse than lower (risk- free) interest rates. Interest rate externalities are *pecuniary* externalities. Pure pecuniary externalities have distributional consequences but no efficiency implications. Higher interest rates are good for creditors, bad for debtors, good for savers, bad for enterprises contemplating capital formation. There are indeed other distortions in the economy that cause interest rate spillovers to have efficiency implications (e.g. distortionary taxes or costly revenue collection), but these spillovers can be positive and well as negative. In this approach a country can incur deficit to stimulate demand and thereby their individual economies. It is considered a 'bad', only for the externality is imposes namely inflation etc., and hence taxed. However, if a country experiences high growth, giving rise to the Harrod-Balassa- Samuelson effect, then the cost of additional debt will be less than its benefit and in that respect the country can balance that out on its own. The SGP does not take this into account and a country cannot use extra spending and investment to stimulate its economy, while at the same time paying for it. In trying to avoid breaching the limit, it is required to adhere to the strict Excessive Deficit procedure.

This system of tradable deficits can be analyzed to be superior, as it is based on rules rather than discretion. Circumstances always exist where giving up a commitment is actually welfare enhancing, although seen from the current perspective it is highly undesirable. Discretionary policy is often procyclical and in case of the SGP a lot of discretion is used, namely the voting procedures to determine when a country breaches the limits of the 'Pact' and what, if at all measures should be imposed. Therefore, there is a need to provide incentives to authorities to abide by past commitments. In the case of deficit permits, this tradeoff does not arise. This happens because clear rules are delineated which state that the country must produce permits to cover the year's deficit.

Another criticism of the scheme is that it is unable to solve the problem of enforcement as under the SGP rule. The criticism reflects the situation where a country issues debt for which it does not have a permit. The question then arises of how fines, if any, would be imposed and the impact on the purchaser of that debt. I however feel that is would not be the case, for as mentioned above, in such a case the country would have to purchase permits for the amount of the debt it issues in the market for these tradable permits. If at the end of the accounting year, it does not produce permits to the amount of debt it has issued, these permits could be relinquished from the next year's quota. In case of an economic downturn, or a severe negative shock, the Central Bank would use monetary policy to counter the shock.[24]

This policy also does not require that the budget be in balance or close to surplus in the long run and therefore does not imply a net creditor government. Governments can therefore borrow to undertake public investments, the return and benefit of which would be higher than the costs incurred, when timed right, even in the case when it has to buy excess permits in order to finance this investment. The motivation for governments to borrow to finance spending, however, would be low since, it would be apparent that the costs of incurring such debt would be higher than the benefit.

This approach would also solve the problem of procyclicality of Fiscal Policy in contrast to the SGP (against its main agenda). This would occur because countries would have an incentive to keep deficit below 3% in times of boom and would therefore let automatic stabilizers work. The governments then would not be forced to increase taxes and decrease spending in downturns to satisfy the (SGP) criteria.

The greatest strength of the above proposal lies in its dependence on the market mechanism and non-partisan implementation of procedures in case a country defaults. Its flexibility in allowing individual countries to equate their costs and benefits of deficit reduction provides a great advantage to countries and allows them to adjust at their own speeds and according to their individual fiscal climate. It does not lead to a situation where countries have to constrain themselves to enter the EMU, giving rise to a period of slow and constrained growth and once in the

[24] This is enlightened in the first part of the section, which outlines the deficit permits approach.

EMU, have to still perform under restricted conditions. It minimizes the aggregate cost of compliance with the fiscal target by ensuring that the costs of fiscal discipline are as low as possible. By allowing countries to trade in the excess/unused permits, it gives countries incentive to reduce deficit below 3% when conditions are good. This, moreover, ensures that automatic stabilizers are able to work in periods of economic slowdown.

5.2 Modification of the SGP as an alternative

It is clear that rules, such as the SGP, that constrain fiscal policies and their spillovers are needed in a monetary union (so that members do not have an incentive to free ride as they bear only a fraction of the cost of their fiscal misconduct). It is also clear, as pointed out in section 4 that the SGP is in need of reform. There is a vast literature motivated by the reform of the SGP and how an optimal pact constraining the policy should be. This paper however, does not review all the literature on modification of the pact. Only a few important points will be stressed here.

The modification of the SGP is analysed from different viewpoints. First a general discussion is presented on the rules that need to be incorporated into its present working for example, non-partisan application and the rules to tackle the pro-cyclical bias in good times. Then other alternatives are discussed. A case for political integration of Europe and the need for fiscal policy coordination amongst the members of the EMU in light of the common monetary policy, are discussed. The ways to modify the inadequacy of institutional set up whereby there is no clear mandate as to allocation of responsibilities between the three institutions, the ECOFIN, the Euro-group and the European Commission with overlapping powers, is also analysed. Other suggested modifications are also discussed.

The section mainly provides insight from the current literature for the modification of the SGP (without having to give it up). This is in light of the view that the proposed deficit permit approach may be considered too drastic. Also many may not favour a total change in rules governing the member countries and would be more open to modifications of the current system. It only analyses the pros and cons of such approaches without concluding as to which is would/could be superior.

5.2.1 Some general modifications

In case of the SGP, the finance ministers of individual countries who are responsible for drafting national budgets also are part of the ECOFIN (the European Council of Finance Ministers). As members of ECOFIN, they pass judgement over their decision-making abilities as national policy drafters and decide if they breach the rules. This leads to a partisan application of rules. The guiding principle of the Excessive Deficit Procedures, in this regard, is peer pressure. It is apparent from both these arguments that it appears to be difficult, if not next to impossible, that fines are imposed. Not only do counterparts have incentive to vote in favor of the defaulting country, hoping that the favor is extended when they default, but that larger countries would have more power in the voting process.

As analysed by Sutter (1999), larger countries have more power to stop the excessive deficit procedures against themselves as compared to smaller countries, even though they do not free ride more often than smaller countries. As stated in Article 205 European Council Treaty (ECT), all EU countries are assigned voting rights and are allowed to vote on the issue (breaching of the pact), including the country under consideration. Further, both the deposits and fines are redistributed to countries, which did not have excessive deficit in the year that the procedure started, in equal parts. In his experimental results, he found that a procedure like the SGP reduces free riding. However, the different voting weights give an advantage to the bigger countries.

If deficit is treated as a public bad, then a larger country breaching the limit will impose a greater externality on the Union as a whole, as compared to a smaller country. This is outlined in the previous section. In this regard, I propose that, the voting weights may be changed for the purposes of Excessive Deficit Procedure only, whereby the larger and smaller countries all have equal weights. For all other purposes of voting in the EU, the discrepancy between voting weights of smaller and larger countries may be maintained. This will, in effect treat all countries as equal in the voting procedure and not give bigger countries more weight so that they could bias EDP in their favour.

Another amendment, as discussed in literature[25], is to all-together exclude countries from the voting procedure, which are themselves in breach of the limits or

[25] Sutter(1999) , Giavazzi, F., Berglof, E., Baldwin, Richard E. and Widgren, Mika (2001).

have warnings, issued against them or, are also subjected to the EDP procedures. As remarked by Otimar Issing, one cannot be satisfied with a mechanism in which fiscal sinners pass judgment on other sinners.

Perhaps, the SGP would function better and the countries not seem to be in such deep waters, had they utilized the economic boom of 1998-2000, when the economy was doing well, to sort out their fiscal situation[26]. However, the SGP does not provide any incentives to governments to keep their budget in balance or surplus in times of boom so that during recessions, automatic stabilizers can be effective. The countries now are also required to have their budgets 'in balance' or 'close to surplus' in the medium term. The 'medium term' is arbitrary. It should be defined well so that the countries have no problem interpreting it.

The deficit limits have been calculated assuming a nominal growth rate of 5% in the euro area[27] and debt ratio in steady state as 60% of GDP. For any given rate of growth of nominal income, a higher debt-GDP ratio means that debt-GDP will come down faster and a higher public debt should imply a lower permissible deficit level. I, therefore propose that it be required, that whenever the nominal growth rate in the euro area is or exceeds 5%, the countries keep their budget in deficit below 3%. The exact calculations can be made using this simple rule, which is also used to calculate at present the debt and deficit ratios.

This would ensure that the SGP would not have an asymmetric effect over the cycle and would require budgetary supervision in good times and bad. Once countries are able to manage their budgets in times of boom, and thus not strained by the requirements of squeezing their expenditures to meet the 3% limit in economic booms, they would surely not have to worry in times of recession. The working of the automatic stabilizers would also ensure this.

Not only are the rules in the present version of the SGP inadequate, but also the institutional set-up leaves much room for confusion regarding the allocation of responsibilities. Presently there are three institutions with overlapping responsibilities, the ECOFIN, the Euro group and the European Commission.[28]

The ECOFIN is responsible both for defining the rules and implementing them. It is the only body that sets rules and is not challenged in that sphere.

[26] The graph showing real GDP growth rate and deficit incurred is on page 36-37.
[27] Net debt to GDP (60%) equals ratio of long run fiscal deficit (3%) to long run nominal growth rate (5%).
[28] Benoît Coeuré and Jean Pisani-Ferry (2003) argue this point.

However, in the sphere of policy, it faces a competition from the Euro group. The Euro group does not appear to have a well-defined function and the only thing that is clearly known is what it is not supposed to do. The function of surveillance is shared between the ECOFIN and the Commission and while the decision on early warning is to be taken by the ECOFIN, the recommendations and the excessive deficit procedures are to be carried out by the Commission. Therefore, even though the Commission appears to be independent, the ability of the ECOFIN to make the decision of early warning makes the system skewed, whereby the finance ministers who are responsible for national fiscal budgets pass decisions on themselves. The distribution of functions to the three bodies is summarized in the table below.

Table 1: Allocation of policy responsibility in the EMU[29]

Current set-up

	Rule-Setting	Policy	Surveillance
ECOFIN	Decision on economic legislation	Decision on BPEGs, recommendations under Article 99	Decision on early warning
Euro group		Informal coordination and dialogue, temptation to be a caucus	
Commission			Recommendation on early warning, excessive deficit procedures.

It is clear that the present institutional set-up is insufficient and inadequate. Problems would arise in view of the enlargement of the EU into Eastern Europe, which looms large into the horizon. With the entering of other East European countries, there would be the fear that the decision making is not lost to them, while at the same time they would fear that rules are not changed and prejudiced in against them.

An efficient solution would be a clear demarcation of rule-setting, policy and surveillance rules between the various interest groups and committees. Benoît Coeuré and Jean Pisani-Ferry (2003) provide such a solution. They stress the need of making

[29] Table taken from Benoît Coeuré and Jean Pisani-Ferry (2003)

the basic legislation, regarding the principles and functioning of the EMU, the responsibility of the Council and the Parliament. However, a distinction is drawn regarding the responsibility of defining, amending and implementation of rules. Such a clear demarcation of functions assigned to the three bodies is summarized in the table below.

Under this framework, the members participating in the euro, within the Euro group, could make the policy decisions regarding the operation of the Euro zone. This would make sense because they are the ones most and directly vulnerable to changes in policy through participation in a common currency. Thereby the policy function, which at present is taken care of by the ECOFIN should be entrusted to the Euro group.

Table 2: Allocation of policy responsibility in the EMU[30]

Proposed set-up

	Rule-Setting	Policy	Surveillance
ECOFIN	Decision on economic legislation, Euro zone members may decide on adapting the rules, subject to call back		
Euro group		Informal dialogue and coordination, QMV decision on BEPGs, QMV decision on joint action, recommendation to a member state under Art 99, Sanctions	
Commission			Decision on early warning, recommendation on EDP

The Commission would be entrusted the responsibility of surveillance, which it would be required to carry out in an efficient and independent way. This would not only make it stronger, but would also ensure implementation of rules in a non-partisan fashion. It would be assigned the responsibility of not only making a recommendation in case of an early warning, but also the task of decision to issue an early warning. It would obviously, also give recommendations on the EDP. This

[30] Table taken from Benoît Coeuré and Jean Pisani-Ferry (2003)

would rid the current formulation of the SGP of political implementation of rules, its partisan applications and would not make the imposition of fines, a political impossibility.

The ECOFIN would then be responsible for rule setting, namely for decisions on economic legislations and basic rules, which require a vote by all the members. The role of ECOFIN would therefore be single folded and thus would assist it in its impartial functioning.

5.2.2 Need for Political Integration and Fiscal Coordination

There is a discussion in literature arguing that the European Central Bank (ECB) is too independent, even though it has to report to the European Parliament. It advances that the ECB has its own objective function and so a situation may arise that it takes only price stability into consideration, without considering the other economic variables. The ECB should be accountable to the people of the Union and its elected representatives while at the same time having independence in its operations. There may, therefore be a need for a stronger European Parliament to hold the ECB accountable and thereby encourage the development of a common fiscal policy at the EU level. There is thus the need for political integration within Europe. In the absence of political integration, according to this argument, the ECB is constrained only by its function and has no oversight, as in contrast with the congressional oversight of the Federal Reserve Board in USA. Eichengreen (1998) however points out the flaw in this argument showing that the world over, countries are increasing the statutory independence of their central banks and weakening their democratic accountability (e.g. New Zealand).

Eichengreen (1998) in his paper argues that the relationship between monetary and political integration is contingent on the initial conditions, which then determine the evolution of the integration process, depending on the accompanying fiscal constitution. They can either develop together if the fiscal policy under a monetary union is constrained or one can progress without the other if fiscal policy is not constrained and allowed to follow its own path.

After the introduction of the single market in Europe, the remaining threat to the creation of a free and integrated market in Europe is political opposition from

sectoral interests that suffer disproportionately from exchange rate fluctuations. With monetary integration and thereby the elimination of capital controls, governments can no longer peg exchange rates within narrow bands and prevent misalignment. Political integration will ensure that producers in a country can no longer run to their central governments for subsidies or threaten to not support the governments in light of the competitive devaluations.

By the need for fiscal coordination among member states and thereby fiscal integration, by transferring of the key fiscal functions to a union wide body (for example the ability to tax), an entity will be created at the centre with fiscal capacity at the level of the Union. Political integration will soon follow, which will then also become essential to formulate common fiscal policy and make the formulators, politically accountable. This would occur because the distributional aspect of fiscal policy is more prominent. Interest rate changes have distributional consequences and are more pronounced in case of taxes and public spending.

5.2.3 Debt sustainability and the Golden rule

It is argued by Buiter and Grafe (2002) that the EMU could formulate a rule similar to that followed by the UK to ensure financial stability, efficient financing of public spending and macroeconomic stability. The UK follows a golden rule, sustainable investment and permanent balance rule. The golden rule states that over the cycle, the government will borrow only to invest and not to finance public spending. It is met, when over the economic cycle, the current budget is in balance or in surplus. It implies that since borrowing takes place only for productive investment, it cannot be inflationary and cannot impose negative externalities on other countries of the Union. The sustainable investment rule states that the public sector net debt as a proportion of GDP should be held at a stable and prudent level. That is, a reduction in public sector net debt to below 40% of GDP over the economic cycle is desirable. The permanent balance rule is a tax smoothening rule stating that the tax revenues should be planned as a constant share of GDP, the permanent tax rate or share.[31] This implies that the permissible general government deficit is a composition of three parts; reduction in debt-GDP ratio due to nominal

[31] Definitions of the golden rule, the permanent balance rule and sustainable investment rule, taken from Buiter (2003)

GDP growth, the excess of actual share of government spending in GDP over its permanent share and the excess of actual interest bill over the permanent interest bill.[32]

As argued by Buiter (2003), these three rules are simple, verifiable and together ensure solvency of the government. However, only the permanent balance rule has the property of solvency by construction. Accordingly, the SGP deficit rule and the medium term balance rule do not have expiration and therefore do not make sense in the long run. Under the permanent balance rule, the debt to GDP ratio is constant while the SGP medium term balance condition implies that in the long run the realized budget should more likely be in surplus than deficit and that the government in the long run will either have zero net debt or be a net creditor. This, however, does not make sense and it is not likely that the public spending will take place out of the income earned on the government's portfolio. Moreover, public debt is a governmental tool for achieving intergenerational redistributions and insurance.

These three rules, as expressed by Buiter (2003), constrain the fiscal policy of each government without any reference to other member in the EMU or the behavior of ECB and do not take into account past, current or future economic developments. They are credible and flexible, impartial and consistent and have a competent enforcement mechanism.

Pisani-Ferry (2002) also argue for the introduction of a debt sustainability pact by moving to a country-by-country articulation of close-to-budget balance. Wyplosz (2002) argues that long-term debt sustainability requires that debt not increase as a percent of GDP. As taxes are distortionary, the lowest possible debt level allows reduction in debt burden but there is no evidence of this in practice. Debt sustainability can be defined in two alternative ways[33]: It can be an obligation to achieve budget balance on average over a number of years. The number of years should be of the same order as the length of ordinary business cycles (4 to 6 years). It should not be fixed *ex ante* since two cycles are never alike. A possibility is to delegate to another, independent institution – like the NBER in the US – the task of identifying cyclical peaks and troughs, and require *ex post* that the budget be at least

[32] Actual interest bill is defined to be inflation and growth corrected and permanent interest bill is long run inflation and long run growth corrected. Definitions taken from Buiter (2003).
[33] Charles Wyplosz (2002), pg 12

balanced over each cycle.

It can be an obligation to stabilize the debt-to-GDP ratio over the long run, i.e. cycle after cycle. Countries which start with a high debt, or which face large future commitments (due to an ageing population, for example) could aim at a given reduction of the debt-to-GDP ratio over a given horizon tailored to the length of the business cycles.

5.2.4 Fiscal Policy Committee[34]

To delegate the task of fiscal policy (due to its redistributive powers), Wyplosz (2002) stresses on the need for a Fiscal Policy Committee (FPC) within different countries. The argument is that fiscal policy fulfils a structural and redistributive function by determining the aims and size of various spending items and the tax structure, which cannot be delegated to a single agent. It also has the task of ensuring budgetary balance. Accordingly, in each country a new institution, the FPC, would be responsible for setting budget balance. It would constitute of qualified members, appointed for non-renewable term in office and who cannot be removed from office unless they violate their mandate. This would ensure their independent and impartial functioning. They would produce their own forecast of economic and budgetary conditions. The explicit mandate of the FPC would be ensure debt sustainability over the defined horizon while in the short run it would be allowed to choose its deficits and surpluses.

The FPC would set annual deficit figures ahead of the government budgetary cycle and would impose itself on both the government and the parliament. It would have no authority regarding the size of the budget, tax structure and allocation of public spending. The revenue and spending projections would require FPC approval before becoming the law.

The debt sustainability mandate of the FPC would provide the right incentives, as authorities would know ex ante, that any budgetary relaxation would later have to be tightened in the near future and would therefore increase debt only if the costs of doing so would outweigh the future costs of debt reduction.

Such a set up would ensure democratic accountability by being accountable to the national elected body. Ex ante it would take account of the procedures and

[34] Charles Wyplosz, " Fiscal discipline in the EMU: Rules or Institutions?" 2002

rules, analysis and testimony. Ex post it would be held accountable for it. It would do away with the arbitrariness in the present SGP and would be credible while at the same time providing governments independence in their operations, allowing them to choose their specific goals.

5.2.5 Different debts, different deficits

The debt criterion of the SGP requiring countries to maintain a debt level of 60% of GDP and close to balance in the long run implies that governments are either net creditors or have to finance all public spending on education, health, infrastructure etc. from its interest earned on its portfolio of assets. This may be inefficient; if one takes the view that the governments make productive investments on behalf of future citizens also, who benefit from these investments and therefore it becomes reasonable to let future taxpayers share in the costs of these investments.

The SGP also does not make sense in the light of the fact that not every government's debt is on an unsustainable path and therefore, all should not be made to bring down their debts levels to near zero in the long run. This is especially so in light of the enlargement of the EU, where the countries in the East do not have the same living standards and are not comparable to the western European countries. They would require more public investments and at the same time will experience faster growth rates, to catch up to the west. The increased public investment in these economies would require governments to be able to incur debt to finance it. Therefore, they should be allowed to incur debt, as long as it is on a sustainable path.

Paul de Grauwe (2003) argues that countries can be allowed to have different debt and therefore different deficit levels because they have different future liabilities and it does not make sense to subject all governments to the same debt level. Accordingly, he calculates debt and the corresponding sustainable deficit levels as percentage of GDP. Some of them are shown below.

Table 3: Required deficits as % of GDP to reach target debt levels[35]

Target Debt Ratio	10%	20%	30%	40%	50%	60%
Required Deficit	0.5%	1.0%	1.5%	2.0%	2.5%	3.0%

The table above calculates debt and associated deficit levels that countries could incur. Therefore, if a country sees that its sustainable debt level is lower, the country should also have a lower deficit target to aim at in steady state. The country should not be subjected to the requirement of bringing its debt in balance in the long or medium term. Once it has identified its target debt ratio, it should be subjected to the deficit implied by that target ratio. Minor deviations from it should be possible, but it should not be possible for any country to exceed the 60% debt ratio and 3% deficit level. He further argues that a procedure of mutual control should be applied, like the EDP procedures, whereby when the debt ratio seems to be deviating too much from target, a warning must be issued by the Commission and in case of excess above 60%, serious measure be taken to make the country bring its debt level to below 60% of GDP. If countries were close to their target debt levels, there would be enough flexibility for automatic stabilisers to work.

The problem with this approach is that it makes monitoring difficult. One of the main advantages of the SGP is that it is a simple rule and can be observed. With a complicated rule such as above, not only will it be difficult for countries to decide their optimal or target debt ratios, it will also be difficult for other countries to measure it. There maybe debates concerning what the right target level should be. And if such is that case, what about countries whose target debt level exceeds 60%, for instance, Belgium. What would be the argument, to subject countries like that, to an arbitrary debt ratio below 60%? With enlargement and the EMU consisting of 25 countries, the problem would be magnified, for now there would be a need for calculating and remembering these target levels for 25 countries. The benefit of this approach is that it does away with the one-size-fits-all policy of the SGP and each government is not subject to an arbitrary debt ratio not suited to it. However, the

[35] This assumes a nominal growth rate of 5%. The calculations are made using formula in footnote 6.

trade-off between simplicity of the SGP and this perfectly tailored debt for countries whose target debt ratio is below 60% is hard to decide.

5.2.6 Other Approaches

A brief introduction to some of the other approaches suggested in literature is presented here.

Blanchard and Giavazzi (2002), suggest an "Investment Agency" approach based on the theory of capital budget (Musgrave, 1939). The SGP would, in this case be applied to a budget including capital depreciation but excluding net public investment. Therefore, public investment would be separated from the budget and delegated to an agency so as to ensure cost-efficiency and to identify the share of public debt arising from the financing of public capital stock.

Gros (2003) suggests the "Stability Pact for Public Debt". According to this, first a debt-to-GDP target for each country would be computed, which would then specify the transition path for this debt. This would take place by requiring that one-twentieth of the difference between the initial debt ratio and the target be eliminated each year.

Calmfors and Corsetti (2003) propose the "differentiated deficit ceiling". According to this argument, each country would be assigned differentiated deficit ceiling depending on its debt level, which would be made based on a numerical scale. Thus, for example, member states whose debt ratio is below 25% would be allowed to run deficits up to 5% of GDP, while those with a debt ratio above 55% would not be given additional leeway with respect to the 3% ceiling.

6 Conclusions

The paper thus shows that rules constraining budget debts and deficits of member countries in a Monetary Union are needed. As shown in section 3, this ensures that the debt of the entire union is on a sustainable path so that fiscal shocks do not have any long-term impact on inflation rates, interest rates and output. These rules are also necessary to suppress an individual government's incentives to free ride on other governments.

The paper also brings out that these rules, as incorporated in the SGP, are not optimum, for they do not give the right incentives to governments. The SGP appears also to be problematic in light of the inoptimal institutional arrangements and partisan application of rules.

Some modifications as discussed in literature have been presented. However, this paper presents a strong case for a change in the methodology of the rules. The tradable deficit permits approach, as outlined here, appears to be a better rule, for it provides the right incentives, is a good ex-ante deterrent and imposes the right costs, ex-post. It is flexible, clearly defined and transparent. Its implementation is non- partisan and it is not questionable in light of the current enlargement into Central and Eastern Europe.

An implementation of the tradable permits approach would rid the union of the current problems faced by it, making it more optimum.

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APPENDIX I - First Order Conditions

(1) Aggregate Price Level

$$\min \int_0^1 p(z)c(z)dz \qquad \text{s.t.} \qquad C = \left[\int_0^1 c(z)^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}} = 1$$

Writing the Lagrangian

$$\int = \max_{c(z)} - \int_0^1 p(z)c(z)dz \; - \; \lambda\left\{1 - \left[\int_0^1 c(z)^{\frac{\theta-1}{\theta}} dz\right]^{\frac{\theta-1}{\theta}}\right\}$$

∂ c(z): $\lambda = p(z).c(z)^{\frac{1}{\theta}}$

Multiplying both sides with $c(z)^{\frac{\theta-1}{\theta}}$

$$c(z)^{\frac{\theta-1}{\theta}}.p(z).c(z)^{\frac{1}{\theta}} = \lambda$$

Or, $$c(z)^{\frac{\theta-1}{\theta}}.\lambda = p(z).c(z)$$

Or, $$c(z)^{\frac{\theta-1}{\theta}}.p(z).c(z)^{\frac{1}{\theta}} = \lambda$$

Or, $$\int_0^1 c(z)p(z)dz = \lambda\int_0^1 c(z)^{\theta-1} dz = \lambda$$

Also,

$$c(z)^{\frac{1}{\theta}} = \lambda / p(z) = \lambda.p(z)^{-1}$$

$$\int_0^1 c(z)^{\frac{\theta-1}{\theta}} = 1 \Rightarrow \int_0^1 \lambda^{\theta-1} p(z)^{1-\theta} dz = 1$$

Or, $$\lambda = \left[\int_0^1 p(z)^{1=\theta} dz\right]^{\frac{1}{\theta-1}}$$

$$\boxed{\lambda = \left[\int_0^1 p(z)^{1-\theta} d(z)\right]^{\frac{1}{1-\theta}} = \int_0^1 p(z)c(z)dz = P}$$

(2) Demand

$$\max\left[\int_0^1 c(z)^{\frac{\theta-1}{\theta}} dz\right]^{\frac{\theta}{\theta-1}} \qquad \text{s.t.} \qquad \int_0^1 p(z)c(z)dz = \overline{Z}$$

$$\int = \max_{c(z)} - \left[\int_0^1 c(z)^{\frac{\theta-1}{\theta}} dz\right]^{\frac{\theta}{\theta-1}} + \mu\left\{\overline{Z} - \int_0^1 p(z)c(z)dz\right\}$$

∂ c(z): $c(z)^{\frac{1}{\theta}} C^{\frac{-1}{\theta}} = \mu.p(z)$

Or,

$$\boxed{c(z) = C\left(P / p(z)\right)^{\theta}}$$

(3) Total Output

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

$\Rightarrow C\left(p(z)/P\right)^{-\theta} + G(p(j)/P)^{-\theta}$

Or,

$$\boxed{y^j = Y\left(p(j)/P_t\right)^{-\theta}}$$

(4) Intertemporal Budget Constraint

$$E_t\left\{\sum_{t=0}^{\infty}\beta^t\left[u(C_t^j + G_t) + v(M_t^j / P_t) - w(y_t(j))\right]\right\}$$

such that,

$$\int_0^1 p_t(z)c_t^j(z)dz + M_t^j + E_t\left[R_{t,t+1}B_{t+1}^j\right] \le W_t^j + p_t(j)y_t(j) - T_t$$

where, $W_t^j = M_{t-1}^j + B_t^j$

$$\int_0^1 p_t(z)c_t^j(z)dz + M_t^j + \underbrace{E_t\left[R_{t,t+1}(W_{t+1}^j - M_t^j)\right]}_{E_t\left[R_{t,t+1}W_{t+1}^j\right] - \frac{1}{1+i_t}M_t^j} \le W_t^j + p_t(j)y_t(j) - T_t$$

$$\int_0^1 p_t(z)c_t^j(z)dz + \frac{i_t}{1+i_t}M_t^j + E_t\left[R_{t,t+1}W_{t+1}^j\right] - p_t(j)y_t(j) + T_t \le W_t^j$$

By repeated substitution,

$$\boxed{\sum_{s=0}^{T} E_t\left\{R_{t,t+s}\left[\int_0^1 p_{t+s}(z)c_{t+s}^j(z)dz + \left(\frac{i_{t+s}}{1+i_{t+s}}\right)M_{t+s}^j\right]\right\} \le W_t^j + \sum_{s=0}^{T} E_t\left\{R_{t,t+s}\left[p_{t+s}^j y_{t+s}^j - T_{t+s}\right]\right\}}$$

By No Ponzi Game Condition

$$E_t\left[R_{t,T}W_T^j\right] = 0$$

(5) Lagrangian

$$E_t\left\{\begin{array}{l}\sum_{s=0}^{\infty}\beta^s\left[u(C^j_{t+s}+G_{t+s})+v(M^j_{t+s}/P_{t+s})-w(y_{t+S}(j))\right]- \\ R_{t,t+s}\left[P_{t+S}C_{t+S}+\left(\frac{i_{t+s}}{1+i_{t+s}}\right)M_{t+S}+p^j_{t+s}y^j_{t+s}-T_{t+s}\right] \\ +M_{t-1}+B_t\end{array}\right\}$$

$$\partial C_{t+s}:\beta^s u'(C_{t+s}+G_{t+s})=R_{t,t+s}P_{t+s}$$

$$\partial C_{t+T}:\beta^T u'(C_{t+T}+G_{t+T})=R_{t+T}P_{t+T}$$

$$Y_t=C_t+G_t$$

$$R_{t,t+s}=\frac{u'(Y_{t+T})}{u'(Y_{t+S})}=\frac{R_{t,t+T}P_{t+T}}{R_{t,t+s}P_{t+s}}=\frac{\beta^T\frac{\lambda_{t+T}}{\lambda_t}\frac{P_t}{P_{t+T}}P_{t+T}}{\beta^s\frac{\lambda_{t+s}}{\lambda_t}\frac{P_t}{P_{t+s}}P_{t+s}}$$

$$=\beta^{T-s}\frac{\lambda_{t+T}}{\lambda_{t+s}}\frac{P_{t+s}}{P_{t+T}}=R_{s,T}$$

Or, for one period risk less assets,

$$\boxed{\beta\frac{u'(Y_{t+1})}{u'(Y_t)}\frac{P_t}{P_{t+1}}=(1+i)^{-1}}$$

(6)

$$\partial M_{t+s}:\beta^s v'\left(\frac{M_{t+s}}{P_{t+s}}\right)\frac{1}{P_{t+s}}=R_{t,t+s}\frac{i_{t+s}}{1+i_{t+s}}$$

Or,

$$\boxed{\frac{v'\left(\frac{M_{t+s}}{P_{t+s}}\right)}{u'(Y_{t+s})}=\frac{i_{t+s}}{1+i_{t+s}}}$$

(7) The price in period 't' of a bond portfolio with nominal value '1' in period 't+1' is

$$P_t=\frac{1}{1+i_t}=E_t\left[R_{t,t+1}\right]$$

Or,

$$\boxed{E_t\ R_{t,t+1}=(1+i_t)^{-1}}$$

(8) Household's optimal pricing

$$\int = \max_{p_t^j} \sum_{k=0}^{\infty} \alpha^k \left\{ \Lambda^t E_t \left[R_{t,t+k} p Y_{t+k} \left(\frac{p_{t+k}^j}{P_{t+k}} \right)^{-\theta} \right] - \beta^k E_t \left[w(Y_{t+k} \left(\frac{p_{t+k}^j}{P_{t+k}} \right)^{-\theta} \right] \right\}$$

$$\partial p_t^j : \sum_{k=0}^{\infty} \alpha^k \left\{ \Lambda^t E_t \left[R_{t,t+k} Y_{t+k} \left(\frac{p_{t+k}^j}{P_{t+k}} \right)^{-\theta} (1-\theta) \right] - \beta^k E_t \left[w' \left(Y_{t+k} \left(\frac{p_{t+k}^j}{P_{t+k}} \right)^{-\theta} \right) \right] (-\theta) \frac{Y_{t+k}}{p_{t+k}^j} \left(\frac{p_{t+k}^j}{P_{t+k}} \right)^{-\theta} \right\} = 0$$

Or,

$$\sum_{k=0}^{\infty} \alpha^k \left\{ \left[R_{t,t+k} Y_{t+k} \left(\frac{p_{t+k}^j}{P_{t+k}} \right)^{-\theta} \left[\Lambda^t p_{t+k}^j \frac{\theta}{\theta - 1} . \frac{w'}{R_{t,t+k}} \left(Y_{t+k} \left(\frac{p_{t+k}^j}{P_{t+k}} \right) \right) \right] \right] \right\}$$

Now, $R_{t,t+k} = \dfrac{u'(Y_{t+k})}{P_{t+k}} \beta^k$

Or,

$$\boxed{p_{t+k}^j = \frac{\dfrac{\theta}{\theta - 1} \sum_{s=0}^{\infty} \alpha^k \beta^k E_t \left[w' \left(Y_{t+k} \left(\dfrac{p_{t+k}^j}{P_{t+k}} \right) \right) Y_{t+k} \left(\dfrac{p_{t+k}^j}{P_{t+k}} \right) \right]}{\sum_{s=0}^{\infty} \alpha^k \Lambda^t E_t \left[R_{t,t+k} Y_{t+k} \left(\dfrac{p_{t+k}^j}{P_{t+k}} \right)^{-\theta} \right]}}$$

(9) Solving forward the Government budget constraint

$$E_t \left[R_{t,t+1} B_{t+1} \right] = B_t + P_t \Delta_t - \left(M_t - M_{t-1} \right)$$

s.t.

$$\Delta_t = G_t - \frac{T_t}{P_t}$$

$$B_{t+1} = W_{t+1} - M_t$$

$$E_t \left[R_{t,t+1} W_{t+1} \right] = W_t + P_t \Delta_t - \left(\frac{i_t}{1 + i_t} \right) M_t$$

Solving forward,

$$W_t = \left(\frac{i_t}{1 + i_t} \right) M_t - P_t \Delta_t + E_t \left[R_{t,t+1} \left\{ \left(\frac{i_t}{1 + i_t} \right) M_{t-1} - P_{t+1} \Delta_{t+1} \right\} \right] + E_t \left[R_{t,t+2} W_{t+2} \right]$$

Transversality Constraint

$$\lim_{s \to \infty} E_t \left[R_{t,t+s} W_{t+s} \right] = 0$$

$$\boxed{\frac{M_{t-1} + B_t}{P_t} = \sum_{s=0}^{\infty} E_t \left\{ R_{t,t+s} \left[\left(\frac{i_{t+s}}{1 + i_{t+s}} \right) M_{t+s} - \Delta_{t+s} \right] \right\}}$$

APPENDIX II - Log Linearisation

(10) Equation (5),

$$\beta \frac{u'(Y_{t+1})}{u'(Y_t)} \frac{P_t}{P_{t+1}} = (1+i)^{-1}$$

Specifying, $\pi_t = \frac{P_t}{P_{t-1}}$, $\sigma = -\frac{u'(Y^*)}{u''(Y^*)(Y^*)}$, and $\pi^* = 1$

$$0 = \log(1+i_t) + \log\beta + \log E_t\left\{u'(Y_t)\left[u'(Y_t)^{-1}\right]\pi_{t+1}^{-1}\right\}$$

Taking derivatives and multiplying and dividing by Y^*,

$$0 = \frac{\partial(1+i_t)}{1+i^*} + \frac{u'(Y^*)\pi^*}{u'(Y^*)} E_t\left\{\frac{u''(Y^*)}{u'(Y^*)\pi^*}\frac{\partial Y_{t+1}}{Y^*}.Y^* - \frac{u''(Y^*)}{u'(Y^*)\pi^*}\frac{\partial Y_t}{Y^*}.Y^* - \frac{u'(Y^*)}{u'(Y^*)\pi^{*2}}\partial\pi_{t+1}\right\}$$

Or,

$$\boxed{\hat{Y}_t = E_t\hat{Y}_{t+1} - \sigma(i_t - E_t\hat{\pi}_{t+1})}$$

(11) Government Budget Constraint, Equation (9), (for one period)

$$B_{t+1} = (1+i_t)[B_t + P_t\Delta_t - (M_t - M_{t-1})]$$

Specifying, $P_t = \pi_t P_{t-1}$, $b_{t+1} = \frac{B_{t+1}}{P_t}$, $m_t = \frac{M_t}{P_t}$, $\gamma = \frac{m^*}{\beta b^*}$

$$b_{t+1} = (1+i_t)\left[\frac{1}{\pi_t}b_t + \Delta_t - \left(m_t - \frac{m_{t-1}}{\pi_t}\right)\right]$$

Defining, $\hat{x}_t = x^*(1+\hat{x}_t)$ and subtracting steady state,

$$\frac{b^*}{1+i^*}(\hat{b}_{t+1} - i_t) = \frac{b^*}{\pi^*}(\hat{b}_t - \pi_t) - \Delta^*\hat{\Delta}_t - m^*\hat{m}_t - \frac{m^*}{\pi^*}(\hat{m}_t - \hat{\pi}_t)$$

Rearranging,

$$\boxed{\hat{b}_{t+1} = \hat{i}_t + \beta^{-1}(\hat{b}_t - \hat{\pi}_t) + (\beta^{-1} - 1)\hat{\Delta}_t + \gamma(\hat{m}_{t-1} - \hat{m}_t - \hat{\pi}_t)}$$

(12) <u>Policy Rule of Monetary Authority</u>

$$i_t = \Phi(\pi_t, Y_t)$$

Or, $1+i_t = \Phi(\pi_t, Y_t)$-1

$$\frac{\partial(1+i_t)}{1+i^*}=\frac{1}{\Phi(\pi^*,Y^*)}\left[\underbrace{\frac{\partial\Phi(\pi^*,Y^*)}{\partial\pi^*}}_{\Phi_\pi}\partial\pi_t+\underbrace{\frac{\partial\Phi(\pi^*,Y^*)}{\partial Y^*}}_{\Phi_Y}\partial Y_t\right]$$

$$\boxed{\hat{i}_t=\Phi_\pi\hat{\pi}_t+\Phi_Y\hat{Y}_t}$$

(13) <u>The Money Market Equilibrium</u>

Equation (6),

$$\frac{v'\left(\frac{M_{t+s}}{P_{t+s}}\right)}{u'(Y_{t+s})}=\frac{i_{t+s}}{1+i_{t+s}}$$

Specifying, $\frac{v'(m^*)}{v''(m^*)m^*}=\chi$, $\quad i^{-1}=\frac{\beta}{1-\beta}$

$$\frac{v''(m^*)m^*}{v'(m^*)}\frac{\partial m_t}{m^*}+\frac{\partial(1+i_t)}{1+i^*}=\frac{u''(Y^*)Y^*}{u'(Y^*)}\frac{\partial Y_t}{Y^*}+\frac{\partial(1+i_t)}{1+i^*}\left(\frac{1+i^*}{i^*}\right)$$

Or,

$$-\frac{1}{\chi}\hat{m}_t+\hat{i}_t=-\frac{1}{\gamma}\hat{Y}_t+\left(\frac{1+i^*}{i^*}\right)\hat{i}_t$$

$$\boxed{\hat{m}_t=\chi\left[\frac{1}{\gamma}\hat{Y}_t-\left(\frac{\beta}{1-\beta}\right)\hat{i}_t\right]}$$

APPENDIX III- MATLAB CODES

Using 'Toolkit'

(a) With exogenous AR(1) process for deficit

```
% cycle model in H. Uhlig, "A toolkit for solving nonlinear dynamic stochastic models easily".
% First, parameters are set and the steady state is calculated. Next, the matrices are
% declared.  In the last line, the model is solved and analyzed by calling DO_IT.M

% Copyright: H. Uhlig.  Feel free to copy, modify and use at your own risk.
% However, you are not allowed to sell this software or otherwise impinge
% on its free distribution.
clear;

disp('                Woodford Model 1996 ,');
disp('    "Control of Public Debt: A Requirement for Price Stability?,"');
disp('                NBER Working Paper Series');

disp('Hit any key when ready...');
pause;

% Setting parameters:

beta             = 0.95;  % Subjective discount factor between 0 and 1
rho              = 0.6; % serial correlation coefficient for defict process
phi_pi           = 0.1; % sensitivity of monetary policy to inflation
phi_y            = 0.1; % sensitivity of monetary policy to output
gamma            = 0.1; % indicates relative importance of money and bonds in overall financial wealth
k                = 0.3;  % (((1-alpha)*(1- alpha *beta))/ alpha) * ((omega + sigma )/(sigma*(omega +
theta)))
sigma      = 1; % u'(Y*)/u"(Y*)*Y*
chi        = 1; % v'(m*)/v"(m*)*m*
sigma_eps  = 0.5; % standard deviation of the fiscal policy shock

% Calculating the steady state:

I_bar   = (1/beta) - 1;  % nominal interest rate
R_bar   = 1/(1 + I_bar);  % real interest rate


% Declaring the matrices.


VARNAMES = ['real money     ',
        'public debt    ',
        'real int rate  ',
        'inflation      ',
        'output         ',
        'interest rate  ',
        'deficit        ',
        ];

% Translating into coefficient matrices.
% The equations are, conveniently ordered:
% 1) 0 = - m(t) + (chi*(1/sigma))* y(t) - (chi * beta/(1-beta)) * i(t)
% 2) 0 = -b(t) + i(t) -((1/beta)+gamma)*p(t) + 1/beta * b(t-1) + (1/beta -1)*z(t) + gamma *m(t-1) -
gamma* m(t)

% 3) 0 = -i(t) + phi_pi * p(t) + phi_y *y(t)
% 4) 0 = E_t [ r(t) - i(t) + p(t+1) ]
% 5) 0 = E_t [ y(t+1) - y(t)- sigma * i(t) + sigma*p(t+1) ]
% 6) 0 = E_t [ beta* p(t+1) + k* y(t) - p(t) ]
% 7) z(t+1) = rho z(t) + epsilon(t)
% CHECK: 7 equations, 7 variables.
```

```
% Endogenous state variables "x(t)": m(t), b(t), r(t)
% Endogenous other variables "y(t)": y(t), p(t), i(t)
% Exogenous state variables  "z(t)": z(t).
% Switch to that notation.  Find matrices for format
% 0 = AA x(t) + BB x(t-1) + CC y(t) + DD z(t)
% 0 = E_t [ FF x(t+1) + GG x(t) + HH x(t-1) + JJ y(t+1) + KK y(t) + LL z(t+1) + MM z(t)]
% z(t+1) = NN z(t) + epsilon(t) with E_t [ epsilon(t+1) ] = 0,

% for  m(t)      b(t)   r(t)
AA = [ -1,        0,    0
      -gamma,   -1,    0
       0,        0,    0
  ];

% for   m(t-1)   b(t-1)     r(t-1)
BB = [ 0,           0,          0
   gamma,        1/beta,       0
      0,           0,          0
];

%Order:      p(t)                    y(t)                        i(t)

CC = [       0,            (chi*(1/sigma)),           - chi*(beta/(1-beta))
      -((1/beta)+gamma),        0 ,                    1
            phi_pi,           phi_y,                 -1
];

% for      z(t)
DD = [      0
      (1/beta -1)
          0
];

% for m(t+1)    b(t+1)   r(t+1)
FF = [ 0, 0, 0
      0, 0 ,0
      0, 0,0
];

% for     m(t)  b(t) r(t)
GG = [ 0, 0, 1
      0, 0, 0
      0, 0, 0];

% for  m(t-1)  b(t-1) r(t-1)
HH = [  0, 0, 0
       0, 0, 0
       0, 0, 0];

%for    p(t+1)        y(t+1)      i(t+1)
JJ = [    1,            0,          0,                % Equ. 4)
       sigma,           1,          0,                % Equ. 5)
        beta,           0,          0,                % Equ. 6)
];

% for      p(t)       y(t)       i(t)
KK = [     0,          0,         -1,                % Equ. 4)
           0,         -1,       -sigma,              % Equ. 5)
          -1,          k,          0,                % Equ. 6)
];

LL = [ 0, 0, 0 ];

% for  z(t)
MM = [ 0 ];
```

```
NN = [rho];

Sigma = [ sigma_eps^2  ];

% Setting the options:

[l_equ,m_states] = size(AA);
[l_equ,n_endog ] = size(CC);
[l_equ,k_exog  ] = size(DD);


PERIOD     = 1;  % number of periods per year, i.e. 12 for monthly, 4 for quarterly
HORIZON = 60;
DISPLAY_AT_THE_END = 0;
GNP_INDEX  = 3; % Index of output among the variables selected for HP filter
IMP_SELECT = [2:6];
   %  a vector containing the indices of the variables to be plotted
DO_SIMUL   = 0; % Calculates simulations
SIM_LENGTH = 150;
DO_MOMENTS = 0; % Calculates moments based on frequency-domain methods
HP_SELECT  = 1:(m_states+n_endog+k_exog); % Selecting the variables for the HP Filter calcs.
% DO_COLOR_PRINT = 1;
% Starting the calculations:

do_it;
```

Using 'gensys.m'

(b) With SGP limits on deficit process and AR(1) process for fiscal shock

```
%defining constants

beta        = 0.95;  % Subjective discount factor between 0 and 1
phi_pi      = 0.1; % sensitivity of monetary policy to inflation
phi_y       = 0.1; % sensitivity of monetary policy to output
gamma       = 1; % indicates relative importance of money and bonds in overall financial wealth
k           = 0.3;
sigma       = 1; % u'(Y*)/u''(Y*)*Y*
chi         = 1; % v'(m*)/v''(m*)*m*
sigma_eps   = 0.5; % standard deviation of the fiscal policy shock
lamda       = 0.03; % deficit as percentage of GDP
rho         = 0.6; % fiscal shock persistence
y_bar       = 1;
z_bar       = 1;
b_bar       = (1/(beta*gamma));
d           = lamda*y_bar + z_bar;

% DEFINING EQUATIONS
% 1) m(t) - (chi/sigma)*y(t) + (beta/(1-beta))*i(t) = 0
% 2) y(t) - si(t) + sigma*i(t) - sigma* sib(t) = 0
% 3) i(t) - phi_pi*p(t) - phi_y*y(t) = epsilon(t)
% 4) b(t) - i(t) + (1/beta+gamma)* p(t) + gamma* m(t) - (1/beta-1)*delta(t) =   %
gamma* m(t-1) + (1/beta)* b(t-1)
% 5) p(t) - beta* sib(t) - k* y(t) = 0
% 6) y(t) = si(t-1) + eta_y(t)
% 7) p(t) = sib(t-1) + eta_p(t)
% 8) delta(t) - (y_bar*lamda/d)* y(t) + (b_bar/d)*b(t)- (1/d)* nu(t)
% 9) nu(t) = rho* nu(t-1)+ meu(t)

% x_t = [ m_t     y_t           i_t          pi_t    b_t     delta_t     si_t    sib_t        nu_t]

g0 = [  1,   (-chi/sigma),  (beta/(1-beta)),    0,      0,       0,         0,         0,         0
        0,      1,              sigma,          0,      0,       0,        -1,      -sigma,       0
        0,     -phi_y,            1,         -phi_pi,   0,       0,         0,         0,         0
       gamma,   0,              -1,     (1/beta +gamma), 1,    -(1/beta -1),  0,         0,         0
```

```
    0,    -k,              0,          1,     0,     0,       0,     -beta,     0
    0,     1,              0,          0,     0,     0,       0,      0,        0
    0,     0,              0,          1,     0,     0,       0,      0,        0
    0, -y_bar*lamda/d,     0,          0,   b_bar/d,  1,       0,      0,      -1/d
    0,     0,              0,          0,     0,     0,       0,      0,        1
  ];


%for   [ m(t-1)    y(t-1)          i(t-1)       pi(t-1)   b(t-1)   delta(t-1)    si(t-1)    sib(t-1)  nu(t-1)]
 g1 = [   0,          0,            0,           0,        0,         0,         0,      0
          0,          0,            0,           0,        0,         0,         0,      0
          0,          0,            0,           0,        0,         0,         0,      0
        gamma,        0,            0,           0,     1/beta,       0,         0,      0
          0,          0,            0,           0,        0,         0,         0,      0
          0,          0,            0,           0,        0,         0,         0,      0
          0,          0,            0,           0,        0,         0,         0,      0
          0,          0,            0,           0,        0,         0,         0,      0
          0,          0,            0,           0,        0,         0,         0,      rho
     ];

% for constants

 c = [ 0 ];

 % for  epsilon(t)  meu(t)
 psi    = [  0,     0
             0,     0
             1,     0
             0,     0
             0,     0
             0,     0
             0,     0
             0,     0
             0,     1
       ];

 % for  eta_y    eta_pi
 pi  = [  0,        0
          0,        0
          0,        0
          0,        0
          1,        0
          0,        1
          0,        0
          0,        0
     ];

%----------Solve the model and get impulse responses
[G1,C,impact,fmat,fwt,ywt,gev,eu]=gensys(g0,g1,c,psi,pi)
% gensys is written by Chris Sims
nvar = size(impact,1); %number of endogenous variables
nshocks = size(impact,2); %number of shocks
periods = 25; %choose the number of periods for impulse responses
response = zeros(nvar,nshocks,periods+1);
response(:,:,1) = impact;
for n = 1:periods;
    response(:,:,1+n) = G1*response(:,:,n);
end;
%-----Plot impulse responses to a fiscal policy shock
figure(1);
time = 1:periods+1;
subplot(2,3,1);
   plot(time,reshape(response(6,2,:),1,periods+1),'k'); hold on;
   xlim([1 periods]); title('Real primary deficit','FontSize',10);
   set(gca,'FontSize',8);
subplot(2,3,2);
```

```
   plot(time,reshape(response(4,2,:),1,periods+1),'k'); hold on;
   xlim([1 periods]); title('   Inflation rate','FontSize',10);
   set(gca,'FontSize',8);
subplot(2,3,3);
   plot(time,reshape(response(3,2,:),1,periods+1),'k'); hold on;
   xlim([1 periods]); title('       Nominal interest rate','FontSize',10);
   set(gca,'FontSize',8);
subplot(2,3,4);
   plot(time,reshape(response(3,2,:)-response(8,2,:),1,periods+1),'k'); hold on;
   xlim([1 periods]); title('   Real interest rate','FontSize',10);
   set(gca,'FontSize',8);
subplot(2,3,5);
   plot(time,reshape(response(2,2,:),1,periods+1),'k'); hold on;
   xlim([1 periods]); title('   Real output','FontSize',10);
   set(gca,'FontSize',8);
subplot(2,3,6);
   plot(time,reshape(response(5,2,:),1,periods+1),'k'); hold on;
   xlim([1 periods]); title('Real government debt','FontSize',10);
   set(gca,'FontSize',8);
```

APPENDIX IV – Other Results

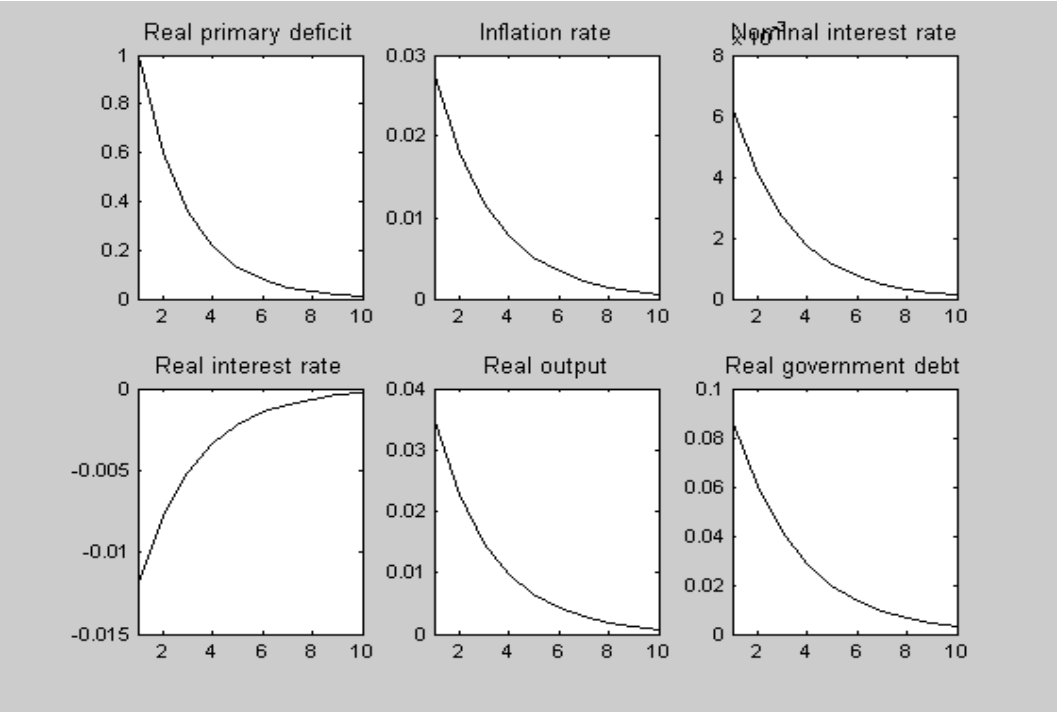
The results using gensys.m[36], which solves linear difference equations of the form

$$\Gamma_0 y_t = \Gamma_1 y_{t-1} + C + \Psi z_t + \Pi \eta_t$$

Where $\Gamma_0, \Gamma_1, C, \Psi, \Pi$ are matrices and $E_t \eta_{t+1} = 0, \forall t$ are similar to those obtained using the 'Toolkit' and to those of Woodford(1996). However, in both cases, public debt as a predetermined variable appears to be forward looking and reacts one period before the innovation starts to take place. In Woodford's(1996) results however, this is not the case and public debt reacts after the shock takes place. Since I have tried it using 2 different programs, I feel that this reaction of public debt could maybe be modeled better using "King and Watson 1995" as used by Woodford(1996).

The impulse responses using 'gensys.m' when deficit is an exogenous AR(1) process are given below. They are similar to the results obtained with ' Toolkit' as presented in Section 3.

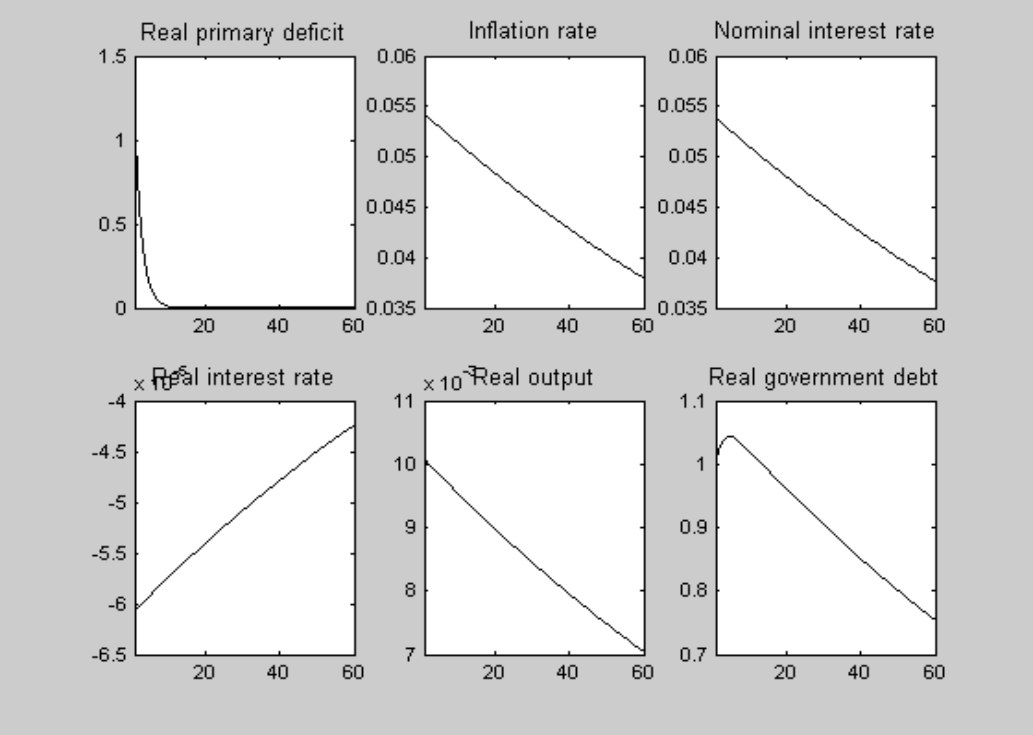
FIGURE A1: IMPULSE RESPONSES FOR AN EXOGENOUS DEFFICIT SHOCK
($\phi_\pi = 0.1, \phi_y = 0.1$)



Below, impulse responses are plotted for the case when the interest rate rule is more sensitive to inflation.

[36] Gensys.m is written by Christopher Sims

FIGURE A2: IMPULSE RESPONSES FOR AN EXOGENOUS DEFFICIT SHOCK
(ϕ_π = 0.9, ϕ_y = 0.5)



The results in this case are also similar to the ones obtained using the 'Toolkit' as presented in section 3 of the paper. Both these results are comparable to results obtained by Woodford(1996).

The results, using the 'Toolkit', in the case when the deficit process is changed to take into account the SGP limits on deficit as 3% of GDP, are different from those obtained using 'gensys.m'. The results using 'Toolkit' are obtained when assumptions about the steady states of some variables, (real money and GDP) are made. In particular, steady state output and real money are normalised to 1. Therefore it is assumed that these values of steady state output and real money are compatible with the calibrated values of σ and χ (=1). This may restrict the utility functions to a particular class. However, I find that the results are independent of the value of steady state output and real money chosen.

As can be seen in the figures below, output, inflation, real and nominal interest rates are seen not to respond to a fiscal shock when deficit is capped by a requirement like the SGP. Public debt however, is seen to increase. In this respect, these results are different from those obtained with 'gensys.m'

FIGURE A3: IMPULSE RESPONSES FOR A FISCAL POLICY SHOCK, WHEN DEFICIT IS CAPPED BY SGP REQUIREMENTS ($\phi_\pi = 0.1, \phi_y = 0.1$)

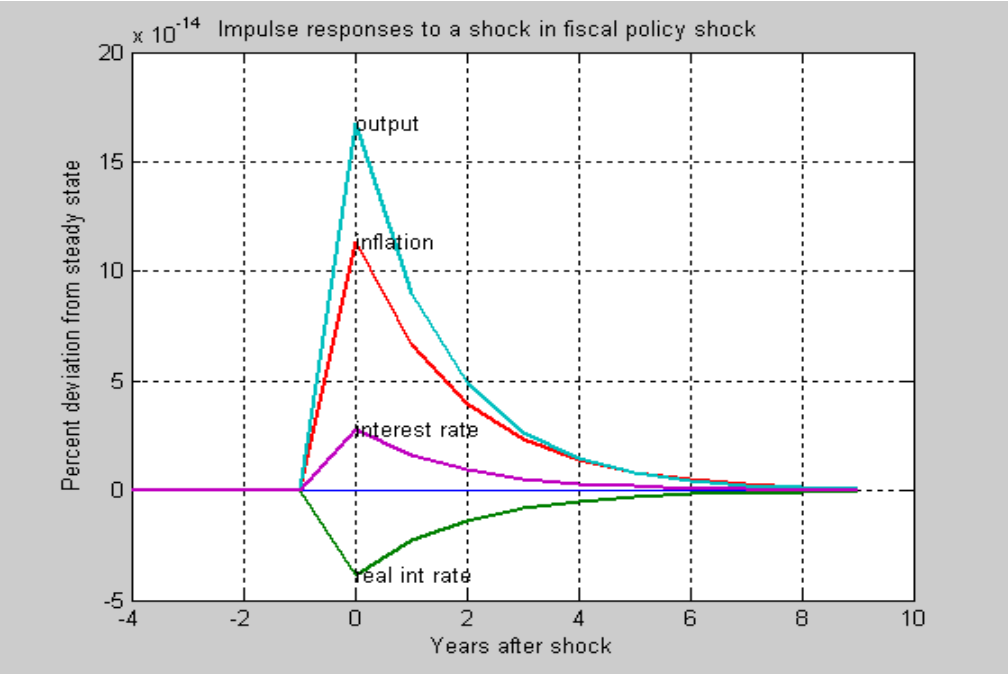


FIGURE A4: IMPULSE RESPONSE OF PUBLIC DEBT FOR A FISCAL POLICY SHOCK, WHEN DEFICIT IS CAPPED BY SGP REQUIREMENTS ($\phi_\pi = 0.1, \phi_y = 0.1$)

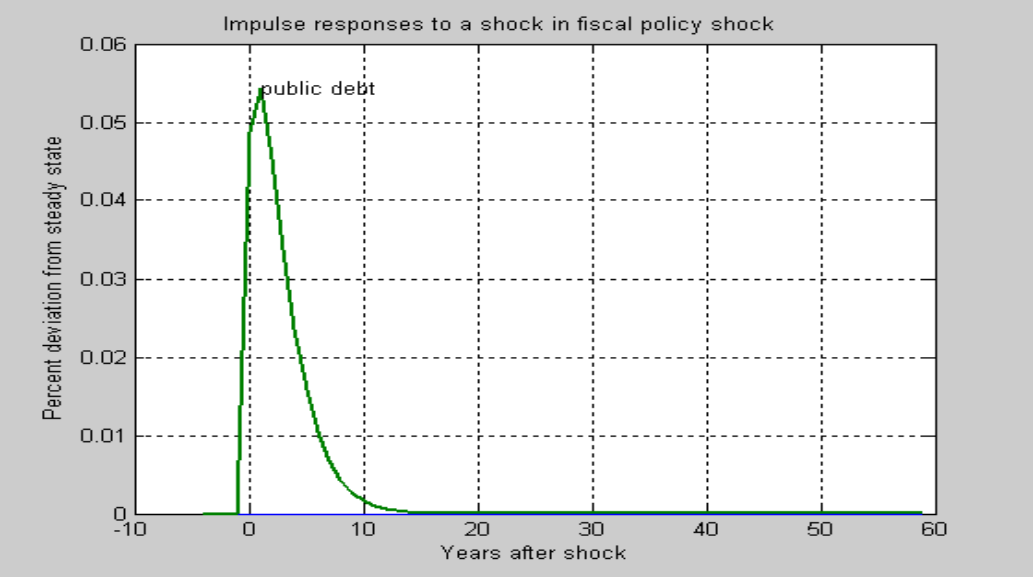


FIGURE A5: IMPULSE RESPONSES FOR A FISCAL POLICY SHOCK, WHEN DEFICIT IS CAPPED BY SGP REQUIREMENTS ($\phi_\pi = 0.9, \phi_y = 0.5$)

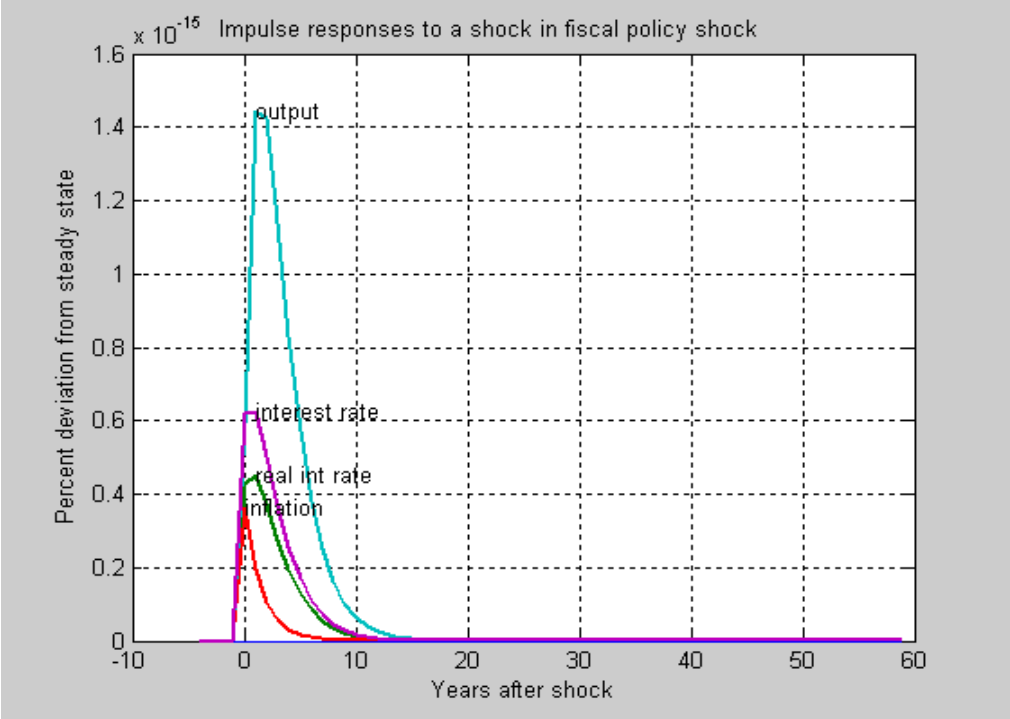
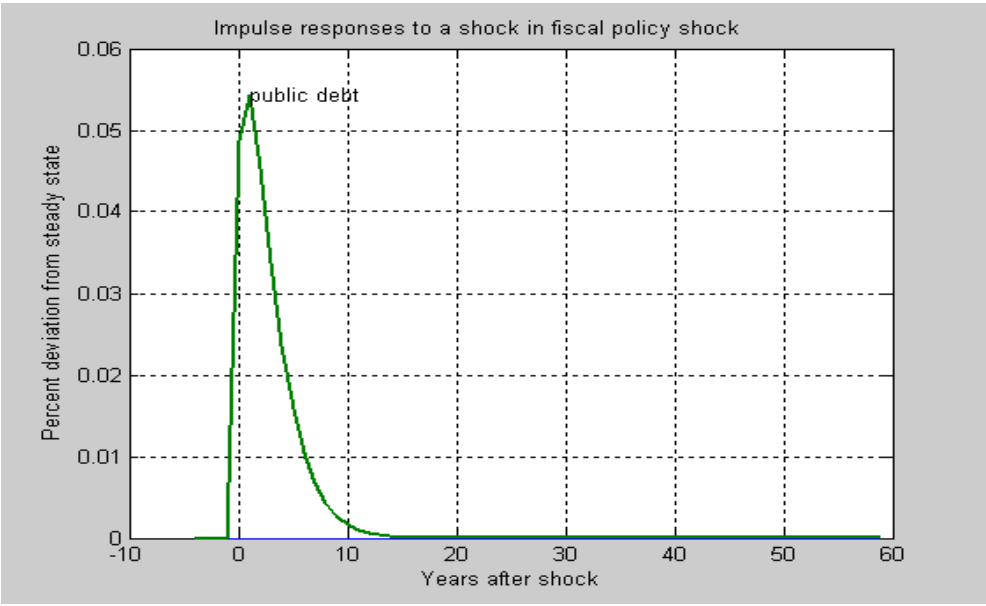


FIGURE A6: IMPULSE RESPONSE OF PUBLIC DEBT FOR A FISCAL POLICY SHOCK, WHEN DEFICIT IS CAPPED BY SGP REQUIREMENTS ($\phi_\pi = 0.9, \phi_y = 0.5$)



Below are provided MATLAB codes for the above impulse responses using 'gensys.m' for the case of an exogenous deficit process and for impulse responses using 'toolkit' for the case when deficit is capped by SGP requirements.

Using 'gensys.m'

(a) With exogenous AR(1) process for deficit

```
disp('                Woodford Model 1996 ,');
disp('    "Control of Public Debt: A Requirement for Price Stability?,"');
disp('                NBER Working Paper Series');
disp('                using Chris Sims gensys.m');

disp('Hit any key when ready...');
pause;

%defining constants

beta       = 0.95;  % Subjective discount factor between 0 and 1
phi_pi     = 0.1; % sensitivity of monetary policy to inflation
phi_y      = 0.1; % sensitivity of monetary policy to output
gamma      = 1; % indicates relative importance of money and bonds in overall financial wealth
k          = 0.3;
sigma      = 1; % u'(Y*)/u''(Y*)*Y*
chi        = 1; % v'(m*)/v''(m*)*m*
sigma_eps  = 0.5; % standard deviation of the fiscal policy shock
rho        = 0.6; % fiscal shock persistence

% DEFINING EQUATIONS
% 1) m(t) - (chi/sigma)*y(t) + (beta/(1-beta))*i(t) = 0
% 2) y(t) - si(t) + sigma*i(t) - sigma* sib(t) = 0
% 3) i(t) - phi_pi*p(t) - phi_y*y(t) = epsilon(t)
% 4) b(t) - i(t) + (1/beta+gamma)* p(t) + gamma* m(t) - (1/beta-1)*delta(t) = gamma* m(t-1) + (1/beta)*
b(t-1)
% 5) p(t) - beta* sib(t) - k* y(t) = 0
% 6) y(t) = si(t-1) + eta_y(t)
% 7) p(t) = sib(t-1) + eta_p(t)
% 8) delta(t) = rho* delta(t-1) + meu(t)

% x_t = [ m_t     y_t         i_t         pi_t    b_t     delta_t     si_t    sib_t ]

g0 = [ 1,   (-chi/sigma),  (beta/(1-beta)),    0,      0,       0,         0,         0
       0,      1,              sigma,          0,      0,       0,        -1,     -sigma
       0,     -phi_y,            1,         -phi_pi,   0,       0,         0,         0
       gamma,   0,              -1,    (1/beta +gamma), 1,    -(1/beta -1),  0,         0
       0,     -k,               0,           1,      0,       0,         0,     -beta
        0,      1,               0,           0,      0,       0,         0,         0
        0,      0,               0,           1,      0,       0,         0,         0
        0,      0,               0,           0,      0,       1,         0,         0
    ];


%for   [ m(t-1)  y(t-1)   i(t-1)    pi(t-1)   b(t-1)     delta(t-1)  si(t-1) sib(t-1)]
 g1 = [   0,     0,        0,          0,        0,         0,          0,       0
          0,     0,        0,          0,        0,         0,          0,       0
          0,     0,        0,          0,        0,         0,          0,       0
        gamma,   0,        0,          0,      1/beta,      0,          0,       0
          0,     0,        0,          0,        0,         0,          0,       0
          0,     0,        0,          0,        0,         0,          1,       0
          0,     0,        0,          0,        0,         0,          0,       1
          0,     0,        0,          0,        0,         rho,        0,       0
      ];
```

```
% for constants

 c = [ 0 ];

 % for  epsilon(t)  meu(t)
 psi    = [  0,     0
             0,     0
             1,     0
             0,     0
             0,     0
             0,     0
             0,     0
             0,     1
         ];

 % for  eta_y    eta_pi
 pi  = [  0,        0
          0,        0
          0,        0
          0,        0
          1,        0
          0,        1
          0,        0
      ];

%--------------Solve the model and get impulse responses
[G1,C,impact,fmat,fwt,ywt,gev,eu]=gensys(g0,g1,c,psi,pi)
% gensys is written by Chris Sims
nvar = size(impact,1); %number of endogenous variables
nshocks = size(impact,2); %number of shocks
periods = 10; %choose the number of periods for impulse responses
response = zeros(nvar,nshocks,periods+1);
response(:,:,1) = impact;
for n = 1:periods;
    response(:,:,1+n) = G1*response(:,:,n);
end;
%-----Plot impulse responses to a fiscal policy shock
figure(1);
time = 1:periods+1;
subplot(2,3,1);
   plot(time,reshape(response(6,2,:),1,periods+1),'k'); hold on;
   xlim([1 periods]); title('Real primary deficit','FontSize',10);
   set(gca,'FontSize',8);
subplot(2,3,2);
   plot(time,reshape(response(4,2,:),1,periods+1),'k'); hold on;
   xlim([1 periods]); title('Inflation rate','FontSize',10);
   set(gca,'FontSize',8);
subplot(2,3,3);
   plot(time,reshape(response(3,2,:),1,periods+1),'k'); hold on;
   xlim([1 periods]); title('Nominal interest rate','FontSize',10);
   set(gca,'FontSize',8);
subplot(2,3,4);
   plot(time,reshape(response(3,2,:)-response(8,2,:),1,periods+1),'k'); hold on;
   xlim([1 periods]); title('Real interest rate','FontSize',10);
   set(gca,'FontSize',8);
subplot(2,3,5);
   plot(time,reshape(response(2,2,:),1,periods+1),'k'); hold on;
   xlim([1 periods]); title('Real output','FontSize',10);
   set(gca,'FontSize',8);
subplot(2,3,6);
   plot(time,reshape(response(5,2,:),1,periods+1),'k'); hold on;
   xlim([1 periods]); title('Real government debt','FontSize',10);
   set(gca,'FontSize',8);
```

Using 'Toolkit'

(b) With SGP limits on deficit process and AR(1) process for fiscal shock

```
disp('                Woodford Model 1996 ,');
disp('    "Control of Public Debt: A Requirement for Price Stability?,"');
disp('                NBER Working Paper Series');

disp('Hit any key when ready...');
pause;

% Setting parameters:

beta       = 0.95;  % Subjective discount factor between 0 and 1
rho        = 0.6; % serial correlation coefficient for defict process
phi_pi     = 0.1; % sensitivity of monetary policy to inflation
phi_y      = 0.1; % sensitivity of monetary policy to output
gamma      = 0.1; % indicates relative importance of money and bonds in overall financial
wealth
k          = 0.3; % (((1-alpha)*(1- alpha *beta))/ alpha) * ((omega + sigma )/(sigma*(omega +
theta)))
sigma      = 2; % u'(Y*)/u"(Y*)*Y*
chi        = 1; % v'(m*)/v"(m*)*m*
sigma_eps  = 0.5; % standard deviation of the fiscal policy shock
neu        = 0.03; % deficit as percentage of output

% Calculating the steady state:
m_bar   = 1;
y_bar   = 1;
b_bar   = (m_bar/(gamma *beta));
pi_bar  = 1;
I_bar   = (1/beta) - 1;  % nominal interest rate
R_bar   = 1/(1 + I_bar);  % real interest rate
delta_bar = (beta -1)* b_bar;

% Declaring the matrices.

VARNAMES = ['real money              ',
        'public debt               ',
        'real int rate             ',
        'deficit                   ',
        'inflation                 ',
        'output                    ',
        'interest rate             ',
        'fiscal policy shock       ',
        ];

% Translating into coefficient matrices.
% The equations are, conveniently ordered:
% 1) 0 = - m(t) + (chi*(1/sigma))* y(t) - (chi * beta/(1-beta)) * i(t)
% 2) 0 = -b(t) + i(t) -(1/pi_bar)*((1/beta)+gamma)*p(t) + 1/(beta*pi_bar) * b(t-1) +
(delta_bar/(beta*b_bar))*delta(t) + gamma/pi_bar *m(t-1) - gamma* m(t)
% 3) 0 = -i(t) + phi_pi * p(t) + phi_y *y(t)
%    0 = - delta(t) + (neu*y_bar/delta_bar)* y(t) + (b_bar/delta_bar)* b(t) +
(z_bar/delta_bar)*z(t)
% 4) 0 = E_t [ r(t) - i(t) + p(t+1) ]
% 5) 0 = E_t [ y(t+1) - y(t)- sigma * i(t) + sigma*p(t+1) ]
% 6) 0 = E_t [ beta* p(t+1) + k* y(t) - p(t) ]
% 7) z(t+1) = rho z(t) + epsilon(t)
% CHECK: 7 equations, 7 variables.
```

```
%
% Endogenous state variables "x(t)": m(t), b(t),r(t), delta(t)
% Endogenous other variables "y(t)": y(t), p(t), i(t)
% Exogenous state variables  "z(t)": z(t).
% Switch to that notation.  Find matrices for format
% 0 = AA x(t) + BB x(t-1) + CC y(t) + DD z(t)
% 0 = E_t [ FF x(t+1) + GG x(t) + HH x(t-1) + JJ y(t+1) + KK y(t) + LL z(t+1) + MM z(t)]
% z(t+1) = NN z(t) + epsilon(t) with E_t [ epsilon(t+1) ] = 0,

% for  m(t)      b(t)   r(t)   delta(t)
AA = [ -1,        0,    0,      0
      -gamma,   -1,    0,    (delta_bar/(beta*b_bar))
       0,        0,    0,      0
       0,       -(b_bar/delta_bar),    0,     -1
   ];

% for   m(t-1)              b(t-1)            r(t-1)   delta(t-1)
BB = [ 0,                  0,                  0,         0
     (gamma/pi_bar),    1/(beta*pi_bar),       0,         0
      0,                  0,                  0,         0
      0,                  0,                  0,         0
];

%Order:      p(t)                          y(t)              i(t)

CC = [       0,                          (chi*(1/sigma)),       - chi*(beta/(1-beta))       % Equ. 1)
      -((1/pi_bar)*((1/beta)+gamma)),          0,                    1                      % Equ. 2)
             phi_pi,                      phi_y,                 -1                  % Equ. 3)
             0,                  (neu*y_bar/delta_bar),            0
];

% for      z(t)
DD = [      0
           0
           0
         1/delta_bar
];

% for m(t+1)    b(t+1)   r(t+1) delta(t+1)
FF = [ 0, 0, 0,0
       0, 0, 0,0
       0, 0, 0,0
];

% for     m(t)  b(t) r(t) delta(t)
GG = [ 0, 0, 1, 0
       0, 0, 0, 0
       0, 0, 0, 0];

% for  m(t-1)  b(t-1) r(t-1) delta(t-1)
HH = [  0, 0, 0, 0
        0, 0, 0, 0
        0, 0, 0, 0];

%for    p(t+1)        y(t+1)      i(t+1)
JJ = [     1,            0,          0,                % Equ. 4)
        sigma,           1,          0,                % Equ. 5)
         beta,           0,          0,                % Equ. 6)
];
```

```
% for      p(t)      y(t)      i(t)
KK = [     0,         0,        -1,              % Equ. 4)
          0,        -1,       -sigma,           % Equ. 5)
         -1,         k,         0];

LL = [ 0, 0, 0 ];

% for  z(t)
MM = [ 0 ];

NN = [rho];

Sigma = [ sigma_eps^2  ];

% Setting the options:

[l_equ,m_states] = size(AA);
[l_equ,n_endog ] = size(CC);
[l_equ,k_exog  ] = size(DD);


PERIOD     = 1;  % number of periods per year, i.e. 12 for monthly, 4 for quarterly
HORIZON = 60;
DISPLAY_AT_THE_END = 0;
GNP_INDEX  = 3; % Index of output among the variables selected for HP filter
IMP_SELECT = [2,3,5,6,7];
   %  a vector containing the indices of the variables to be plotted
DO_SIMUL   = 0; % Calculates simulations
SIM_LENGTH = 150;
DO_MOMENTS = 0; % Calculates moments based on frequency-domain methods
HP_SELECT  = 1:(m_states+n_endog+k_exog); % Selecting the variables for the HP Filter
calcs.
% DO_COLOR_PRINT = 1;
% Starting the calculations:

do_it;
```