EUROPEAN UNIVERSITY INSTITUTE
DEPARTMENT OF ECONOMICS

EUI Working Paper ECO No. 2000/2

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Printed in Italy in April 2000
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Fiscal Policy in EMU:
Simulating the Operation of the Stability Pact

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We study the prospective operation of the Stability Pact by stochastic simulation. Using a forward-looking multi-country macroeconometric model, NiGEM, comprising individual blocks for 10 Euroland economies, the Pact's provisions are formalized in detail, and alternative monetary and fiscal rules are compared. Rules are simple and credible, but a fiscal feedback parameter is made conditional on the stages of the Excessive Deficit Procedure. Under a baseline broadly consistent with national Stability Programmes, excessive deficits are overall rare and easily eliminated; their occurrence increases somewhat under inflation targeting; notices and sanctions only happen when corrective action by governments is considerably delayed.

Keywords: Stability Pact, stochastic simulation, fiscal and monetary rules
JEL Classification: E62, E63, H62

First draft: May 1999
This version: February 16, 2000

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The authors gratefully acknowledge comments and suggestions by Michael Artis, Ray Barrell, Nigel Pain, Ian Hurst and participants at seminars given at the European University Institute (EUI) and ISEG/Universidade Técnica de Lisboa. The usual disclaimer applies. The second author thanks the Ministério dos Negócios Estrangeiros of Portugal and the EUI for a doctoral scholarship.

1. Introduction

On 1 January 1999 the eleven countries joining the Euro have concomitantly become bound by the provisions of the Stability and Growth Pact (henceforth referred to as the SGP or simply the Pact) – a set of legal documents whose most prominent feature is the definition of details and explicit timings for the implementation of the excessive deficit procedure (EDP) introduced by the Maastricht Treaty.

Although relatively recent (it was adopted in June 1997), the Pact has been the object of considerable attention in the economic policy literature, and analysed from a variety of viewpoints. Eichengreen and Wyplosz (1998) and Artis and Winkler (1998), among others, discuss possible rationales for the SGP, emphasizing the prevention of inflationary debt bailouts and the need to safeguard the independence of the European Central Bank (ECB), respectively. Some other papers formalize the optimal behaviour of national governments under stylised SGP rules and/or put forward suggestions for improving the Pact's provisions: examples are Artis and Winkler (1999), who present a simple model of a country's optimal fiscal consolidation effort; Casella (1999), who draws on the experience of environmental regulation to propose a system of tradable deficit permits; and Beetsma and Jensen (1999) – building on Beetsma and Uhlig (1999) - where issues such as shock-contingent sanctions or moral hazard are discussed in the framework of a two-period monetary union model with political myopia. Another topic of interest concerns the stabilization costs implied by the Pact, and in particular to what extent automatic stabilizers will still be allowed to operate – see e.g. Url (1997), Buti *et al.* (1998), Eichengreen and Wyplosz (1998) or Barrell and Pina (2000). Finally, a related strand of literature has addressed the issue of how binding fiscal constraints actually are – i.e., how likely it is that excessive deficits will take place, especially in the wake of cyclical downturns (Buti *et al.*, 1997; Eichengreen and Wyplosz, 1998).

A major limitation of the latter set of studies is their virtually exclusive reliance on retrospective evidence. As in the past the SGP was simply not in place, it could not influence either government decisions or private sector expectations. Further, historical data cannot reflect the new reality of a single currency, nor the alternative monetary strategies the ECB may decide to follow.

In this paper we perform a prospective assessment of the operation of the SGP. Taking as a starting point the April 1999 release of NiGEM - the Global Econometric Model of the National Institute of Economic and Social Research (NIESR) - we have added a formalization of the Pact's provisions, adjusted the model's baseline so as to increase its consistency with the national Stability Programmes, and defined alternative fiscal and monetary reaction functions. Stochastic simulations have then been carried out: over the 1999-2005 period, the model has been solved under vectors of shocks that purport to represent typical macroeconomic turbulence. As a result, we have quantified the probabilities of each of the eleven Euroland countries (bar Luxemburg) finding themselves in the several stages of the EDP – hence extending one of the strands of literature mentioned before.

Several features of NiGEM make it particularly suited for our purposes. It has been widely used for policy analysis and model comparison studies[1], and can be solved under rational expectations for a variety of policy regimes. Demand and supply sides are fully modelled, alongside an extensive monetary and financial sector. NiGEM is largely estimated (as opposed to calibrated) and its equations regularly tested for econometric misspecification. Last but not least, all EU countries have individual models with a similar theoretical structure, so that cross-country variation in simulation properties reflects genuine differences resulting from estimation.

We compare two different reaction functions for each of fiscal and monetary policy. Each of the monetary rules emphasizes one of the two pillars of the ECB's announced strategy (ECB, 1999a), proxied as nominal income targeting *versus* inflation targeting. Recent analyses having argued that monetary policy matters for the success of fiscal consolidation (e.g. Hughes Hallett and McAdam (1999), Allsopp *et al.* (1999)), we wish to study whether alternative monetary strategies make a difference for the operation of the SGP. As for fiscal policy, although both rules ensure government solvency, they differ in the speed of corrective action (namely, tax changes) should deficit ratios deviate from their target values. We have a 'tight' fiscal rule where governments strive for solvency, and a 'weak' one where they only act in extremes. All rules are assumed to be perfectly credible and share a 'simple', non-optimised character[2], but an element of conditionality is introduced in both fiscal reaction functions: the parameter governing the reaction of tax rates to deficits (which is different in each of the rules) increases whenever the EDP reaches the stage of a notice.

Our study of the SGP therefore contains three main innovative features. First, we explicitly model the new European framework for macroeconomic policy (as regards both monetary and fiscal behaviour), which is then reflected in private sector (rational) expectations. Therefore, relative to previous studies, our analysis is less dependent on retrospective evidence, and our findings less vulnerable to the Lucas critique[3]. Second, our formalization of the EDP allows us to go beyond a simple estimation of probabilities of deficits and recessions above given thresholds: by taking into account the forward-looking nature of many of the Pact's provisions, we are in a position to study whether deficits above 3 per cent of GDP will be declared excessive and, if so, whether they are likely to be persistent enough to make the country concerned receive a notice, or suffer pecuniary sanctions. Finally, we extend the class of simple credible rules commonly employed in macroeconometric models by formalizing a *conditional* fiscal policy rule, which makes the value of a feedback coefficient dependent on the stage of the EDP the country is in.

Our empirical findings point to a rather smooth operation of the SGP, with scarce and easily corrected excessive deficits. Notices and subsequent EDP stages (pecuniary sanctions) are only reached when taxes display a slow response to mounting deficits –

[1] Undertaken by the Brookings Institution (e.g. Bryant *et al.*, 1993) and by the ESRC Macroeconomic Modelling Bureau (e.g. Mitchell *et al.*, 1998), among others.

[2] Given the computational requirements of optimal control on a large model, implementing optimised policy rules on NiGEM is not considered here.

[3] Vulnerability to such a critique cannot be completely eliminated insofar as NiGEM's equations are based on past data: the estimated coefficients may not reflect 'deep parameters', and likewise the econometric residuals (used for stochastic simulation) may mirror a regime-dependent shock distribution. However, the model's equations have in general been successfully tested for structural stability, while the consideration of structural change is beyond the scope of this paper.

and even then remain extremely rare. A strong emphasis on inflation targeting brings about a modest increase both in the number of SGP violations and in their degree of cross-country synchronization.

The remainder of this study is organised as follows. Section 2 provides background information on the main features of NiGEM and on the technique of stochastic simulation. A complete presentation of the experimental design comes next: section 3 contains our formalization of the SGP provisions, while section 4 characterizes the behaviour of policy authorities, both as regards the baseline scenario and in terms of alternative feedback rules. The latter are presented and discussed, with particular emphasis on the problems brought about by the conditional fiscal policy rule, as well as the solutions implemented to circumvent them. The following section is devoted to the analysis of simulation results: we estimate the likelihood of SGP violations, assess their degree of synchronization across countries, and discuss their link to the volatility of the deficit ratio under different policy regimes. Section 6 offers some concluding remarks.

2. Model and Simulation Technique Overview

This section starts with an overview of NiGEM, devoting particular attention to its fiscal blocks; we draw heavily on NIESR (1999b), where more comprehensive information can be found. In a second stage, we outline the technique of stochastic simulation.

2.1. The Model

NiGEM is an estimated macroeconometric model, with quarterly periodicity, using a 'New-Keynesian' approach: agents are forward-looking in financial and labour markets, but the process of adjustment to shocks is slowed down by nominal rigidities. Demand and supply sides are fully modelled, alongside an extensive monetary and financial sector.

The model comprises estimated blocks for the whole world: all OECD countries, as well as China, are modelled separately, there being regional blocks for East Asia, Latin America, Africa, Developing Europe, OPEC countries, Visegrad nations and Miscellaneous Developing countries. The major economies have fairly detailed models (60-90 equations in total, with around 20 key behavioural relations) sharing a similar theoretical structure, so that cross-country variation in simulation properties reflects genuine differences resulting from estimation. National or regional blocks are linked through trade, financial variables and asset stocks.

The core structure of NiGEM can be viewed as a Mundell-Fleming model extended in a significant number of ways (Barrell and Sefton, 1997). Consumption is not forward-looking but depends on wealth, which entails the need to ensure that the assets stocks of the private and public sectors are modelled consistently within and across countries. Solvency constraints are imposed on governments, thus ruling out any long-run explosion in public debt stocks. Financial markets are forward-looking: exchange rates follow the uncovered interest parity condition, while long interest rates result from the forward convolution over 10 years of their 3-month counterparts. The latter are assumed to be the monetary authorities' instrument, set according to simple feedback rules (see

section 4.3 for an example). Although households are not forward-looking, the impact of future events is brought forward onto them by financial markets, through variables such as long rates and equity prices. As regards the supply side, estimated demands for capital and labour form a basis to calibrate aggregate CES production functions with exogenous labour-augmenting technical progress. Capacity utilisation - defined as the ratio of actual output to a measure of potential output, the latter following from the production functions - feeds into the wage and price system (e.g. fuelling inflation if there is a shortage of capacity), thus playing an essential role in the model's self-stabilising properties. In those countries where evidence supports the existence of forward-looking behaviour in bargaining, wages depends on expected future inflation. More generally, different institutions in the labour and product markets make the estimated speed of adjustment of wages and prices vary across countries.

For each of the ten countries analysed in this paper, current fiscal revenues are disaggregated into personal taxes (variable TAX, which includes both personal income tax and social security contributions), corporate taxes (CTAX) and miscellaneous taxes (mainly indirect; MTAX). On the expenditure side, one finds government consumption and investment (GC and GI, respectively), interest payments (GIP) and transfers (TRAN)[4]. As GC and GI are expressed at constant prices, a conversion to nominal terms is necessary (using the private consumption deflator CED and the GDP deflator P, respectively). The budget balance thus reads:

BUD = TAX + MTAX + CTAX - TRAN - GIP - GC*CED - GI*P

Government interest payments are modelled as the income on a perpetual inventory, the change in the debt stock each period paying the long interest rate in the issue period until it is replaced[5]. While GC and GI do not depend on other variables, transfers increase with unemployment, and CTAX and MTAX display unit elasticities *w.r.t.* nominal GDP and nominal private consumption, respectively[6]. Personal taxes play a prominent role in the model and in our analysis: they ensure solvency through an appropriately defined closure rule, which in turn provides the basis for alternative fiscal policy regimes – topics dealt with in section 4.2.

2.2. Stochastic Simulation

The technique of stochastic simulation consists in solving the model under a variety of shocks, which are representative of the overall uncertainty surrounding the economic environment. Analysing the effects of a single disturbance (a deterministic simulation exercise) may yield valuable insights into the relative merits of alternative policy rules when faced with a very specific source of macroeconomic instability. However, the world is characterised by a multiplicity of potential disturbances, whose joint distribution must be taken into account when assessing the overall performance of policy reaction functions or the operation of institutional arrangements such as the SGP. We hence apply sequences of random shocks to NiGEM – as Bryant *et al.* (1993) or

[4] As well as, in the case of Germany, a miscellaneous category (GMEXP).

[5] Except in countries like Italy and Belgium, where the existence of a large proportion of short-term public debt is taken into account.

[6] Fiscal equations are also adjusted by 'add-factors' conveying the assumed policy stance – an issue to be developed in section 4.1.

Barrell *et al.* (2000), among others, have done - rather than focussing on individual disturbances.

Stochastic simulation can be either in respect to the model equations' error terms or to their estimated coefficients (or both). As NiGEM's equations have been tested for structural stability, in this work we only shock error terms. Disturbances can either be drawn from an estimated joint distribution (see e.g. Fair, 1993) or 'bootstrapped' from a matrix of actual historical residuals (as in e.g. Blake, 1996), both methods ensuring that the contemporaneous covariance structure is preserved. We take the second route, which relies on the absence of serial correlation in the residuals, and thus successively impose on the model vectors of shocks that are columns of a matrix $M_{N,T}$, where N is the number of behavioural or stochastic equations (around 800 in the current version of NiGEM), and T stands for the number of observations in the historical period whose residual terms we use. In this paper $T = 20$, corresponding to the quarters from 1993:1 to 1997:4 - five years that are common to the estimation period of all stochastic equations and, further, that avoid the structural break induced by German reunification. To capture the fact that governments are unable to exert perfect control over budget items, the latter are also subject to disturbances – i.e., the corresponding equations are included in N.

The mechanics of the simulation procedure are as follows. One starts by applying a set of shocks to the first period of the simulation horizon (1999:1, in this paper), and solves the model forward[7]. One then moves to the following quarter (1999:2), draws a new vector of disturbances, and solves forward again. This second model solution, however, will only determine the values of variables from 1999:2 onwards: 1999:1 is already history, and thus no longer subject to change. We proceed in this way until 2005:4; the ensuing set of 28 simulations (as the period considered comprises 28 quarters) is called a *trial*.

Results in section 5 are presented for a total of 200 trials per policy regime. Though this may seem a low figure[8], Barrell *et al.* (2000) show that measures of macroeconomic variability similar to ours (root-mean-squared deviations - see section 5.1) initially change as the number of replications grows, but settle down after roughly 100 trials: therefore, 200 trials are enough for a reliable assessment of each policy regime. As a further step to control for simulation error, we have seeded our shocks identically across regimes.

3. Formalizing the Stability and Growth Pact

The Stability and Growth Pact consists of Council Regulations (EC) No. 1466/97 and No. 1467/97 (both of 7 July 1997) and the Resolution of the European Council adopted in Amsterdam, 17 June 1997. While the first of those two Regulations aims at reinforcing multilateral surveillance and coordination of budgetary positions and economic policies, the second lays down details and explicit timings for the

[7] The whole model is solved simultaneously using a version of the Fair-Taylor algorithm (Fair and Taylor, 1983), with terminal conditions on expected variables specified as constant rates of growth. This forward solution, yielding model-consistent expectations, must go far enough into the future to ensure that solution values do not depend on the terminal date: in this paper, we have always solved to 2017:1.

[8] With a high computational cost, nonetheless, since performing 200 trials implies undertaking 5600 forward-looking simulations (200 times 28).

implementation of Article 104c of the Treaty establishing the European Community (henceforth simply the Treaty) and the Protocol on the excessive deficit procedure (EDP) annexed to the same Treaty. The purpose of this section is to present the way we have formalized the provisions of Regulation No. 1467/97. A summary of the provisions themselves can be found in annex 1.

Designed as a set of rules to prevent budget deficits over 3 per cent of GDP and to ensure their elimination should they still take place, the EDP (as speeded up and clarified by the Pact) can be regarded as a succession of *stages* (ranging from the declaration of an excessive deficit to the imposition of pecuniary penalties on the Member State concerned), *transitions* among which obey both economic criteria (e.g. the forecast for the deficit/GDP ratio in the current year) and specific timings. Hence, our formalization on NiGEM defines for each country a variable SP that stores the stage of the EDP the country is at; SP is then updated through a block of checks regarding the criteria and timings of the relevant transitions.

While the set of different possible stages is uncontroversial, there is inevitably some room for competing interpretations as far as transitions are concerned. There being no actual application of the Pact provisions to rely upon, our approach has been to closely adhere to the letter of the law (in the spirit of the European Council Resolution of 17 June 1997), making minor adjustments as regards timings - since NiGEM is quarterly while most deadlines are set out in months.

As will become apparent, most economic criteria guiding transitions have a *forward-looking* character, referring to forecasts of future deficit ratios and GDP growth. It is our view that this feature provides a strong argument for analysing the operation of the SGP in the framework of a coherent macroeconometric model, able to deliver such forecasts in the light of different assumptions regarding fiscal and monetary policy regimes.

The set of possible stages is:

- SP = 0: the country is not in excessive deficit
- SP = 1: the **existence of an excessive deficit** is declared, and the Council makes a **recommendation** to the country concerned with a view to correcting the problem.
- SP = 2: the EDP is being held in **abeyance**, as the Member State in question is perceived to be acting in compliance with the recommendation above.
- SP = 3: the Council considers that no effective action has been taken in the wake of the recommendation above and thus issues a **notice** urging the country to take measures for deficit reduction.
- SP = 4: the EDP is being held in **abeyance**, as the Member State in question is perceived to be acting in compliance with the notice above.
- SP = 5: the Council considers that no effective action has been taken in the wake of the notice above, and thus requires the Member State concerned to make a **first deposit**.
- SP = 6: the Council considers that effective action in response to the notice has still not been taken, and thus decides to intensify sanctions by imposing a **second (or subsequent) deposit**.

To present transitions from one stage to another in a systematic way, we will consider the possible outcomes in the current quarter (q) for each of the different possible stages

prevailing in the previous quarter (*q-1*). Throughout we denote by subscript *y* the current year, and by subscript *n* the year in which a deficit ratio above 3% takes place (thus inducing the start of an EDP); *d* stands for the *annual* budget deficit divided by GDP, and Δy is *annual* GDP growth. Table 1 gives an overview of all possible transitions, which are then formalized and discussed in detail below.

Table 1 – SGP formalization: a summary of transitions

SP_{q-1}	SP_q	**Economic criteria**
0	0	$d_{n:4} \leq 0.03$ or $d_{n:4} > 0.03$ not declared as excessive
	1	$d_{n:4} > 0.03$ declared as excessive
1	2	Deficit expected to be corrected within deadlines
	3	Deficit **not** expected to be corrected within deadlines
2	0	Deficit has been corrected ($d_{y-1:4} \leq 0.03$)
	2	Deficit expected to be corrected within deadlines
	3	Deficit **not** expected to be corrected within deadlines
3	4	Deficit expected to be corrected within deadlines
	5	Deficit **not** expected to be corrected within deadlines
4	0	Deficit has been corrected ($d_{y-1:4} \leq 0.03$)
	4	Deficit expected to be corrected within deadlines
	5	Deficit **not** expected to be corrected within deadlines
5	0	Deficit has been corrected ($d_{y-1:4} \leq 0.03$)
	5	Deficit expected to be corrected in the current year
	6	Deficit forecast for current year still over 3%
6	0	Deficit has been corrected ($d_{y-1:4} \leq 0.03$)
	6	Deficit not corrected yet (separate variable records new deposits)

See text for details and information on timings of transitions.

$SP_{q-1} = 0$

The only possibilities for the current quarter are SP = 0 or SP = 1, the latter taking place if the deficit ratio in the last calendar year was bigger than 3% and is seen as excessive. It is assumed that an excessive deficit can only be declared in *quarter two* of year *n*+1 - hence in the wake of the fiscal data reporting taking place by 1 March[9], considering as well the Pact timings as regards the decision on the existence of an excessive deficit.

The conditions under which a deficit ratio above 3% is not deemed excessive have been formalized as the *simultaneous* verification of criteria for exceptionality, temporary nature and closeness to the reference value, disregarding any other considerations (e.g.

[9] As NiGEM's simulations are not subject to data revisions, it would be incongruous to declare an excessive deficit in the wake of the September reporting: the problem would have been detected before. We are also assuming that the EDP is only activated in the wake of past actual data, as opposed to programmed future deficits. Although the latter possibility exists, Member States clearly have a strong incentive not to report any programmed deficits in excess of 3%.

the 'golden rule'). We have assimilated exceptionality to recessions: the former always holds for a real GDP fall in year *n* of at least 2%; and it still holds for a fall between 0.75% and 2%, provided that either such downturn is regarded as abrupt or the accumulated loss of output relative to trend is deemed considerable. Both events have been defined with reference to baseline GDP over the 2000-2010 time span, since over this period baseline GDP is a good approximation to potential output: abruptness is verified whenever real GDP growth in year *n*-1 (i.e, the year before the deficit) was stronger than the baseline 2000-2010 country average; and a considerable accumulated loss of output corresponds to an output gap in year *n* bigger than 3% (the gap being defined with respect to baseline GDP).

A temporary nature of the deficit is assumed if the model-consistent forecast for the deficit ratio in year n+1 no longer exceeds 3%; if it still does, but in a context of a GDP fall of at least 0.75%, the assessment is based on the model's forecast for the deficit ratio in year n+2. Formally, the deficit has a temporary nature *iff*[10]

$$\min\left\{E_{n+1:2}\left(d_{n+1:4}\right), E_{n+1:2}\left(R.d_{n+2:4}\right)\right\} \le 0.03,\ R = \begin{cases} 1,\ E_{n+1:2}\left(\Delta y_{n+1:4}\right) \le -0.0075 \\ \infty,\ \text{otherwise} \end{cases} \qquad (1)$$

Finally, the closeness criterion is modelled by positing a 4% threshold: the criterion is met *iff* $d_{n:4} \le 0.04$.

SP_{q-1} = 1

We formalize the possible outcomes for the quarter following the declaration of an excessive deficit as either the EDP being held in abeyance (SP = 2) or the issue of a notice (SP = 3)[11], using as a guideline the principle that, bar special circumstances, the deficit should be corrected in the year after its identification. Special circumstances are again assimilated to recessions, here with a simple -0.75% threshold.

At n+1:3 we then test whether the model forecasts for the country's deficit ratio at *either* n+1:4 *or* n+2:4 (as n+2 is the year following deficit identification) no longer exceed 3%. If the test is satisfied, the EDP is held in abeyance; otherwise, the Council issues a notice. If *both* n+1 and n+2 are recession years, we assume that the Member State is given an extra year (n+3) to tackle its deficit problem. Formally, we set $SP_{y:q}$ = 3 if the following condition holds, and $SP_{y:q}$ = 2 if it does not:

$$\min\left\{E_{y:q}\left(d_{n+1:4}\right), E_{y:q}\left(d_{n+2:4}\right), E_{y:q}\left(R.d_{n+3:4}\right)\right\} > 0.03,$$
$$R = \begin{cases} 1,\ \max\left\{E_{y:q}\left(\Delta y_{n+1:4}\right), E_{y:q}\left(\Delta y_{n+2:4}\right)\right\} \le -0.0075 \\ \infty,\ \text{otherwise} \end{cases} \qquad (2)$$

[10] In equation (1), as well as in equation (2) below, $R=\infty$ should be read as taking the sign of the deficit ratio it multiplies.

[11] The most likely month for a notice to be given is actually October - already quarter 4. We place a possible notice in quarter 3, however, to keep it separate in time from the sanctions that might follow in December (thus, in quarter 4).

SP_{q-1} = 2

An EDP held in abeyance in the previous quarter may either remain in abeyance, evolve to a notice, or be terminated. The abeyance *versus* notice decision is based on equation (2): we check whether the model forecasts that by n+2:4 at the latest - or, in cases of protracted recession, by n+3:4 at the latest - the deficit problem will have been solved. The EDP is terminated as soon as actual data indicates that a deficit ratio above 3% no longer exists: we assume that such data will be reported by 1 March, causing an EDP always to finish in quarter one. For instance, if $d_{n+1:4} \leq 0.03$, then $SP_{n+2:1} = 0$.

Notice that, although an EDP may remain in abeyance for some quarters[12], eventually SP will have to become either 3 (notice) or 0 (end of procedure), as the deadline for excessive deficit elimination remains n+2:4 (or n+3:4) throughout (i.e., regardless of *y:q*).

Formally, NiGEM first checks whether the following holds:

$$d_{y-1:4} \leq 0.03 \qquad (3)$$

If it does, $SP_{y:q}$ = 0; otherwise, we test (2) to decide whether $SP_{y:q}$ equals 2 or 3.

SP_{q-1} = 3

After a notice the EDP may either be held in abeyance (SP = 4) or a first deposit be required (SP = 5). The assessment (whose two-month deadline has been rounded to one quarter) is still guided by the principle of correction in the year after identification: the model tests (2) and sets $SP_{y:q}$ = 5 if it holds, $SP_{y:q}$ = 4 otherwise[13].

SP_{q-1} = 4

The remarks made under SP_{q-1} = 2 and the ensuing tests apply here as well. The only difference is that we move to a deposit, rather than to a notice, when NiGEM forecasts that the excessive deficit will not be corrected in time.

SP_{q-1} = 5

Once a first deposit has been imposed, the country's fiscal situation continues to be monitored, with three possible outcomes: intensification of sanctions (i.e., imposition of a second deposit: SP = 6), end of the EDP (SP = 0) or an intermediate 'wait and see' attitude (SP = 5) explained below. Our formalization has been the following:

- if actual data shows that the excessive deficit problem has been solved, SP = 0 (this can only happen in a first quarter for the reasons explained under SP_{q-1} = 2)
- if (i) a first deposit has not been required of the Member State concerned in the current calendar year, (ii) the forecast for $d_{y:4}$ still exceeds 3% and (iii) the current quarter is either the second or the fourth, a second deposit is required (SP = 6). Conditions (i) to (iii) must be verified simultaneously. While (iii) follows from the

[12] In our formalization we keep track of exactly how long an EDP has been held in abeyance.

[13] We have not formalized the use of an expedited procedure for deliberately planned excessive deficits (Regulation No. 1467/97, Art. 7).

Pact's reporting dates and decisions deadlines, (i) rules out two deposits in the same calendar year.

- otherwise, let SP remain at stage 5, no new deposit being required. In particular, this will be the case whenever we forecast $d_{y:4} \leq 0.03$ (hence interpreting compliance with a notice as *predicted*, as opposed to *actual*, excessive deficit elimination).

Then, $SP_{y:q} = 0$ if equation (3) is true; else, check

$$E_{y:q}\left\{Q.S.d_{y:4}\right\} > 0.03,\ Q = \begin{cases} 1, & q = 2 \vee q = 4 \\ 0, & \text{otherwise} \end{cases},\ S = \begin{cases} 1, & \sum_{i=1}^{q-1} dep_{y:i} = 0 \\ 0, & \text{otherwise} \end{cases} \qquad (4)$$

and set $SP_{y:q} = 6$ if (4) is verified, $SP_{y:q} = 5$ otherwise.

$SP_{q-1} = 6$

The criteria to be applied as regards the imposition of any further deposits are exactly the same as those under $SP_{q-1} = 5$[14]. The variable SP is reset at zero when the EDP is terminated, otherwise remains at 6 and a separate variable keeps track of whether new deposits are actually imposed (which will be the case if condition (4) holds).

Deposits are given by:

$$dep_{y:q} = \min\left\{0.002F + 0.1\left(d_{y-1:4} - 0.03\right), 0.005\right\}(P.Y)_{y-1:4}$$

where $P.Y$ is annual nominal GDP and F equals 1 for first deposits and 0 for subsequent ones.

If two years after the imposition of a deposit the EDP has not yet been terminated, the deposit is transformed into a fine. Any deposits not transformed into fines are reimbursed to the Member State concerned as soon as its EDP finishes. Fines and interest on deposits are distributed among countries without an excessive deficit. We assume that deposits, reimbursements and revenues from other countries' penalties are not included in a country's budget balance: they are nonetheless added to, or subtracted from, the public debt stock, according to NiGEM's principle of explicitly accounting for all flows of funds.

One might argue that a country in excessive deficit, besides being subject to the Pact's rules and possible penalties, will also face "market-discipline effects" under the form of higher interest rates on its public debt. Evidence for US states shows that such effects are actually at work: Poterba and Rueben (1997) estimate that states with a lax anti-deficit fiscal constitution must pay an extra 15 to 20 basis points on their bonds, relative to states with the strictest constitutions; Bayoumi, Goldstein and Woglom (1995) find an even bigger differential (over 50 basis points at average levels of debt).

[14] The reason to distinguish at all stages 5 and 6 regards the computation of the deposit amounts alone, as the first deposit comprises a fixed component of 0.2% of GDP while any subsequent deposits do not.

Although acknowledging the potential importance of risk premia in the wake of SGP violations, the version of NiGEM used in this paper has not attempted to quantify them: we assume that short rates are fully equalized across Euroland countries, while as regards long rates on public debts some risk premia exist but with a deterministic nature, and thus remaining constant across trials. The reason for this simplification lies in the difficulties (both conceptual and empirical) associated with the formalization of such interest differentials:

- at a conceptual level, we will be analysing policy regimes in which both the Pact regulations and the fiscal reaction functions (see below) are *common* across Euroland countries. While there will still be diversity in domestic fiscal institutions (see e.g. Hallerberg and von Hagen, 1997), the SGP, which is the object of our analysis, is precisely *the* common fiscal institution of EMU members. Furthermore, we assume that all national fiscal reaction functions are fully credible: agents therefore know that any deficits are the result of adverse shocks, and bring about increased tax rates. The above evidence on interest rate impacts of *different* institutions seems therefore ill-suited for our purposes.
- at an empirical level, the two US studies mentioned above show that, besides fiscal institutions, many other factors (e.g. unemployment rates and debt ratios) affect public debt yields. Further, American states and sovereign European countries differ in many respects[15], making it extremely hazardous to calibrate risk premia for the latter based on the experience of the former. Our assessment is that a rigorous analysis of public debt interest differentials in EMU will still have to wait some years.

4. The Policy Environment

Having presented our formalization of the SGP rules, we now characterize the behaviour of the policy authorities. Such a characterization is twofold: it consists both of a set of assumed trajectories for policy instruments in the absence of disturbances to the economy, and of reaction functions specifying how instruments are adjusted should disturbances take place. The former aspect concerns the issue of defining a baseline, and is dealt with in section 4.1, while the latter – the choice of policy rules - is the object of sections 4.2 to 4.4.

While all our simulations use the same baseline - which generally assumes that Euroland countries pursue the fiscal consolidation targets set out in the national Stability Programmes - we investigate the operation of the SGP under alternative fiscal and monetary policy rules, whose specification has drawn on both previous economic policy literature (details given in the appropriate sections) and on the announced strategies of some policy authorities (particularly as regards the ECB). Following standard practice in studies using macroeconometric models, policy rules are assumed to be credible - thus providing a basis for expectations formation – and 'simple' (see e.g. Currie and Levine, 1993), rather than optimised. Nonetheless, as far as fiscal behaviour is concerned, we extend the category of simple rules by introducing an element of conditionality: the value of the feedback parameter in the fiscal reaction function is made dependent on the stages of the EDP, reflecting the adoption of measures aimed at avoiding pecuniary

[15] Mobility of tax bases and magnitude of debt ratios being two examples.

sanctions. The outcome is named a *conditional* simple rule. Further, when discussing simulation outcomes, we will check whether what we view as a necessary condition for credible SGP enforcement holds: namely, that not many countries are simultaneously in excessive deficit[16].

As mentioned in the introduction, several theoretical papers – e.g. Artis and Winkler (1999), Casella (1999), Beetsma and Jensen (1999) - have analysed optimal behaviour of national governments under a *stylised* formalization of the actual SGP rules and/or put forward suggestions for improving the Pact's provisions. In contrast, our paper simulates the operation of the actual SGP rules, formalized in considerable detail. Even assuming, as we do, perfect credibility and enforcement, the high degree of conditionality and non-linearity of the Pact's provisions, together with the size and (again) non-linearity of NiGEM, make the study of optimal policy rules impractical, if not impossible. Hence our use of simple rules - though augmented with an element of conditionality.

4.1. The Baseline

Stochastic simulations on NiGEM have as a prerequisite the definition of a baseline - the modeller's forecast of the future. The baseline embodies assumptions about the paths of exogenous variables and policy instruments, as well as some 'add-factors' corresponding to judgemental corrections of the outcomes of the model's econometric equations.

This paper uses a slightly modified version of NiGEM's April 1999 baseline, details of which can be found in NIESR (1999a). Though the latter baseline was already prepared taking into account the Member States' deficit targets, as set out in their respective Stability Programmes, we have made a further effort of consistency with such objectives. The outcome has been a forecast where Member States gradually converge towards medium term fiscal positions close to balance (Table 2) and where the average deviation from the deficit targets of Stability Programmes is as small as 0.04 percentage points of GDP. More detailed information is provided in annex 2: some differences between baseline and Programmes inevitably persist, as it is clearly impossible for the former to perfectly emulate the latter - neither were the different Stability Programmes prepared simultaneously nor do they share a common underlying macroeconometric framework[17].

[16] If several countries found themselves in excessive deficit at the same time, it is at least conceivable that they would vote against issuing notices or applying sanctions. Recall from Annex 1 that decisions at the different stages of the EDP are taken by a majority of two thirds (excluding the votes of the country concerned). Since the eleven Euroland countries have a total of 65 votes, a blocking minority would require 19 to 21 votes (depending on the size of the country concerned, and thus excluded), which corresponds to a coalition of two, or in most cases three, countries, including some of the biggest ones.

[17] Eliminating the (minor) remaining differences between NiGEM's baseline and the Stability Programmes would weaken the internal consistency of the former – whose assumptions have been discussed with the model's users (mainly national central banks).

Table 2 - Baseline Budget Balances as a % of GDP: EMU average[18]

1999	2000	2001	2002	2003	2004	2005
-1.9	-1.6	-1.1	-0.8	-0.8	-0.8	-0.8

Since simulation results (e.g. the probability of an excessive deficit) will always be baseline-dependent, one is led to ask whether overall compliance with Stability Programmes is a sensible scenario. It is definitely not uncontroversial: for instance, the ECB (1999b) has recently expressed reservations as to whether such Programmes encapsulate fiscal consolidation strategies which are prudent and credible[19]. However, it seems reasonable to claim that Stability Programmes provide a natural benchmark for fiscal policy in the coming years. Other scenarios could be analysed as well, but the computational burden of stochastic simulations forces one to be selective – and we have chosen to concentrate on the effects of different policy rules.

4.2. Fiscal Policy

We simulate two different fiscal rules, whose parameterisation corresponds to different speeds of response of fiscal authorities when stochastic disturbances make deficit ratios diverge from baseline values. The rules are otherwise similar: (i) they are both designed to ensure solvency, ruling out debt explosions (or implosions), and (ii) in both a feedback parameter is made contingent on the stages of the EDP. We therefore start by tackling these common features, and only afterwards is the difference between the rules presented.

4.2.1. Fiscal rules and solvency

The specification of a fiscal closure rule that ensures government solvency has become standard practice in macroeconometric models, for both theoretical and practical reasons (Mitchell *et al.*, 1998).

In models incorporating forward-looking behaviour, a long run explosion of the debt stock would have a destabilizing impact on short-run behaviour, making it impossible to find a saddlepath - as formalized by Barrell and Sefton (1997). The intuition behind this result lies in the simple fact that public debt must be held by either the domestic private sector or the foreign sector: while in single-country models the latter can be viewed as a 'black hole', no such possibility exists in a coherent world model (Barrell *et al.*, 1994). As for practical reasons, fiscal consolidation has become a major policy issue in the

[18] Unweighted average of all Euroland countries, except Luxemburg (not modelled), Finland and Ireland. This latter pair of countries have baseline trajectories for budget ratios which are very different from those of other member states: (i) they start off with sizeable surpluses and plan to maintain them over the years covered by their Stability Programmes; (ii) to achieve a smoother decline of their debt ratios, the baseline assumes that surpluses gradually converge to zero after 2002. Including Finland and Ireland in the table would therefore blur the general consolidation trend.

[19] Though Barrell and Pina (2000), who use the same baseline as this paper, show that, with some exceptions in 1999 and 2000, baseline deficits, once cyclically adjusted, have enough room for the operation of automatic stabilizers, where such room is defined along the lines of OECD (1997) – i.e., considering historical output gaps and how a 1 percentage point change in the output gap affects the budget.

1990s, leading modellers to pay increased attention to the subject. One may carry this point further by arguing that, in the light of the Pact's rules and possible rationales (see e.g. Eichengreen and Wyplosz, 1998), it would be highly contradictory to simulate its operation in the absence of a fiscal reaction function ensuring solvency.

There is nowadays a variety of solvent fiscal rules, whose theoretical and simulation properties are compared in Mitchell *et al.* (1998). For the purposes of this paper it is enough to consider NiGEM's fiscal closure rule, which can be presented in a stylised way in the form

$$\Delta tr_t = \beta\left(d_{t-1} - d^*_{t-1}\right)$$

where *tr* is the average tax rate, *d* is the actual deficit/GDP ratio and d^* is the corresponding target value[20]. Mitchell *et al.* (1998) show that this rule implies solvency (understood as a stable debt/GDP ratio in a dynamic steady state), while Barrell *et al.* (1994) analyse its robustness properties.

Written in full, the fiscal closure rule used in standard versions of NiGEM is given by:

$$\frac{TAX_t}{PI_t} = \frac{TAX_{t-1}}{PI_{t-1}} + \beta\frac{BUD^*_{t-1} - BUD_{t-1}}{PI_t} \qquad (5)$$

where TAX and PI denote direct taxes and personal income, respectively, BUD is the budget balance and the asterisk stands for a target value (the target budget balance results from multiplying the baseline balance-to-GDP ratio by nominal GDP). Parameter β is assigned the value of 0.2, which, besides ensuring stability, makes the short-run multiplier of a temporary government spending expansion take 'conventional wisdom' values[21], thus avoiding the possibility that a fiscal impulse is immediately negated by higher taxes (see Barrell *et al.* (1994) for details). Annex 3 presents the macroeconomic impact of an increase in the direct tax rate (*TAX/PI*), thus complementing both this section and the general description of NiGEM contained in section 2.1.

4.2.2. A conditional policy rule

The simple solvency rule above faces one important shortcoming in the light of SGP rules: once a notice is issued, the country concerned can only avoid pecuniary sanctions in the following quarter if some stochastic disturbances, rather than explicit adjustment efforts, improve its fiscal position.

We illustrate this point by means of an example. Suppose that in 1999 Lilliput (an imaginary EMU member) runs an excessive deficit, declared as such in 2000:2. The shocks that hit the Lilliputian economy in quarters 2000:3 and 2000:4 make NiGEM predict that the country will have returned to a deficit ratio under 3% by the end of 2001 (although not yet in 2000:4), and thus in those two quarters the EDP is held in abeyance (SP = 2). In 2001:1, however, Lilliput is hit by stochastic disturbances that worsen its

[20] Though we use the same notation *d* as in Section 3, the deficit ratio is now meant to be quarterly, not annual.

[21] Of which the IMF Multimod-based estimates are an example (with figures in the 0.4-0.7 range for the major economies – see Barrell *et al.*, 1994, p. 18).

fiscal prospects: the model-consistent forecast for 2001:4 indicates a deficit over 3%, GDP growth in 2001 is expected to exceed -0.75% (i.e., no special circumstances apply) and hence the country is addressed a notice. Suppose that the economic outlook in 2001:2 remains fairly unchanged: in stochastic simulation terms, the 2001:2 random draw has a negligible impact. Then the forecast for the deficit ratio in 2001:4 will remain in excess of 3%, and Lilliput will suffer sanctions (SP moves from 3 to 5). Notice that we are not overlooking the effects of the simple solvency rule: the feedback implied by β is at work, raising average tax rates. Nonetheless, to the extent that the prospective increased revenues were not enough to avoid the notice, they will not prevent a deposit either. Formally, this limitation of the standard rule is simply an application of the law of iterated projections. In our example:

$$E_{01:1}\left\{E_{01:2}\left(d_{01:4}\right)\right\} = E_{01:1}\left(d_{01:4}\right)$$

Our aim is thus to formalize a policy regime that allows countries to undertake an additional fiscal adjustment effort to avoid financially and politically costly penalties.

The blueprint

We envisage a policy regime in which the standard solvency rule is augmented by an extra feedback on the deficit gap. Such feedback is activated as soon as the country concerned receives a notice[22], and stays in place until the EDP is terminated. Formally:

$$\frac{TAX_t}{PI_t} = \frac{TAX_{t-1}}{PI_{t-1}} + (\beta + \alpha_t)\frac{BUD^*_{t-1} - BUD_{t-1}}{PI_t}, \alpha_t = \begin{cases} 0, SP_t < 3 \\ 0.2, SP_t \geq 3 \end{cases} \qquad (6)$$

Rule (6) can thus be considered a *conditional simple rule*[23]. To the best of our knowledge, the use of a conditional policy rule in a stochastic simulation study on a macroeconometric model has never been attempted before.

The implementation

Using a conditional rule in a forward-looking model like NiGEM entails considerable difficulties. The forward-looking character of our model has two dimensions: on the one hand, exchange rates, long interest rates and (for some countries) wages have a forward-looking nature; on the other hand, most of the transitions across EDP stages are also forward-looking, taking into account model-consistent forecasts of deficit ratios and output growth. Both dimensions pose problems.

The most obvious obstacle concerns whether to issue a notice at all, as the increased feedback the latter activates may well eliminate the reason for its existence. Take our example again. Assume that collecting taxes with $\alpha = 0.2$ from 2001:1 onwards brings the prospective 2001:4 Lilliputian deficit under 3%. Then we would not be able to solve

[22] The increased feedback is in general contemporaneous to the notice. The only exception takes place when the notice is issued immediately after the declaration of an excessive deficit (i.e., according to our earlier convention, in year n+1:3): in that case we activate the increased feedback only one quarter after the notice (n+1:4), since the latter is unlikely to actually be issued before October (see note 11).

[23] The choice of 0.2 for the increased feedback is based on NiGEM's standard use of that value (see sections 4.2.1 and 4.2.3).

the model: a notice would reappear every other iteration, as it would be issued under the standard rule, but withdrawn when solving the model with the increased feedback in place.

The length of the period during which α stays at 0.2 also proves problematic. The reason is that forward-looking variables feed through the economic system making deficit ratios at any given point in time dependent on future policy rules. Ignore for a moment the difficulty dealt with in the previous paragraph, and suppose that a notice is definitely issued in 2001:1. Admit further that under the standard solvency rule (5) the end of the EDP would only be declared in 2003:1, leading us (in the light of eq. (6)) to solve the model with α = 0.2 from 2001:1 to 2002:4 and α = 0 afterwards. Once in place, however, the increased feedback makes the deficit ratio go slightly under 3% by 2001:4, bringing the termination of the EDP forward from 2003:1 to 2002:1. The model, following equation (6), will in the next iteration set α = 0.2 only from 2001:1 to 2001:4. It may be the case, however, that the return to the standard rule in 2002 makes the forecast deficit ratio in 2001:4 exceed again 3%. Then the following iteration will once more use the increased feedback also during 2002, and so on. Again we fail to solve the model.

The problems described in the two previous paragraphs can be thought of as *mutually inconsistent conditional expectations*. One can formalize the example above (regarding the length of the period of increased feedback) as

$$E_{01:1}\left(SP_{02:1}\middle|\alpha_{01:1},\ldots,\alpha_{02:4}=0.2\right)=0\wedge E_{01:1}\left(\alpha_{02:1},\ldots,\alpha_{02:4}\middle|SP_{02:1}=0\right)\neq 0.2$$

To avoid the above pitfalls, our strategy for the implementation of the conditional rule has been based on the separation of the decision of when to set α = 0.2 from the actual use of the increased feedback. We first give a general description of the algorithm; then we illustrate it by means of an example, and point out some limitations.

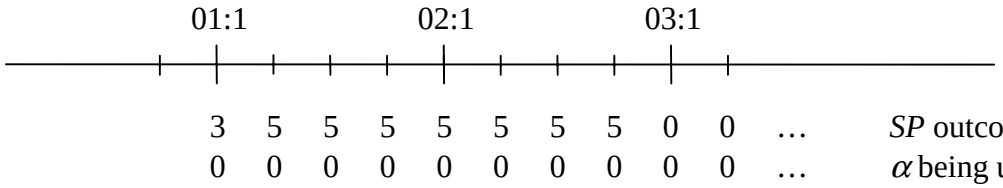
The conditional rule is implemented by solving the model *twice* for each random draw of disturbances. In the first time (call it the 1st loop) we use for each country a predetermined path of α values, based on the outcome of the previous vector of shocks. From the ensuing model solution and eq. (6) one finds a new path for α (i.e., when to follow the standard *versus* the increased feedback), which is then used to solve the model again (2nd loop), using, naturally, the same vector of shocks and the same initial quarter.

While it is the 2nd loop that provides the model solution for the period under consideration, the 1st loop yields what might be seen as a diagnostic solution, used by the Council to assess whether a notice is called for and, more generally, by economic agents to form expectations about the policy rule that will be in place. By default, the 1st loop is run with α = 0 for all countries and periods: the need for a notice must be assessed in the light of the standard tax feedback, since governments will only adopt α = 0.2 after a notice is issued. If, however, a certain country has already been addressed a notice in the recent past (formally, if a country has $SP \geq 3$ in the quarter preceding the one being shocked), then the 1st loop uses for that country the path of α values determined when shocking the previous quarter; the argument being that regardless of

how the EDP evolves under the impact of the new disturbances, the increased tax feedback has already been activated, and should therefore be taken into account.

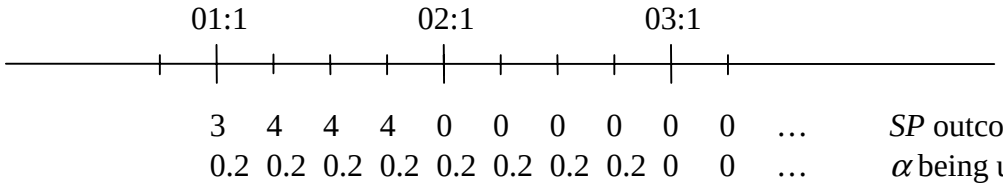
Take Lilliput as an example. In 2000:4 there was no notice yet (SP = 2), and we thus run the 1st loop under $\alpha = 0$. Assume that the deficit ratio only falls below 3% by 2002:4:

1st loop



When solving for the second time, we thus apply $\alpha = 0.2$ from 2001:1 to 2002:4. Further, although in this example the increased feedback makes the deficit ratio in 2001:4 no longer exceed the 3% threshold, the case for a notice has been established, and thus the value of SP in 2001:1 is no longer subject to recalculation:

2nd loop



When moving on to shock 2001:2, we use this same path for α in the 1st loop.

Apart from being computationally demanding, our method does not always ensure a perfect coincidence between the expected end of the EDP and the expected 'turning off' of the augmented feedback: see the example above. Nonetheless, this limitation seems hard, if not impossible, to circumvent without risking to fail to solve the model, as shown before. Formally, our method avoids pairs of mutually inconsistent conditional expectations for *SP* and α by making the latter independent of the former in the current loop. The implemented closure rule (used in the 2nd loop) can be written as

$$\frac{TAX_t}{PI_t} = \frac{TAX_{t-1}}{PI_{t-1}} + (\beta + \alpha_t)\frac{BUD^*_{t-1} - BUD_{t-1}}{PI_t}, \alpha_t = \begin{cases} 0, E_{y:q}\left(SP_t \middle| \{\tilde{\alpha}\}_{y:q}^{17:1}\right) < 3 \\ 0.2, E_{y:q}\left(SP_t \middle| \{\tilde{\alpha}\}_{y:q}^{17:1}\right) \geq 3 \end{cases} \quad (7)$$

where $\{\tilde{\alpha}\}$ is predetermined (it is the path of α values used in the 1st loop).

4.2.3. The two fiscal regimes

In both regimes the fiscal reaction function is specified according to equation (7), the difference lying in the value of β: we consider the cases of $\beta = 0.2$ and $\beta = 0$. Both act as fiscal closure rules with the EDP in place.

The former case adopts NiGEM's standard feedback (recall eq. (5)), and doubles it in the case of a notice. National governments are then both committed to a medium term effort of deficit reduction (as expressed in the baseline) and willing to take corrective action (formalized as tax rate changes) should deviations from the target trajectories occur; such corrective action is intensified if pecuniary sanctions are looming. In contrast, when β equals 0 the elimination of excessive deficits is left to the economy's endogenous adjustment mechanisms (and/or to favourable subsequent disturbances), fiscal tightening only taking place once a notice is issued. This may be interpreted as a context where the baseline deficit reduction exhausts governments' political capital for fiscal consolidation, further restrictive measures being only possible in extreme circumstances. However, in extremes, fiscal authorities act, and solvency is ensured in the long run.

The correction of deficits through endogenous mechanisms requires a word of clarification. Although such forces are at work (e.g. the gradual adjustment of wages and prices in a recession contributes to economic recovery, and higher tax revenues ensue), they cannot be trusted to correct the problem under all circumstances: debt spirals may occur, which is precisely why solvency must be ensured by an appropriate closure rule. The latter is activated whenever endogenous adjustment (or new disturbances) fails to bring the deficit ratio below 3 per cent of GDP within a given delay – i.e., whenever the country concerned receives a notice[24]. In a way, we might regard $\beta = 0$ as a regime where the SGP alone safeguards government solvency – through a prudent baseline and through corrective action brought about at certain stages of the EDP.

4.3. Monetary Policy

Some recent analyses of fiscal consolidation using macroeconometric models - e.g. Hughes-Hallett and McAdam (1999), Allsopp *et al.* (1999) – stress that some degree of monetary loosening is needed if significant output losses are to be avoided. Although the scope and methodology of our study differ from those above – the deficit reduction is assumed (in the baseline), rather than analysed; and we rely on stochastic simulations, instead of deterministic ones - it remains of interest to determine whether monetary policy makes a difference for the probability and length of excessive deficits.

The two monetary rules considered in this paper take into account the main components of the ECB's announced monetary strategy (ECB, 1999a). The ECB has defined price stability as an annual Euroland inflation rate[25] under 2%, to be attained by pursuing a two-pillar strategy: (i) a prominent role for money, actualised in the announcement of a reference value of 4.5% for the annual growth of the M3 aggregate, and (ii) a broadly based assessment of price developments and inflationary risks in the Euro area.

With regard to the first pillar, the ECB has made it clear that the announced reference value does not entail a *strict* form of money targeting whereby interest rates promptly

[24] It could be objected that, as the conditional feedback is in general not used in the 1st loop (recall section 4.2.2.), the model might then fail to find a saddlepath. Should this happen, however, we automatically move to the 2nd loop, using $\alpha = 0.2$ according to the solution file of the 1st loop. Alternatively, we might set $\beta = 0.2$ from, say, 2006:1 onwards, as in Barrell and Pina (2000). In practice, the model has never failed to solve.

[25] Measured by the Harmonised Index of Consumer Prices (HICP).

respond to deviations of money growth from 4.5%: even broad monetary aggregates are subject to short run developments that need not convey relevant information about future inflation prospects. This argument is reinforced if one considers the uncertainty surrounding the stability of money demand in the Euro area. As in the long run money is strongly correlated with nominal output, the latter being much less vulnerable to short run volatility, we *proxy* the first pillar of the ECB strategy by modelling a nominal GDP target.

Strict adherence to a nominal GDP target, however, might conflict with the overriding objective of price stability in case of an adverse supply shock that both depressed real output growth and fuelled inflation; more generally, a nominal target stabilizes inflation in the long run, but not necessarily in the short term (Barrell *et al.*, 1999). The second pillar of the strategy seems to address this shortcoming by introducing in the monetary reaction function an element of inflation targeting.

Formally, we take the general specification of the ECB's policy rule to be given by

$$i_t = i_t^b + \gamma_1 \log\left(\frac{P_t.Y_t}{P_t^b.Y_t^b}\right) + \gamma_2\left(\pi_t - \pi_t^b\right) \qquad (8)$$

where i is the 3-month nominal interest rate, P is the GDP deflator, Y is real output, π is inflation (measured by the deflator of private consumption) and the superscript b denotes baseline values (corresponding to target values for nominal output and inflation). Variables naturally refer to Euroland aggregates.

There being a continuum of relative weights that can be assigned to each of the two pillars of the strategy, we have chosen to analyse the polar cases of pure nominal income targeting (γ_2 set to zero) and pure inflation targeting (γ_1 set to zero). In the former regime, γ_1 equals 32.9 - a value obtained as the inverse of the long run (semi)elasticity of Euroland money demand *w.r.t.* the interest rate. Under inflation targeting, the coefficient γ_2 takes the value of 1.0. This second rule may be regarded as more 'conservative', since the implicit countercyclical stabilization stemming from the nominal output target disappears[26]; and might be followed in a scenario of conflict between the ECB and fiscal authorities or wage setters, inducing the former to reassert its independence and establish its anti-inflationary credentials by conducting a tighter monetary policy.

4.4. The Rest of the World

The fiscal and monetary rules of the largest economies outside Euroland are kept constant across regimes. The US, the UK, Japan and Canada have fiscal closure rules similar to (5) - with the same coefficient of 0.2 - and monetary reaction functions with the same specification as (8). Parameter values, however, vary: γ_1 equals 21.6, 21.0, 25.9 and 20.2, respectively, while γ_2 is set at 0.5 for the UK and Canada, and 0.75 for the US and Japan.

[26] The reference value for money growth takes into account, among other determinants, trend real GDP growth, which may give *some* anticyclical stance to monetary policy (ECB, 1999a, p. 48).

5. Empirical Results

In this section we present our simulation results. Three combinations of fiscal and monetary rules have been analysed:

- Regime 1: *standard plus conditional* fiscal feedback (β = 0.2 in equation (7)) and pure nominal income targeting (γ_1 = 32.9, γ_2 = 0 in equation (8)).
- Regime 2: *standard plus conditional* fiscal feedback and pure inflation targeting (γ_1 = 0, γ_2 = 1).
- Regime 3: *conditional* fiscal feedback *only* (β = 0) and pure nominal income targeting.

Regime 1 therefore serves as a benchmark: by comparing it with regime 2, one sheds light on the consequences of alternative monetary strategies; by contrasting regimes 1 and 3, the effects of different degrees of corrective action should deficits deviate from target trajectories are brought out.

Table 3 summarizes results for the whole simulation period, whereas Table A.3 (in Annex 4) presents a breakdown by years. Both show that, regardless of the specific policy regime considered, the general outlook is undoubtedly optimistic. Only four out of ten countries ever go through an EDP, and an overwhelming majority of the (relatively scarce) excessive deficits never reach the stage of a notice, let alone pecuniary sanctions – even in the case of the sole country for which the operation of the SGP poses non-negligible problems, Austria[27]. We also observe that moving from nominal GDP targeting to inflation targeting induces a modest increase in the number of excessive deficits, and that dropping the standard fiscal feedback (regimes 3 *versus* 1) leads to non-zero – albeit very small – probabilities of notices or sanctions in a number of countries (precisely because such feedback speeds up deficit elimination).

Table 3 - Probabilities (%) of events ever taking place over 1999-2005

		GE	FR	IT	NL	BG	SP	PT	OE	IR	FN
ED	Reg. 1	0.0	0.0	2.0	0.0	3.5	0.0	0.0	20.5	0.0	0.0
	Reg. 2	0.5	0.0	2.5	0.0	5.0	0.0	0.0	23.0	0.0	0.0
	Reg. 3	1.0	0.0	1.5	0.0	2.5	0.0	0.0	28.5	0.0	0.0
Notice	Reg. 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Reg. 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Reg. 3	0.0	0.0	0.5	0.0	0.5	0.0	0.0	1.0	0.0	0.0
Dep.	Reg. 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Reg. 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Reg. 3	0.0	0.0	0.0	0.0	0.5	0.0	0.0	1.0	0.0	0.0
Fine	Reg. 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Reg. 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Reg. 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0

ED = excessive deficit; GE = Germany; FR = France; IT = Italy; NL = Netherlands; BG = Belgium; SP = Spain; PT = Portugal; OE = Austria; IR = Ireland; FN = Finland. Non-zero entries shaded for readability.

[27] One might expect that a country like Italy would face significant problems as well. Their absence is a consequence of both the moderate volatility of the Italian deficit ratio during the simulation period (see section 5.1) and of the fact that our baseline does not reflect the revision of the Italian Stability Programme as regards the deficit target for 1999 (which was increased from 2.0 to 2.4 per cent of GDP).

The remainder of this section analyses simulation outcomes in more detail. As the baseline is common to all regimes, SGP violations are closely related to the volatility of the deficit ratio. Section 5.1. explores this link and attempts to elucidate why such volatility varies across policy rules. Section 5.2. investigates whether there is a tendency for several countries to be in excessive deficit at the same time.

5.1. Excessive Deficits and the Volatility of the Deficit Ratio

For given mean values of the deficit-to-GDP ratio (roughly equal to baseline figures[28]), the bigger the volatility of the latter, the more excessive deficits one is expected to witness. Though this link is broadly confirmed by examining how the relative root-mean-squared deviations (RMSDs) presented in Table 4 (shaded rows) square with the probabilities of Table 3, a significant number of exceptions exist, motivated by one or more of the following factors.

Table 4 - Variability of deficit ratios: relative RMSDs (reg. 1 = 100) and decomposition of absolute changes in variance

		GE	FR	IT	NL	BG	SP	PT	OE	IR	FN
Reg. 2	*RMSD(d)*	102.3	96.1	97.2	100.3	107.5	101.2	100.7	96.4	99.6	92.2
	VAR(d)	0.7	-0.5	-0.8	0.1	12.6	0.9	0.1	-3.1	-0.3	-4.3
	VAR(dp)	4.6	0.3	-0.2	0.8	-2.5	1.8	-0.7	-2.0	0.1	-2.5
	VAR(ip)	2.8	0.0	0.7	0.4	7.1	-0.1	0.6	0.0	0.1	0.1
	COV(dp,ip)	-6.8	-0.7	-1.4	-1.1	7.9	-0.8	0.2	-1.1	-0.5	-1.9
Reg. 3	*RMSD(d)*	117.2	142.7	125.5	133.2	109.3	136.7	117.1	111.3	109.3	121.3
	VAR(d)	5.6	6.8	8.9	15.2	15.6	31.4	2.2	10.7	6.0	13.5
	VAR(dp)	4.7	7.0	5.8	11.0	12.9	27.4	1.0	7.9	3.7	10.7
	VAR(ip)	0.1	0.1	0.2	0.1	-1.4	0.4	0.3	-0.2	0.1	0.6
	COV(dp,ip)	0.9	-0.3	2.8	4.0	4.2	3.5	0.9	3.0	2.2	2.2

Root-mean-squared deviations (shaded entries) are summary statistics of the simulated volatility of a given variable x at different time horizons, defined as

$$RMSD(x) = \sqrt{\frac{1}{N}\sum_{t=1}^{N}\left\{\frac{1}{J}\sum_{j=1}^{J}\left(x_t^j - x_t^b\right)^2\right\}}$$

where N is the number of time periods, J is the number of trials and the superscript b denotes value on baseline. These statistics have been computed for annual budget deficits as a percentage of GDP (d) over the final quarters of 1999 to 2005 (i.e., in the equation above, t = 1999:4, 2000:4, …, 2005:4). See text for information on non-shaded entries.

Firstly, the positive relationship between volatility and excessive deficits is highly non-linear, due to the threshold nature of the latter. Countries like France and Spain record sizeable increases in deficit volatility when moving from regime 1 to regime 3, and yet excessive deficits fail to take place, as the 3% ceiling is never broken. Once the tail of the deficit ratio distribution starts to go beyond 3%, however, even modest rises in volatility may induce large increases in SGP violations: comparing regimes 1 and 3, Austria is a case in point. Incidentally, the same argument applies with regard to differences in baseline deficits: the fact that fiscal consolidation has a slightly more sluggish start in Austria than in other countries (see annex 2) has a more than proportional impact in terms of the number of excessive deficits.

[28] Not exactly coincident, though, due to stochastic error and to non-linearities.

A second factor to bear in mind is the existence of waivers – deficits over 3% which are not deemed excessive. Waivers are easier to obtain in a context of recession, which in itself is a cause of deficit volatility (through smaller tax revenues and higher unemployment benefits). Table A.3 in annex 4 reports detailed information on deficits, recessions and waivers. It can be seen, for instance, that the increase in the probability of excessive deficits for Austria from regime 1 to regime 2 (which is at odds with the slight decrease in the RMSD of the deficit ratio) is partly due to a decrease in the number of waivers.

Further, the probabilities of excessive deficits contained in Table 3 do not take into account for how long the problem subsists. Under regime 3 Italy and Belgium face less excessive deficits than under regime 1, but they tend to last longer – which helps to resolve the contradiction between less excessive deficits and higher RMSDs. Finally, though to a much lesser extent, the stochastic imprecision of results also contributes to blur the link between deficit volatility and SGP violations (for instance, by affecting the exact shape of the deficit ratio distribution).

The next step in our analysis of results is to understand what makes the volatility of the deficit ratio vary across regimes. While a full explanation would entail exploring the multiple economic interactions modelled in NiGEM, we attempt to shed some light on the issue by decomposing the variability of deficits into terms that reflect the relative contributions of primary balances and interest payments. The latter are particularly sensitive to interest rates and thus to monetary policy, while the former depend, among a variety of other factors, on the cyclical position of the economy and on the operation of the fiscal feedback rules.

Formally, let *dp* denote the primary deficit, *ip* interest payments and (as before) *d* the overall deficit, all in annual terms and expressed as a percentage of GDP. We take the square of *RMSD(d)*, defined as under Table 4, and use $d = dp + ip$ to write:

$$\frac{1}{N}\sum_{t=1}^{N}\left\{\frac{1}{J}\sum_{j=1}^{J}\left(d_t^j - d_t^b\right)^2\right\} = \frac{1}{N}\sum_{t=1}^{N}\left\{\frac{1}{J}\sum_{j=1}^{J}\left(dp_t^j - dp_t^b\right)^2\right\} + \frac{1}{N}\sum_{t=1}^{N}\left\{\frac{1}{J}\sum_{j=1}^{J}\left(ip_t^j - ip_t^b\right)^2\right\} + 2\frac{1}{N}\sum_{t=1}^{N}\left\{\frac{1}{J}\sum_{j=1}^{J}\left(dp_t^j - dp_t^b\right)\left(ip_t^j - ip_t^b\right)\right\} \quad (9)$$

For simplicity, we henceforth refer to this equation's terms as variances (*VAR*) or covariances (*COV*). The non-shaded rows of Table 4 decompose the (absolute) change in *VAR(d)* from regime 1 to regimes 2 and 3 into the contributions of *VAR(dp)*, *VAR(ip)* and *COV(dp,ip)*[29].

One finds relatively modest changes in deficit variability when comparing regimes 1 and 2. Inflation targeting causes output growth to become somewhat more volatile, especially in Germany and Spain (see Table 5), the two countries that experience the largest increases in the variance of primary balances. Moving to regime 2 also makes interest rates considerably more unstable, as documented in Table 6: this translates into higher *VAR(ip)* for practically all countries, Belgium, Germany and Italy being the most affected. Although there are many other determinants of the variance of interest

[29] Changes in *VAR(d)* are multiplied by 100 for readability; all the underlying figures can be found in Table A.4, Annex 4. Notice that *dp* and *ip* are not independent: *ceteris paribus*, higher interest payments worsen the overall deficit, leading to an increase in taxes (through the fiscal rule) and thus to a decrease in *dp*. Table A.4 confirms that this negative covariance is indeed found in most of the cases.

payments (such as debt dynamics or different debt maturities), one naturally finds the two most highly indebted economies (Italy and Belgium) among the hardest hit by more volatile interest rates.

Table 5 - Volatility of GDP growth

		GE	FR	IT	NL	BG	SP	PT	OE	IR	FN
Reg. 1	RMSD	2.26	1.07	1.13	1.78	1.51	1.89	1.37	2.01	2.64	0.87
Reg. 2	RMSD	2.41	1.11	1.16	1.78	1.51	2.01	1.38	2.06	2.72	0.90
	Index	106.3	103.1	102.1	99.7	99.9	106.5	101.3	102.8	102.8	103.7
Reg. 3	RMSD	2.33	1.08	1.07	1.71	1.40	1.94	1.32	2.00	2.49	0.87
	Index	103.0	100.5	94.3	96.1	92.6	102.6	96.4	99.8	94.4	99.6

GDP growth is defined in annual terms (4 quarters over previous 4 quarters); RMSDs are computed along the lines of Table 4; indices take Reg. 1 = 100.

Table 6 - Volatility of short-term and long-term interest rates

	Reg. 1	**Reg. 2**		**Reg. 3**	
	RMSD	RMSD	Index	RMSD	Index
short i	0.69	0.88	127.4	0.67	97.8
long i	0.12	0.18	149.0	0.08	71.9

RMSDs are computed considering all quarters from 1999:1 to 2005:4; indices take Reg. 1 = 100.

As for regime 3, the driving force behind the increased deficit volatility is a higher variance of primary balances, which in turn hinges upon the suppression of the standard feedback on deficit deviations from baseline.

5.2. Do Countries Face Problems at the Same Time?

Though the main finding of this paper is that the operation of the SGP is likely to be rather smooth, with rare and easily corrected violations, there could still be a threat to the Pact's credibility if several countries tended to face excessive deficits at the same time. Apart from voting issues – a country in excessive deficit might well vote and lobby against a strict application of the Pact's provisions to other countries in a similar situation – the political tensions involved could lead to some form of waivers or extended deadlines for deficit elimination, inducing other countries to slow down their fiscal consolidation efforts.

Table 7 - No. of countries simultaneously in EDP (probabilities, %)

	0	**1**	**2**	**3**	**>3**
Reg. 1	95.9	4.0	0.1	0.0	0.0
Reg. 2	95.4	4.3	0.3	0.0	0.0
Reg. 3	94.4	5.5	0.1	0.0	0.0

Table entries give the percentage of quarters in which the variable *SP* differs from zero for the number of countries indicated in each column. The period 1999:1 – 2000:1 is excluded, as in these five quarters *SP* = 0 by construction.

A first look at this potential problem is given by Table 7, which tells us that situations where two countries are simultaneously in excessive deficit are extremely rare, and cases of three or more countries jointly in EDP simply do not take place. Furthermore, a detailed look at simulation outcomes has revealed that Germany is never in excessive deficit at the same time as any other country, thus making the fears expressed in the previous paragraph look remote (recall n. 16 as well), and reinforcing the optimistic outlook of our results.

As far as cross-country EDP synchronization is concerned, however, the approach of Table 7 is subject to the criticism that, since excessive deficits are seldom declared, the chances that two countries violate the SGP at the same time necessarily tend to be minuscule. We take this point on board in Table 8, where, for each regime, the probability (per thousand) of each country being in EDP is contained in the diagonal entries, the actual probabilities of each pair of countries being simultaneously in EDP are presented in the triangle above the diagonal, and their counterparts under independence (i.e., the product of the appropriate diagonal entries) can be found below the diagonal. There is some tendency for national excessive deficits to be positively correlated, particularly between Italy and Belgium under regime 2 – which follows from the common nature of monetary policy and from the vulnerability of these two countries to interest rate increases, due to their high public debt stocks.

Table 8 - Joint SGP violations (probabilities per thousand)

	Regime 1				Regime 2				Regime 3			
	GE	**IT**	**BG**	**OE**	**GE**	**IT**	**BG**	**OE**	**GE**	**IT**	**BG**	**OE**
GE	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	1.3	0.0	0.0	0.0
IT	0.0	2.6	0.0	1.3	0.0	3.3	2.6	0.0	0.0	2.8	0.7	0.7
BG	0.0	0.0	4.6	0.0	0.0	0.0	8.9	0.7	0.0	0.0	5.0	0.0
OE	0.0	0.1	0.2	35.4	0.0	0.1	0.3	36.7	0.1	0.1	0.2	48.3

As in Table 7, SGP violations are defined as non-zero values for the *SP* variables, and probabilities are computed across trials and quarters from 2000:2 to 2005:4. See text for further details.

6. Concluding Remarks

This paper has analysed the prospective operation of the Stability and Growth Pact in an uncertain environment. Under the maintained assumption of a base scenario which broadly encapsulates the fiscal consolidation targets set out in the national Stability Programmes, we have looked at the implications of different ECB monetary strategies and fiscal reaction functions. The latter have been specified bearing in mind both the literature on closure rules designed to ensure government solvency and plausible features of fiscal behaviour under the SGP: (i) more stringent tax increases when the threat of pecuniary sanctions looms dangerously close, which has been formalized as an innovative conditional simple rule; and (ii) little scope for further restrictive measures on top of the baseline consolidation effort, by comparison with a situation where such room for manoeuvre still exists.

Our simulation results present an optimistic outlook. Only four countries ever record SGP violations, which are rare and, in an overwhelming majority of cases, short-lived – i.e., excessive deficits are corrected[30] within the deadlines required to avoid a notice. Pure inflation targeting by the ECB is found to make interest rates more volatile, with (dampened) consequences on the variability of interest payments: we witness a modest increase in the probability of excessive deficits and in their degree of synchronization as regards the two most highly indebted Member States of the Euro zone, Belgium and Italy. In turn, a situation where corrective action in the wake of deviations from the deficit target trajectories only takes place after a notice is issued naturally implies that excessive deficits take longer to be eliminated – but even so notices and sanctions hardly ever happen.

As results inevitably depend on assumptions, it seems appropriate to conclude by recalling the main regime-invariant features of our experimental design. These include the baseline and the assumption of perfect credibility, both of policy rules and as far as a strict application of the SGP wording is concerned. Although other possibilities could be considered, especially as regards the baseline, we view our assumptions as a useful benchmark – judgemental considerations are kept at a minimum, and results themselves do not cast doubt on the plausibility of a strictly enforced Stability and Growth Pact.

[30] And *expected* to be corrected – recall section 3.

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Annex 1

Here we summarize the provisions of Council Regulation (EC) No. 1467/97 (and related legislation) as regards 'participating Member-States' - i.e., countries that have adopted the single currency[31].

1. Member States report macroeconomic and budget data twice a year, by 1 March and 1 September.

2. The Commission prepares a report assessing budgetary developments and whether an excessive deficit exists. The Economic and Financial Committee formulates an opinion on the Commission's report. Taking this opinion into account, the Commission, when it considers that an excessive deficit exists, addresses an opinion and a recommendation to the (ECOFIN) Council. The latter then decides on the **existence of an excessive deficit**; such a decision is to be taken within three months of the reporting dates mentioned in 1.

   (i) Deficits above the reference value of 3% of GDP will not be declared as excessive provided they are considered exceptional and temporary: exceptional insofar as resulting from an unusual event with major budgetary implications, or from a severe economic downturn; temporary if the Commission forecasts that the deficit will fall below 3% once the unusual event or severe economic downturn is over. Cyclical downturns in which real GDP falls by at least 2% qualify as exceptional; smaller recessions may also be regarded as exceptional if the downturn is abrupt or the accumulated loss of output relative to past trends is significant. Member States have however committed themselves not to claim as exceptional any downturns where annual real GDP falls by less than 0.75% (Resolution of the European Council on the Stability and Growth Pact, Amsterdam, 17 June 1997).
   Article 104c(2) and (3) of the Treaty mention further criteria to be used in the assessment of deficits in excess of 3%. Besides exceptional and temporary, deficit ratios must also remain close to the reference value; and the Commission's report should also take into account whether the deficit exceeds government investment expenditure, as well as the medium-term economic and budgetary position of the country concerned.

   (ii) If the Council decides that an excessive deficit exists, it will at the same time issue a **recommendation** to the Member State concerned. The country is to take effective action within a deadline of four months at the most, and to complete the correction of the excessive deficit in the year after its identification (unless special circumstances apply).

3. Immediately after the expiry of the deadline for effective action, the Council may decide to make its recommendation public if it considers that the Member State has failed to put the latter into practice. Within one month of the expiry of the same deadline, and if the failure to take effective action persists, the Council may decide to give **notice** to the country concerned to take specific measures for deficit reduction.

[31] For convenience, the several EDP stages are in bold, whereas timings and deadlines are underlined.

4. If the Member State fails to comply with the above notice, the Council shall impose a non-remunerated **first deposit** as a sanction. The assessment of compliance, and the ensuing decision of whether to require the country concerned to make a deposit, is to take place no later than two months after the decision to issue a notice. A Member State with an excessive deficit that fails to put into practice both the recommendation (see 2.) and the notice (see 3.) will therefore incur pecuniary sanctions within ten months of the reporting dates (see 1.) An expedited procedure is available for a deliberately planned deficit viewed by the Council as excessive.

5. If a country acts in compliance with either a recommendation or a notice, the EDP is held in **abeyance**. The time during which an EDP is held in abeyance is not included in either the 2-month or the 10-month deadlines referred to in 4. The Commission and the Council monitor the implementation of the action taken by the Member State; in case such measures prove inadequate, or new actual data reported under 1. shows that the excessive deficit has not been corrected within the specified time limits, the Council will immediately take a decision as regards the issue of a notice (if the EDP was being held in abeyance after a recommendation) or the imposition of a deposit (if the EDP was being held in abeyance after a notice).

6. In each year following the imposition of a first deposit, and within two months of the reporting dates mentioned in 1., the Council assesses whether the country concerned has taken effective action in response to the notice. If non-compliance still prevails, sanctions are intensified, and a **second (or subsequent) deposit** is required.

7. Whenever, in the view of the Council, an excessive deficit no longer exists, the previous decisions taken in the framework of the EDP are abrogated. Any such decision to abrogate is to be taken as soon as possible, with a maximum deadline of two months after the reporting dates mentioned in 1.

8. The amount of a first deposit equals a fixed component of 0,2% of the country's GDP plus a variable component of one tenth of the difference between the deficit as a percentage of GDP in the previous year and the reference value of 3%. Second and subsequent deposits consist only of the variable component, determined as above. No deposit can exceed 0.5% of the country's GDP.

9. If it is the Council's view that, two years after a deposit is required, the excessive deficit has not yet been corrected, such deposit will be transformed into a fine.

Any deposits not transformed into fines are reimbursed to the Member State concerned as soon as the EDP is terminated (see 7.). Fines and interest on deposits are distributed among Member States without an excessive deficit, in proportion to GNP.

When taking any of the decisions mentioned above in points 2. to 7. and 9., the Council acts by a majority of two-thirds, excluding the votes of the country concerned.

Annex 2

Table A.1 - NiGEM's baseline *versus* the national Stability Programmes

Member State		surplus(+)/deficit(-) (% of GDP)				GDP growth (%)			
		1999	2000	2001	2002	1999	2000	2001	2002
Germany	Baseline	-2.3	-1.8	-1.6	-1.2	1.6	2.8	2.7	2.9
	S. Prog.	-2.0	-2.0	-1.5	-1.0	2.0	2.5	2.5	2.5
France	Baseline	-2.5	-1.7	-1.3	-1.2	2.3	2.6	2.5	2.7
	S. Prog. [(a)]	-2.3	-2.0	-1.6	-1.2	2.4	2.5	2.5	2.5
Italy	Baseline	-1.9	-2.3	-1.6	-	1.5	2.5	2.6	-
	S. Prog.	-2.0	-1.5	-1.0	-	2.5	2.8	2.9	-
Spain	Baseline	-1.5	-1.0	-0.2	0.0	3.1	3.7	2.8	2.3
	S. Prog.	-1.6	-1.0	-0.4	0.1	3.8	3.3	3.3	3.3
Netherl.	Baseline	-1.6	-1.3	-0.9	-0.7	2.0	2.5	2.5	2.6
	S. Prog. [(b)]	-1.3	-1.2	-1.1	-1.0	2.3	2.3	2.3	2.3
Belgium	Baseline	-0.9	-0.5	-0.6	-0.7	1.8	2.7	2.1	2.1
	S. Prog.	-1.3	-1.0	-0.7	-0.3	2.4	2.3	2.3	2.3
Portugal	Baseline	-2.0	-1.8	-1.2	-0.9	3.2	3.6	2.7	2.5
	S. Prog.	-2.0	-1.5	-1.2	-0.8	3.5	3.2	3.2	3.3
Austria	Baseline	-2.5	-2.4	-1.3	-1.0	2.1	2.5	2.0	1.9
	S. Prog.	-2.0	-1.7	-1.5	-1.4	2.8	2.6	2.1	2.2
Ireland	Baseline	2.3	2.3	2.2	-	8.0	7.4	7.6	-
	S. Prog.	1.7	1.4	1.6	-	6.7	6.4	5.8	-
Finland	Baseline	2.8	2.7	2.3	2.2	3.3	3.3	3.1	3.0
	S. Prog.	2.4	2.2	2.1	2.3	4.0	2.7	2.6	2.6

Sources: Stability Programmes and NiGEM

(a) Cautious macroeconomic scenario; in the favourable scenario, figures for the deficit ratio over the period 1999-2002 are -2.3, -1.7, -1.2 and -0.8, respectively, while projections for growth become 2.7 in 1999 and 3.0 in 2000-2002.

(b) Cautious macroeconomic scenario; figures for the 2002 budget ratio become -0.25 and 0.25 under the intermediate and favourable scenarios, respectively. The growth forecast of 2.3% is an average over 1999-2002. As the Programme does not contain deficit targets for the intermediate years (2000 and 2001), a linear interpolation was used.

Annex 3

In order to shed some light on the transmission channels of fiscal policy and how they differ across countries, we have performed a set of deterministic simulations consisting of a 2 percentage point (p.p.) rise in the average direct tax rate of each Euroland country in turn. The reason to shock taxes rather than, as usual, government consumption stems from the central role played by the former in responding to deficit deviations from the target trajectory: in this paper's analysis, countries react to a rise in the deficit to GDP ratio by increasing the average direct tax rate rather than by curbing spending. The 2 p.p. shock was applied to the 1999:1 tax rate; in subsequent quarters taxes followed from the operation of the standard NiGEM's fiscal closure rule (eq. (5)), implying a gradual return to baseline tax rates[32].

The results – summarized in Table A.2 - were qualitatively similar across countries. A tax rise is contractionary in the short run, mainly through the concomitant fall in disposable income, which depresses consumption and output. The decrease in the latter reduces labour demand and thus leads to higher unemployment. Wages and prices are then gradually adjusted downwards, making the economy return to baseline both through demand-side and supply-side factors (mainly a better export performance and a recovery in employment, respectively). The direct tax rate gradually falls after the initial rise, thus also contributing to the overall recovery[33]. Quantitative differences across countries can be ascribed to two main sources: higher short-run elasticities of consumption *w.r.t.* disposable income are conducive to bigger short-run output losses, whereas greater nominal rigidity slows down the return to baseline. Germany exemplifies the former point, France the latter.

Table A.2 – Impact of national tax shocks: differences from baseline

		GE	FR	IT	SP	NL	BG	PT	OE	IR	FN
GDP	1999	-0.86	-0.22	-0.29	-0.40	-0.15	-0.20	-0.42	-0.37	-0.26	-0.24
	2000	-0.18	-0.34	-0.56	-0.76	-0.20	-0.10	-0.27	-0.23	-0.26	-0.51
	2001	0.04	-0.35	-0.39	-0.41	-0.14	-0.04	-0.17	-0.04	-0.13	-0.54
	2002	0.12	-0.25	-0.05	0.02	-0.07	-0.02	-0.07	0.07	0.04	-0.43
	2013	-0.01	-0.05	-0.05	-0.03	0.02	0.00	0.04	0.00	-0.01	0.13
CED	1999	-0.08	0.01	-0.05	-0.01	-0.03	0.01	-0.09	-0.08	-0.01	-0.01
	2000	-0.45	-0.01	-0.34	-0.11	-0.11	-0.09	-0.23	-0.24	-0.07	-0.07
	2001	-0.74	-0.09	-0.72	-0.40	-0.21	-0.12	-0.36	-0.34	-0.17	-0.22
	2002	-0.85	-0.24	-1.05	-0.72	-0.27	-0.10	-0.43	-0.36	-0.20	-0.38
	2013	0.02	0.08	0.15	0.10	0.05	0.01	0.09	0.04	0.03	0.09
TAX/PI	1999	1.64	1.50	1.50	1.49	1.50	1.50	1.57	1.54	1.57	1.53
	2000	0.92	0.70	0.76	0.81	0.70	0.71	0.85	0.83	0.81	0.90
	2001	0.49	0.39	0.54	0.58	0.40	0.34	0.53	0.51	0.48	0.76
	2002	0.23	0.27	0.41	0.36	0.25	0.15	0.35	0.30	0.27	0.73
	2013	-0.08	-0.08	-0.10	-0.08	-0.14	-0.12	-0.22	-0.12	-0.10	-0.29

Percent differences for GDP and CED (consumption deflator); differences in p.p. for TAX/PI.

[32] This is a consequence of unchanged targets for the deficit ratio – a feature which emulates our stochastic simulation assumptions, where targets remain constant across trials. A permanent rise in *TAX/PI* would require an increase in the target for the budget balance-to-GDP ratio.

[33] The EMU context implies that impacts on financial variables are second-order, especially when the country being shocked is small. The biggest impacts were obtained when shocking Germany: a nominal depreciation of 0.25% in 1999, and a 17 basis points fall in short interest rates in the same year.

Annex 4

Table A.3 – Probabilities (%) of deficits and recessions: detailed simulation results

		P(def)			P(rec)			P(def|rec)		
		reg. 1	reg. 2	reg. 3	reg. 1	reg. 2	reg. 3	reg. 1	reg. 2	reg. 3
GE	1999	0.5	2.0	2.5	5.0	5.0	5.0	10.0	30.0	30.0
	2000	0.0	0.0	0.0	6.0	7.0	7.5	0.0	0.0	0.0
	2001	0.5	0.0	0.0	9.5	11.0	10.5	5.3	0.0	0.0
	2002	0.0	0.0	0.0	10.0	10.5	9.5	0.0	0.0	0.0
	2003	0.0	0.0	0.0	9.5	10.0	10.5	0.0	0.0	0.0
	2004	0.0	0.0	0.0	9.0	9.5	9.5	0.0	0.0	0.0
FR	1999	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2000	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2001	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2002	0.0	0.0	0.0	0.5	0.5	0.5	0.0	0.0	0.0
	2003	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2004	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
IT	1999	0.0	0.0	0.0	0.0	0.5	0.0	-	0.0	-
	2000	1.0	1.0	1.0	0.0	0.0	0.0	-	-	-
	2001	0.5	1.5	0.0	0.0	0.0	0.0	-	-	-
	2002	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2003	0.0	0.0	0.5	0.5	0.5	0.0	0.0	0.0	-
	2004	0.5	0.0	0.5	1.5	2.0	0.0	33.3	0.0	-
NL	1999	0.0	0.0	0.0	1.0	0.0	0.0	0.0	-	-
	2000	0.0	0.0	0.0	2.5	3.0	2.0	0.0	0.0	0.0
	2001	0.0	0.0	0.0	6.5	5.0	6.0	0.0	0.0	0.0
	2002	0.0	0.0	0.0	4.0	4.5	5.0	0.0	0.0	0.0
	2003	0.0	0.0	0.0	3.5	3.5	4.0	0.0	0.0	0.0
	2004	0.0	0.0	0.0	2.5	1.5	1.5	0.0	0.0	0.0
BG	1999	0.5	1.5	0.5	0.5	1.5	0.0	100.0	100.0	-
	2000	0.0	0.5	0.0	2.0	1.5	1.0	0.0	33.3	0.0
	2001	1.0	2.0	0.5	4.5	4.0	3.0	22.2	37.5	16.7
	2002	2.5	0.5	0.5	3.0	2.0	2.0	33.3	25.0	0.0
	2003	1.0	2.0	1.5	1.5	2.5	1.5	0.0	60.0	66.7
	2004	0.0	2.5	1.0	4.5	2.5	2.5	0.0	60.0	0.0
SP	1999	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2000	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2001	0.0	0.0	0.0	2.0	3.0	3.0	0.0	0.0	0.0
	2002	0.0	0.0	0.0	9.0	10.5	10.5	0.0	0.0	0.0
	2003	0.0	0.0	0.0	9.0	9.0	9.0	0.0	0.0	0.0
	2004	0.0	0.0	0.0	6.0	6.5	6.5	0.0	0.0	0.0
PT	1999	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2000	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2001	0.0	0.0	0.0	0.5	1.0	1.0	0.0	0.0	0.0
	2002	0.0	0.0	0.0	1.0	0.0	0.0	0.0	-	-
	2003	0.0	0.0	0.0	0.5	0.5	0.0	0.0	0.0	-
	2004	0.0	0.0	0.0	0.0	1.0	0.0	-	0.0	-
OE	1999	12.0	13.5	13.5	2.0	2.5	1.0	100.0	100.0	100.0
	2000	14.0	13.0	18.0	4.0	4.0	5.0	25.0	0.0	10.0
	2001	0.5	0.5	1.5	12.0	13.5	13.0	0.0	0.0	3.8
	2002	1.0	1.0	1.5	11.5	13.0	11.5	4.3	0.0	0.0
	2003	0.0	1.0	1.5	9.5	9.5	10.0	0.0	0.0	0.0
	2004	0.5	0.5	0.5	8.5	9.0	7.0	0.0	0.0	0.0
IR	1999	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2000	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2001	0.0	0.0	0.0	0.0	1.0	0.0	-	0.0	-
	2002	0.0	0.0	0.0	0.5	0.0	0.0	0.0	-	-
	2003	0.0	0.0	0.0	4.5	4.0	2.5	0.0	0.0	0.0
	2004	0.0	0.0	0.0	8.5	8.0	7.5	0.0	0.0	0.0
FN	1999	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2000	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2001	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2002	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2003	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2004	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-

Table A.3 – Probabilities (%) of deficits and recessions: detailed simulation results (cont.)

		P(defIno rec)			P(ED)			P(waivIdef&rec)		
		reg. 1	reg. 2	reg. 3	reg. 1	reg. 2	reg. 3	reg. 1	reg. 2	reg. 3
GE	1999	0.0	0.5	1.1	0.0	0.5	1.0	100.0	100.0	100.0
	2000	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2001	0.0	0.0	0.0	0.0	0.0	0.0	100.0	-	-
	2002	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2003	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2004	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
FR	1999	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2000	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2001	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2002	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2003	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2004	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
IT	1999	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2000	1.0	1.0	1.0	1.0	1.0	1.0	-	-	-
	2001	0.5	1.5	0.0	0.5	1.5	0.0	-	-	-
	2002	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2003	0.0	0.0	0.5	0.0	0.0	0.5	-	-	-
	2004	0.0	0.0	0.5	0.5	0.0	0.0	0.0	-	-
NL	1999	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2000	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2001	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2002	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2003	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2004	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
BG	1999	0.0	0.0	0.5	0.0	0.5	0.5	100.0	66.7	-
	2000	0.0	0.0	0.0	0.0	0.5	0.0	-	0.0	-
	2001	0.0	0.5	0.0	0.5	1.5	0.5	50.0	0.0	0.0
	2002	1.5	0.0	0.5	2.0	0.5	0.0	50.0	0.0	-
	2003	1.0	0.5	0.5	1.0	1.0	1.0	-	66.7	50.0
	2004	0.0	1.0	1.0	0.0	1.5	0.5	-	33.3	-
SP	1999	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2000	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2001	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2002	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2003	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2004	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
PT	1999	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2000	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2001	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2002	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2003	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2004	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
OE	1999	10.2	11.3	12.6	10.5	11.0	13.0	75.0	100.0	50.0
	2000	13.5	13.5	18.4	9.0	10.0	13.0	50.0	-	100.0
	2001	0.6	0.6	1.1	0.5	0.5	0.0	-	-	100.0
	2002	0.6	1.1	1.7	0.0	1.0	1.0	100.0	-	-
	2003	0.0	1.1	1.7	0.0	1.0	1.5	-	-	-
	2004	0.5	0.5	0.5	0.5	0.0	0.5	-	-	-
IR	1999	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2000	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2001	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2002	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2003	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2004	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
FN	1999	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2000	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2001	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2002	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2003	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
	2004	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-

Table A.3 presents, for each country, year and regime, the estimated probabilities of the following events:
(i) budget deficits over 3% of GDP ('def');
(ii) recessions, defined as annual GDP falls of at least 0.75% ('rec');
(iii) deficits over 3% conditional on the occurrence of a recession ('def|rec');
(iv) deficits over 3% conditional on there being no recession ('def|no rec');
(v) excessive deficits, i.e., deficits over 3% which are not regarded as exceptional, temporary and close to the reference value ('ED');
(vi) deficits over 3% being 'waived' (i.e., not deemed excessive) conditional on the occurrence of a recession ('waiv|def&rec').

Results for (v) and (vi) refer to the year in which deficits actually take place – i.e., the year before they are either declared as excessive or waived. As a consequence, no probabilities are reported for 2005: decisions regarding those deficits would be taken only in 2006, already beyond the end of the period under stochastic simulation. For readability, all non-zero entries are shaded.

Table A.4 – Decomposition of deficit ratio variability

		GE	FR	IT	NL	BG	SP	PT	OE	IR	FN
Reg. 1	*RMSD(d)*	0.39	0.26	0.39	0.44	0.90	0.60	0.24	0.67	0.55	0.54
	VAR(d)	0.15	0.07	0.15	0.20	0.80	0.36	0.06	0.45	0.30	0.29
	VAR(dp)	0.18	0.10	0.20	0.15	0.66	0.41	0.08	0.44	0.27	0.33
	VAR(ip)	0.01	0.02	0.08	0.01	0.07	0.03	0.05	0.01	0.01	0.08
	COV(dp,ip)	-0.04	-0.05	-0.13	0.03	0.07	-0.08	-0.07	-0.01	0.02	-0.13
Reg. 2	*RMSD(d)*	0.40	0.25	0.38	0.44	0.96	0.61	0.25	0.65	0.55	0.49
	VAR(d)	0.16	0.06	0.15	0.20	0.93	0.37	0.06	0.42	0.30	0.24
	VAR(dp)	0.23	0.10	0.20	0.16	0.64	0.43	0.07	0.42	0.27	0.31
	VAR(ip)	0.04	0.02	0.09	0.02	0.15	0.03	0.05	0.01	0.01	0.08
	COV(dp,ip)	-0.11	-0.06	-0.14	0.02	0.15	-0.09	-0.06	-0.02	0.02	-0.15
Reg. 3	*RMSD(d)*	0.45	0.36	0.49	0.59	0.98	0.82	0.28	0.75	0.60	0.65
	VAR(d)	0.21	0.13	0.24	0.35	0.96	0.67	0.08	0.56	0.36	0.42
	VAR(dp)	0.23	0.17	0.26	0.26	0.79	0.69	0.09	0.52	0.31	0.44
	VAR(ip)	0.01	0.02	0.08	0.01	0.06	0.04	0.05	0.01	0.01	0.09
	COV(dp,ip)	-0.03	-0.05	-0.10	0.07	0.11	-0.05	-0.06	0.02	0.05	-0.11

For simplicity, *COV(dp,ip)* equals the covariance term $\frac{1}{N}\sum_{t=1}^{N}\left\{\frac{1}{J}\sum_{j=1}^{J}\left(dp_t^j - dp_t^b\right)\left(ip_t^j - ip_t^b\right)\right\}$ - recall eq. (9) - multiplied by 2, so that *VAR(d)* corresponds to the sum of the three subsequent rows. See section 5.1. of the main text for notation and definitions of second moments.