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# The Economic Importance of Fiscal Rules

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# The economic importance of fiscal rules*

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April 19, 2006

**Abstract**

The present paper provides an assessment of the effect of the recent revision of the Stability and Growth Pact (SGP) on the European economies. A set of structural VARs, one for each eurozone country, is estimated. The estimated models are then used to assess the possible effect of alternative sets of fiscal rules, with particular attention to the Stability and Growth Pact in its old and reformed versions.

The investigation suggests that fiscal policy has had in the past a limited smoothing effect on the cycle, and therefore the cost of the old rules in the corrective arm of the Pact was also limited. As for the reform of the Pact, the analysis is overall supportive of the new country-specific Medium Term Objectives. The modified rules of the Excessive deficit procedure are likely to give the governments only a limited extra leeway to reduce the variability of the cycle.

Keywords: European Monetary Union, Stability and growth Pact, fiscal-monetary interactions.

JEL codes: E61, E62, E63.

## 1 Introduction

Only few years since the start of EMU, the Stability and Growth Pact (SGP) has undergone an extensive process of revision. The present paper provides an assessment of the effect of this revision on the European economy. A set of structural VARs, one for each eurozone country, is estimated. The VARs are identified via long run restrictions that are relatively uncontroversial and compatible with most theoretical models of fiscal policy; they also take into account the effect of monetary policy in order to avoid misspecification. The estimated models are then used to assess the possible effect of alternative sets of fiscal rules, with particular attention to the Stability and Growth Pact in its old and reformed versions.

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The investigation highlights a number of facts. First, fiscal policy has had in the past a limited smoothing effect on the cycle. Second, the rules of the Stability and Growth Pact have had overall a limited effect on fiscal discipline. The modified rules of the Pact are thus likely to give the governments only a limited extra leeway to reduce the variability of the cycle.

The paper is organized as follows. Section 2 presents some historical and economic background on the fiscal policy constraints established by the Maastricht Treaty and the SGP and tries to explain why the latter entered into its recent crisis. Section 3 briefly describes the proposed reform of the Stability and Growth Pact. Sections 4 and 5 focus on methodological aspects such as the description of the model and the related literature. Section 6 assesses whether, in the past, discretionary fiscal policy has been effective in smoothing the economic cycle, or whether a procyclical component has prevailed, thus increasing the amplitude of the cycle. Section 7, the main one, estimates the effect that the reform of the Pact may have on the variability of the cycle and on the public finances. Section 8 concludes.

# 2 Economic and historical background

The fiscal rules laid down in the Treaty of Maastricht and the Stability and Growth Pact (SGP) are the result of a perception that qualification for participation in the monetary union would rmove the incentive to conduct disciplined fiscal policies. The main objective of the SGP is to safeguard the credibility of monetary policy both in the long term, by preventing excessive public debt build-up, and in the short run by keeping deficits low, thus reducing the risk of an unbalanced ex post policy mix (Artis and Winkler, 1998). This in turn would make the monetary union viable by ensuring low inflation and economic stability and protecting the European Central Bank from potential pressure for debt bailouts coming from the national governments.

According to Bini-Smaghi, Padoa-Schioppa and Papadia (1994), the binding thresholds on deficit and debt were adopted on the ground that market discipline alone would not have a sufficient disciplinary effect on the public finances of the countries in the euro area. The approach adopted in the Maastrich criteria and reiterated in the Stability and Growth Pact associated binding nominal thresholds with a procedure for assessing excessive deficits which provided for margins of discretion, thus mediating between the two extreme views advocating on the one side strict binding rules and on the other simple reliance on market imposed discipline.

The threshold values were chosen somewhat arbitrarily. The debt ceiling of 60% was simply more or less the Community average, and was not intended as a limit of acceptability for the debt, but simply as a threshold after which changes in debt become relevant and a close look at the deficit is necessary. The deficit ceiling of 3% of GDP, although broadly compatible with the 60% deficit ratio and a nominal growth of 5%, was criticized as being potentially too strict and inflexible. However, the excessive deficit procedure was supposed to provide the

necessary margins for discretion. All the alternative proposals were rejected on practical grounds; the so-called "golden rule" required a strict and harmonized differentiation between current and capital expenditure which was not available at the time; a proposal for assessing the budgetary position over a number of years was rejected on the ground that it would be heavily based on intentions for the future rather than on measurable facts. In the end, the limits were set on nominal annual figures.

After only few years since the start of EMU, the SGP has undergone an extensive process of revision. This may appear surprising, as the Maastricht criteria, very similar to those in the SGP, were never put into discussion. Three elements may help to explain this difference.

First, the economic outlook seems much less favorable now than in the second phase of the EMU (1998-2001). The improvement in balances experienced until 1999 was largely due to the favorable economic upswing, and the structural surpluses turned out to be insufficient to allow the automatic stabilizers to work fully through the recession which started in 2001. As a result, some countries adopted a restrictive pro-cyclical fiscal stance in order to respect the 3% threshold despite the economic slowdown, possibly increasing its amplitude.

Second, the structure of incentives has changed. While the possibility of being excluded from participation in the EMU proved to be a powerful incentive to support fiscal restraint, the stick of the sanctions provided by the excessive deficit procedure of the SGP is relatively weak and uncertain. Calculations by Von Hagen (2002) suggest that after entry to the Union most countries, and especially the big ones, abandoned the process of fiscal consolidation. As a result, many EMU participants have expanded their budgets in good times, thus hitting the 3% deficit during the recent economic stagnation.

Finally, the experience of the first years of EMU has highlighted that the SGP rules have not been correctly implemented in the conduct of fiscal policies. The correct or incomplete implementation can be attributed to several factors, some of which are summarized by Buti and Giudice (2002). First, the requirement of budgets close to balance or in surplus in the medium run is confronted with a lack of consensus of how an output gap, and therefore a structural balance, should be measured. As a result, the only binding (nominal) rule in the SGP makes it intrinsically asymmetric in that it sanctions excessive deficits but does not provide incentives for fiscal consolidation in good times. Second, in the presence of current expenses that are difficult to cut, the balanced budget requirement may result in an insufficient level of investment. More generally, Buiter and Grafe (2001) remark that the enforcement of uniform nominal deficit and debt rules may cause problems for EU members whose initial conditions or medium term growth and inflation rates are different from the EU average. This problem is particularly relevant for the new member states, whose catch-up process may imply a need for higher public investment in infrastructures.

Finally, respect for the 3% deficit threshold of the Treaty does not explicitly address nor automatically ensure sustainable public finances[1], and may in theory

[1]For instance, one-off measures can be used by the national governments as substitutes

still expose the ECB to the "unpleasant monetaristic arithmetic" of Sargent and Wallace (1981).

# 3 The reformed SGP

The European Council of 22-23 March 2005 agreed on a reform of the Stability and Growth Pact. The Pact includes two Council regulations: Regulation 1466/97 on the strengthening of budgetary surveillance and coordination of economic policies (the "preventive arm") and Regulation 1467/97 on the excessive deficit procedure (the "corrective arm"). Both legal texts have been amended in accordance with the report endorsed by the Council. Thus, the reform implies changes to both the preventive and the corrective arms of the Stability and Growth Pact.

The main agreed amendments under the preventive arm are:

- The Stability and Growth Pact lays down the obligation for Member States to adhere to the medium-term objective (MTO) for their budgetary positions of 'close to balance or in surplus' (CTBOIS). In the new formulation the medium-term budgetary objective should be differentiated for individual Member States, to take into account the diversity of economic and budgetary positions and developments as well as of fiscal risk to the sustainability of public finances. The medium-term budgetary objectives may diverge from CTBOIS for individual Member States[2]. They must provide a safety margin with respect to the 3 % of GDP government deficit ratio and ensure rapid progress towards sustainability; taking this into account, they shall allow room for budgetary manoeuvre and public investment. For euro area and ERM2 Member States, budgetary objectives shall be specified within a defined range between – 1 % of GDP and balance or surplus, in cyclically adjusted terms[3], net of one-off and temporary measures.

- The adjustment effort towards the medium-term objective consists of an annual adjustment in cyclically adjusted terms, net of one-off and temporary measures, of 0.5% of GDP as a benchmark. The Commission should issue "policy advice" to encourage Member States to stick to their adjustment path.

- When defining the adjustment path towards the MTO major structural reforms which have direct long-term cost saving effects, including by raising potential growth, will be taken into account. A safety margin with

for structural changes in the budget, and issues as ageing population are at the moment not considered.

[2] The adoption of new, looser medium term targets implicitly recognizes the lack of rationale of the close to balance or in surplus requirement which, if respected, would drive the debt ratios to zero or even to negative values.

[3] The production function approach of the European Commission provides a common framework for calculating CABs. For a description of the Commission's production function approach, see Denis, C., K. McMorrow and W. Röger (2002)

require only minimal identifying assumptions. SVAR models are widely used in empirical studies of monetary policy, but their use in the analysis of fiscal policy is fairly recent.

The lack of high frequency fiscal data or of long annual data series is partially responsible for this lack of interest. However, a number of important contributions have shown that the approach can give useful results. Blanchard and Perotti (1999) use a SVAR with taxes, government spending and GDP, all expressed in real terms, to investigate the dynamic effects of shocks in government spending and taxes in the US. A similar approach, with different specification of the model, can be found in Fatas and Mihov (1999). De Arcangelis and Lamartina (2001) use different identifying restrictions to explore the existence of different fiscal policy regimes. Perotti (2002) studies the effects of fiscal policy on GDP, prices and interest rates in 5 OECD countries. Favero (2003) and others have shown that fiscal and monetary policy cannot be estimated separately, because the interaction effects would bias the estimates.

Following Blanchard and Quah (1989), some authors use long run restrictions, which are relatively easy to reconcile with economic theory. This is the case of Bayoumi and Eichengreen (1992), who apply the long run restriction to divide between supply and demand shocks, and more recently of Dalsgaards and De Serres (2000), who estimate a SVAR for the 11 EMU countries[8]. Garcia and Verdelhan (2001) use a specification scheme à la Clarida-Galí, including both short and long run restrictions. They apply it to synthetic Euro Area data, including yearly GDP, inflation, real short term interest rate and budget balance, and manage to identify four types of shocks: supply, demand, monetary and fiscal. They also estimate cyclically adjusted budget balances and a synthetic indicator of policy mix.

A SVAR has some properties that make it particularly suitable for the present study. First, it can incorporate a measure of the cycle that is completely consistent with the model itself, without requiring additional information as input. It also avoids the need to identify specific and possibly restrictive fiscal and monetary policy rules. The presence of a sufficient number of lags can also include forward-looking behavior of policymakers, to the extent that VAR models can be interpreted as reduced forms of forward-looking models (see e.g. Favero 2003).

A specific advantage of SVAR models is that at least some identifying restrictions can be specified in the form of behavioral rules. This is for instance the case of the Blanchard and Quah long run restrictions that separate temporary from permanent shocks on the basis of their very own definitions. Behavioral restrictions can normally be reconciled with a large variety of economic models, and are therefore easier to accept. Our restrictions are of this nature.

Building on the SVAR approach, we estimate a simultaneous equation model, identifying fiscal shocks on the basis of long-run restrictions.[9]

[8] Their restrictions are that only supply shocks have a permanent effect on output, and that nominal shocks have a permanent impact on prices only.

[9] For a careful description of the properties of simultaneous equation models see Lütkepohl (1993), Ch. 10. For a model with variables similar to ours see Canova and Pappa (2003).

# 5 The model

The structure of the reduced-form model used for estimation is the following one:

$$Y = \sum_{L=1}^{p} C(L)Y + \sum_{L=1}^{q} D(L)X + e \tag{1}$$

where $C(L)$ and $D(L)$ are polynomials in the lag operator and the matrices are defined as follows:

$$Y = \begin{pmatrix} \gamma \\ d \\ \pi \end{pmatrix}; X = \begin{pmatrix} r \\ oil \\ b \end{pmatrix}; e = \begin{pmatrix} e_\gamma \\ e_d \\ e_\pi \end{pmatrix}$$

The model expresses the deficit/GDP ratio $d_t$, the growth rate $\gamma_t$ and the inflation rate $\pi_t$ as a linear function of their own lagged values and of the debt/GDP ratio $b_t$, the real interest rate on debt $r_t$ (or, in a robustness check, the long run interest rate on debt) and the oil price index $oil_t$. The reduced form residuals $e$ are assumed to be identically and independently distributed with mean zero and variance-covariance matrix $\Sigma = E(ee')$.

Our structural model contains three structural shocks: an aggregate supply shock $\varepsilon_t^S$, an aggregate demand (non fiscal) shock $\varepsilon_t^D$, and a fiscal shock $\varepsilon_t^F$. In order to identify these shocks we can rewrite model (1) in moving average ($MA$) form. Omitting the exogenous component we have

$$Y = \sum_{L=0}^{\infty} A(L)e \tag{2}$$

where $A(L) = [I - C_1 - ... - C_p]^{-1}$ and $A(0) = I$ are known.

Structural form residuals $\varepsilon_t$ are assumed to have a normalized covariance matrix: $E(\varepsilon\varepsilon') = I$. They are linked to the reduced form residuals $e$ by the linear transformation $S$:

$$\varepsilon_t = \begin{bmatrix} \varepsilon_t^S \\ \varepsilon_t^F \\ \varepsilon_t^D \end{bmatrix} = S^{-1}e_t \qquad \forall t \tag{3}$$

Taking into account that $SS^{-1} = I$, equation (2) may be rewritten as

$$Y = \sum_{L=0}^{\infty} A(L)SS^{-1}e = \sum_{L=0}^{\infty} B(L)\varepsilon \tag{4}$$

where

$$\begin{aligned} B(L) &= A(L)S \qquad \forall L \\ B(1) &\equiv \sum_{L=1}^{\infty} B(L) = \sum_{L=0}^{\infty} A(L)S \equiv A(1)S \end{aligned}$$

Three identifying restrictions are required to just-identify the structural innovations from the reduced form VAR. Following a solidly established tradition, we identify the supply shocks $\varepsilon_t^S$ as the only shocks to have a permanent long-run effect on growth. This is equivalent to restricting to zero the $(1,2)$ and $(1,3)$ elements of matrix $B(1)$. Moreover, the aggregate (temporary) demand shock $\varepsilon_t^D$ is assumed to have no long-run impact on the deficit/GDP ratio. This is equivalent to restricting to zero the $(2,3)$ element of matrix $B(1)$. The fiscal shock $\varepsilon_t^F$ is left free. After imposing these restrictions, the long-run matrix $B(1)$ looks like:

$$B(1) = \begin{bmatrix} b_{11} & 0 & 0 \\ b_{21} & b_{22} & 0 \\ b_{31} & b_{32} & b_{33} \end{bmatrix} \tag{5}$$

After imposing these restrictions, the signs of some of the elements of the $S$ matrix need to be normalized.[10] We choose a normalization such that the structural disturbances correspond to what are normally considered positive shocks.

## 5.1 The variables

Our dataset contains 25 annual observations of six variables for each of the EMU countries, with the exception of Luxembourg, over the years $1980 - 2004$. The beginning of the sample in 1980 is chosen in order to concentrate on monetary regimes that stabilize inflation around a target value and to avoid modelling the impact of the two oil shocks.

The endogenous variables are: the rate of inflation (GDP-deflator based) $\pi_t$, the real GDP growth rate $\gamma_t$, the deficit/GDP ratio $d_t$. A negative value of $d_t$ indicates a deficit, a positive value a surplus. The exogenous variables include a measure of the real interest rate on debt (the implicit interest rate, calculated as general government interest as percent of gross public debt of preceding year) $r_t$, the oil price index expressed in national currency $oil_t$, the debt/GDP ratio $b_t$. The use of annual data when working with a dataset containing fiscal variables is in line with the literature and due to the absence of non-interpolated data at higher frequencies. The real interest rate on debt is introduced to take into account the relationship between financial and monetary developments and the interaction between fiscal variables, inflation and real GDP. A robustness check uses long term bond yields, leading to similar results. Oil prices are used to capture the world economic cycle and exchange rate movements. The lagged value of government debt is introduced on the basis of the arguments contained in Favero and Monacelli (2003) and OECD (2003), according to which sustainability problems associated with indebtedness seem to be an important determinant of whether fiscal stance is pro-cyclical.

[10] See Christiano, Eichenbaum, and Evans (1999) for a discussion of this issue.

## 5.2 The EMU effect

A problem arising in this simulation exercise is that the beginning of EMU towards the end of sample may lead to a structural break in the conduct of economic policies. More specifically, it has been argued that the EMU may provoke a structural break in governments' behavior. The adoption of a common currency eliminates exchange rate risk and the associated interest rate premia among the participating countries. Furthermore, additional deficit can be financed more easily because the cost of the additional borrowing in terms of higher interest rates is partly spread across the entire currency area. Both factors may in principle lead to an increase in the deficit bias of fiscal policies. Fiscal developments since 1999 seem to suggest that indeed after the beginning of EMU fiscal consolidation has stopped and even reversed in some countries. This hypothesis is tested by adding a dummy starting in 1999 until the end of available data[11], and testing for its relevance. The results, reported in table <DUM>, show that this dummy is often not significant; when it is, the sign is not always the one expected.

[11] The choice of 1999 as first year coincides with the beginning of the third phase of the EMU. From the purely economic point of view, it presents a margin of arbitrariness, as argued in Canova and Pappa (2004), according to whom previous years (1997 and 1998) may already belong to the new regime. However, Canova and Pappa also find that the qualitative conclusions do not change by omitting these two years. An earlier break date would probably be opportune in a monetary policy rule, but we do not model monetary policy as an endogenous variable.

| | | Betas | | T-stats | |
|---|---|---|---|---|---|
| | | D 94-98 | D 99-04 | D 94-98 | D 99-04 |
| Belgium | Y= | -0.04 | -0.01 | *-0.52* | *-0.31* |
| | S= | 0.06 | 0.02 | *1.16* | *0.87* |
| | P= | -0.01 | 0.00 | *-0.28* | *-0.18* |
| Germany | Y= | -0.04 | -0.02 | *-0.26* | *-0.48* |
| | S= | 0.16 | 0.03 | *2.71* | *1.96* |
| | P= | 0.06 | 0.02 | *1.13* | *1.97* |
| Greece | Y= | -0.08 | 0.00 | *-0.67* | *-0.04* |
| | S= | 0.25 | 0.02 | *2.42* | *0.65* |
| | P= | 0.01 | 0.00 | *0.10* | *-0.05* |
| Spain | Y= | 0.11 | 0.03 | *1.33* | *1.59* |
| | S= | 0.12 | 0.04 | *1.98* | *3.08* |
| | P= | -0.04 | 0.00 | *-0.40* | *0.15* |
| France | Y= | 0.10 | 0.00 | *1.77* | *0.22* |
| | S= | 0.04 | 0.00 | *1.02* | *-0.14* |
| | P= | 0.03 | 0.00 | *0.63* | *0.26* |
| Ireland | Y= | 0.17 | 0.00 | *1.76* | *0.09* |
| | S= | -0.05 | -0.05 | *-0.82* | *-1.96* |
| | P= | -0.07 | -0.04 | *-0.62* | *-0.84* |
| Italy | Y= | 0.20 | 0.02 | *3.24* | *1.33* |
| | S= | -0.01 | 0.00 | *-0.16* | *0.16* |
| | P= | 0.19 | 0.03 | *2.09* | *1.22* |
| Neth. | Y= | 0.06 | 0.01 | *1.38* | *0.63* |
| | S= | 0.12 | 0.04 | *2.03* | *1.33* |
| | P= | -0.01 | -0.02 | *-0.14* | *-0.58* |
| Austria | Y= | -0.03 | -0.02 | *-0.32* | *-0.70* |
| | S= | -0.01 | 0.02 | *-0.29* | *1.72* |
| | P= | 0.03 | 0.01 | *0.77* | *0.83* |
| Portugal | Y= | -0.02 | -0.02 | *-0.20* | *-0.62* |
| | S= | -0.12 | -0.03 | *-1.31* | *-1.09* |
| | P= | -0.06 | -0.02 | *-0.30* | *-0.41* |
| Finland | Y= | 0.16 | 0.04 | *0.92* | *1.07* |
| | S= | 0.04 | 0.03 | *0.33* | *1.16* |
| | P= | -0.09 | -0.01 | *-0.55* | *-0.27* |

Table <DUM> - convergence and EMU dummies in the model

The few available data after 1998 do not allow for a test for structural breaks. However, graphs <BR98.1> to <BR98.3> in the appendix show the out-of-sample forecasts of the models estimated with data until 1998 against the observed variables until 2004. The dotted lines represent the median and the 90%, 95% and 99% confidence bands, the continuous circled line the observed data from 1998 onwards. The forecasting ability of the model estimated until 1998 turns out to be quite good. One can thus conclude that the structural

break is not statistically relevant and that pre-EMU estimated VARs are a good approximation of the economic structure in the whole sample. Following this conclusion, the model is re-estimated using the whole 1981-2004 sample.

Finally, a structural change certainly induced by the EMU is that the monetary authority, now targeting union-wide aggregates, will appear as little or not at all reactive to the national policymakers. While this phenomenon does not affect much our estimations, since we do not aim at estimating an interest rate rule, the out-of-sample simulation will be run using a constant real interest rate equal to the one observed in the country in 2004. This is a compromise solution in the absence of information about the future developments of the real interest rate. The other assumption concerns the inflation rate, which in the simulations is set at 2%, a value compatible with the definition of price stability of the ECB.

# 6 The historical effect of European fiscal policy

This section assesses whether, in the past, discretionary fiscal policy has been effective in smoothing the economic cycle, or whether a procyclical component has prevailed, thus increasing the amplitude of the cycle. With the term "discretionary fiscal policy" we mean here those changes in fiscal variables that do not respond automatically to changes in economic conditions, as opposed to the so-called "automatic stabilizers". Indeed, several recent works (e.g. Fatas and Mihov, 2003) questioned the conventional wisdom that fiscal policy is necessarily counter-cyclical by showing that in many countries discretionary fiscal policy has been pro-cyclical. Other authors (e.g. Mélitz, 2000) claimed that in Europe the conduct of discretionary fiscal policy also reduced the effectiveness of the automatic stabilizers. A study of the OECD (2003) finds evidence of procyclical easing in upturns and suggests that a high level of automatic stabilization associated with large public sectors may easily lead to more pro-cyclical discretionary fiscal policy. Galí and Perotti (2003) conclude that discretionary fiscal policy has become more counter-cyclical over time in EMU countries, but find the same trend in other industrialized countries.

The evaluation of the past effect of fiscal policies is conducted by comparing the variance of synthetic economic cycles, each constructed under different assumptions about fiscal policy. How a cycle can be constructed in the context of the estimated model is quite straightforward: only one of the identified shocks has a permanent effect on growth, the two other shocks (demand and fiscal) measure the temporary component, that is the cycle. The cycle is derived simply by shutting down the permanent shock in the estimated structural model.

Different assumptions on the fiscal shocks produce counterfactual economic cycles, whose variance can easily be compared[12]. By assumptions about fiscal

[12] The averages of growth and inflation are intentionally omitted from the tables. The reason is that fiscal policy cannot sustain growth beyond the short run and has to be repaid at some point in time. In our model the effect is zero in the long run, following the identifying

policy we simply mean a sequence of fiscal shocks, which can be for example the sequence of residuals estimated from the deficit equation (we refer to this case as observed fiscal policy) or some other completely different sequence. The only limit imposed on these alternative sequences is that the probability distribution from which each shock is drawn is the same as the distribution of the observed residuals. This bootstrapping technique allows us to derive different fiscal policies but keeps them "reasonable". It has to be noted that every different sequence of shocks defines a different *discretionary* fiscal policy; the systematic component of fiscal policy, the so called automatic stabilizers, is always operating, as it is embedded in the structural parameters of the model.

The "observed cycle", corresponding to observed fiscal policy, is our baseline scenario and is compared with counterfactual cycles derived from different fiscal shocks. Its variability (measured by the variance of growth) is normalized to 100 in column 1 for comparability purposes. The results are reported for the whole sample and for the pre-1992 and post 1992 sub-samples.

**Variability of growth: 1980-2004**

| | Cycle | Without fiscal shocks | Best fiscal policy |
|---|---|---|---|
| | | All | All |
| Belgium | 100 | **71.9** | **67.2** |
| Germany | 100 | 93.0 | **84.4** |
| Spain | 100 | 91.8 | **83.6** |
| France | 100 | 99.3 | **94.8** |
| Ireland | 100 | 99.8 | **97.4** |
| Italy | 100 | **91.0** | **82.5** |
| TheNetherlands | 100 | 93.9 | 85.2 |
| Austria | 100 | 98.9 | 93.6 |
| Portugal | 100 | 98.3 | 92.3 |
| Finland | 100 | 83.2 | **75.5** |

restrictions, therefore the differences would never be significant.

**Variability of growth: 1980-1992**

| | Cycle | Without fiscal shocks | Best fiscal policy |
|---|---|---|---|
| | | 80s | 80s |
| Belgium | 100 | **70.9** | **56.9** |
| Germany | 100 | 95.1 | **80.7** |
| Spain | 100 | 94.3 | **81.3** |
| France | 100 | 106.0 | **99.0** |
| Ireland | 100 | 99.6 | **95.2** |
| Italy | 100 | **124.7** | **103.7** |
| TheNetherlands | 100 | 103.1 | 84.9 |
| Austria | 100 | 94.6 | 86.6 |
| Portugal | 100 | 98.0 | 89.2 |
| Finland | 100 | 68.6 | **53.8** |

**Variability of growth : 1993-2004**

| | Cycle | Without fiscal shocks | Best fiscal policy |
|---|---|---|---|
| | | 90s | 90s |
| Belgium | 100 | **75.5** | **58.5** |
| Germany | 100 | 111.3 | **93.3** |
| Spain | 100 | 104.2 | **87.7** |
| France | 100 | 89.5 | **81.4** |
| Ireland | 100 | 102.3 | **96.7** |
| Italy | 100 | **71.8** | **56.4** |
| TheNetherlands | 100 | 79.4 | 64.8 |
| Austria | 100 | 105.3 | 94.1 |
| Portugal | 100 | 106.6 | 91.7 |
| Finland | 100 | 90.7 | **74.0** |

The second column shows what happens when the discretionary part of fiscal policy is shut down, letting the automatic stabilizers and every systematic component operate freely. The cycle in the "without fiscal shocks" column is derived by shutting down (putting to zero) both the permanent and the fiscal shocks, thus constructing a cycle purely driven by the third (demand) shock: it is useful to recall that this simulation does not refer to a world without fiscal policy, as the automatic stabilizers are embedded in the impulse responses of the deficit, but simply to one in which rules predominate over discretion[13]. This simulation has the interesting feature that it eliminates the component

[13] The reason for which we do not simply build a fiscally induced cycle and measure its

of fiscal policy which can be misused by politicians. The results suggest that discretionary fiscal shocks explain only a moderate part of the variance in the cycle, with the possible exceptions of Italy and Belgium, in which discretionary fiscal policy appears to have been a major source of economic fluctuations.

The other counterfactual simulation aims at deriving some measure of the *potential* for fiscal policy to stabilize the economy. Our simulation proceeds in two steps: in the first, we simulate the effect of quasi-random sequences of fiscal shocks, where the definition of quasi-random refers to the fact that the sequences of fiscal shocks are bootstrapped from the observed ones in order to have the same a priori distribution[14]. Among the simulations, we then choose as "best fiscal policies" those that best succeded in minimizing the variance of the cycle. However, the implementation of such best fiscal policies would require an amount of resources and information which is equivalent to perfect foresight and is way beyond the possibilities of any government. We take this objection into account and at the same time we increase the robustness of the analysis by considering, among the possible fiscal policies, the 5th to the 10th percentile of best scoring fiscal policies, and by averaging the corresponding variability of the cycle. It appears that fiscal policies could have been better used for countercyclical purposes in many countries. However, the only really big effects are to be found in Belgium and Finland, where the variability of growth is reduced by more than 25%. Germany, Italy and Spain present potential reductions close to 20%.

The comparison between the "without fiscal shocks" and the "best fiscal policy" scenarios is of particular interest, as the resulting output variances go in the same direction and are sometimes close to each other. In practice it appears that the "best policy" can be to some extent approximated by not using discretionary fiscal policy and simply letting the automatic stabilizers work freely. This latter solution also requires a comparatively minimal amount of information.

# 7 Reforming the Stability Pact

## 7.1 The simulated scenarios

In this section we try to assess whether some of the reforms of the Pact that are currently being implemented are likely to have an effect on the variability of the cycle. Since many of the proposals are difficult to quantify, we focus on stylized scenarios.

For the Preventive arm of the Pact:

variance is that there are interactions between the effects of demand, fiscal and monetary shocks, and we want to capture them in the simulation.

[14] The simulation is conducted on the shocks over the whole sample and on the two subsamples representing the 80s and the 90s, in order both to check robustness and to see if there are important cases of different policies. The model is always the one estimated over the whole sample.

- We calculate for each single country a "safety margin with respect to the 3 % of GDP government deficit ratio" and a second "safety margin ensuring rapid progress towards sustainability". These two conditions motivate the introduction of the new country-specific Medium Term Objectives (MTOs) of the new Stability Pact, which would be, in cyclically adjusted terms and net of one-off and temporary measures, between -1% of GDP and "in balance or surplus".

For the corrective arm of the Pact the effect of a different set of rules is simulated:

- In the "SGP scenario" the simulation is conducted in accordance with a stylized version of the old rules. In practice, as the operation of the corrective arm in the previous formulation of the SGP required that an excessive deficit must be corrected in the year following its identification, up to two years above 3% are allowed in the simulation before the deficit is forced again below the reference value. The imposed correction, when it happens, is instantaneous. This rule is not applied in the presence of "exceptional circumstances", defined in the simulation as a negative growth of -0.75% of GDP.

- A "no Pact scenario" is the second benchmark. In this case, the simulation is simply run on the estimated model without any constraint on fiscal variables.

- The three following simulations assess the effect of different changes in the Pact, each taken in isolation. The current SGP is modified in scenario 3 to allow for a longer time period (three years) above the reference value, scenario 4 modifies the threshold that defines the "exceptional circumstances" to 0% and scenario 5 allows a country in excessive deficit to revert below the 3% threshold progressively and taking into account the cycle, that is by imposing a 0.5% structural consolidation per year.

- The interactions between two modifications in the Pact are taken into account in simulation 6, which implements the changes in the time allowed to correct the deficit and the new 0% threshold for the exceptional circumstances.

## 7.2 Results: the medium term objective

This section finds numerical values for a "safety margin with respect to the 3 % of GDP government deficit ratio" and a "safety margin ensuring rapid progress towards sustainability", and compares them with the MTOs of the reformed SGP and with the results of Artis and Buti (2000).

In order to perform statistical analysis, we resort to dynamic stochastic simulation (DSS). As a statistical methodology, DSS is based on two assumptions. First, that the estimated model provides an adequate description of the economic phenomenon under consideration over the simulation period. Second,

that the original distribution of estimated residuals is an adequate empirical measure of economic shocks, embracing a sufficiently ample spectrum of possibilities to form an adequate basis for the bootstrapping exercise[15]. For any period in the simulation, the DSS requires taking the following steps:

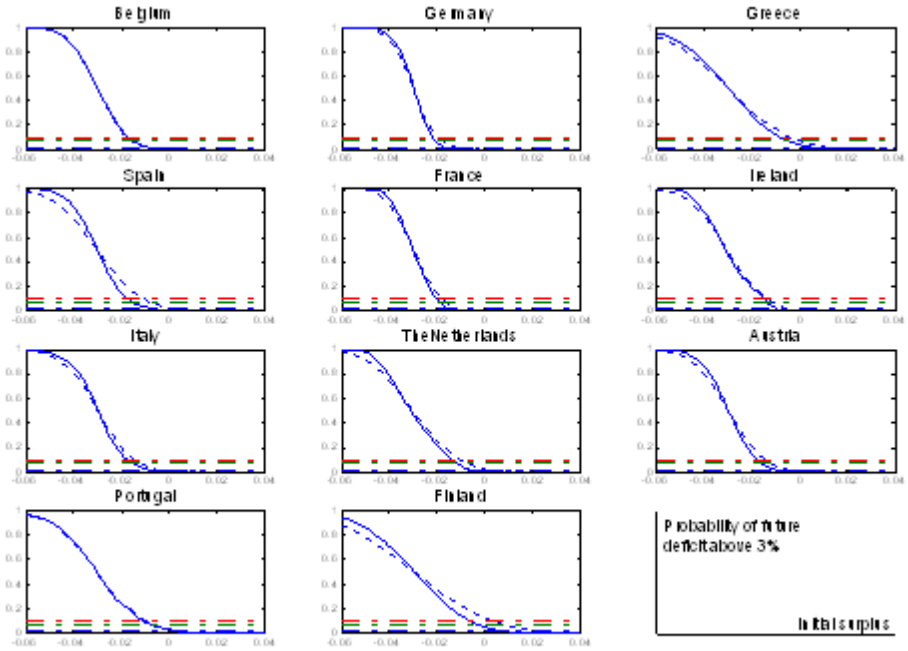
1. A shock is randomly chosen among the residuals of the estimated model (bootstrapping).
2. A new (simulated) data point is obtained by applying this shock to the estimated model.
3. This new corrected data point is added to the data
4. For every period over the simulation horizon, points 1 to 3 are repeated. At every step, statistics of interest are collected.

Replicating the simulation described in steps $1-4$ a congruous number of times (10000 in our case for each country), each time with a new set of shocks randomly chosen from the original distribution, it is possible to construct an ample set of alternative paths the economy might follow on the basis of the structure of the model and of the original distribution of residuals. These replications are the basis for our subsequent analysis.

The "safety margin" is defined as the target for the cyclically adjusted deficit which prevents the nominal deficit from breaching the 3% limit under normal economic fluctuations. In order to identify the safety margin, two informations are necessary: the knowledge of the probability of breaching the 3% reference value given an initial deficit value, and a (forcely subjective) assessment of what can be considered a sufficiently prudent probability $\overline{p}$.

The first of the two elements, the probability of exceeding the 3% threshold conditional on different levels of deficits, can be calculated on the basis of our simulations. The probability curves are reported in figure <MTO>: the continuous curves report the probability of going above 3% one year ahead for every initial level of deficit, the dotted curves the same probability two years ahead. As expected, a higher initial deficit implies higher probabilities of excessive deficits given normal economic fluctuations.

[15] In this context, the DSS assumes that the cyclical behavour of the economies has not changed with the advent of EMU. This hypothesis is unlikely to hold in the long run. Artis and Buti point out that "as the cyclical behavior of the euro-area economy adapts to the new EMU environment, the medium-term targets will need to be re-addressed"




As for the prudent probability $\bar{p}$, since the main scope of the safety margin is to prevent the occurrence of deficits above 3%, it should be fixed to a fairly low level, to make sure that the probability of future excessive deficits is not too high. Given the arbitrariness of choosing a "prudent probability", we pick up probabilities which are consistent with the rest of the rules contained in the Pact: the safety margin will then be such that the probability of trespassing the 3% limit under normal economic fluctuations is *grosso modo* the same as the probability of applying the exceptional circumstances clause, under which a deficit higher that three per cent is allowed. Looking at the real growth figures for the eurozone countries in the period 1980-2004, we observe that growth has been below -2% in 1.45% of the cases, below -0.75% in 6.91% of the cases and below 0% in 9.82% of the cases. The first two probabilities correspond to "prudent probabilities" of the old SGP, the third is derived from the new set of rules. Figure <MTO> also represents these probabilities as horizontal dotted lines.

The one-year-ahead safety margin for a country is then defined as the level of the deficit/GDP ratio which keeps the probability of that country's deficit being larger than 3% one year ahead below the prudent probability $\bar{p}$. Analogously, the two-years-ahead safety margin is defined as the level of the deficit/GDP ratio associated with a $\bar{p}$% probability of being larger than 3% two years ahead. In picture <MTO>, one looks at the intersection of the curves with the horizontal probability lines.

The values corresponding to the different safety margins are reported in the following table:

| Safety margin with respect to the 3 % threshold | | | | | | |
|---|---|---|---|---|---|---|
| | Probability: 1.45% | | Probability: 6.91% | | Probability: 9.82% | |
| | 1yr ahead | 2yr ahead | 1yr ahead | 2yr ahead | 1yr ahead | 2yr ahead |
| Belgium | -0.7% | -0.9% | -1.5% | -1.6% | -1.7% | -1.8% |
| Germany | -1.6% | -1.1% | -2.0% | -1.7% | -2.1% | -1.9% |
| Greece | 1.1% | 2.3% | -0.3% | 0.6% | -0.6% | 0.1% |
| Spain | -0.7% | 0.1% | -1.6% | -0.9% | -1.8% | -1.2% |
| France | -1.7% | -1.4% | -2.1% | -1.9% | -2.3% | -2.0% |
| Ireland | -1.0% | -0.5% | -1.5% | -1.2% | -1.7% | -1.5% |
| Italy | -0.6% | -0.1% | -1.4% | -1.0% | -1.6% | -1.3% |
| TheNetherlands | -0.5% | 0.5% | -1.2% | -0.6% | -1.4% | -0.9% |
| Austria | -0.7% | 0.4% | -1.5% | -0.8% | -1.6% | -1.1% |
| Portugal | -0.1% | 0.6% | -1.0% | -0.4% | -1.2% | -0.7% |
| Finland | 0.8% | 2.1% | -0.3% | 0.6% | -0.6% | 0.2% |

Safety margin with respect to the 3 % threshold. Negative numbers are deficits.

The resulting safety margins one year ahead calculated for the 0% threshold of the 'new Pact' (that is for a prudent probability of 9.82%) are as high as 2.3% deficit for France, where the shocks are relatively small, and as small as 0.6% for Greece, a country whose estimated model tends to produce systematic high deficits, or Finland, whose bootstrapped shocks include the fall of Soviet Union in the beginning of the 1990s. The average safety margin is around 1.5%. Looking at the safety margins two years ahead, they are slightly more restrictive, as one might expect, with an average of around 1.1% and a maximum at 2% (again France). This results are very similar to those obtained by Dalsgaard and DeSerres (1999) with a similar SVAR methodology.

A similar exercise has already been undertaken by Artis and Buti (2000), who use output gap and elasticities of the budget balance to the cycle. The methodology used in this section is different, in that it does not use any outside information on output gap or elasticities. This difference in methodology is partially reflected in the results; in their paper, Germany, Greece, France, Italy and Austria could aim for a deficit slightly above 1% of GDP, while the other countries should remain below.

As a second requirement, the medium term objectives would be defined in such a way that the debt would be "sufficiently diminishing and approaching the 60% reference value at satisfactory pace".

Debt sustainability is listed among the relevant factors that the Commission has to take into account when preparing a report under article 104(3) of the treaty. It has been agreed that the debt condition shall be evaluated in qualitative terms, but it cannot be ruled out that the reaffirmed commitment to debt

reduction may actually lead to the definition of a more specific framework of assessment. In the present paper the definition of debt ratio sufficiently diminishing and approaching the 60% reference value at satisfactory pace is quantified by the following general form:

$$b_t - b_{t-1} = -\lambda \left( b_{t-1} - b^* \right) \tag{6}$$

in which the required rate of debt reduction $b_t - b_{t-1}$ declines linearly with the deviation from debt target $b_{t-1} - b^*$ at a constant adjustment speed $\lambda$. Budget dynamics in terms of GDP ratios are expressed by

$$b_t = def_t + \frac{b_{t-1}}{(1 + y_t)(1 + \pi_t)} \tag{7}$$

where $def_t$ is deficit (including interest payments), $y_t$ is real GDP growth and $\pi_t$ is inflation. Putting together the required consolidation (6) and the equation of debt dynamics (7) we obtain the following expression:

$$def_t = \lambda b^* + \left( 1 - \lambda - \frac{1}{(1 + y_t)(1 + \pi_t)} \right) b_{t-1} \tag{8}$$

which shows that for every nominal growth rate $(1 + y_t)(1 + \pi_t)$ the required deficit level $def_t$ is a positive function of the debt target $b^*$ and, for realistic values of the parameters[16], a negative function of the previous level of debt $b_{t-1}$. Taking long run values for $\pi$ and $y$, equation (8) identifies for each debt level a safety margin ensuring rapid progress towards sustainability.

In order to implement the simulation, numerical values are needed for the parameters. In equation (6) we choose $\lambda = 0.05$ and experiment with both $b^* = 0.4$ and $b^* = 0.6$. The first value of $b^*$ implies that a country with a high debt ratio around 100% of GDP will be initially required to reduce this ratio by 3% yearly, while the required debt reduction will be of 1% for a debt ratio just above 60% of GDP; as a consequence, the 60% debt criterion would be satisfied in a finite number of years. The second value of $b^*$ would drive the debt ratio to 60% only asymptotically. The long run value for inflation in equation (7) is set to $\pi = 0.02$, a value compatible with the objective of price stability of the ECB. Two values of structural growth are tried in order to provide with robust evidence, the structural growth provided from the estimated model and the average real growth observed in the 2001-2004 period. The results are summarized in the following table.

Medium term objectives such that the debt would be "sufficiently diminishing and approaching the 60% reference value at satisfactory pace". Negative numbers are deficits.

The resulting medium term objectives vary extensively from country to country. With the adoption of the more restrictive debt target at 40% of GDP and

[16] For small values of $\lambda, y$ and $\pi$ the condition to have a negative coefficient is $\lambda > y + \pi$.

| | Debt in 2004 | Thresholds based on Average real growth 2001-2004 | | Thresholds based on structural growth from model | |
|---|---|---|---|---|---|
| *Lambda* | | *0.05* | *0.05* | *0.05* | *0.05* |
| *Bstar* | | *60%* | *40%* | *60%* | *40%* |
| Belgium | 96% | -1.4% | -0.4% | -1.6% | -0.6% |
| Germany | 65% | -1.5% | -0.5% | -1.6% | -0.6% |
| Greece | 111% | -4.0% | -3.0% | -4.2% | -3.2% |
| Spain | 47% | -3.0% | -2.0% | -2.6% | -1.6% |
| France | 65% | -2.0% | -1.0% | -2.1% | -1.1% |
| Ireland | 30% | -3.6% | -2.6% | -3.9% | -2.9% |
| Italy | 107% | -0.7% | 0.3% | -1.7% | -0.7% |
| TheNetherlands | 56% | -1.6% | -0.6% | -2.7% | -1.7% |
| Austria | 65% | -1.8% | -0.8% | -2.1% | -1.1% |
| Portugal | 62% | -1.4% | -0.4% | -1.9% | -0.9% |
| Finland | 45% | -2.6% | -1.6% | -2.9% | -1.9% |

the average 2000-2004 growth, both of which imply a higher consolidation effort, Belgium, Germany, France, The Netherlands, Austria and Portugal should aim at structural deficits between 0 and 1% of GDP. Greece, Spain, Ireland and Finland wold achieve the necessary debt reduction also in presence of higher structural deficits, while Italy should target a surplus of about 0.3% of GDP. The less demanding 60% target would allow for structural deficits 1% higher, while the adoption of the growth estimated from the models changes the results only marginally (excepted for Italy and Portugal).

In order to derive numbers comparable with the medium-term budgetary objective of the new SGP, which must both provide a safety margin with respect to the 3 % of GDP government deficit ratio and ensure rapid progress towards sustainability, the lowest numbers from both exercises must be considered. In a somewhat arbitrary choice, the one year ahead safety margins and the second column of the previous table are considered. The resulting picture is overall supportive of the new MTOs from 1% deficit to close to balance or in surplus; Ireland and Spain could be allowed less demanding targets, whilst Italy should target a structural surplus in order to reduce the debt ratio.

It should however be noted that the data used in the simulation are overall deficits, while the MTOs are defined on deficits excluding temporary measures and implicit liabilities. The results are therefore to be considered as indicative.

## 7.3 Results: the corrective arm

The corrective arm of the Pact has been subject to extensive revisions. Such revisions or "improvements" in the corrective arm followed the repeated breaching of the old rules by large countries such as France and Germany. They were

justified on the basis of the need to increase the economic rationale of the Pact and diminish the character of "straightjacket" of rules which were leading to pro-cyclical policies and increased variability of the economic fluctuations.

This section aims at evaluating the systematic effect of different fiscal rules on the amplitude of the economic cycle and on the level of deficits which are obtained under normal economic fluctuations. The six scenarios described at the beginning of the section are simulated and the resulting variability of growth is compared.

In practice, the variabilities are calculated by repeating the Dynamic Stochastic Simulation as explained in the previous section. According to the chosen scenario, suitable shocks are fed to the simulation. The working of fiscal rules which act ex post is imposed on the simulated data: if a simulated point violates the rules imposed by the scenario (e.g. a simulated deficit/GDP ratio higher than 3% in scenario 2), a correction is applied. Following the DSS, it is possible to determine the distributions and probabilities of the real growth rate and of the deficit/GDP ratio, and calculate means and variances.

The results on the variability of growth are summarized by graphs <VAR1> and <VAR2>, one for each country. The variability of output corresponding to the benchmark scenario ("free" fiscal policy, without any constraint from the pact) has been normalized to 100 for comparability purposes.

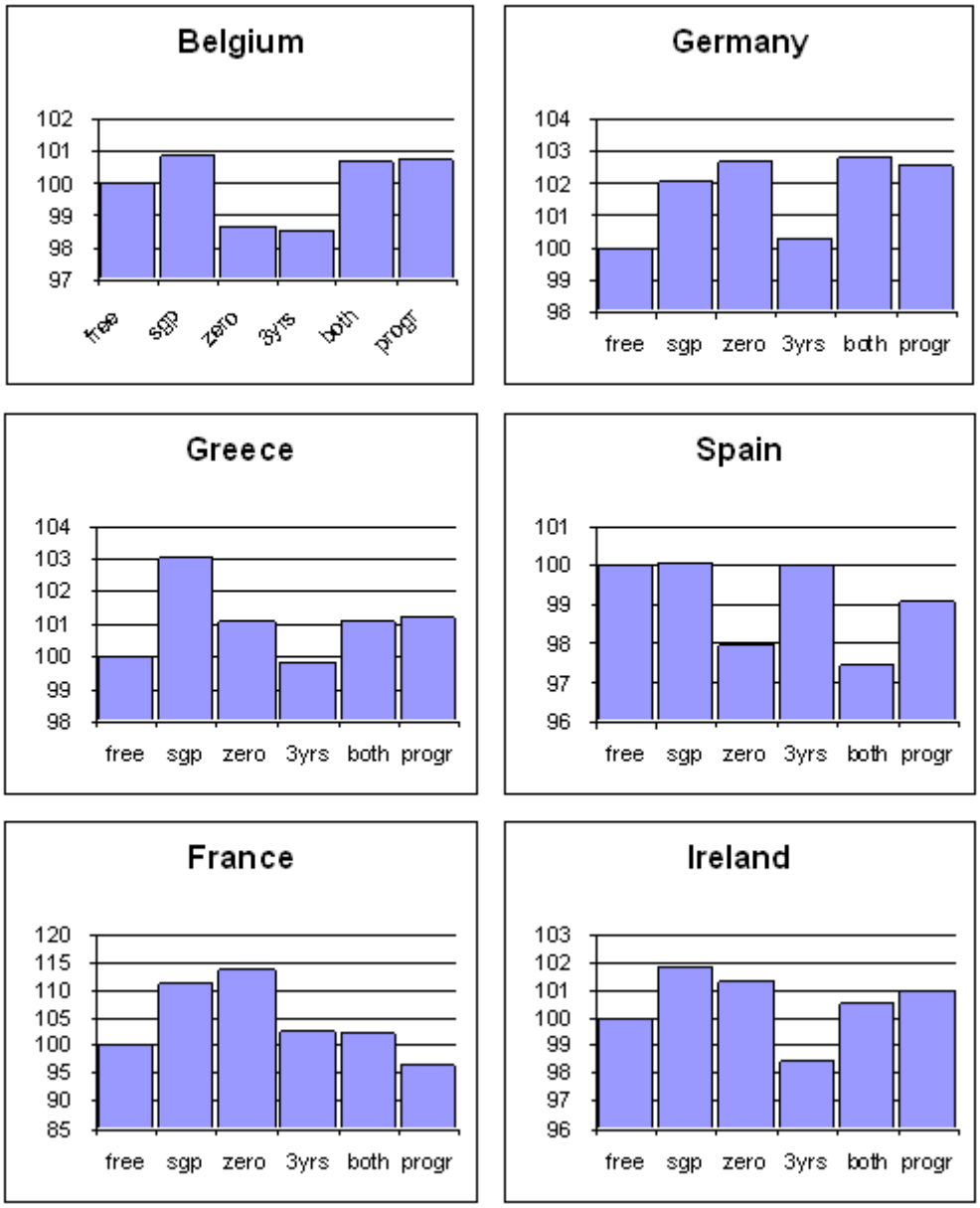



Figure <VAR1> - variability of output

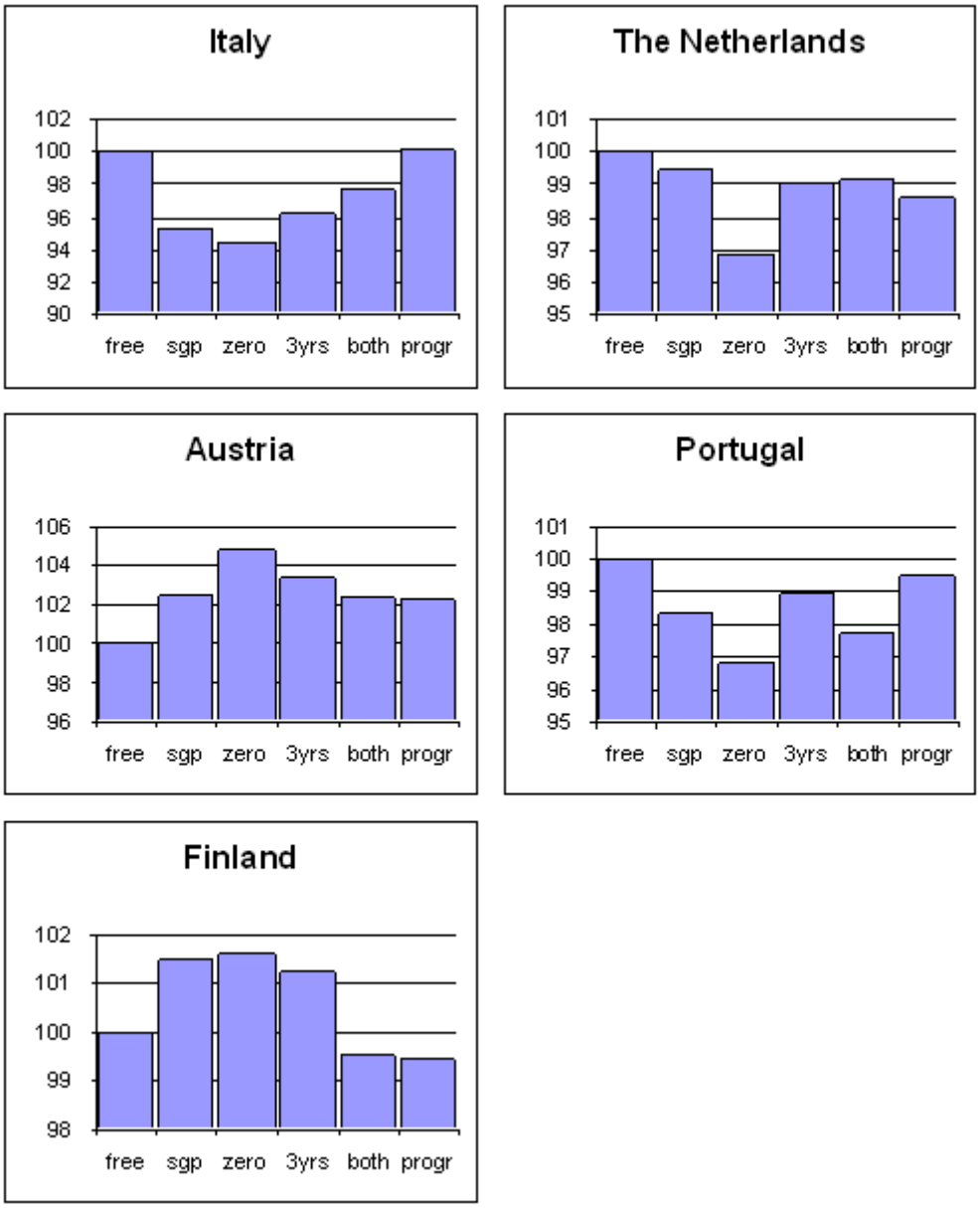



Figure <VAR2> - variability of output

The figures provide somewhat surprising results. First, the variability of growth increases under the effect of the SGP rules only for a few countries. Among those we find some of the countries that have been struggling to respect the rules, or that have failed to do so, such as Germany, Greece and France, but not Italy and Portugal, which on the contrary seem to have benefitted from the

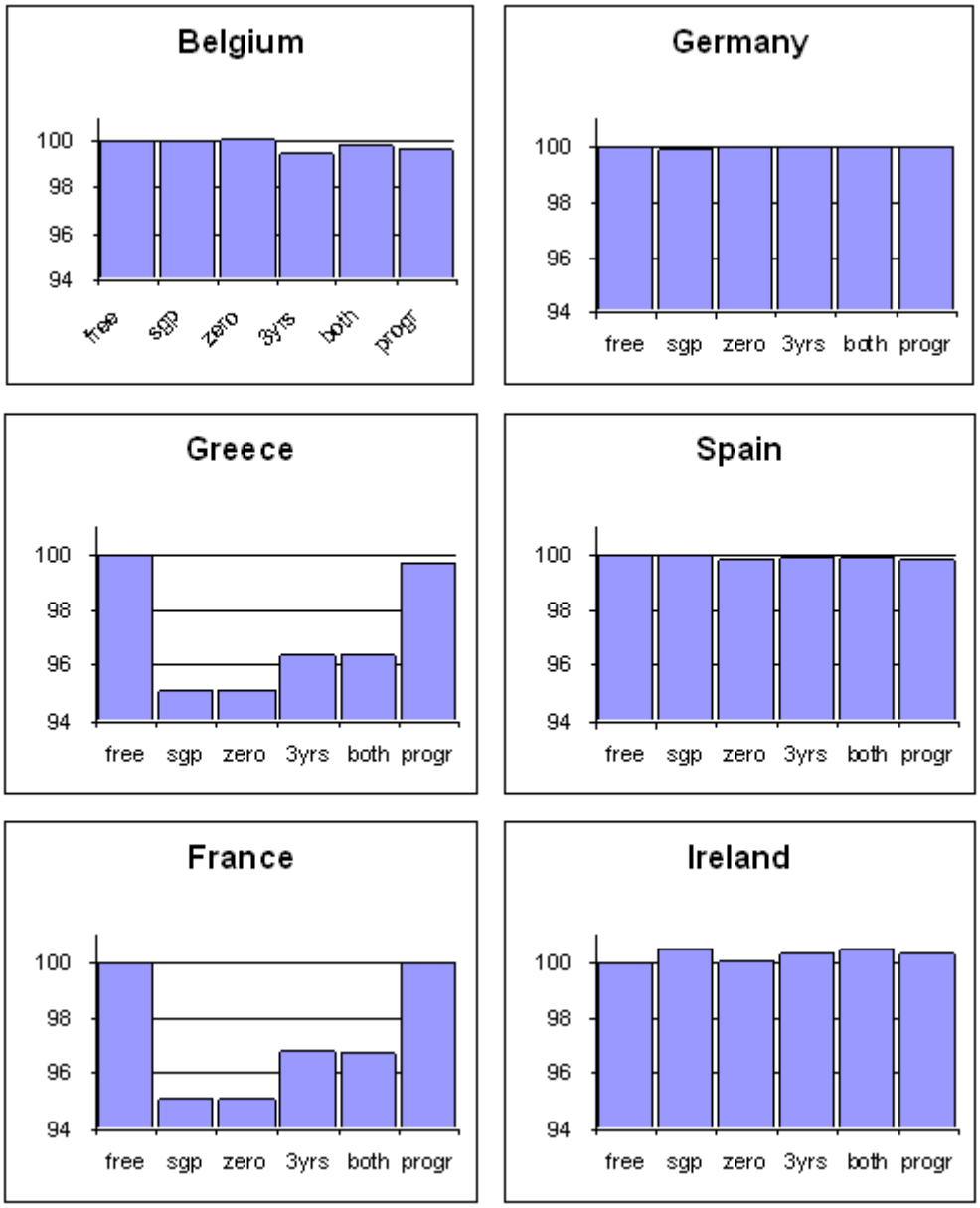
higher discipline that the Pact imposed on a naturally pro-cyclical fiscal policy. Even for these countries, however, the effect is limited. A possible interpretation of this result could be that for many countries the Stability and Growth Pact has been little more than the officialization on paper of policies which were already in place.

This conclusion is supported by comparing the "sgp" column with the following columns in each graph. Column "zero", corresponding to the new 0% growth threshold for applying the exceptional circumstances clause, is at least 2% lower than the "SGP" column in Belgium, Spain and the Netherlands, and at least 2% higher in France only. A longer time span given to correct a situation of excessive deficit seems to moderately reduce the variability of the cycle in several countries, namely Belgium, Germany, Greece, France, Ireland and the Netherlands. This change in the Pact seems as a matter of fact to improve economic stabilization by avoiding an immediate correction of the deficit below the 3%. On the other hand, the progressive correction of excessive deficit, highlighted in column "progr", does not seem to have relevant effects. This may be due to the fact that even in our free models the countries are never willing to go from one year to the other to such high deficits that an instantaneous correction is much different from a progressive one.

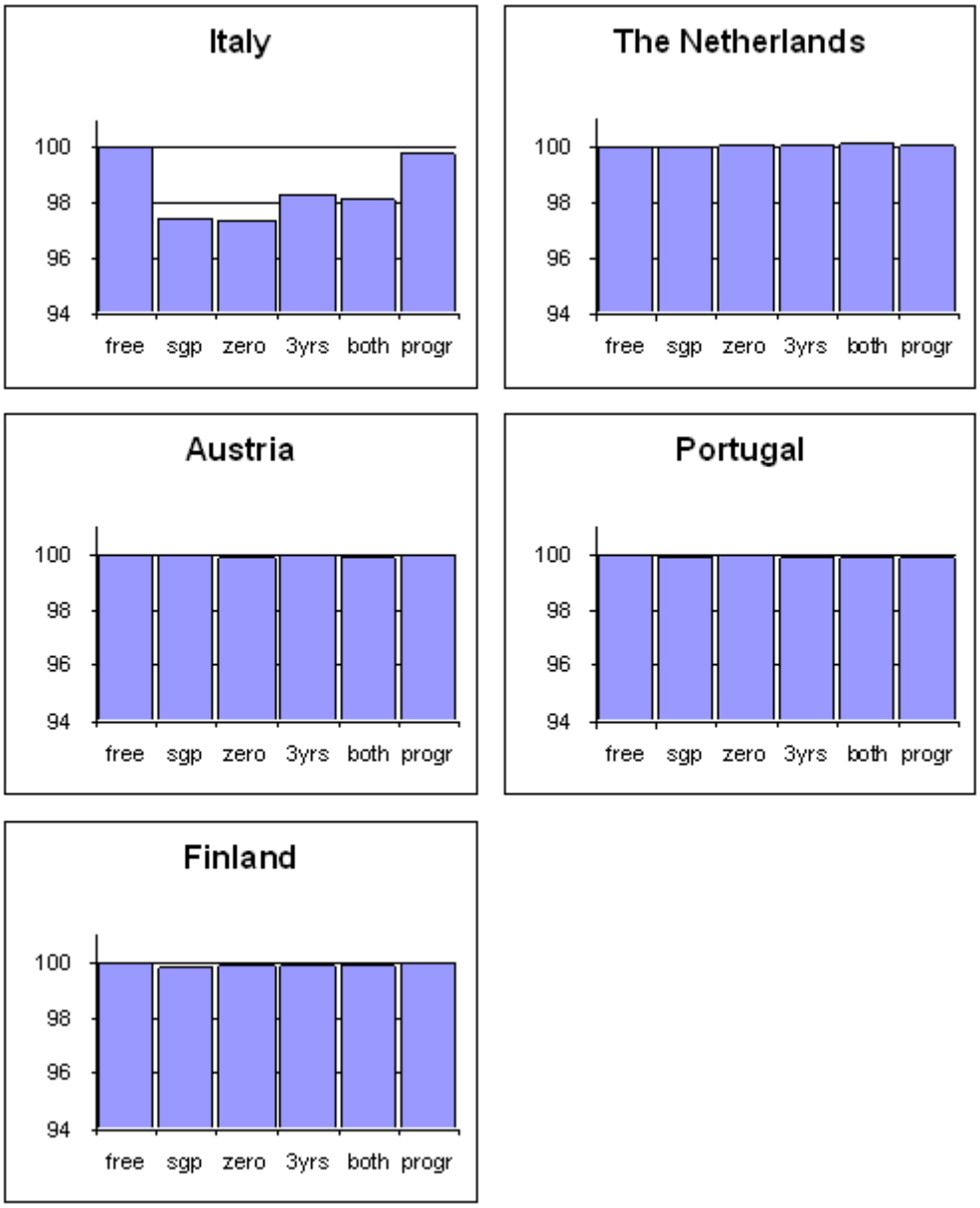
Finally, the interaction of the different modifications has some effect only in Italy, Spain and France, which are affected by at least one of the single provisions anyway. The hypothesis that the effects of different aspects of the reform may reinforce each other does not seem to be confirmed.

Overall, the impact of different rules on the variability of growth is quite reduced. From this result it follows that the modifications of the Pact are likely to give the governments only a limited extra leeway to reduce the variability of the cycle. This evidence is consistent with previous findings, e.g. by Galí and Perotti (2003) or OECD (2003), according to which the constraints of the Maastricht treaty and the SGP do not seem to have created a pro-cyclical bias in the conduct of fiscal policies.

The explanation of such a limited impact of different rules is easily found in the following graphs, which report on the average deficit that the model simulates under each set of rules.




deficit levels




deficit levels

Greece, France and Italy appear to be the only countries whose deficit would naturally be higher without the SGP rules. For these countries, the change of the threshold that defines the "exceptional circumstances" to 0% does not make a difference from current rules, while one more year to correct the excessive deficit increases the average deficit, and a "progressive approach" from excessive deficit

is definitely the major weakening of the current fiscal rules for all three countries. For most other countries the current set of rules, if used to the maximum extent, would have resulted in a very small change compared to the "no Pact" scenario.

Following these considerations, it can be expected that changes in the rules of the Pact are likely to have very little impact on fiscal policies, as the current rules already guaranteed ample margins of discretion.

The previous analysis was conducted over more than one economic cycle, and it therefore took into consideration the variability of growth. However, in the current stagnating economic environment many of the proposals for reforms of the Pact are aiming at short run increases in the economic growth. An evaluation of the different scenarios in relative terms in the short run has been implemented via simulations covering a period of 5 years after the end of the sample (2004-2008). The evaluation of the short run effects of the different rules is in this case based on mean variables. The analysis confirms the long run conclusions: the extra leeway in the conduct of fiscal policies is extremely limited, and the effect on growth absolutely negligible (less than 0.1% extra growth per year for all the countries).

# 8 Conclusions

The present paper provides an assessment of the effect of the reform of the Stability and Growth Pact on the European economy.

A set of structural VARs, one for each eurozone country, is estimated. The estimated models are used for assessing the possible effect of alternative sets of fiscal rules, with particular attention to the Stability and Growth Pact in its old and reformed version.

The investigation highlights a number of facts.

- Fiscal policy has not been effectively used as a counter cyclical macroeconomic tool, nor it has had strong pro-cyclical characteristics; simply, the discretionary component of fiscal policy seems to have been mainly assigned to objectives other than stabilization. The overall evidence suggests that fiscal policy has had in the 1990s a limited (if any) smoothing effect on the cycle.

- The restricted impulse response functions confirm that fiscal policy has generally a limited and ambiguous effect on output.

- The results of a "best stabilizing fiscal policy" are difficult to obtain even for a benevolent government, due to informational constraints. However, the "best policy" can be approximated by not using discretionary fiscal policy and simply letting the automatic stabilizers work freely. This latter solution requires a comparatively minimal amount of information and is less prone to abuse by politicians.

The dynamic stochastic simulation is used to assess the effect of the fiscal rules of the old and the reformed SGP.

- The analysis is overall supportive of the new country-specific Medium Term Objectives from 1% deficit to close to balance or in surplus; possibly Ireland and Spain could be given less demanding targets, while Italy should target a structural surplus in order to reduce the debt ratio.

- Overall, the cost in terms of stabilization of the old rules in the corrective arm of the Pact was limited. A possible interpretation of this result could be that for many countries the Stability and Growth Pact has officialized on paper policies which were already in place. Furthermore, while the variability of the cycle increased under the SGP rules for some countries, others seem to have benefitted from the higher discipline that the Pact imposed on naturally procyclical fiscal policies.

- The simulations of the modifications of the corrective arm of the Pact suggest that they are likely to give the national governments only a limited additional fiscal freedom. The more lenient threshold for applying the exceptional circumstances and the progressive rules for correcting excessive deficits are of little quantitative importance, while a longer time span given to correct a situation of excessive deficit only moderately affects fiscal policy and reduces the variability of the cycle in few countries. The findings also suggest that the scenarios with the assumed interpretation of the new Pact would raise deficits only in some of the high debt countries. This evidence is consistent with previous findings in the literature.

The results of this study should be interpreted with caution. First, the estimation of the model assumes that government behavior estimated over the 1980-2004 period can be conveniently represented by a unique model with some dummies. Second, it is assumed that governments do not change behavioural preferences in the EMU and that they strictly comply with the assumed interpretation of the fiscal rules under any given scenario. In reality a more lenient Pact may bend governments towards a more relaxed attitude on deficits. Third, trend growth may in the future be lower than in the past 25 years so that instances with negative or even significantly negative growth may become more frequent than expected according to the estimated models.

# 9 Appendix

## 9.1 Unit root test of the variables

| ADF unit root tests on variables | | | | | | |
|---|---|---|---|---|---|---|
| | GDP real growth | | Deficit ratio | | GDP deflator | |
| *Probability of unit root* | Intercept | No intercept | Intercept | No intercept | Intercept | No intercept |
| Belgium | 0.00 | 0.02 | 0.84 | 0.20 | 0.41 | 0.22 |
| Germany | 0.10 | 0.10 | 0.23 | 0.47 | 0.30 | 0.08 |
| Greece | 0.53 | 0.64 | 0.34 | 0.46 | 0.84 | 0.17 |
| Spain | 0.00 | 0.34 | 0.75 | 0.37 | 0.35 | 0.02 |
| France | 0.05 | 0.19 | 0.13 | 0.58 | 0.09 | 0.00 |
| Ireland | 0.20 | 0.30 | 0.58 | 0.04 | 0.19 | 0.03 |
| Italy | 0.03 | 0.06 | 0.89 | 0.40 | 0.01 | 0.00 |
| TheNetherlands | 0.02 | 0.19 | 0.50 | 0.29 | 0.03 | 0.05 |
| Austria | 0.01 | 0.36 | 0.29 | 0.31 | 0.42 | 0.09 |
| Portugal | 0.00 | 0.08 | 0.24 | 0.20 | 0.71 | 0.08 |
| Finland | 0.15 | 0.06 | 0.15 | 0.02 | 0.27 | 0.03 |

*H0: Unit root exists.Probability of unit root reported. Lag length in the test: Schwarz info criterion.*

### 9.2 The identification of the model

The three long run restrictions on $B(1)$ imply that

$$\begin{aligned} A(1)SS^{-1}e &= B(1)\varepsilon = B(1)S^{-1}e \\ A(1) &= B(1)S^{-1} \\ A(1)S &= B(1) \end{aligned}$$

where $A(1)$ is totally known and the zeros of the $B(1)$ are the long run restrictions. The restrictions apply to the transition matrix $S$.

Finally, the normalization of restricted residuals $\varepsilon$ implies that

$$E(\varepsilon\varepsilon') = I$$

since $\varepsilon = S^{-1}e$ or $S\varepsilon = e$, then

$$E(ee') = E(S\varepsilon\varepsilon'S') = SS' = \Sigma.$$

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