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Abstract

This paper develops a simple framework for describing fiscal policy where policymakers attempt to minimise deviations in output and budget balance from target values. Optimal policy is given by minimising a quadratic loss function subject to a linear structure of the economy. This policy can be viewed as weighted average of two polar cases – the case where the budget deficit adjusts to eliminate any deviations from potential output (hyperstabilisation), and the case where taxes and spending are determined exclusively by some budgetary goal (hooverism). We estimate such a rule for Estonia using data from 1996–2003. We find no evidence of a systematic expansionary, or deflationary bias in fiscal policy. Recovered preference parameters imply behaviour consistent with roughly equal weights given to output and budget stability. We find that for every 1 kroon shock to output there is an offsetting fiscal policy response of around 51 sents.

JEL Code: E61, E62

Key words: Fiscal Policy, Fiscal Policy Rules, Automatic Stabilisers, Output Stabilisation, Estonia

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Contents

1. Introduction

Whilst it is common to view monetary policy as a "Taylor Rule" (Taylor (1993) described in terms of the minimisation of a (typically quadratic) loss function, with terms capturing several objectives), fiscal policy is rarely viewed in the same way. However fiscal policy is typically utilised to pursue more than one objective in a similar way. For example governments may use fiscal policy to alter the rate of output, most typically to minimise the second order costs of fluctuations around some long-run equilibrium level and in addition, fiscal policy may also be influenced by other considerations such as income distribution, or by attempting to hit some kind of budgetary target.

It is widely recognised that such budgetary constraints may impede the governments ability to stabilise the level of output, implying that when output is below trend, a trade-off exists between the goals of output stabilisation and budget balance (or fiscal consolidation). The existence of such a tradeoff naturally begs the question as to what the preferences of the authorities are between the two goals.[1]

Economic theory offers the prospect of uncovering those preferences by analysing the choices of fiscal authorities. In particular, a popular method for describing the behaviour of monetary authorities charged with pursuing two objectives with one instrument, is to view policy interventions as the solution to an optimal control problem in which the authorities minimise a quadratic loss function subject to a linear constraint which describes the behaviour of the economy. So far however, there has been little attempt to apply this approach to fiscal policy. There is a literature which aims to describe fiscal policy in terms of rules[2], but typically little attempt is made to deal explicitly with the issue of the governments relative preferences, in the way the monetary policy literature does so clearly.

From an economic modelling perspective, there is a clear need for being able to model the behaviour of fiscal authorities in a simple way which can be traced back to easily identifiable economic objectives. In addition, if parameters of the model have a ready economic interpretation, then standard econometric tests can be employed to answer questions about the stability of co-efficients over time, and to detect structural breaks in fiscal policy regimes.

[1] See Fatas and Mihov (2004) for an overivew of the debate on the costs and benefits of balanced budget amendments in the US.

[2] See Turini and in't Veld (2004) for example.

These three observations motivate this paper, which aims to provide a simple analytical framework to describe fiscal policy. In this paper we model fiscal policy as the solution to a optimal control problem where the government seeks to minimise a quadratic loss function in output and its budget deficit. Output stabilisation is typically included in the loss function for monetary policymakers to calculate policy rules, and under monetary union or a currency board, fiscal policy may well be the only major policy instrument open to governments to achieve this aim.[3] Meanwhile, the level of debt and deficits affects the welfare of agents through its consequences for the intertemporal path of taxes and/or the probability of sovereign default.[4]

This paper makes several contributions to the literature on fiscal policy. First, it proposes a simple framework for analysing the conduct of fiscal authorities which utilises a well established methodology from the field of monetary policy. This allows us to describe fiscal policy in terms of parameters which have a clear economic interpretation, and which are grounded in optimising behaviour.

Second, the model offers a framework for testing a variety of hypotheses about the behaviour of fiscal authorities, such as the sustainability of fiscal policies over the longer term, quantifying fiscal discipline and searching for possible structural breaks in behaviour. This approach has the advantage that fiscal policy is specified in terms of only two parameters, which is particularly important in cases such as Estonia, where there are relatively few observations available for empirical estimation.

Third, we provide a simple equation representing fiscal policy which can be readily incorporated into a model. In such a setting, parameter values may be estimated, calibrated or imposed, allowing the possibility to use a full macro model to analyse changes in fiscal policy.

Fourth, the paper provides an account of fiscal policy in Estonia over the period 1996-2003. Our analysis indicates that there is no expansionary bias in fiscal policy, and that roughly equal weights are given to output and budgetary stabilisation. We find that this reaction function implies an offsetting response of around 51 sents to each kroon shock to output.

The paper is organised as follows: the basic derivation of the framework is presented in section 2, section 3 applies the framework to Estonia

[3]There is a growing literature which documents the effectiveness of fiscal policy to alter output. See Blanchard and Perotti (2002), Fatas and Mihov (2002), Mountford and Uhlig (2002) and Gali *et al* (2002).

[4]See Alesina and Perotti (1996) for a summary of the arguments surrounding the costs of unrestricted fiscal policy.

and estimates the parameters over the period 1996–2003. Lastly, conclusions are presented in section 4.

2. Deriving a Simple Fiscal Policy Measure

In what follows, we make no distinction between discretionary and automatic fiscal policy, rather the focus is on the combined effect on fiscal stance – as measured by the difference between expenditures and revenues. We assume that the total amount of government expenditure and revenues are exogenous variables which can be selected by the fiscal authorities. This does not necessarily imply that the government has full (or in fact any) knowledge of shocks, before it acts in response to them. One could characterise the governments choice of taxes, benefits and other spending as equivalent to setting a kind of "Taylor rule" for fiscal policy – where the authorities, armed with knowledge about the behaviour of expenditures and revenues in response to cyclical trends, select the system which produces the desired (automatic) fiscal response to any given shock. The decision is made as to what system of automatic stabilisers to introduce, rather than of a discretionary choice having observed a shock. In this way, the government need not observe the shock before setting fiscal policy, since the operation of automatic stabilisers (the magnitude of which is decided by the government) happens simultaneously. One may also add discretionary fiscal policy influences onto this framework. Either way, the key assumption here is that the government knows the budgetary consequences of any given tax and benefit system under any shock, and hence selects the system which gives the optimal fiscal response, rather than having to observe the shock directly before acting.

We also assume that governments take into account any second round effects on revenues and spending of policy induced changes in output. The government (or other fiscal authority) has one fiscal instrument at its disposal – the budget deficit (or surplus) – to pursue two objectives: a budgetary one and an output stabilisation one.

Clearly this approach does not consider other objectives for which fiscal policy may be used – for instance to finance investment in public goods, or to re-distribute income. These omitted goals will only be problematic to the extent that they conflict with other goals. In the case of income redistribution for example, transferring money from one agent to another is budget neutral, so this aspect of fiscal policy is orthogonal to the budget deficit. Similarly, since we focus on the difference between taxes and spending, rather than their absolute value, our analysis is independent of the size of the public sector. However, our analysis does abstract from some potentially important considerations such as intergenerational equity, the need to borrow to invest in public infrastructure, or purely political factors.

Formally speaking, we may therefore write the governments objective as the minimisation of the following quadratic loss function:

$$min_{D_t} L_t = \frac{1}{2}\delta(y_t - \bar{y})^2 + \frac{1}{2}(1-\delta)(D_t - \bar{D})^2, \tag{1}$$

where y_t denotes output at time t, $\bar{y}$ denotes the potential output, D_t is the budget deficit, and $\bar{D}$ denotes the budget target. In what follows, we assume that a budget deficit implies a negative value of D_t, and a surplus implies a positive D_t, and that all variables are expressed as ratios to potential output.

The constraint faced by the government is defined as:

$$y_t = \bar{y} + \tilde{y}_t - \lambda D_t. \tag{2}$$

This equation describes how fiscal policy affects output. It represents the constraint – or equivalently the frontier of feasible policy outcomes – posed by the structure of the economy. It says that in any period output is equal to its long run value $\bar{y}$, plus some short-run deviation $\tilde{y}_t$, plus some term capturing the effect of fiscal policy. $\tilde{y}_t$, is a pure shock to output, which is not directly observable. What we observe in the data is $\hat{y}_t = \tilde{y}_t - \lambda D_t$, the output gap which is a combination of the pure shock, plus some fiscal policy response. The data that we have consists of the actual realisation of output and budget deficits, but in much the same way as the monetary policy literature, we can use this information on outcomes to uncover preferences between the two goals.

The parameter λ reflects the fact that expanding fiscal policy by one kroon may not increase output by one kroon. If the expansionary fiscal policy serves to raise the interest rate or prices, then part of the stimulus will be choked off, on the other hand multiplier effects imply that output will increase by more than the initial stimulus. If the former predominate then $\lambda < 1$, if the latter are stronger then $\lambda > 1$. This constraint captures the core features of the economy.

We may now solve for the optimal fiscal policy. Since we have one choice variable, this is most easily done by substituting the constraint into the objective function and differentiating with respect to the choice variable.

Substituting (2) into (1) and collecting terms yields:

$$min_{D_t} L_t = \frac{1}{2}\delta(\tilde{y}_t - \lambda D_t)^2 + \frac{1}{2}(1-\delta)(D_t - \bar{D})^2. \tag{3}$$

Differentiating this function with respect to D_t and setting right hand side equal to zero allows us to solve for D_t^*, the optimal fiscal policy, D_t^*:

$$D_t^* = \frac{(1-\delta)\bar{D}}{1-\delta+\delta\lambda^2} + \frac{\delta\lambda\tilde{y}_t}{1-\delta+\delta\lambda^2}. \tag{4}$$

We find it helpful to view this fiscal policy equation as a weighted average of two polar cases, the first term on the right hand side in $\bar{D}$ captures the effect of the budgetary stabilisation objective; the second shows the effect of the output stabilisation objective. Such a representation gives a simple intuition of the governments actions and in addition, it allows us to relate our findings to earlier work on fiscal policy reaction functions for use in economic models.[5]

2.1. Hooverism

If $\delta = 0$, then fiscal policy is concerned exclusively with maintaining some budgetary objective, with no regard at all to the consequences for output. One possible for $\bar{D}$ is zero, corresponding to stabilising the budget around zero, though may take any value. We term this polar case of extreme emphasis on budget targets *Hooverism*.[6]

Thus, in each period:

$$D_t^* = 0. \tag{5}$$

In this setup, the balanced budget requirement is symmetric in the sense that neither surpluses nor deficits are permitted, or if $\delta > 0$, in the sense that budget surpluses are seen as equally "undesirable" as budget deficits.

2.2. Hyperstabilisation

The second case, is where $\delta = 1$. In this instance the government sets fiscal policy to ensure that, in each and every period, output is at its long-run equilibrium level, with no concern for the budgetary implications of such a policy. We term this case *Hyberstabilisation*.

[5]For example, the specification of fiscal policy for the Eesti Pank's macroeconomic model contained in Kattai (2004).

[6]This phrase is borrowed from Stiglitz (2002), to denote a rigid pursuit of budgetary objectives regardless of the costs in terms of lost output.

Thus fiscal policy is given by:

$$D_t^* = \frac{\delta\lambda\tilde{y}_t}{1-\delta+\delta\lambda^2}. \tag{6}$$

In calculating this measure we make a number of simplifying assumptions which require some discussion. First, policy at a given point in time may affect the economy in the subsequent as well as current periods. For the purposes of this analysis, we consider only the same period effects.

Second, we define our counterfactual policy as the policy which, if the government switched at that point to a regime of output stabilisation, would ensure the target was hit. Therefore by assuming that the government was not trying to stabilise output in previous periods, we can sidestep the issue that had the government pursued different policies in the past, the current values of consumption, investment and net exports would have been different.

2.3. Halfway-House

Fiscal policy is expressed as a weighted average of the two polar cases, where $0 < \delta < 1$ gives the relative strength of preferences. The higher the value of δ, the greater the emphasis given towards stabilising output, the lower the value of δ the greater the emphasis given towards budgetary requirements.

We may also consider $\bar{D}$ to be a preference parameter to be uncovered. One possible target value is $\bar{D} = 0$, this would embody the principle that budgets should balance over the cycle.

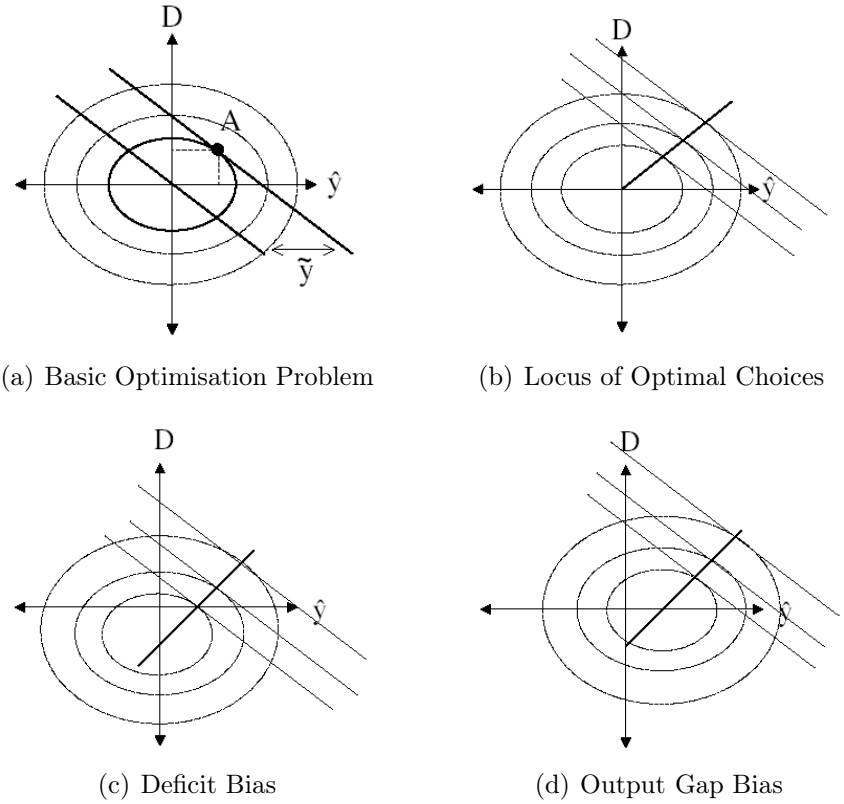
However, in reality, it may well be argued that many governments cyclically adjusted, or long-run budget positions are not balanced. Accordingly, $\bar{D}$ may be less than zero for a variety of reasons. Governments may simply be concerned with maintaining existing debt ratios, rather than the convergence towards zero which is implied by a balanced budget. Or for reasons of myopia, indiscipline or other factors, governments may not seek to stabilise deficits around zero. A third option is that governments may wish to smooth the costs of one-off expenditures such as public investment over time, and will so finance these by borrowing rather than taxation.

Alternatively, there may be cases in which $\bar{D}$ is positive. The most obvious is the case where the fiscal authorities are pursuing a debt reduction strategy which would imply year on year budget surpluses. In any case, $\bar{D}$ is a parameter which can be estimated from the data itself.

2.4. Graphical Analysis

This approach can be simply demonstrated using graphical analysis. Figures 1(a) to 1(d) show the process of optimisation in deficit-output gap space. Our quadratic loss function will yield concentric indifference contours. Higher levels of utility correspond to progressively smaller ellipses, converging to some bliss point given by $(\bar{D}, \bar{y})$.

Figure 1(a) shows the basic optimisation procedure. Assuming a that there is no deficit bias, then the bliss point will be at the origin. In the absence of a shock, the possible combinations of output and deficits will be given by a line passing through the origin with slope $\frac{-1}{\lambda}$. A shock to output of $\tilde{y}$ corresponds to a rightward shift of this line by $\tilde{y}$. The optimal fiscal policy is given by the smallest possible indifference contour that is compatible with the locus of deficit/output gap combinations and is obtained using the standard tangency conditions. This is shown by point A.



(a) Basic Optimisation Problem

(b) Locus of Optimal Choices

(c) Deficit Bias

(d) Output Gap Bias

Figure 1: Optimal Fiscal Policy

For any given shock, there is an optimal fiscal policy response. Given the objective function and the structural constraint giving the trade-off

between output and deficit stability, we may obtain locus of these points, as shown in figure 1(b). This line, in deficit-output gap space can be estimated empirically using observed values of deficits and output gaps.

Figure 1(c) shows the optimisation problem when there is a deficit bias. In this case, the locus of optimal points no longer passes through the origin, since the bliss point is no longer the origin. Thus by estimating this line, we may discover whether or not there is a budget deficit.

Logically speaking, since we can only estimate the locus of optimal points and not the indifference contours themselves, an observed locus of the form of figure 1(c), could be due to an output bias, rather than a deficit bias. Figure 1(d), shows the same identical locus arising from an output bias. In this paper, output (as opposed to deficit) biases are ruled out by assumption, as the output target is fixed at zero. In reality this distinction may be largely uninimportant, since a deficit bias may be motivated by a desire to increase output beyond its natural level. In the context of the model, nothing is changed by assuming an output as opposed to a deficit target bias.

2.5. Other Objectives for Fiscal Policy

The R-squared of our regression measures how much of the observed variation in budget deficits can be explained by the explanatory variables – in this case the output gap. Accordingly, we can view the R-squared as indicating the extent to which stabilisation influences fiscal policy. A low R-squared value means that there must be some other objective or factor beyond our model which is guiding influencing fiscal policy. Therefore, we must be clear that the behavioural parameter δ measures the *relative* preference between output and budgetary objectives, rather than being a measure of absolute preference for output stabilisation.

For example, we may find a high value for δ but a low R-squared. This would imply that whilst output stabilisation is important *relative to budgetary objectives*, it is clearly not very important *relative to some other (unspecified) objectives.*

3. Analysing Fiscal Policy in Estonia

In this section, we estimate a fiscal policy function for Estonia of the form outlined above. We use national accounts data from 1996–2003 for the public sector budget deficit, and for GDP. Our data period is governed by the availability of statistics compiled using the ESA 95 convention. A measure of the long-run rate of output is obtained by applying the Hodrick-Prescott Filter to the GDP time series. For ease of computation, all variables in our dataset are expressed as ratios to potential output.

Up to now our analysis has been derived in terms of a reaction function relating deficits to shocks. However, we cannot observe the shock directly, and so have to impute the shock in each period using (2). To get round this problem, we may substitute (2)'s expression for $\tilde{y}_t$ into the optimal solution, and re-arrange. This yields:

$$D_t^* = \bar{D} + \frac{\delta}{1-\delta}\lambda\hat{y}_t. \tag{7}$$

This equation corresponds to the observed relationship between output gaps and budget deficits. We thus estimate the line which corresponds to the locus of optimal points. Knowing the parameters which describe this line, we may then uncover the preference parameters of the government. Specifically, we estimate the equation:

$$D_t = \theta_0 + \theta_1\hat{y}_t. \tag{8}$$

To avoid the problem of simulateneity, we instrument $\hat{y}_t$ using the money supply, inventories, gross fixed capital formation and the first lag of the deficit ratio.

$$\bar{D} = \theta_0, \tag{9}$$

$$\frac{\delta}{1-\delta}\lambda = \theta_1, \tag{10}$$

$$\Rightarrow \delta = \frac{1}{1+\frac{\theta_1}{\lambda}}. \tag{11}$$

Through simulations carried out using the Eesti Pank's macro model, we calculate $\lambda = 1.13$, and find it to be constant with respect to the fiscal stimulus and output gap, or to put it another way, the constraint is a linear one. Trend output is calculated using the Hodrick-Prescott Filter.

The estimation method used is ordinary least squares. Preliminary analysis of the variables cannot reject the hypothesis of a unit root for both variables. However, the Augmented Dickey Fuller test has low power in small samples, so this may not be reliable.

As a further check, the residuals from the regression can be tested for autocorrelation, but none is found at conventional significance levels. This suggests that, even if there is in fact non-stationarity in the variables, our parameter estimates are still valid.

The regression results are reported in Table 1 and graphical representation is shown below.

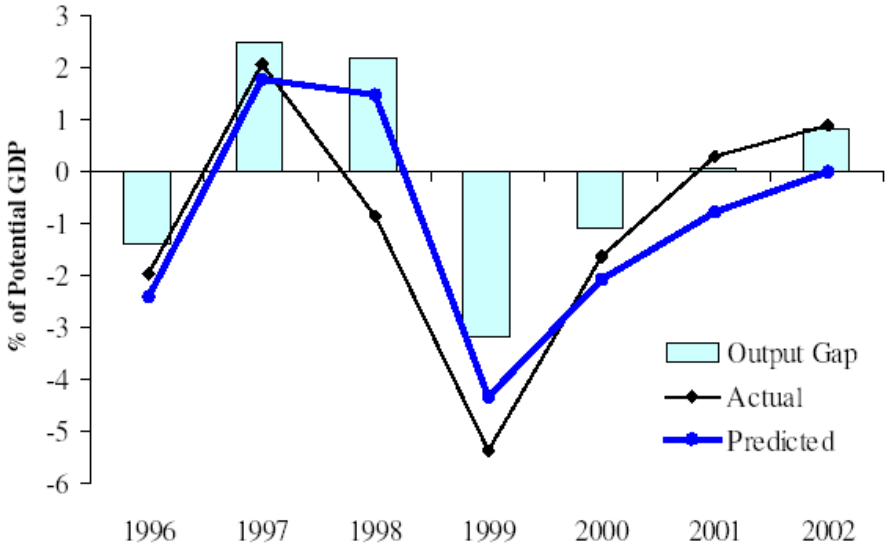


Figure 2: Actual Versus Fitted Values

Table 1: Regression Results for Estonia

d	Coef.	Std. Err.	t	P value	[95% Conf.	Interval]
θ_1	1.056	0.278	3.80	0.013	0.342	1.769
θ_0	-0.881	0.502	-1.75	0.140	-2.17	0.409
δ	0.517				Observations	7
$\bar{D}$	-0.881				P-value	0.01

Standard diagnostic tests on the properties of the residuals reported no problems at standard significance levels.

The results suggest that the simple equation provides a reasonably good description of fiscal policy in Estonia, explaining over 70% of the observed variation in budget deficits. Visual inspection of the actual versus fitted values reveals that the model is a good fit throughout the whole sample, including 1999 when output dropped sharply following the Russian crisis.

The slope co-efficient indicates that the $\bar{D}$ is not significantly different from zero, meaning that in the absence of a shock, we would expect the budget to be balanced; or alternatively put, there is no "deficit bias" in Estonian fiscal policy.

The co-efficient on the output gap can be used to impute a value for δ of 0.51 – implying almost equal weights are given to output and budgetary stabilisation. This also means that for every kroon shock to output, there is an offsetting fiscal response of around 51 sents.

Recall that, we found that the target budget balance is not significantly different from zero implying that there is no systematic expansionary bias in fiscal policy over the period. Thus our figures make the point that the *ex post* budget figures do not show any systematic expansionary bias, as evidenced by the fact the difference between actual and expected budget balances sum to zero when aggregated over time, suggesting that the amendment is achieving its desired ends in practice, at least when one aggregates over the course of the cycle.

We may deduce that the assumptions about growth have not been incorrect, from our results indicate that the current system has not produced a bias towards deficits in practice.

The size of the response – defined as chance in the budget deficit for a one unit change in output – is given by δ, which we find to be 51.7 sents for each kroon by which output changes. Using a different methodology, Kattai *et al* (2003) find that automatic stabilisers are around 35.1 sents for each Kroon shock to output. Putting this together with the result in this paper implies that discretionary policy contributes a further 16 sents of stabilisation. Alternatively put, this means that around 2/3 of the fiscal response to a shock is through automatic stabilisers, and around 1/3 due to discretionary policy.

4. Conclusions

In this paper, we present a simple framework for analysing fiscal policy as the solution to a quadratic loss function in two terms. The government then selects the optimal policy based on their relative preferences for output stability, and budget stability. We estimate such a function for Estonia, and derive point estimates for the two key parameters – the target budget balance, and the relative preference for debt stabilisation. We find that the target budget balance is not significantly different from zero and that roughly equal weights are given to stabilising output and the budget deficit. This means that a 1 kroon shock to output yields a response of around 51 sents.

These results have a number of important policy implications. First, they suggest that the current Estonian budget setting system does permit automatic fiscal stabilisers and some discretionary response to operate. At the very least, it avoids the pro-cyclical destabilising effects of a rule Second, it suggets that in relation to the Maastricht criteria on budget deficits, Estonia has considerable room for maneouvre. On the basis of our figures, it would take a shock of around 6% of potential GDP to push the budget deficit above 3% of GDP. This would imply a shock on the scale of the 1999 Russian Crisis. This is an important result, since the features of the Estonian budget setting system render discretionary responses difficult, and so it would be almost impossible to make a "last minute" fiscal consolidation to ensure compliance with the Maastricht criteria in response to a negative shock. It also means that the difficult economic and political situation created by such a conflict between the desire to avoid a contraction and the desire to meet the Maastricht criteria – which may be a problem for many countries[7] – is not likely to occur.

Lastly, it should be stressed that this current approach is somewhat simplistic, and might be better viewed as the first step towards a more detailed analysis. This basic approach opens up the possibility of several fruitful extensions. First, a more complex treatment of the governments optimisation problem could include taking into account the effects of current period fiscal policy on future output. Second, we might consider the possibility of asymmetric preferences for output and/or debt stability, so that for example, governments cared more about correcting negative output gaps, than than about positive ones. Third, whilst monetary policy in Estonia is exogenously given under the currency board arrangement, for other countries there might be scope to incorporate possible mone-

[7]See Buiter (2004) and Hughes Hallett and Lewis (2004) for an analysis of the fiscal prospects of new EU members vis a vis the Maastricht Criteria.

tary and fiscal policy interactions into the behaviour of fiscal authorities. More generally, the fiscal policy rules used in this paper might be embededded in a fuller macroeconomic framework, which captured dynamics, as well as as price and exchange rate adjustment and other features of the macroeconomic ignored by this basic analysis.

Nevertheless, the paper does provide a simple methodology for describing, analysing and interpreting fiscal policy. It allows us to test for (and eventually reject) deficit bias, and to estimate the magnitude of fiscal stabilisers. Our results suggest that fiscal policy does perform some stabilising role, consistent with roughly equal weights ascribed to output and deficit stabilisation, avoiding some of the criticisms frequently levelled at more stringent balanced budget requirements.

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