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FISCAL CONSOLIDATION AND THE PROBABILITY DISTRIBUTION OF DEFICITS: A STOCHASTIC ANALYSIS OF THE STABILITY PACT

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Abstract

Using stochastic simulations, this paper analyses the probability distribution of a country's deficit ratio under fixed exchange rates and a variety of monetary policy rules. The purpose is to show how the probability of getting an "excessive deficit", defined as a deficit / GDP ratio in excess of 3% by Europe's Stability Pact, varies with different deficit target rules and different fiscal and monetary policy rules. We find that these fiscal ratios typically have a wide distribution, with fat tails and significantly longer tails on the upper side. That means fiscal targets may have to be country specific and conservative, and that fiscal policy has to be forward looking to keep the probability of excessive deficits below acceptable limits.

JEL Classification: E61, E63.

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1. Introduction

Europe's Stability and Growth Pact has two important features. First, it places a limit, at 3% of GDP, on the maximum budget deficit allowed in any country, and imposes fines on governments which exceed that limit. Second, the threat of sanctions make it desirable for national governments to maintain a "cushion" in which their deficits are held away from this limit, so that random shocks or stabilisation policy will not take the deficit beyond 3% except in exceptional circumstances. That means budget planning has effectively been converted into a system in which governments aim for a certain target deficit on average in order to reduce the *probability* of being forced beyond the 3% limit.

Furthermore, whilst we know that the frequency of Stability Pact fines will be based on $\frac{T - n}{T}$ (where T is the time horizon and n the number of occasions that the deficit ratio is less than 3%), we do not know what such a strategy implies for the distribution of the deficit ratio and deficit planning over time. In particular, where do those deficit targets need to be set in order to keep the probability of an excessive deficit below a certain limit, 10% say? Advocates of the Pact argue that deficits will have to be set "close to balance or in surplus", on average to achieve such an outcome.[1] But is that correct? Is it sufficient?

Such issues are all the more interesting since the analysis of the implied distribution of deficits under the Stability Pact has been largely absent from the literature. That is the purpose

[1] See Artis and Buti (2000), Duisenberg (1997).

of this paper. We examine how imposing deficit targets can reduce the probability of excessive deficits to within reasonable limits, and how the setting of those target values will depend on the type of monetary (and fiscal) rules in operation. We do that by analysing the results of stochastic simulations, constructed over a 40-year period, using the IMF's multi-country model MULTIMOD. The idea is to examine what proportion of those 40 time periods repeated over 400 replications of each policy experiment (i.e. what proportion of 16,000 "observations") actually has any particular country's fiscal deficit going beyond the 3% limit?

The point that emerges is that the probability distribution of the deficit ratio, because its numerator and denominator are both driven by the same stochastic variable (i.e., economic activity), has a fairly complicated form. In particular, it tends to have a wide variance with fat tails, and is often highly skewed with a long tail to the right (i.e. beyond the 3% limit). Consequently the target value for the deficit ratio may have to be shifted a long way to the left (i.e., towards balance or surplus) to systematically reduce the probability of exceeding 3% to an acceptably low level.

In fact, our results show that this *cannot* be completely done, even with balanced budgets as the target value, unless the tax or expenditure policy reaction functions have reasonably strong forward looking elements which start raising revenues (or reducing expenditures) well in advance of the deficit ratios which can be expected in the future. But that, as Perotti *et al* (1998), Perotti (1999) and von Hagen *et al* (2000) among others have observed, is exactly what the policy makers have *not* been doing. Instead, they typically start to spend those extra revenues as they appear.

2. Motivation

That we should get such results - in which budget targets are routinely exceeded even in a world of fiscal discipline and pre-commitment, and where revenues from growth in good times can be spent before a fiscal “cushion” against bad times is created - is hardly surprising. To see why this might happen one needs only to recognise that deficit targets are nearly always set as a *ratio* to national output. The numerator will be made up from tax revenues and fiscal expenditures, which, because they are paid out of past earnings and profits and reflect decisions based on the recent history of demand and employment, will be linear functions of national output in the recent past.

The denominator, on the other hand, is again national output - but a contemporaneous value this time. Thus, if we make the usual econometric assumption that national output is roughly normally distributed around its mean of full capacity, then the deficit ratio will - to a first approximation at least - be a ratio between two contemporaneously independent normally distributed variables. The ratio itself might therefore follow a Cauchy distribution. This distribution is given by:

$$f(x) = \left(\pi\left[1+\frac{(x-\alpha)^2}{\beta^2}\right]\right)^{-1}, \quad -\infty \leq \alpha \leq \infty, \ \beta > 0$$

where α is a location parameter and β is a scale parameter. Moments and cumulants of this distribution do not exist. The Cauchy distribution is unimodal and symmetric around α but with much heavier (“fatter”) tails than a normal distribution. Hence we might expect that the deficit ratio will similarly have a large variance and fat tails; if not strong asymmetries of one sign or the other in its distribution over time. Indeed, if policy makers typically spend any new revenues as they come in, then the contemporaneous independence property will be lost and the deficit ratio will be large more often than it is small - rising more in recessions than it falls in good times. That would suggest strong positive asymmetries. Under those circumstances the deficit targets which policy makers set around the cycle would have to be especially conservative - and the anticipatory components in their fiscal decision making rules especially strong - if we are going to reduce the probabilities of excessive deficits to an suitably low level.

The purpose of this paper is therefore to investigate how much this “ratio effect” increases the probability that cyclical movements and stochastic shocks will lead to the maximum limits on deficits being breached - even when the target values have been set at a much lower level. Just how often should we expect that to happen? How low do you have to set the target levels in order to reduce the probability of violations to, say, less than 10% at any one time? Will the Stability Pact encourage the creation of a suitable fiscal “cushion”, and what is the cost of that cushion? Needless to say, the non-linear nature of this effect means that questions of that kind can only be answered with numerical simulations. Closed form solutions are not possible.

3. The Modelling Approach

3.1 An Empirical Model

MULTIMOD (Laxton *et al*, 1998) is an annual estimated world econometric macro-model. It is in the Keynesian-Classical mould (with standard balanced growth closures but nominal rigidities and error corrections in the short run) and is constructed more for its long-term insights than forecasting. Specific features include a non linear relationship between inflation and unemployment, investment determined by Tobin’s *q*, age-earnings profiles for consumption, uncovered interest parity (UIP) as the determinant of exchange rates, a tax reaction function which precludes unsustainable fiscal accumulations and endogenous short-term nominal interest rates to observe money, inflation, exchange rate targets etc. The model, and its vintages, has been used extensively for policy analysis in public policy and academic circles. It contains explicit models for the four largest EU economies (Germany, France, the UK and Italy) representing nearly 80% of the European economy. They are linked with the US, Canada and Japan, and with the rest of the world, through trade, capital flows; and a single currency in Europe, but flexible exchange rates elsewhere.

MULTIMOD has a clear theoretical structure. The specification is designed to explain the main expenditure categories and production flows in each country, from which employment, investment, prices, interest rates and exchange rates are determined. Financial markets, trade flows, and capital movements (including loans and interest payments) are all represented. Trade is divided into three markets: oil, primary commodities and manufactured goods. Perfectly flexible prices clear the commodity markets, where demands are driven by activity levels and supplies by prices and a predetermined capacity. Manufactured goods are produced and traded everywhere. Aggregate demand is built up from consumption (based on current and expected future earnings, and asset values), investment (based on market evaluations of firms' current and expected future earnings), trade and the net fiscal position. Both consumption and investment therefore adjust positively to earnings, but negatively to rising prices or interest rates. This determines output in the short run. Note that since assets incorporate the stock of capital and government bonds, as well as net foreign assets, human capital will be constrained to cover discounted future tax liabilities. The model therefore embodies strong, but incomplete Ricardian equivalence. Potential output is determined by a production function so that capacity utilisation (the ratio of actual to potential output) can vary. Output prices are also subject to a Phillips curve, so there is no absolute output constraint in the short run. In fact, prices change by an amount which depends both on the remaining spare capacity and on the state of the labour markets. Prices are therefore partly sticky and partly forward looking, depending on wage contracts, international competitiveness and capacity utilisation.

In the monetary sector, non-EMU exchange rates are determined by UIP and the *expected* depreciations consistent with a complete model solution. As we shall see, this assumption for exchange rates is important in constraining long-run Euro Area monetary policy, compared to US monetary policy. Monetary policy rules in this model can take a variety of forms and targets such as monetary growth values (this is the default rule of the model and the one used for the US), exchange rate targets, inflation targets, Taylor rules etc.

Similarly, tax rates are set to gradually eliminate the gap between actual and targeted levels for the deficit to GNP ratio, subject to an intertemporal budget constraint. Fiscal expenditures are therefore exogenous, but revenues are endogenised. A full description of MULTIMOD's properties is given in Laxton *et al* (1998), and comparisons with other models in Mitchell *et al* (1998).

3.2 Fiscal Policy Reactions

In the simulations reported below, that is in Tables 2-7, we use the following tax reaction function,

$$tax\ rate_t = tax\ rate_{t-1} + \alpha_1 (d_t - d_t^*) + \alpha_2 \Delta(d_{t-1} - d_{t-1}^*) \tag{1}$$

where $\alpha_1 = 0.9$ and $\alpha_2 = 0.25$, and d^* is the target value for the deficit to GDP ratio, *d*. That target value will be defined separately in each simulation exercise.

This is of course a purely backwards-looking rule, in line with what many understand by the

Stability Pact. But it does not capture the possibility that the *threat* of fines under the excessive deficit procedure may, in itself, produce budgetary contractions. The policy makers would therefore have little incentive to create a fiscal cushion. For that we would need some forward looking elements in the tax reaction function, so that rates are made to rise whenever the deficit is anticipated to go beyond the 3% limit in the near future - or is close to doing so. On the other hand, tax rates could also be reduced whenever the deficit ratio has, or is expected to fall well below its target value. In this paper, putting such forward looking elements into the tax reaction function means replacing (1) with MULTIMOD's own fiscal reaction function:

$$tax\ rate_t = \alpha_1 (d_t - d_t^*) + \alpha_2 \Delta (d_{t-1} - d_{t-1}^*) + \alpha_3 \frac{1}{5} \sum_{i=-2}^{+2} tax\ rate_{t+i} \qquad (2)$$

$\alpha_1 = 0.9$, $\alpha_2 = 0.25$ and $\alpha_3 = 0.15$; and d^* is defined as before. However, this change makes little difference, as we shall see. So the Stability Pact's "strategic" threat is not the mechanism which really matters. Instead, it is the shape and dispersion of the probability distribution of the deficit ratio itself which generates the need for a decent-sized fiscal cushion.

Notice that the moving average component of (2) makes tax rates respond both to excessive deficit ratios built up in the past, and to the excessive deficit ratios that can be expected to appear in the future.[2] Thus, anything that is expected to increase deficits beyond their target value will cause tax rates to rise. Conversely, anything that has lowered the deficit ratio below

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[2] This specification also makes the tax function common across countries, in the following sense. Since d^* is a constant, even if it takes different values in different countries, we need only a first order difference equation in (2) to ensure the deficit target will be met eventually (Salmon, 1982) (or a second order equation if it is to be met within a specified period). But the fact that (2) is a fifth order scheme means that any fiscal interventions will be completely dominated by a country's current deficit target - whatever that may be. Also see Mitchell *et al* (2000) who discuss the equivalence of deficit and debt tax reaction functions. These rules refer to general taxes: capital and labour taxes are also endogenous but not subject to (2).

its target value will cause tax rates to fall. Moreover tax rates will continue to rise so long as $d > d^*$, even if the deficit ratio is falling; and vice versa if d remains below d^*.

That said, one can also show that the weight put on the future expected deficits in rule such as (2), is not large compared to the weight put on the *currently* expected deficit. But it is somewhat larger than the weight given to correct past deficit failures. We can see that because (2) may be rewritten as

$$\begin{aligned} tax\ rate_t &= b(L)(d_t - d_t^*) + a(L) tax\ rate_t \\ &= \left(\frac{b(L)}{1-a(L)}\right)(d_t - d_t^*) \end{aligned} \quad (3)$$

where $b(L) = 0.9 + 0.25L - 0.25L^2$, and $a(L) = 0.03\sum_{j=-2}^{2} L^j$ are both polynomials in the lag operator L. Evaluating $[(1-a(L)]^{-1}$ by a power series expansion, we can write:

$$\begin{aligned} &[1-a(L)]^{-1} = \\ &\quad 1.103\left[1.004 + 0.0332(L+L^{-1}) + 0.0332(L^2+L^{-2}) + 0.002(L^3+L^{-3}) + 0.001(L^4+L^{-4}) + ...\right] \end{aligned} \quad (4)$$

which is symmetrically distributed about the currently expected deficit terms, but with a rapid decay in the lead and lag coefficients. Nevertheless, the lag structure in $b(L)$, in which the terms in L and L^2 largely cancel out, means that the future expected deficits and the past deficits ultimately affect tax rates rather little:

$$\begin{aligned} b(L)/[1\text{-}a(L)] = 0.932 + 0.299L - 0.237L^2 + 0.002L^3 - 0.008L^4 \\ + 0.039L^{-1} + 0.031L^{-2} + 0.002L^{-3} + 0.001L^{-4} + ... \end{aligned} \quad (5)$$

The coefficients of expected future deficits therefore account for 7% of the total *net* impact on tax rates; the corrections for past deficits for just 5%; and the reaction to the currently expected deficit for 88% of the changes to tax rates. If this represents the way in which policy makers actually do react to excessive deficits, then we can expect little change from the traditional model in which they just react to current and past deficit failures - as in (1).

Consequently forcing policy makers to pay most attention to past and present deficit failures - which is what the Stability Pact requires them to do - can easily cancel out the effects of some quite strong forward looking terms, like those in (2). A fiscal cushion is unlikely to emerge from such an arrangement therefore - explicit deficit targets at or near balance will still be needed. In other words, this version of the model takes the Stability Pact's fiscal consolidation properties very seriously.

3.3 Monetary Policy

We use a variety of monetary policy rules. They can be nested as

$$r_t = r_{t-1} + \phi_1(\pi_e - \pi_e^*) + \phi_2 y_t^{gap} - \phi_3 \log(m_t^* / m_t) \qquad (6)$$

where r_t is the short run nominal interest rate, π_e is the EU-wide inflation rate (with target value π_e^*), y_t^{gap} is the output gap (the percentage difference between actual and capacity output, as calculated by the model), and m_t^* (m_t) is target (actual) M3 in the Euro Area. Equation (6) gives a standard Taylor rule for $\phi_1, \phi_2 > 0$ and $\phi_3 \to 0$. We set $\phi_1 = \phi_2 = 0.5$ and $\pi_e^* = 1\%$. But it gives an inflation targeting rule if $\phi_1 > 0$, $\phi_2, \phi_3 \to 0$. And a monetary targeting rule if $\phi_1, \phi_2 \to 0$ and $\phi_3 > 0$ ($\phi_3 = 6.17$, the default parameter for Germany in the model). Given that the European Central Bank (ECB) uses a two-pillared strategy (i.e. medium-term M3 growth reference values and short-term inflation indicators) such an eclectic approach to monetary rules is warranted.[3]

4. The Simulation Analysis

Our results are set out in two stages. First, in Tables 2-9, we set out the overall results for the

[3] European Central Bank (1999, 2000).

main economic indicators in each country: GDP growth, inflation, investment, short run interest rates, the nominal exchange rate, and the public sector debt and deficit ratios. This is done for each European country, and for the US as their outside comparator, first for the conventional (backwards-looking) fiscal policy rules, and then for the forward looking rule designed to create a fiscal cushion. For the purpose of this exercise, we treat all four European countries as being members of EMU and the Stability Pact. For each variable, we then quote summary statistics as measured across the 400 replications of each of the 40 simulation periods. Second, in Table 10 and the next section, we consider the characteristics of the probability distribution of the deficit ratios, and what that may mean for the success of the Stability Pact.

In constructing these tables we actually ran each stochastic simulation over a 150 year time period, and then discarded the first 15 observations and the last 95 observations from each in order to remove any biases that might possibly arise from starting or finishing each simulation from particular preassigned equilibrium values. This is standard practice (see Bryant *et al*, 1993). Moreover, we also started each Euro Area country in the stochastic simulation exercises with an initial deficit ratio of 3%, in order to ensure common initial conditions. We do this, like Masson and Symansky (1996), not because it produces the most realistic projections of deficit evolutions. It clearly does not. Rather we do it because it shows what would have to be done to reduce a fiscal deficit of a given size over a certain period without the aid of favourable shocks. In so doing, it provides an illustration of the *general* strategies implied by the Stability Pact, irrespective of current *specific* conditions of countries in the monetary union.

The technique for generating the stochastic shocks is essentially the method recommended by

McCarthy (1972) for reproducing the characteristics of the observed random disturbances of the historical period - but adapted for use with rational expectations models (see the appendix[4]) Thus, shocks distributed according to the sample periods distribution of equation residuals, are applied to MULTIMOD's behavioural equations for Germany, France, Italy and the UK. In line with Fair (1998) and others, we do not shock policy rules, identities or quasi-identities such as the term structure or UIP conditions. So we do not account for the possibility that policy, measurement, or implementation errors may also have contributed to the variations in deficit ratios and the proportion of time that they have exceeded 3%. Our results, therefore, represent the best that policy makers can hope for.

Finally, Table 1 reports a baseline or reference path, being a steady state solution of the model with no shocks, and with the default policy rules of money targeting (6) and backwards-looking tax reactions (1). This gives the background against which all other (stochastic) simulation results need to be considered. This steady state simulation is constructed using the IMF's "World Economic Outlook" information set for 1998 and beyond, and shows that the four European countries would, if left to themselves, converge on a long run growth rate of 2.2%; a long run inflation rate of 2.7%; and debt ratios of 33%, 42%, 89% and 30% for Germany, France, Italy and the UK. The long run steady state deficit ratios would be, correspondingly, 2%, 2.2%, 4.7% and 1.6%. Thus, the only differences in underlying performances would be on the fiscal side; not in output, inflation or investment. Monetary conditions are, however, rather tighter than those actually experienced in the first year of EMU because the control rule is tighter; and because the external events which have led to a higher dollar/lower Euro have not been modelled. However those differences play no role in

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[4] Efficient stochastic simulation and control of forward-looking non-linear models is discussed extensively in Holly and Hughes Hallett (1989) and McAdam and Hughes Hallett (1999).

what follows since every other simulation is assessed in comparison with this one; that is to say with the same underlying baseline and information set, so that any such changes/omissions “wash out”.

5. The Simulation Results: General Characteristics

We now consider the stochastic simulation results reported in Tables 2-8. Each represents a different deficit target rule and/or monetary policy reaction function. Tables 2 and 3 consider 3% deficit targets for every country (except the US), with inflation (or monetary) targeting or a Taylor monetary policy rule. Tables 4 and 5 do the same with 1% deficit targets. Tables 6 and 7 then repeat the same two exercises with individual deficit ratio targets (0% for Italy and the UK, 0.5% for Germany and France). Table 8 completes the picture by replacing the usual backwards-looking tax reactions (1), with the forward-looking tax rule (2).

Finally, and importantly, the last row in each of these tables quotes the proportion of times that each country exceeded the 3% deficit limit in the given set up, and hence the probability that that country would attract a Stability Pact fine if it were to adopt the associated deficit targets, and tax and monetary policy rules.[5]

(a) 3% Deficit Targets

As far as the first two simulations are concerned (Table 2 and 3, with 3% deficit targets for all), there appears to be little difference between the monetary policy rules. The 3% deficit targets remain well within reach; and the stability of those outcomes (as measured by their

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[5] This probability figure will be taken over and discussed again as part of the analysis of the deficit ratio’s probability density functions in the next section.

standard deviations or max-min spread) is broadly similar as well. The main problem appears to be that, even with an aggressive tax reaction whenever the deficit ratio exceeds 3%, the probability of violating the Pact and attracting a fine remains high at 80%. This asymmetry (a symmetric distribution would imply a 50% probability of excessive deficits) implies two things. First, that there is an underlying expansionary bias in fiscal policy to compensate for the tight monetary policies and contain adverse shocks and spillovers from elsewhere. And, second, because fiscal policies focus on current and past deficits, it is hard for policy makers to be forward looking and prevent a build up of deficits in the future. If they cannot do that, they need to operate a safety cushion - in particular because most fiscal decisions are taken well in advance and do not typically possess the flexibility of monetary policy.

(b) 1% Deficit Targets

If, instead, policy makers set their deficit targets at 1% of GDP, we get some differences in regime. Under a Taylor rule, there is a significant-monetary easing to compensate for the tighter fiscal policies, compared to the inflation-targeting regime. This eases interest rates (¾% point), lowers the Euro (6%) and allows slightly higher inflation. Yet, in both cases the freedom of monetary action in Europe is closely constrained by US interest rates. That imposes a long-term constraint on the Euro Area, in that the ECB may not be able to relax monetary policy as much as it would like – a tension that has been very much apparent in the first year of EMU’s life. However, that constraint is stronger under inflation targeting, where the inflationary consequences of a Euro depreciation acts as an effective breaking mechanism. This is a feature which re-appears in the remaining simulations.

The Taylor rule also shows lower volatility in growth, at least for Germany and the UK, and avoids the worst of the output slumps for all of them. But it produces slightly more variability in inflation on the upside. It is therefore more effective in avoiding deflations, but less effective for containing inflationary pressures. And it uses interest rate changes more vigorously, and that slows investment. Thus, there will be considerable interaction between the impacts of fiscal and monetary policies under the Stability Pact.

In other words, what rule should be chosen depends on what is wanted. A Taylor rule outperforms inflation targeting during a slowdown or large fiscal contraction, but not otherwise. In addition, there is an obvious trade off between deficit control and output losses when low deficit ratios are targeted. These interactions cannot be avoided, it seems. Moreover, there are relatively few country differences - at least until we come to low deficit targets, whereupon the losses in output appear to be skewed against the traditionally higher inflation countries (the UK and Italy). The main problem however is that, despite an increase in the fiscal cushion, the probability of violating the Stability Pact has still not been substantially reduced. We still have single period probabilities of 15% to 24% of going beyond the 3% limit, even with these much lower deficit targets. The best that can be said is that the Taylor rule is a little less risky.

(c) Country Specific Deficit Targets

If we now move to reducing the target ratios yet further in an attempt to reduce the probability of exceeding the Stability Pact's 3% limit to more acceptable limits, we get the results in Tables 6 and 7. Here the traditionally less disciplined economies (Italy and the UK) have been given deficit ratio targets of 0% - or budget balance - while France and Germany aim at 0.5% ratios. These targets broadly reflect the common perception of what fiscal performance is needed in each country and is clearly in the spirit of targeting close to budgetary balance. Not much that is new happens in these two tables - the general characteristics of the different monetary regimes and their interactions with the fiscal policies are as before. There are of course some country differences in the outcomes now, but they are not large. Growth is naturally slower in Italy and the UK, and more variable compared to France and Germany; and debt is lower. But inflation remains similar and the deficit ratios are actually higher on average. So this strategy is perhaps not a success. Nevertheless, the probability of exceeding the 3% limits has been reduced - although by only a small amount. That probability has in fact fallen to 10%-11% under inflation targeting, and to 14%-22% under monetary targeting. We have to go one stage further to get the probability of fines to below 10% therefore.

(d) Forward Looking Policy Rules

Finally we have the results in Table 8, where we introduce the forward looking or tax smoothing rule (2), but keep inflation targeting as the monetary regime together with the low deficit targets for Italy and the UK (0%) and France and Germany (0.5%). This has the effect of making the countries more homogenous in their performance, and finally gets the probability of violating the Stability Pact down below 10%. However, at 8% it is not a large reduction. There is not much evidence of a flexible fiscal cushion therefore. On the other hand, tax smoothing does appear to generate somewhat higher growth - and hence lower deficit and debt ratios on average. What seems to be happening is that, by looking forward, policy makers can reduce taxes when circumstances are favourable (i.e. when there is growth); but raise them for shorter periods when things are unfavourable. So there is now some use of the cushion which the lower deficit targets has created. The downside of this is small increases in inflation, and hence interest and exchange rates. Also, output and inflation variances are a little higher, especially when larger shocks hit the economy.

To get a better idea of the potential impact of forward looking budgets, we have re-run the same exercise again but with a stronger forward looking tax function to constrain future deficits close to their target values. We therefore repeat the exercise of Table 8, but with (2) replaced by:

$$tax\ rate_t = \alpha_1(d_t - d_t^*) + \alpha_2\Delta(d_{t-1} - d_{t-1}^*) + \alpha_3 \frac{1}{3}\sum_{i=1}^{3} tax\ rate_{t+i} \tag{7}$$

where α_1, α_2, α_3 and d^* take the same values as before. The last term is now purely forward looking, although the current and backward looking components associated with α_1 and α_2 remain the same. We can therefore write:

$$tax\ rate_t = \left(\frac{b(L)}{1-a(L)}\right)(d_t - d_t^*) \tag{8}$$

where $b(L) = 0.9 + 0.25L - 0.25L^2$ and $a(L) = 0.05\sum_{j=-3}^{-1} L^j$. Rewriting (8) now yields:

$$\begin{aligned} b(L)/[1\text{-}a(L)] = 0.926 + 0.238L - 0.25L^2 + 0.072L^{-1} + 0.063L^{-2} \\ + 0.052L^{-3} + 0.008L^{-4} + 0.003L^{-5} + \ldots \end{aligned} \tag{9}$$

in place of (5). The coefficient on expected future deficits now accounts for nearly 20% of the net changes in tax rates, whereas current deficits account for about 80%, and past deficits virtually none. That increases the importance of the forward-looking behaviour in deficit control by a factor of more than 2½ times. (The deficit targets are unchanged).

The results of this new exercise are in Table 9. The main point is that the probability of exceeding a 3% deficit ratio has been reduced again, but only by about ¼% point in each case. That confirms the importance of forward-looking behaviour. But that kind of decision rule will still not be very powerful if much attention is being paid to current deficit levels at the same time. The distribution of the deficit ratio variable is simply too wide and has too long a tail at the upper end. Hence, to get the probability of suffering excessive deficits down further, the deficit target values will have to be shifted yet further towards a surplus.

The remaining results in Table 9 show that forward looking budgeting produces lower interest rates, and hence a little more inflation and more growth, in the European economy. This is because the peak deficits have been successfully smoothed out and the debt burdens are a little lower.

6. Results: The Distribution of the Deficit Ratios around their Maximum Permitted Limits

We now try to pull all these results together by analysing them in terms of the probability distribution of each country's fiscal deficit ratio around the limit of 3%, for each exercise. The results are summarised in Table 10. The first four columns recall the results when there are common deficit targets of 3% or 1% of GDP across all four countries. The last three impose national targets of 0% (budgetary balance) for the UK and Italy, and 0.5% (mild deficit) for Germany and France. Various monetary policy rules were used: (6) with $\phi_1, \phi_2 > 0$, $\phi_3 = 0$ for the Taylor rule; with $\phi_1 > 0$, $\phi_2, \phi_3 = 0$ for inflation targeting; and with $\phi_1, \phi_2 = 0$, $\phi_3 > 0$ for the monetary targeting rule. Again, the first seven columns use the backwards-looking tax reaction function. Only columns 8 and 9 use the forward-looking tax smoothing functions, (2) and (7).

The results show that the targeted values for the fiscal deficit ratio can usually be met, on average. For the 3% target regimes there is no problem, although the target value is slightly exceeded everywhere - most notably in France and Germany. By contrast, the 1% targets are nearly met in France and Germany on average (the deficit ratio is no more than 10% larger than its intended value). But for Italy and the UK those deficit targets are not met even on average, the deficits being 50% (or ½% point) over the targeted value. Similarly, where there are individual targets for each country, Germany and France finish up between 0.05% and 0.7% points above their targeted values on average. For Italy and the UK, the outcomes are a little worse than that on average, at between 0.8% and 1.5% points above their targeted values. These are poor outcomes given the budgetary targets set, although it must be said that setting deficit targets well below 3% does keep the average deficit well away from the Stability Pact's 3% limit - and that inflation targeting is clearly better than monetary targeting in this regard. Nevertheless, tough budgetary targets such as "being close to balance or in surplus" are going to be hard to meet, even on average, over the long haul.

However, the average outcomes are not the most problematic feature of these results. More awkward are the large probabilities with which deficit ratios exceed their 3% limit even when tough deficit targets are imposed. Those probabilities are around 80% if the deficit targets are set at 3% of GDP. But they are still at the 13%-24% level, or higher, with the deficit targets at 1% of GDP, depending on the country and monetary policy rule in play. And they are at 10%-22% when the national targets are set at "budget balance or close to it". Thus, even with deficit targets of close to balance, deficit ratios will tend to exceed their maximum allowed value of 3% roughly one year in five or six - if policy makers follow a traditional backwards looking "error correction model" when setting their fiscal policies. In fact, only when they employ forward looking policy rules and tight national targets (column 7), can the policy makers get those probabilities down to below 10% and expect to exceed the 3% limit no more than one year in twelve.

The root cause of these results is clearly the skew and fat tails of the deficit ratio's probability distribution, as we surmised at the start. Indeed, the fact that the probability of exceeding a

3% ratio, when the mean ratio was 3%, remains well above 50%, shows that the deficit ratio distributions are strongly skewed. To give an idea of these different characteristics, we have computed the ratio of the coefficients of variation for the deficit ratio and output growth:

$$\text{Ratio CV} = \frac{\sigma_d}{\bar{d}} \bigg/ \frac{\sigma_y}{\bar{y}}$$

(where *d* is the deficit ratio (%) and *y* is output growth (%)) to show that *d* continues to have an "abnormally" large variance even as $\bar{d} \to 0$ in the tough targets case. We also have the ratio of the range of the distribution above $\bar{d}$, to its range below $\bar{d}$:

$$\text{R}(d) = \frac{d_{\max} - \bar{d}}{\bar{d} - d_{\min}}$$

This is to show something of the asymmetry of the distribution of the deficit ratios under each fiscal consolidation exercise. All these results are quoted in Table 10. Finally we could compute the probability of getting an observation of *d*, in each experiment, above $\bar{d}$ + two standard deviations. To the extent that this probability is greater than 2½% then we have distribution tails that are very much fatter than we would have got under the normal distribution. However the P(*d*>3%) rows show that probability to be in excess of 8% or more, even in the tax smoothing cases of columns 8 and 9, which means the upper tails are at least three times fatter than those of a normal distribution. In fact they are fatter than that: since $\bar{d}$ + two standard deviations is less than the 3% deficit ratio limit in each case, we would only get tails three times fatter if the distribution were bimodal with no probability between those two values. Ordinarily they would be rather fatter than that[6].

The calculations in Table 10 therefore show very clearly that the deficit ratio distribution has

[6] For example, the triangular shape produced by our empirical probability distributions suggests probabilities somewhere between 30% and 70% beyond $\bar{d}$ + two standard deviations.

large variances, fat tails and strong asymmetries in every case. Moreover, the variances evidently *increase* sharply when we tighten the deficit targets, relative to any increases in the variance of output growth. This effect is strongest for the UK and Germany, but it is also true for France and Italy too. (However, it is always somewhat less marked when inflation targeting is being used as the monetary control rule).

More important for our purposes, the asymmetry measure shows a long tail to the left (i.e. towards budget balance or surplus) when 3% is the deficit target. But it switches to being a tail to the right (i.e. towards excessive deficits) when *lower* values are being targeted - especially in the UK and Italy, and the more so the tougher are the budget deficit targets. Finally, and most telling, the probability of getting a deficit ratio which is larger than two standard deviations above its mean (target) value, runs at 8%-20% even in the most restrictive regimes. That is about 3 to 8 times larger than would be found in a normal distribution. However it is these “fat tail” probabilities which the forward-looking budgetary behaviour has managed to bring down (compare columns 8 or 9 with columns 4-7).

7. Conclusions

This paper has simulated the implied probability distribution of deficit ratios under the Stability Pact and monetary union. Our purpose was to examine, what would be the appropriate policy, if governments, with initial conditions given by the ceiling of the Pact, attempted to minimise the probability of fines. In this way, we highlight the strategic aspects of observing the Stability Pact (such as the need for a fiscal cushion, forward looking taxes, the importance of the policy mix etc) irrespective of the current state of national deficits.

Clearly, the results of the last section suggest that the deficit distributions have fat tails - particularly on the upper side; and most noticeably in France and Germany, and when the deficit targets are at their most conservative. It is that, more than anything else, which might make it difficult to maintain a fiscal consolidation once it is achieved. Any fiscal consolidation programme needs to build in some kind of explicit allowance for these kinds of stochastic risks, if it is to appear credible and sustainable. A backward looking Stability Pact mechanism, even with some forward-looking elements, does not do that.

Instead we require a forward looking budgetary regime which targets expected future deficit ratios - to take into account what are, in effect, shifts in the shape of the deficit ratios' probability distribution. To achieve that regime two things are needed: fiscal decisions which react to expected future deficits (to smooth the actual deficits experienced), and tight deficit targets which shift the whole distribution in such a way as to reduce the probability of excessive deficits to acceptable levels. Thus, it is shape and dispersion in the deficit ratio's probability distribution, not the threat of Stability Pact fines, which generates the need for a fiscal cushion.

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APPENDIX

Methodology for Performing Stochastic Simulations

Given the residuals from the estimated behavioural equations of the model (denoted *U*) we derived the shocks or innovations (denoted by *v*) in the residual process by performing the following filter over a historical horizon[7]:

$$U_t = \alpha_0 + \sum_{i=1}^{I} \alpha_i U_{t-i} + \alpha_{I+1} t + v_t$$

where *t* is a linear time trend and *I* is chosen to ensure white-noise error processes. These innovations (v_t) were then used to create a variance co-variance matrix, *C*. A Choleski decomposition is performed on *C*, generating the lower-triangle matrix, *L*.

$$LL' = C$$

From a random number generator we generate drawings from a standard normal distribution, $k \sim N(0,1)$. The actual shocks then applied to the model (v_t^*) are drawn from the pre-multiplication of the decomposition of the historical variances and the random number generated[8]:

$$v^* = Lk$$

These drawings have the same historical properties of the original historical co-variance matrix (McCarthy, 1972):

$$E(v^* v^{*\prime}) = C$$

Thus, having drawn up the appropriate matrix of historical innovations, we can then set up a

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[7] Specifically, we have the historical variance co-variance matrix for Germany, France, Italy and the UK covering the following variables: Money, Capital, Consumption, Consumption of Oil, Exports of Manufacturing, Imports, Imports of Oil, GNP Deflator, Real Human Wealth, Price of Imports, Price of Manufacturing Exports. This yields a 44×44 co-variance matrix. We choose the model's own (World Economic Outlook) database horizon for these estimations: 1974 to 1998.

[8] As is standard, we added a small factor (1e-07) to the diagonal of this matrix to preclude singularity.

replication procedure with the same stochastic properties as the model exhibited in the sample period. For each vector of shocks at period *t*, the model is simulated from the start date to the date of the simulation period, and agents form expectations of the future based on their information set at *t* [9]. We then make the transition to period $t+1$ and update the information set and repeat over the whole replication sample. So for each replication, a set of shocks is drawn, the model is simulated, time is advanced and then another set of shocks drawn and so on. The agents' information set (at *t*) contains all data up to and including *t* (that is, including any expectations formed at *t*).

[9] We use the forward-looking *Stacked Time* algorithms to solve the model, see Juillard *et al* (1998). In practice the STACK for the stochastic simulation is set well in advance of the actual simulation horizon in order to remove the end-point problem. We stack for 150 years, which is sufficient to satisfy the terminal and steady state properties of the model.

Table 1

The Steady State Solution Used in MULTIMOD's Stochastic Simulations

	Germany	France	Italy	UK	USA	Units
Output Growth	2.18	2.18	2.18	2.18	2.18	**% pa**
CPI inflation	2.70	2.70	2.70	2.70	2.70	**% pa**
Investment/GDP	0.11	0.10	0.10	0.11	0.10	**Fraction**
Short interest rate	7.01	7.01	7.01	7.01	7.01	**%**
Nominal exch. rate	0.55	0.55	0.55	0.55		**$**
Debt/GDP	32.73	42.25	89.33	30.32		**%**
Deficit/GDP	1.98	2.18	4.67	1.62		**%**

Notes:
For these exercise (as in Masson and Turtleboom, 1997), we quote the Dollar-Euro exchange rate in terms of Deutsche Marks (i.e. in the baseline 1 DM = 0.55 $). These rates can, if desired, be recomputed into the Euro using the known and irrevocably EMU conversion rate of 1 € = DM 1.95583.

Shaded Areas represent Not Applicable.

Table 2

3% Deficit Targets (Inflation Targeting Regime)

	US	GERMANY	FRANCE	ITALY	UK
GDP GROWTH					
MEAN	2.198	1.707	1.520	1.924	2.271
MIN	1.730	-1.782	-1.350	-1.331	-1.911
MAX	2.285	3.006	2.079	3.559	4.099
STD. DEVIATION	0.582	1.128	1.117	1.224	1.350
INFLATION					
MEAN	2.710	2.560	2.149	2.667	2.899
MIN	2.101	0.141	0.140	1.240	1.331
MAX	2.740	5.237	5.100	7.707	6.156
STD. DEVIATION	0.487	1.250	1.100	1.351	1.371
INVESTMENT/GNP					
MEAN	0.100	0.103	0.093	0.091	0.099
MIN	0.099	0.085	0.071	0.074	0.082
MAX	0.104	0.111	0.102	0.096	0.103
STD. DEVIATION	0.003	0.008	0.009	0.005	0.004
SHORT-TERM NOMINAL INTEREST RATE					
MEAN	7.951	8.667	8.667	8.667	8.667
MIN	7.434	7.522	7.522	7.522	7.522
MAX	7.958	11.748	11.748	11.748	11.748
STD. DEVIATION	0.144	1.044	1.044	1.044	1.044
NOMINAL EXCHANGE RATE					
MEAN		0.604	0.604	0.604	0.604
MIN		0.547	0.547	0.547	0.547
MAX		0.676	0.676	0.676	0.676
STD. DEVIATION		0.059	0.059	0.059	0.059
DEBT-GDP					
MEAN		0.352	0.468	0.944	0.299
MIN		0.294	0.320	0.868	0.281
MAX		0.380	0.532	1.040	0.375
STD. DEVIATION		0.019	0.055	0.039	0.021
DEFICIT-GDP					
MEAN		0.03100	0.03100	0.03100	0.03000
MIN		0.02300	0.01400	0.02400	0.02800
MAX		0.03600	0.03800	0.04700	0.03400
STD. DEVIATION		0.00200	0.00400	0.00500	0.00100
Pr(Deficit-GDP)≥0.03		0.80000	0.82500	0.79500	0.80000

Note:
The probabilities in the final row of this table are calculated according to $\Pr(\cdot) = (T - n)/T$ where T is the time horizon and n the number of occasions that the deficit to GDP ratio is less than 3%. Thus if $n = 0$ (T), the country always (never) violates the Stability Pact ceiling – or, in probability terms, $\Pr(\cdot) = 1$ (0).

Table 3

3% Deficit Targets (Standard Taylor Rule)

	US	GERMANY	FRANCE	ITALY	UK
GDP GROWTH					
MEAN	2.203	1.719	1.522	1.931	2.289
MIN	1.739	-1.778	-1.340	-1.298	-1.882
MAX	2.291	3.010	2.081	3.573	4.100
STD. DEVIATION	0.582	1.126	1.116	1.224	1.344
INFLATION					
MEAN	2.711	2.573	2.151	2.686	2.910
MIN	2.017	0.142	0.145	1.247	1.338
MAX	2.740	5.238	5.110	7.710	6.163
STD. DEVIATION	0.498	1.254	1.101	1.350	1.391
INVESTMENT/GNP					
MEAN	0.100	0.104	0.093	0.091	0.099
MIN	0.099	0.085	0.071	0.075	0.082
MAX	0.104	0.112	0.103	0.096	0.104
STD. DEVIATION	0.003	0.008	0.009	0.005	0.004
SHORT-TERM NOMINAL INTEREST RATE					
MEAN	7.821	8.640	8.640	8.640	8.640
MIN	7.413	7.512	7.512	7.512	7.512
MAX	7.960	11.720	11.720	11.720	11.720
STD. DEVIATION	0.143	1.050	1.050	1.050	1.050
NOMINAL EXCHANGE RATE					
MEAN		0.600	0.600	0.600	0.600
MIN		0.543	0.543	0.543	0.543
MAX		0.661	0.661	0.661	0.661
STD. DEVIATION		0.062	0.062	0.062	0.062
DEBT-GDP					
MEAN		0.350	0.465	0.942	0.300
MIN		0.295	0.321	0.869	0.283
MAX		0.381	0.520	1.050	0.381
STD. DEVIATION		0.019	0.053	0.041	0.025
DEFICIT-GDP					
MEAN		0.03100	0.03100	0.03100	0.03100
MIN		0.02300	0.01500	0.02400	0.02800
MAX		0.03600	0.03800	0.04800	0.03500
STD. DEVIATION		0.00200	0.00400	0.00500	0.00100
Pr(Deficit-GDP)≥0.03		0.80000	0.82500	0.79500	0.80000

Table 4

1% Deficit Targets (Inflation Target Regime)

	US	GERMANY	FRANCE	ITALY	UK
GDP GROWTH					
MEAN	2.021	1.103	0.912	0.650	0.753
MIN	1.701	-2.320	-2.315	-2.500	-2.351
MAX	2.240	2.710	2.572	2.306	2.493
STD. DEVIATION	0.583	1.326	1.260	1.411	1.422
INFLATION					
MEAN	2.740	1.550	1.321	1.743	1.753
MIN	1.821	0.140	0.143	0.371	0.394
MAX	2.770	2.710	2.221	2.985	2.801
STD. DEVIATION	0.502	1.410	1.820	1.513	1.653
INVESTMENT/GNP					
MEAN	0.098	0.102	0.091	0.089	0.097
MIN	0.097	0.083	0.070	0.073	0.080
MAX	0.100	0.102	0.092	0.089	0.099
STD. DEVIATION	0.003	0.009	0.009	0.006	0.005
SHORT-TERM NOMINAL INTEREST RATE					
MEAN	7.211	7.803	7.803	7.803	7.803
MIN	6.804	7.023	7.023	7.023	7.023
MAX	7.864	8.101	8.101	8.101	8.101
STD. DEVIATION	0.140	0.621	0.621	0.621	0.621
NOMINAL EXCHANGE RATE					
MEAN		0.584	0.584	0.584	0.584
MIN		0.531	0.531	0.531	0.531
MAX		0.591	0.591	0.591	0.591
STD. DEVIATION		0.052	0.052	0.052	0.052
DEBT-GDP					
MEAN		0.281	0.371	0.804	0.241
MIN		0.264	0.334	0.795	0.227
MAX		0.351	0.451	0.931	0.351
STD. DEVIATION		0.020	0.053	0.050	0.035
DEFICIT-GDP					
MEAN		0.01100	0.01100	0.01500	0.01500
MIN		0.00400	0.00300	0.00200	0.00200
MAX		0.03100	0.03000	0.04100	0.04000
STD. DEVIATION		0.00300	0.00400	0.00500	0.00600
Pr(Deficit-GDP)≥0.03		0.15000	0.15000	0.22000	0.24100

Table 5

1% Deficit Targets (Standard Taylor Rule)

	US	GERMANY	FRANCE	ITALY	UK
GDP GROWTH					
MEAN	2.001	1.203	1.056	0.810	0.915
MIN	1.751	-2.201	-2.304	-2.000	-2.222
MAX	2.250	2.771	2.570	2.331	2.522
STD. DEVIATION	0.583	1.262	1.221	1.410	1.324
INFLATION					
MEAN	2.703	1.712	1.516	1.854	1.912
MIN	1.800	0.210	0.202	0.610	0.524
MAX	2.706	2.834	2.512	3.000	3.020
STD. DEVIATION	0.501	1.441	1.921	1.624	1.854
INVESTMENT/GNP					
MEAN	0.099	0.093	0.091	0.090	0.097
MIN	0.098	0.085	0.067	0.074	0.081
MAX	0.103	0.102	0.092	0.099	0.099
STD. DEVIATION	0.003	0.080	0.009	0.006	0.005
SHORT-TERM NOMINAL INTEREST RATE					
MEAN	7.203	7.215	7.215	7.215	7.215
MIN	6.776	6.400	6.400	6.400	6.400
MAX	7.855	7.950	7.950	7.950	7.950
STD. DEVIATION	0.173	0.760	0.760	0.760	0.760
NOMINAL EXCHANGE RATE					
MEAN		0.553	0.553	0.553	0.553
MIN		0.503	0.503	0.503	0.503
MAX		0.580	0.580	0.580	0.580
STD. DEVIATION		0.069	0.069	0.069	0.069
DEBT-GDP					
MEAN		0.277	0.368	0.771	0.231
MIN		0.260	0.310	0.701	0.224
MAX		0.344	0.444	0.921	0.347
STD. DEVIATION		0.022	0.055	0.066	0.039
DEFICIT-GDP					
MEAN		0.01100	0.01100	0.01500	0.01500
MIN		0.00400	0.00400	0.00200	0.00300
MAX		0.03000	0.03000	0.03700	0.03700
STD. DEVIATION		0.00300	0.00400	0.00700	0.00600
Pr(Deficit-GDP)≥0.03		0.13000	0.13500	0.19000	0.21000

Table 6

Asymmetric Deficit Targets (Inflation Target Regime)

	US	GERMANY	FRANCE	ITALY	UK
GDP GROWTH					
MEAN	1.9200	0.8310	0.6520	0.3100	0.3400
MIN	1.6660	-2.3800	-2.3300	-2.5700	-2.4200
MAX	2.2000	2.6000	2.6100	2.1100	2.2300
STD. DEVIATION	0.5800	1.3100	1.2500	1.3700	1.4000
INFLATION					
MEAN	2.6900	1.3500	1.1100	1.3220	1.2620
MIN	1.8400	0.1000	0.1300	0.1910	0.2210
MAX	2.7290	2.6000	2.5200	2.5100	2.3900
STD. DEVIATION	0.5060	1.2000	1.3100	1.1200	1.2450
INVESTMENT/GNP					
MEAN	0.0968	0.1000	0.0890	0.0879	0.0953
MIN	0.0964	0.0810	0.0713	0.0751	0.0800
MAX	0.1000	0.1020	0.0911	0.0891	0.0991
STD. DEVIATION	0.0031	0.0079	0.0089	0.0051	0.0042
SHORT-TERM NOMINAL INTEREST RATE					
MEAN	7.1800	7.7000	7.7000	7.7000	7.7000
MIN	6.9100	7.0200	7.0200	7.0200	7.0200
MAX	7.8410	7.9030	7.9030	7.9030	7.9030
STD. DEVIATION	0.1390	0.6100	0.6100	0.6100	0.6100
NOMINAL EXCHANGE RATE					
MEAN		0.5750	0.5750	0.5750	0.5750
MIN		0.5250	0.5250	0.5250	0.5250
MAX		0.5880	0.5880	0.5880	0.5880
STD. DEVIATION		0.0510	0.0510	0.0510	0.0510
DEBT-GDP					
MEAN		0.2410	0.3201	0.7283	0.2102
MIN		0.2260	0.2880	0.7200	0.1977
MAX		0.2940	0.4720	0.8610	0.2640
STD. DEVIATION		0.0230	0.0550	0.0680	0.0410
DEFICIT-GDP					
MEAN		0.00500	0.00530	0.00900	0.00800
MIN		0.00180	0.00193	0.00150	0.00400
MAX		0.03020	0.03010	0.03300	0.03300
STD. DEVIATION		0.00270	0.00300	0.00530	0.00420
Pr(Deficit-GDP)≥0.03		0.10000	0.10700	0.12000	0.11300

Table 7

Asymmetric Deficit Targets (Monetary Base Targeting Regime)

	US	GERMANY	FRANCE	ITALY	UK
GDP GROWTH					
MEAN	2.000	1.105	0.930	0.711	0.771
MIN	1.750	-2.210	-2.350	-2.100	-2.400
MAX	2.211	2.700	2.570	2.311	2.500
STD. DEVIATION	0.581	1.290	1.260	1.300	1.370
INFLATION					
MEAN	2.720	1.600	1.400	1.760	1.800
MIN	1.800	0.145	0.151	0.375	0.405
MAX	2.730	2.800	2.350	3.014	2.876
STD. DEVIATION	0.500	1.415	1.825	1.520	1.660
INVESTMENT/GNP					
MEAN	0.099	0.090	0.090	0.088	0.096
MIN	0.098	0.084	0.066	0.074	0.081
MAX	0.104	0.102	0.091	0.099	0.099
STD. DEVIATION	0.003	0.008	0.009	0.006	0.005
SHORT-TERM NOMINAL INTEREST RATE					
MEAN	7.214	7.400	7.400	7.400	7.400
MIN	6.820	7.000	7.000	7.000	7.000
MAX	7.867	7.950	7.950	7.950	7.950
STD. DEVIATION	0.140	0.640	0.640	0.640	0.640
NOMINAL EXCHANGE RATE					
MEAN		0.565	0.565	0.565	0.565
MIN		0.520	0.520	0.520	0.520
MAX		0.580	0.580	0.580	0.580
STD. DEVIATION		0.056	0.056	0.056	0.056
DEBT-GDP					
MEAN		0.280	0.370	0.800	0.230
MIN		0.260	0.320	0.700	0.226
MAX		0.347	0.447	0.922	0.348
STD. DEVIATION		0.020	0.053	0.054	0.034
DEFICIT-GDP					
MEAN		0.01100	0.01200	0.01500	0.01500
MIN		0.00400	0.00400	0.00250	0.00325
MAX		0.03080	0.03030	0.03750	0.03800
STD. DEVIATION		0.00310	0.00410	0.00800	0.00700
Pr(Deficit-GDP)≥0.03		0.14000	0.14000	0.21000	0.22000

Note:
This table assumes that countries engage on the same asymmetric deficit targets as Table 6, but with interest rates set by the monetary targeting rule in (6) of $\phi_1, \phi_2 \to 0$ and $\phi_3 = 6.17$.

Table 8

Asymmetric Deficit targets and Smoothed Taxation (Inflation Target Regime)

	US	GERMANY	FRANCE	ITALY	UK
GDP GROWTH					
MEAN	1.923	0.850	0.710	0.366	0.372
MIN	1.657	-2.100	-2.120	-2.410	-2.310
MAX	2.149	2.640	2.610	2.210	2.320
STD. DEVIATION	0.581	1.280	1.230	1.300	1.290
INFLATION					
MEAN	2.730	1.380	1.210	1.323	1.266
MIN	1.860	0.110	0.136	0.198	0.227
MAX	2.760	2.641	2.710	2.670	2.410
STD. DEVIATION	0.511	1.170	1.241	1.104	1.240
INVESTMENT/GNP					
MEAN	0.097	0.100	0.089	0.088	0.095
MIN	0.096	0.080	0.071	0.075	0.081
MAX	0.100	0.102	0.091	0.089	0.099
STD. DEVIATION	0.004	0.008	0.009	0.005	0.004
SHORT-TERM NOMINAL INTEREST RATE					
MEAN	7.152	7.750	7.750	7.750	7.750
MIN	6.912	7.050	7.050	7.050	7.050
MAX	7.844	7.941	7.941	7.941	7.941
STD. DEVIATION	0.132	0.618	0.618	0.618	0.618
NOMINAL EXCHANGE RATE					
MEAN		0.577	0.577	0.577	0.577
MIN		0.526	0.526	0.526	0.526
MAX		0.588	0.588	0.588	0.588
STD. DEVIATION		0.053	0.053	0.053	0.053
DEBT-GDP					
MEAN		0.236	0.306	0.715	0.200
MIN		0.221	0.283	0.705	0.192
MAX		0.291	0.468	0.855	0.257
STD. DEVIATION		0.020	0.052	0.060	0.033
DEFICIT-GDP					
MEAN		0.00500	0.00500	0.00750	0.00800
MIN		0.00180	0.00190	0.00125	0.00140
MAX		0.03050	0.03052	0.03100	0.03100
STD. DEVIATION		0.00240	0.00280	0.00480	0.00190
Pr(Deficit-GDP)≥0.03		0.08000	0.08000	0.07500	0.07500

Table 9

Asymmetric Deficit Targets with a Purely Forward Looking Taxation Rule (Inflation Target Regime)

	US	GERMANY	FRANCE	ITALY	UK
GDP GROWTH					
MEAN	1.921	0.855	0.711	0.370	0.375
MIN	1.655	-2.000	-2.000	-2.310	-2.180
MAX	2.147	2.640	2.620	2.230	2.340
STD. DEVIATION	0.580	1.250	1.210	1.300	1.270
INFLATION					
MEAN	2.710	1.401	1.230	1.340	1.270
MIN	1.850	0.130	0.144	0.230	0.233
MAX	2.740	2.700	2.750	2.630	2.370
STD. DEVIATION	0.509	1.190	1.230	1.090	1.220
INVESTMENT/GNP					
MEAN	0.097	0.100	0.088	0.088	0.085
MIN	0.096	0.082	0.072	0.075	0.081
MAX	0.100	0.103	0.091	0.089	0.099
STD. DEVIATION	0.004	0.008	0.009	0.005	0.004
SHORT-TERM NOMINAL INTEREST RATE					
MEAN	7.210	7.620	7.620	7.620	7.620
MIN	6.950	7.050	7.050	7.050	7.050
MAX	7.800	7.900	7.900	7.900	7.900
STD. DEVIATION	0.130	0.611	0.611	0.611	0.611
NOMINAL EXCHANGE RATE					
MEAN		0.573	0.573	0.573	0.573
MIN		0.527	0.527	0.527	0.527
MAX		0.586	0.586	0.586	0.586
STD. DEVIATION		0.050	0.050	0.050	0.050
DEBT-GDP					
MEAN		0.230	0.290	0.691	0.192
MIN		0.261	0.274	0.652	0.183
MAX		0.285	0.465	0.853	0.257
STD. DEVIATION		0.019	0.050	0.057	0.031
DEFICIT-GDP					
MEAN		0.00475	0.00480	0.00710	0.00750
MIN		0.00191	0.00200	0.00140	0.00150
MAX		0.03001	0.03001	0.03002	0.03002
STD. DEVIATION		0.00200	0.00200	0.00400	0.00200
Pr(Deficit-GDP)≥0.03		0.06000	0.07800	0.07300	0.07600

Table 10

The Distribution of the Deficit to GDP Ratios: Summary Statistics

	3% targets and inflation targets	3% targets and Taylor rule	1% targets and inflation targets	1% targets and Taylor rule	National targets and inflation targets	National targets and monetary targets	National targets, inflation targets & tax smoothing	National targets, inflation targets & fwd looking taxes
Source Table	**Table 2**	**Table 3**	**Table 4**	**Table 5**	**Table 6**	**Table 7**	**Table 8**	**Table 9**
				GERMANY				
$\bar{d}$	3.110	3.090	1.090	1.100	0.500	1.100	0.500	0.475
R(d)	0.610	0.650	2.870	2.750	7.875	2.830	7.970	8.890
SD	0.200	0.190	0.270	0.300	0.270	0.310	0.240	0.200
P(d>3%)	0.800	0.800	0.150	0.130	0.100	0.140	0.080	0.060
Ratio CV	0.100	0.100	0.210	0.260	0.340	0.240	0.318	0.290
				FRANCE				
$\bar{d}$	3.140	3.140	1.110	1.100	0.530	1.200	0.500	0.480
R(d)	0.360	0.370	2.390	2.730	7.360	2.290	8.230	9.000
SD	0.360	0.360	0.350	0.400	0.300	0.410	0.280	0.200
P(d>3%)	0.830	0.830	0.150	0.140	0.107	0.140	0.080	0.078
Ratio CV	0.160	0.160	0.230	0.320	0.295	0.250	0.323	0.250
				ITALY				
$\bar{d}$	3.070	3.070	1.520	1.500	0.900	1.500	0.750	0.710
R(d)	2.470	2.770	1.980	1.750	3.200	1.800	3.760	4.020
SD	0.480	0.490	0.410	0.700	0.530	0.800	0.480	0.400
P(d>3%)	0.800	0.800	0.220	0.190	0.120	0.210	0.075	0.073
Ratio CV	0.240	0.250	0.150	0.270	0.133	0.290	0.180	0.160
				UK				
$\bar{d}$	3.020	3.080	1.480	1.500	0.800	1.500	0.800	0.750
R(d)	1.650	1.390	1.940	1.770	6.250	1.840	3.480	3.750
SD	0.120	0.120	0.610	0.600	0.220	0.700	0.190	0.200
P(d>3%)	0.800	0.800	0.240	0.210	0.113	0.220	0.075	0.076
Ratio CV	0.070	0.070	0.220	0.280	0.128	0.260	0.070	0.078

Notes:

d = deficit to GDP ratio (%)

$\bar{d}$ = mean deficit to GDP ratio

$R(d) = (d_{max} - \bar{d})/(\bar{d} - d_{min})$ an index of the asymmetry in the distribution of d

SD = Standard Deviation of deficit ratio

$P(d \rangle 3\%)$ = Probability of d exceeding 3%

Ratio CV = CV(d)/CV(y) where y is growth rate in output, a measure of wide dispersions around the mean