Preliminary draft

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Policy rules and policy errors : some simulations with the QUEST model

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June 2002

Note prepared for the CEPII – ENEPRI workshop on Impact of Alternative Policy Rules , Royaumont Abbey, Paris, July 1-2, 2002. The views expressed in this paper are those of the authors and should not be attributed to the European Commission.
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1. Introduction

This paper looks at the effectiveness of monetary and fiscal policy rules for stabilising output and inflation. Concerning monetary rules we look at two alternative specifications of the Taylor rule, namely strong and weak inflation targeting and analyse their performance in the presence of misperceptions about the nature of output shocks by the central bank. Limited information about the nature of shocks for initial realisations of a supply shock constitutes a real problem. For example in the 1990s it was difficult for the Federal Reserve, but also for European Central banks, to exactly classify the nature of the productivity shock related to ICT investment and production as either a temporary or a more permanent phenomenon. Similarly in the mid 1970s it was difficult, conditional on the information available at that time, to identify what turned out to be a permanent decline in the growth rate of productivity. In this paper we look at an experiment where the central bank fails to recognise a permanent positive shock to potential output in the Euro Area.

Concerning fiscal rules the paper addresses the issue of stabilising country specific demand shocks in EMU. Already in the first years of EMU we have seen growth rates in some countries departing significantly from the euro area average. Here we ask about the relative effectiveness of expenditure versus revenue based (direct and indirect taxes) fiscal stabilisation. Though expenditure based stabilisation is generally regarded as more efficient, the specification of consumer behaviour suggests that stabilisation based on temporary changes in VAT rates could be very efficient. The paper distinguishes between large and small countries.

The paper is organised as follows. In the next section a brief overview of the QUEST model is given. Section 3 presents the model's response to a technology shock and considers several alternative monetary policy rules under perfect foresight and when uncertainty about the nature of the shock exists and central banks fail to recognise the improvement to potential output. Section 4 considers the effectiveness of fiscal policy and examines several alternative fiscal policy rules designed to stabilise output after asymmetric demand shocks. The final section summarises the conclusions.

2. The QUEST model

This section provides an overview of the QUEST model and its main features[1]. The focus of the model is on the transmission of the effects of economic policy both on the domestic and the international economy. The model was constructed to serve as a tool for policy simulation and is not used for forecasting. Its main purpose is to analyse how effects of policy actions are transmitted over the medium term.

[1] For a more detailed description, see Roeger and in't Veld (1997) http://europa.eu.int/comm/economy_finance/publications/economic_papers/economicpapers123_en.htm

The model can be characterised as a New Neoclassical-Keynesian synthesis model, which combines the rigours of dynamic general equilibrium models with features of Keynesian style rigidities. The behavioural equations in the model are based on principles of dynamic optimisation of private households and firms. Economic agents are assumed to maximise utility and profit functions subject to intertemporal budget constraints and consumption and investment decisions therefore incorporate forward looking behaviour. Economic theory not merely determines the long-run model properties, but also drives its short run dynamics. The dynamic responses of the model have a theoretical basis, like the presence of adjustment costs and overlapping contracts, and adding *ad hoc* dynamics has been avoided as much as possible.

The supply side of the economy is modelled explicitly via a neo-classical production function. This assures that the long run behaviour of the model resembles closely the standard neo-classical growth model and the model reaches a steady state growth path with a growth rate essentially determined by the rate of (exogenous) technical progress and the growth rate of the population.

There are two major departures from the neo-classical model in the long run. Because firms are not perfectly competitive but can charge markups over marginal cost in the long run, the level of economic activity will be lower than that predicted from a model with perfect competition. Also, a bargaining framework along the lines of Pissarides (1990) is used to describe the interaction between firms and workers. Labour market rigidities and therefore involuntary unemployment persist even in the long run and the model economy will therefore not reach a steady state equilibrium with full employment. The short run behaviour of the model is influenced by standard Keynesian features since the model allows for imperfectly flexible wages and prices, liquidity constrained consumption, adjustment costs for investment and labour hoarding.

Description of model structure

Consumption specification

The specification of consumption and saving behaviour in the model is based on the concept of intertemporal utility maximisation of households, as formalised by Blanchard (1985) and Buiter (1988). It is a generalisation of the Permanent Income Hypothesis, since it allows for the analysis of consumption and saving behaviour of households under possibly only a finite planning horizon (positive probability of death). Consumers decide how much to consume and how much to save each period by maximising the present discounted expected utility from the consumption stream subject to their intertemporal budget constraint. Under the assumption of isoelastic or constant relative risk aversion (CRRA) utility, the consumption function, i.e. the optimal consumption rule for the household's optimisation problem, depends on human wealth H and financial wealth F and the marginal propensity to consume out of total wealth δ is a function of the rate of time preference q, the probability of death p , the intertemporal elasticity of substitution s and the real interest rate r at period t

$$C_t = d(q, p, s, r_t)[H_t + F_t] P_t / PC_t \qquad (1)$$

Human wealth H is the present discounted value of the entire future stream of after-tax income (including benefits *U.ben*)

$$H_t = E_t \sum_{j=0}^{\infty} b_{tj} \left[(1 - t_l) L_{t+j} w_{t+j} + U_{t+j} ben_{t+j} \right]$$

and financial wealth F equals the sum of the total equity wealth V, bonds and net foreign assets *NFA*

$$F_t = V + B + M + NFA$$

Equation (1) above assumes all consumers can freely substitute consumption today for consumption in the future at the going real interest rate. In reality, not all people may be able to borrow against their future income due to capital market imperfections and as a result they will not be able to smooth their consumption over time. These ‘liquidity constrained’ consumers cannot achieve intertemporal optimisation and their consumption is better represented as a function of current real disposable income (‘rule-of-thumb’ consumers). In the model, total consumption is therefore represented as the aggregation of the responses of two groups of consumers, one forward looking group of consumers who follow the optimal consumption rule (1) and another group that does not obey the life cycle/permanent income hypothesis and whose consumption depends on current disposable income

$$C_t = (1 - l) * d(q, p, s, r_t)[H_t + F_t] + l * Ydis_t \qquad (1b)$$

where l is the share of liquidity constrained consumption and *Ydis* current real disposable income.

Intertemporal substitution constitutes an important stabilising feedback, as a rise in interest rates can induce consumers to postpone consumption. When other components of aggregate demand rise, an increase in interest rates reduces consumption and the effect on total output is dampened. Consumption smoothing is an essential feature of this consumption specification. If households expect a temporary decline in their income they will according to this hypothesis mainly react via a reduction in their savings rate. Alternatively, if they expect an increase in their future net income, e.g. because of credibly announced tax reductions, the current savings rate may also fall, i.e. consumption may already increase in the present period in anticipation of higher future income.

Empirical studies using aggregate time series data have generally found evidence of "excess sensitivity" to income and concluded that a significant share of consumption is "liquidity constrained" (e.g. Campbell and Mankiw (1989,1991)). However, the range of estimates of the share of rule-of-thumb households vary widely and is sensitive to the assumed household utility function.[2] Studies using aggregate time series have also tend to find estimates of the elasticity of intertemporal substitution that are small (e.g. Hall (1988)). On the other hand, studies based on micro household survey data, have generally found much stronger support for the life cycle model, and often no evidence of liquidity constrained consumption. They also find higher estimates for the elasticity of substitution (e.g. Attanasio and Weber (1993,1995), DeJuan and Seater (1999)). The estimates used in the model lie within the range found in the empirical literature: the values for the share of consumption that is liquidity constrained is around 30%, while the elasticity of intertemporal substitution for that fraction of consumption that obeys the life cycle model is around 0.5.

Production

Firms operate in a monopolistically competitive environment. Private sector GDP Y_t is produced via a nested CES and Cobb Douglas production function with capital K_t, energy E_t and private sector employment L_t as inputs. The variable T_{Kt} represents an efficiency index for the fixed capital stock and the variable T_{Lt} represents labour augmenting technical progress. The following equation describes potential output $YPOT_t$ of the corporate sector under the assumption that all factors of production are fully utilised.

$$YPOT_t = \left(\left[aK_t^{-r} + (1-a)E_t^{-r}\right]^{-1/r} T_{Kt}\right)^{(1-a)} \left(L_t T_{Lt}\right)^{a} \qquad (2)$$

Labour augmenting technical progress grows with an exogenous rate and the efficiency index for capital T_{Kt} is a function of the mean age of capital and captures embodiment effects resulting from current and past investment. Firms may not always operate at full or optimal capacity, therefore actual output can differ from potential output. The objective of the firm is to maximise the present value of its cash flow (total revenue minus costs), subject to a capital accumulation constraint and costs of adjustment associated with capital and labour. The solution of the maximisation problem gives the behavioural equations for investment, employment and energy.

Investment

Firms maximise profits by buying labour services from households and renting capital to produce output. The investment demand equation is the optimal rule for the firms' optimisation problem. The model specification is based on a framework that extends the

[2] E.g. Weber (2002) finds the share never to be statistically significant when allowing for intertemporal non-separability in the utility finction.

neo-classical model of investment by incorporating adjustment costs [3]. The neo-classical model of investment can be linked to Tobin's Q-model, which couples investment decisions to forward-looking stock market valuations of the firm. According to this hypothesis, investment is determined by the gap between the market value of a firm and the replacement value of its capital. The ratio between these two variables is referred to as Tobin's-Q. This model can be derived from the neo-classical theory if it is assumed that investment is subject to adjustment costs, which are a convex function of the rate of change of the firm's capital stock. Firms face such adjustment costs when changing their capital stock, as there are disruptions to the existing production process: installation of new capital can be costly, workers may have to be retrained, etc. Convexity implies that these installation costs increase at an increasing rate and a too rapid accumulation of capital is more costly.

Total real investment expenditures are equal to investment purchases J_t plus the costs of installation. The unit installation costs are assumed to be a linear function of the investment to capital ratio. Total investment expenditure I_t can be written as

$$I_t = J_t\left(1+(f/2)\left(\frac{J_t}{K_t}\right)\right)\frac{PI_t}{P_t} \qquad (3)$$

where f is the adjustment cost parameter, K the capital stock and PI_t/P_t denotes the relative price of investment goods relative to the GDP deflator.
The optimisation problem yields the following investment rule

$$I_t = \frac{1}{f}\left(\frac{q_t}{(PI_t/P_t)} - 1\right)K_t \qquad (4)$$

The shadow price of capital q is equal to the marginal product of capital plus any anticipated future events which are expected to influence the marginal product after period t. It is a function of current and discounted future expected profitability, including adjustment costs, and adjusted for profit taxes tc and monopoly rents. This representation of q allows us to interpret it as reflecting the present discounted value of the marginal revenue from current investment and illustrates the forward looking nature of capital accumulation. Central to investment decisions are expectations about future demand conditions and costs.

The adjustment cost parameter f has a crucial effect on the volatility of investment. Estimates show some variation between countries, with the lowest estimate found for the United States. They imply that adjustment costs amount to about 10 per cent of total

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[3] The standard neo-classical model is an essentially static framework, with firms equating current marginal product of capital to current cost of capital. The underlying assumption is that firms can adjust their capital stock instantaneously and without costs. Even though dynamics is often added to reflect delays in decision making, production and deliveries, such added lags are purely *ad hoc*. Moreover, the standard model ignores the forward looking nature of capital accumulation. Estimated dynamic coefficients derived from the neo-classical model can not be linked explicitly to underlying technology and expectation parameters and are therefore vulnerable to the Lucas Critique.

investment expenditure. This is consistent with estimates found in other studies based on aggregate and firm-level data (e.g. Eberly (1997), Cummins et al. (1997)).

Labour Market:

The labour market specification is based on theoretical search models of the labour market as developed e.g. by Pissarides (1990). The basic incentive for search activities in the labour market by both workers and firms are the profit opportunities in present value terms which are associated with a successful job match for both parties. Wages are determined by an implicit bargain at the individual level, *i.e.* the firm engages in Nash bargains with each individual worker by taking the wage of all other employees as given. Thus, wage contracts are set such as to maximise the product of their respective profit opportunities. In the case of households, this is given by the difference between the present value of labour income a household can earn in the case of a successful current job match (net wages), versus the net present value of labour income in case of a failure (the reservation wage, *i.e.* unemployment benefits and/or the value of leisure). Arbitrage equations for the returns from their respective human capitals incorporate the expected capital loss from a job separation, and the expected capital gain from finding a job, depending on labour market tightness. For the firm, the return from a successful job match is given by the real pure profit of a firm per employee, the difference between the return of an occupied position and the costs of a vacant position. The wage rule is then the outcome of the maximisation of the product of both parties' profit opportunities and how much of the total return of a successful job match goes to each party depends on their relative bargaining position.

$$W_t = \frac{(1-\boldsymbol{b})}{(1-tl)} Z_t + \boldsymbol{b}\left\{(\boldsymbol{a}+\boldsymbol{h}(1-\boldsymbol{a}))\frac{Y_t}{L_t} + \frac{prob(.)vc_t}{q(.)}\right\} \qquad (5)$$

where $\boldsymbol{b}$ is the relative bargaining strength of workers, tl the labour income tax rate and Z the reservation wage (unemployment benefits). The last term in brackets reflects the probability of finding and quitting a job for an unemployed/employed person and the vacancy costs incurred by the firm, and this is assumed to depend on labour market tightness (unemployment rate).

Nominal rigidities are introduced into the wage setting process through the assumption of wage staggering, as suggested by Taylor (1980). Contracts last for 4 periods (quarters) and at each date, exactly one quarter of all workers signs a new contract with firms. At each date t firms bargain with one quarter of the work force over a nominal wage contract, which will remain fixed for one year. Wage contracts in the current period are thus indexed to an average of the current price level and expected price levels for three consecutive periods. They are further determined by labour productivity Y/L, the reservation wage Z, vacancy costs VC and labour market tightness in the current and three consecutive periods.

This wage rule exhibits the feature that the importance by which the marginal product of labour and labour market tightness influence the level of current wage contracts, depends positively on the bargaining power of workers. As the bargaining strength of workers diminishes, firms can tie wages more narrowly to the reservation wage. The average nominal wage rate in period t is thus given by the average value of all wage contracts signed in the current and the previous three periods

Pricing behaviour

The modelversion used in this paper has a hybrid version of forward and backward looking pricing behaviour (Gali, Gertler 1999). It derives price setting behaviour as the product of optimisation by monopolistically competitive firms subject to constraints on the frequency of price adjustment. It allows for a “cost-push” effect influenced by expected inflation, which makes inflation a forward looking phenomenon. However, it is assumed that a fraction of firms uses a backward looking rule of thumb (Gali, Gertler, Lopez-Salido, 2001).

Financial markets

Asset markets are assumed to be fully integrated across all the industrialised regions covered in the model, i.e. there is full capital mobility. Exchange rates between European currencies, US dollar and the yen are fully flexible. The exchange rate e, expressed as the amount of domestic currency per unit of foreign currency, is determined endogenously according to the following (uncovered) interest arbitrage relation with respect to the dollar

$$i_t^j = i_t^{us} + E_t\left[\frac{\Delta e_{t+1}}{e_t}\right] + risk_t \qquad (6)$$

The second term on the right hand side denotes the expected depreciation of the currency vis-à-vis the US dollar. The risk premium *risk* is assumed to be exogenous and reflects, among other factors, the markets’ perception of the risk differential between assets denominated in the two currencies.

The impact of shocks in the model depends to a large extent on the response of the monetary authorities and the expected future monetary stance. The model can be simulated under alternative monetary policy assumptions, and short term interest rates can be set to target the money stock, an inflation target, or in accordance to some formulation of a Taylor rule[4]. monetary authorities. Some alternative monetary policy rules are considered in this paper but the standard setting in the model is based on a policy rule which assumes that the monetary authorities adhere to an inflation forecast based rule but which attaches a small positive weight to the output gap

[4] It is assumed that of the three EU member states not participating in EMU, Denmark follows the ECB and keeps the interest rate differential vis-à-vis the euro-area constant, while Sweden and the UK have an independent monetary policy and floating currencies against the euro.

$$rs_t = rr^{eq} + \inf_{t+1} + 1.0(\inf_{t+1} - \inf^{target}) + 0.25YGAP \qquad (7)$$

where the equilibrium real rate is the (here unchanged) steady state real interest rate and the weight given to expected inflation (*1.0*) is much larger than that to the output gap (*0.25*).(this rule is labelled *IFB25* in the comparisons)

Government:

Governments follow exogenously given spending patterns. Government expenditure is divided into unemployment benefits, purchases of goods and services, government wages, investment expenditure, transfers to households and interest payments on government debt. Revenues are divided into labour income taxes (including social security contributions), corporate profit taxes, value added taxes, energy taxes and other receipts (lump sum tax)

A debt rule is imposed in order to make the evolution of the government budget sustainable. In default setting, it is lump sum taxes that adjust proportionally to the gap between the debt to GDP ratio and its target level b_0 according to

$$\Delta T_t = \varphi_1 \left(b_0 - B_t / Y_t\right) - \psi_2 \Delta(B_t / Y_t)\,. \qquad (8)$$

3. Some monetary policy rules and technology shocks

3.1 Technology shock

This section describes a simulation experiment in which the supply side in the model is affected by a technology shock. It is a shock that raise potential output above base directly through an increase in total factor productivity[5]. The shock is an EU wide shock affecting all EU member states.

Table 1 shows the effects of this improvement in total factor productivity of 1 percentage point under the default interest rate rule targeting expected inflation and assigning a low weight to the output gap (IFB25). Graph 1 summarises the GDP effect for the euro area average in the first five years. The shock raises output in the euro area in the long run by 1.3 per cent. Following the immediate increase in productivity, potential output is shifted

[5] By design, this scenario is a somewhat artificial experiments, with the full effect coming in immediately. A more realistic scenario of supply shocks of this kind would allow for a gradual phasing in of the shock. The scenarios presented here are merely intended to illustrate the implications of alternative policy rules when there are misperceptions about the nature of the output shocks affecting the economy.

upwards. Permanent income consumers increase their spending as their human wealth and financial wealth increases, but liquidity constrained consumers base their spending on disposable income, which increases slower as real wages only gradually catch up with the productivity improvement. In the first year, GDP rises by less than potential output and the resulting negative output gap puts downward pressure on prices, which allows the central bank to reduce interest rates. Hence, monetary policy is accommodating, and prices do not change much. With the European Central Bank reacting to a weighted aggregate of (expected) inflation and output gap, interest rates are reduced by 0.25 percentage points in the first year. In the second year demand in the euro area has risen by enough to close the output gap for the euro area on aggregate. In the third year the output gap becomes positive and with inflation back on base, interest rates increase.

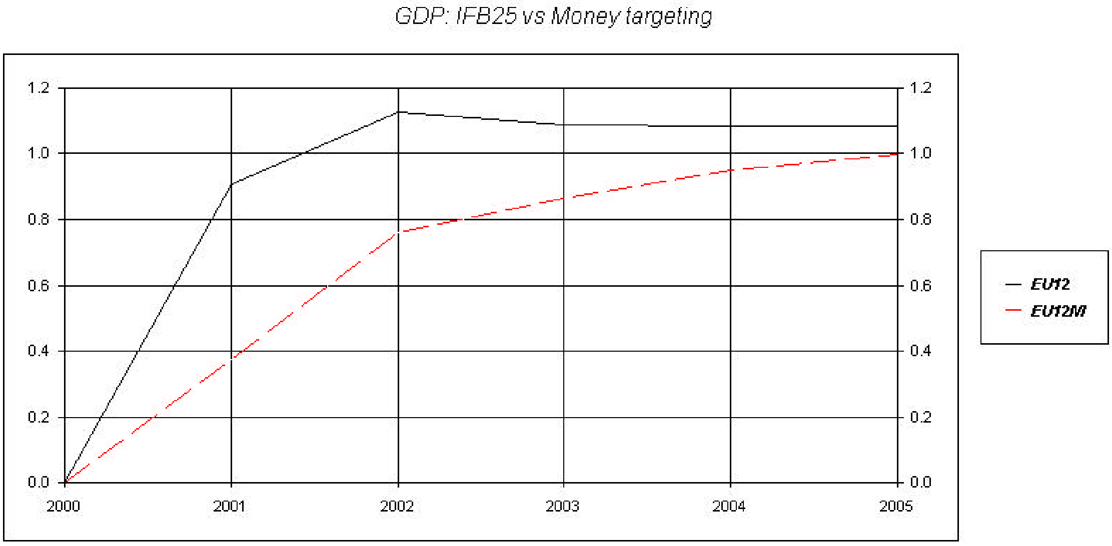
Wages are indexed to productivity and increase, but employment falls slightly in the long run as the reservation wage is in this scenario indexed to consumer prices and rises more strongly due to the depreciation of the exchange rate. For similar reasons, the capital stock increases by slightly less than output as the depreciation raises the cost of capital.

The euro depreciates in real terms together with a worsening of the trade balance. The depreciation is required here in order to prevent foreign debt to explode. However one could imagine alternative technology shock scenarios where a European technology shock would be associated with either a temporary or a permanent real appreciation. The first case could in principle arise if the technology shock would be phased in slowly. In this case the initial output gap would be larger and interest rates would be higher. But eventually Europe would nevertheless run a trade deficit because it would grow faster. In order to generate a permanent appreciation of the euro with a technology shock one would have to assume the technology shock shifts preferences in favour of European goods.

The scenario described here assumes an accommodating monetary policy, which boosts demand immediately and helps to bring forward the adjustment of GDP to its new higher long run level. The output gap is rapidly closed in this scenario. As a variant to this simulation, an alternative scenario is also shown in the graph, in which the central bank adheres to a money supply target[6]. Under money targeting, monetary policy is considerably less accommodating after a supply shock, and demand is much slower to converge to the new higher level. Under such monetary assumptions, the output gap can persist for much longer. The bottom part of Table 1 reports the results for the scenario with money targeting in place. While the long run is not affected by the monetary assumption, the speed of adjustment to the new steady state is dependent on the monetary policy assumption and can be significantly slower under a less accommodating stance.

[6] Where nominal interest rates respond to deviations in money demand from target :
$rs_t=a.rs_{t-1}+b.\log(M^{target}/M_t)$

Graph 1 Effects of a permanent EU productivity improvement of 1%: money targeting



Note: % differences from base. Solid line inflation targeting (eq.8), dashed line money targeting.

Table 1 Productivity improvement EU12

IFB25 rule:

EU12	2001A	2002A	2003A	2004A	2005A	2010A	2030A
TOTAL.GDP_PCER	0.91	1.13	1.09	1.08	1.08	1.15	1.31
PRIV.GDP_PCER	1.01	1.21	1.17	1.16	1.16	1.23	1.38
POT.PRIV.GDP_PCER	1.20	1.19	1.16	1.15	1.15	1.22	1.37
PRIV.CONS_PCER	1.05	1.41	1.33	1.29	1.27	1.31	1.41
PRIV.INV.I_PCER	1.27	1.19	1.14	1.12	1.11	1.09	1.08
EXPORTS.EX_PCER	0.74	0.84	0.83	0.86	0.87	0.98	1.22
IMPORTS.IM_PCER	0.92	1.10	1.04	1.00	0.98	0.98	0.94
EMPLOYMENT_PCER	0.08	0.01	-0.07	-0.10	-0.12	-0.13	-0.13
REAL.WAGE.COSTS_PCER	0.79	1.39	1.34	1.33	1.32	1.39	1.53
PRICE.LEVEL_PCER	-0.06	-0.06	-0.05	-0.03	-0.02	0.05	0.28
DOLLAR.EXCH.RATE_PCER	0.27	0.21	0.26	0.30	0.34	0.53	1.07
REAL.EFF.EXCH.RATE_PCER	0.18	0.17	0.20	0.22	0.23	0.29	0.48
NOM.EFF.EXCH.RATE_PCER	0.09	0.06	0.08	0.10	0.12	0.19	0.40
REAL.SHORT.RATE_ER	-0.22	0.03	0.03	0.03	0.02	0.02	0.02
CONS.GDP_ER	0.59	0.79	0.75	0.72	0.71	0.74	0.82
INV.GDP_ER	0.28	0.27	0.26	0.26	0.26	0.25	0.21
NET.EXP.GDP_ER	-0.08	-0.11	-0.09	-0.07	-0.06	-0.02	0.07
INFLATION.PGDP_ER	-0.06	-0.00	0.02	0.02	0.01	0.01	0.01
UNEMPL.RATE_ER	-0.07	-0.01	0.06	0.09	0.11	0.12	0.12
DEBT.TO.GDP_ER	-0.52	-0.42	-0.23	-0.12	-0.07	-0.03	-0.01
DEFG.TO.GDP_ER	0.22	0.19	0.13	0.08	0.06	0.05	0.04
TRADE.BAL.TO.GDP_ER	-0.09	-0.12	-0.10	-0.08	-0.07	-0.05	0.01

Money targeting rule:

EU12	2001A	2002A	2003A	2004A	2005A	2010A	2030A
TOTAL.GDP_PCER	0.37	0.76	0.87	0.95	1.00	1.10	1.28
PRIV.GDP_PCER	0.40	0.82	0.93	1.02	1.07	1.18	1.35
POT.PRIV.GDP_PCER	1.05	1.10	1.10	1.11	1.12	1.19	1.35
PRIV.CONS_PCER	0.63	1.01	1.08	1.12	1.16	1.24	1.36
PRIV.INV.I_PCER	0.16	0.70	0.87	0.99	1.03	1.06	1.05
EXPORTS.EX_PCER	0.18	0.49	0.62	0.74	0.81	0.96	1.22
IMPORTS.IM_PCER	0.42	0.72	0.78	0.83	0.86	0.90	0.87
EMPLOYMENT_PCER	-0.00	-0.03	-0.07	-0.09	-0.11	-0.13	-0.13
REAL.WAGE.COSTS_PCER	0.42	0.90	1.07	1.17	1.23	1.33	1.50
PRICE.LEVEL_PCER	-0.33	-0.70	-0.89	-1.00	-1.06	-1.18	-1.36
DOLLAR.EXCH.RATE_PCER	-0.26	-0.45	-0.58	-0.62	-0.65	-0.64	-0.47
REAL.EFF.EXCH.RATE_PCER	0.09	0.19	0.22	0.25	0.27	0.33	0.53
NOM.EFF.EXCH.RATE_PCER	-0.10	-0.18	-0.22	-0.24	-0.25	-0.24	-0.17
REAL.SHORT.RATE_ER	0.33	0.05	0.07	0.04	0.03	0.02	0.02
CONS.GDP_ER	0.36	0.57	0.61	0.63	0.65	0.70	0.79
INV.GDP_ER	0.04	0.16	0.20	0.23	0.24	0.24	0.21
NET.EXP.GDP_ER	-0.09	-0.09	-0.07	-0.05	-0.04	0.00	0.10
INFLATION.PGDP_ER	-0.33	-0.37	-0.20	-0.11	-0.06	-0.02	-0.01
TRADE.BAL.TO.GDP_ER	-0.07	-0.09	-0.08	-0.06	-0.06	-0.03	0.03

3.2 Uncertainty about nature of supply shock

The scenario in the previous section assumed the monetary authorities had full knowledge about the nature of the shock and recognised the increase in potential output. The central bank adjusted its assessment of the output gap by taking into account the increase in the economy's productive capacity. However, in reality it may take some time before a technology improvement like this is fully recognised and the implications of incomplete information for the conduct and the design of monetary policy are worth analysing. What if monetary authorities are not able to exactly distinguish between demand and supply shocks and fail to recognise the improvement in productive capacity? The scenarios in this section consider the implications of misperceptions about the true level of potential output, in which the output gap targeted by the central bank is not adjusted for the positive technology shock and the old pre-shock level of potential output is targeted.

Three alternative monetary policy rules are considered here. The rules are all variants of a Taylor type rule in which the real interest rate responds to deviations in (expected) inflation from target and the output gap. The standard setting in the model is based on a policy rule which assumes that the monetary authorities adhere to an inflation forecast based rule but which attaches a small positive weight to the output gap

IFB25: $rs_t = rr^{eq} + \inf_{t+1} + 1.0(\inf_{t+1} - \inf^{target}) + 0.25YGAP$

where the equilibrium real rate is the (here unchanged) steady state real interest rate and the weight given to expected inflation (1.0) is much larger than that to the output gap (0.25).

The first alternative is a rule which more closely resembles the original Taylor rule, with interest rates reacting to *current* inflation deviations from target and the output gap with parameters 1.5 and 0.5 respectively:

Taylor: $rs_t = rr^{eq} + \inf_{t+1} + 1.5(\inf_t - \inf^{target}) + 0.5YGAP$

The second alternative is an inflation forecast based rule based on the one period ahead forecast of inflation and with a negligible weight on the output gap:

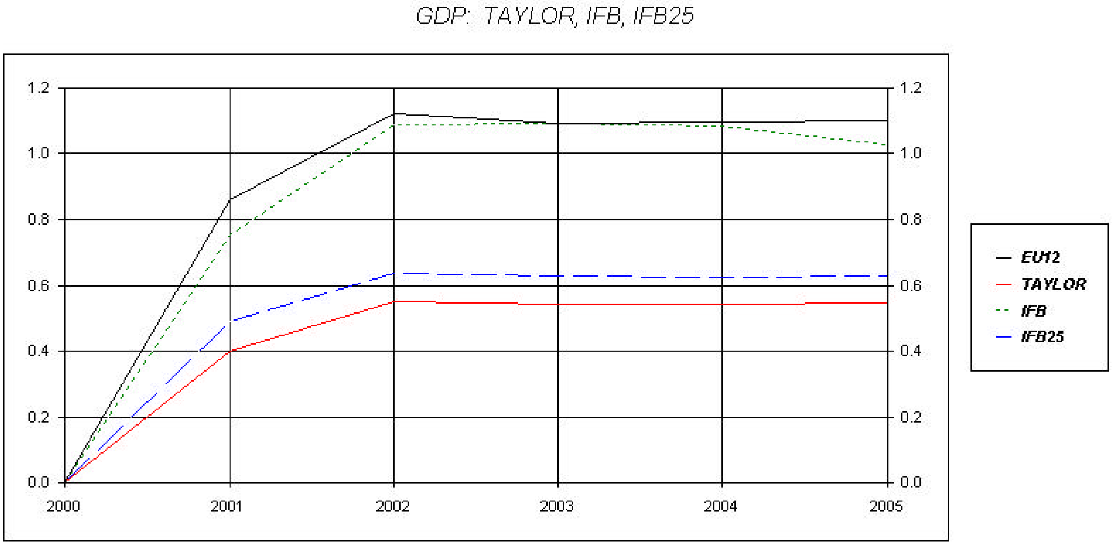
IFB: $rs_t = rr^{eq} + \inf_{t+1} + 1.0(\inf_{t+1} - \inf^{target}) + 0.01YGAP$

These three rules reflect different degrees of inflation targeting, with the "Taylor" rule assigning it the lowest relative weight and the IFB rule the highest.

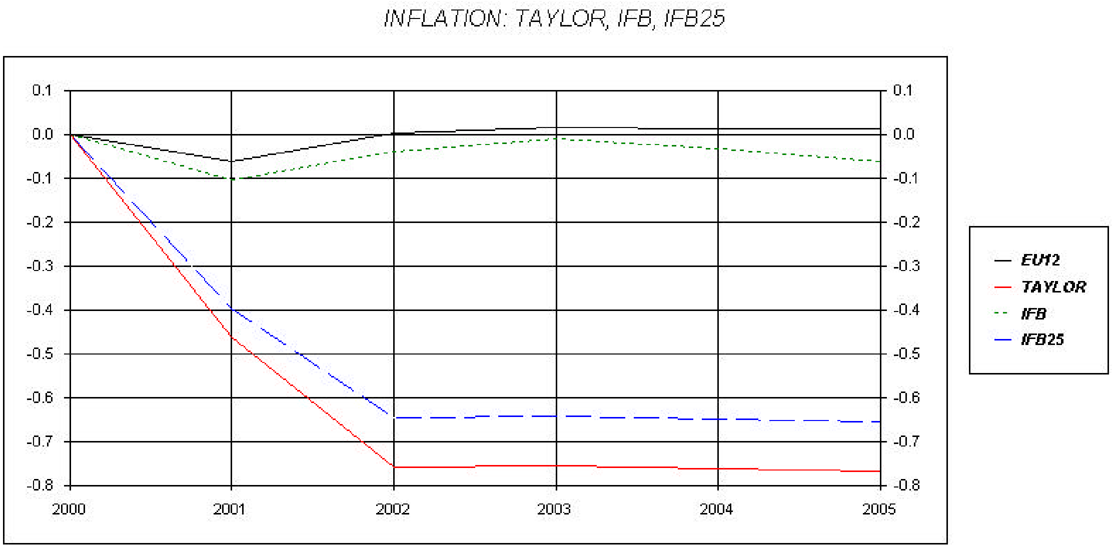
Graph 2 shows the GDP effects for the technology shock during the first five years and graph 3 the differences for inflation. It is assumed that at some stage the monetary authorities learn about the increase in productive capacity and adjust their target for potential output. Hence we focus on the first five years of these simulations. The bold line shows the reference scenario in which the shock is correctly perceived and the potential output target is adjusted. In this scenario with a fully accommodating monetary policy, the output gap, correctly measured, is rapidly closed and GDP is 1.1 per cent above base after two years. In the scenario under a rule with Taylor-like coefficients (1.5 on inflation and 0.5 on the output gap) and with the old pre-shock level of potential output targeted, GDP is only 0.55 above base after two years and the difference with the new potential output level persist for some years. Inflation also falls much further below base and the inflation gap persists. The IFB rule, which does not give any weight to the output gap, comes very close to the reference scenario, while GDP is around 0.65 per cent above base under the rule which gives a small weight of 0.25 to the output gap (IFB25).

These scenarios illustrate the implications of incomplete information for the conduct of monetary policy and the costs in terms of output that misperceptions on the nature of shocks could produce. A large share of the potential benefits from a technology improvement of this type would be lost if the monetary authorities would fail to recognise the nature if the supply side improvement and target the incorrect potential output level. The larger the weight on the inflation target, the smaller these losses would be. When the output gap persists under the alternative rules, this tends to be accompanied by persistent inflation gaps , which should be a warning signal to the central banks to readjust their potential output targets.

Graph 2 Taylor rule and IFB rules with unchanged output target



Graph 3 Taylor rule and IFB rules with unchanged output target: Inflation



Note:

Taylor: $rs_t = rr^{eq} + \inf_{t+1} + 1.5(\inf_t - \inf^{target}) + 0.5GAP$

IFB25: $rs_t = rr^{eq} + \inf_{t+1} + 1.0(\inf_{t+1} - \inf^{target}) + 0.25GAP$

IFB: $rs_t = rr^{eq} + \inf_{t+1} + 1.0(\inf_{t+1} - \inf^{target}) + 0.01GAP$

$GAP = Y_t - Ypot_0$ (where $Ypot_0$ is pre-shock potential output)

4. Some alternative fiscal policy rules

This section looks at the effectiveness of fiscal policy in stabilising output. We consider different alternative fiscal policy rules and analyse how efficient they are in stabilising country specific demand shocks in EMU. In particular, we look at the relative effectiveness of expenditure versus revenue based (direct and indirect taxes) fiscal stabilisation.

Before examining the performance of alternative fiscal policy rules in stabilising output after asymmetric shocks, we first discuss the relative effectiveness of the various fiscal policy variables in the model. The model distinguishes between different budgetary expenditure components and each of these has a different impact on aggregate demand and output. Graphs 4 and 5 show the first year fiscal multipliers for some of the expenditure and revenue components separately for Germany. Graphs 6 and 7 show the impact multipliers for Ireland, a small open economy. On the expenditure side four variables are considered: government employment, government purchases of goods and services, government investment and transfers to households (excl. unemployment benefits). These multipliers are derived from separate shocks in which the government expenditure components are increased by one per cent of (baseline) GDP. In the design of these shocks the focus was on cyclical stabilisation, and the underlying assumption is that fiscal policy operates symmetrically over the cycle, i.e. they are all temporary positive shocks lasting for two years, reversed in following years.[7] Interest rate reaction functions are not switched off, but monetary policy is assumed to operate normally, and this partially offsets the demand boosts from these fiscal expansions.

The graphs show the different impacts each expenditure component has on GDP. The overall effectiveness to stimulate economic activity by higher government expenditure is relatively modest, because a large part of the fiscal expansion is crowded out or leaks abroad through higher imports. This is the outcome of several effects. Higher real interest rates triggered by expansionary fiscal policy makes saving more attractive and induces forward-looking consumers to reduce consumption. A rise in interest rates has also negative wealth effects, as it increases the rate at which expected future income is discounted. However, in this case permanent income consumers anticipate the temporary nature of the fiscal expansion (which is later reversed), and permanent income is not much affected. Moreover, liquidity constrained consumers increase their consumption as they see their disposable income rise. The net effect on consumer spending is therefore small. The second channel through which a fiscal expansion can crowd-out private spending is private investment. While profitability is increased by the fiscal expansion in the short run, the rise in real interest rates offsets this positive effect and net effect on private investment is likely to be slightly negative. Furthermore, an increase in domestic demand raises imports and part of the demand boost leaks abroad. The latter effect is particularly strong in the case of Ireland.

[7] It is assumed that the fiscal expansion is followed in the medium term by a fiscal contraction, such that there is no autonomous increase in government indebtedness (and no increase in future tax liabilities).

According to the simulations the impact of a 1 per cent of GDP increase in government outlays varies significantly across spending categories and over time, but the pattern is roughly the same in all countries. The first-year impact of all spending categories is positive. The largest effect is found for government employment, which has a multiplier close to unity in all countries[8]. However, the strong positive impact of higher government employment is only temporary and in case of more persistent or even permanent shocks, it would be crowded out in the medium term through its effect on private sector wages (higher public employment reduces overall unemployment and leads to higher wage demands, which have a negative effect on private sector employment and output).

The short-term impact of government purchases of goods and services as well as government investment is somewhat smaller than that for employment, the multipliers being in the range of 0.6-0.7. In case of more persistent shocks, the expansionary effect of higher government purchases would fade away rapidly over the medium term, whereas that of government investment would have a more lasting impact by raising public capital stock and potential output. The smallest expansionary effect in all countries is achieved through a temporary increase in higher government transfer payments to households, most of which is saved.

In general, the impact of temporary labour and corporate income tax cuts on output is small because the intertemporal optimising behaviour of economic agents smooths away most of it[9]. Over the medium-term the impact of a tax cut would gain strength as distortionary effects of taxation are reduced.

A reduction in labour income taxes has a direct demand effect through its impact on disposable income and a positive supply side effect by increased employment. The principal reason why the short-term impact of lower labour income taxes remains very small is that consumers smooth the temporary tax cut over a large number of periods, while supply-side effects by fostering labour demand would only start to feed in only with a lag.

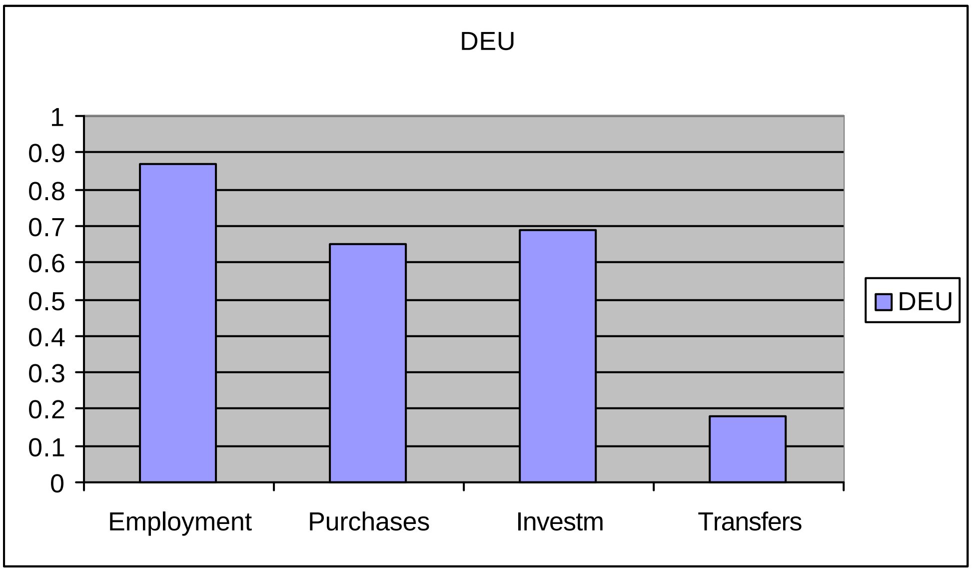
The employment response to a change in labour taxation differs per country, but tends to be higher in the continental European countries than in the Scandinavian and 'Anglo-Saxon' countries. These country-specific differences arise inter alia from varying lags in the labour demand and different labour market institutions.[10] A reduction in corporate taxes has a direct demand impact through its effect on current profits, but as the tax cut is reversed in the medium term the positive impact remains small. A reduction in the value added tax boosts consumer spending in the short term, as forward looking consumers frontload their spending to the current year in anticipation of higher indirect taxes again in

[8] This is partly due to the way GDP is measured, with GDP defined as the sum of private GDP and the government wage bill. An increase in the latter raises potential GDP automatically.
[9] In a pure optimising model, temporary tax changes that are later reversed should not have any effect on spending. The reason temporary income tax multipliers are positive in the model is because some consumers and firms are assumed to finance their spending out of current disposable income and profits respectively, due to liquidity constraints.
[10] In the model these differences are reflected in the indexation of unemployment benefits to gross/net wages.

following years. However, a large proportion of the positive impact is crowded out through higher interest rates or, for the smaller more open economies, leaks abroad via higher imports. As interest rates rise to contain inflationary pressures stemming from higher consumer spending, private investment is also crowded out.

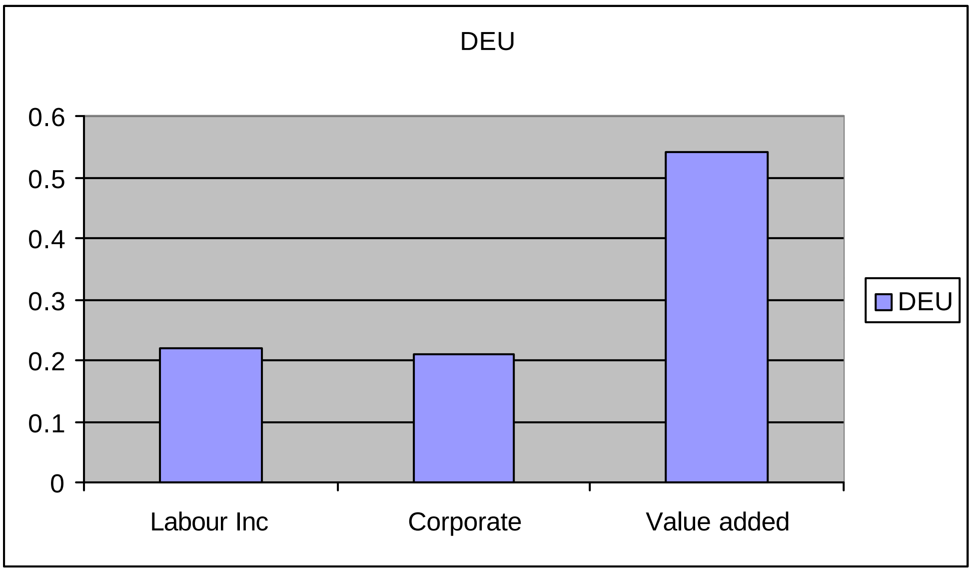
As a very broad characterisation, the results therefore indicate that in the short run, the impact of fiscal policy is larger on the expenditure side than on the tax side. However, it should be borne in mind that this conclusion holds for temporary fiscal policy. In case of longer lasting more persistent fiscal policy actions, the impact from the expenditure side would fade out in the medium term (due to crowding out effects) while on the tax side the impact increases over time as supply side effects become more important.

Graph 4 Fiscal multipliers temporary expenditure increase: Germany



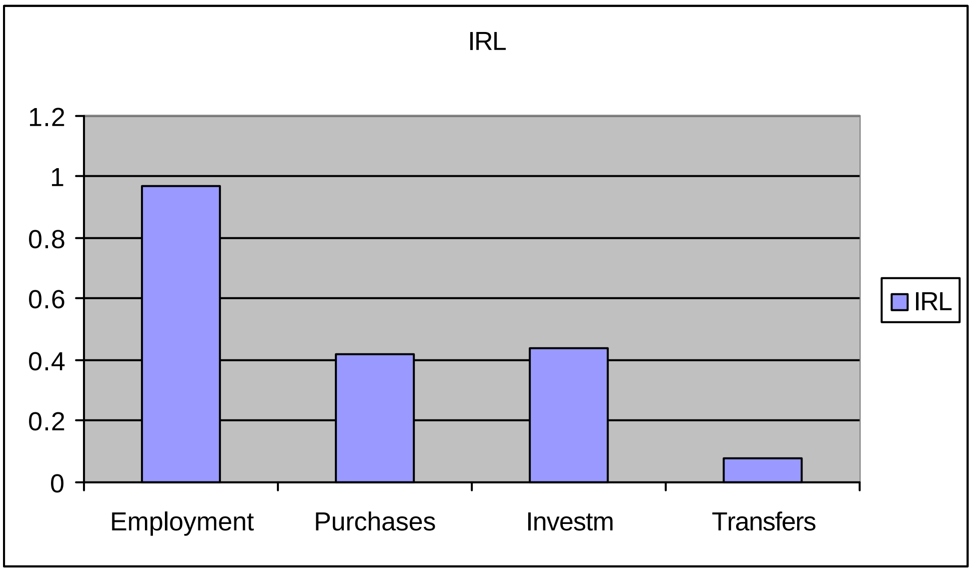
Note: First year GDP effect of a temporary 1% of GDP increase in public employment, government purchases of goods and services, public investment and government transfers to households. Fiscal expansion reversed in following years. Monetary policy adheres to inflation target.

Graph 5 Fiscal multipliers temporary tax reductions: Germany



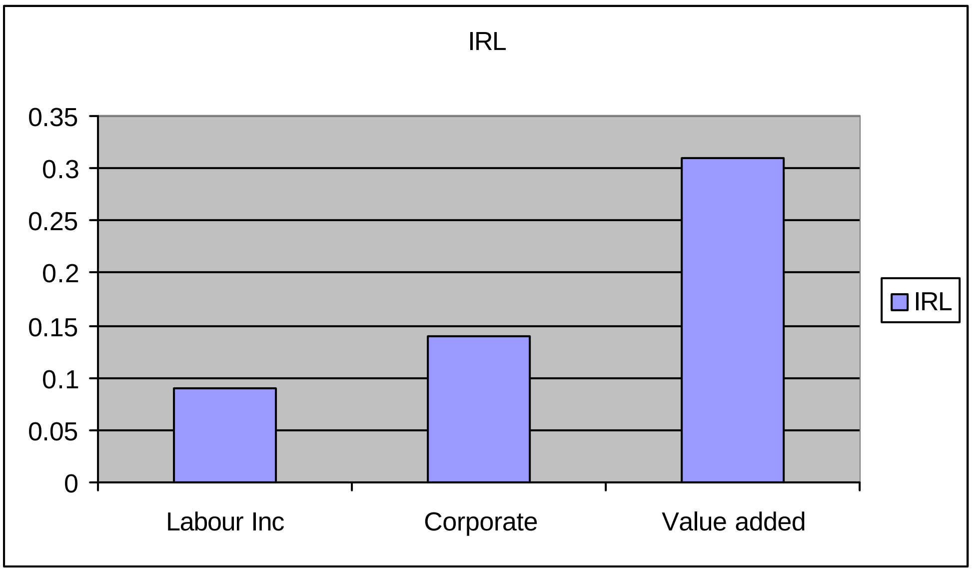
Note: First year GDP effect of a temporary 1% of GDP reductions in labour income tax, corporate profit tax and VAT. Fiscal expansion reversed in following years. Monetary policy adheres to inflation target.

Graph 6 Fiscal multipliers temporary expenditure increase: Ireland



Note: First year GDP effect of a temporary 1% of GDP increase in public employment, government purchases of goods and services, public investment and government transfers to households. Fiscal expansion reversed in following years. Monetary policy adheres to inflation target.

Graph 7 Fiscal multipliers temporary tax reductions: Ireland



Note: First year GDP effect of a temporary 1% of GDP reductions in labour income tax, corporate profit tax and VAT. Fiscal expansion reversed in following years. Monetary policy adheres to inflation target.

Having considered the efficiency of various fiscal policy instruments in general in the model, we now turn to the effectiveness of some specific fiscal policy rules. In the default setting, the share of government purchase of goods and services in total GDP, the VAT rate and the labour income tax rate are exogenous in the model. In the alternative fiscal policy rules we are investigating in this note, these variables are made dependent on the output gap and react in a countercyclical way.

For the share of government purchases in GDP, this implies the following rule:

GC: $$GC_t / Y_t = \overline{GC_t / Y_t} - a\left(Y_t - \overline{Y_t}\right)$$

where the bar indicates base values and *a* is the fiscal reaction parameter measuring the fiscal response to the output gap.

Similarly, in an output-stabilising rule for the labour income tax rate, the tax rate is a positive function of the output gap

TL: $$tl_t = \overline{tl_t} + aY_t / W_t\left(Y_t - \overline{Y_t}\right)$$

where the reaction parameter *a* is adjusted for the inverse of the share of the tax base *W* in total GDP.

In a third fiscal stabilisation rule the VAT rate is adjusted in line with the output gap

VAT: $$vat_t = \overline{vat_t} + a(Y_t / C_t)\left(Y_t - \overline{Y_t}\right)$$

where again the reaction parameter *a* is adjusted for the share of the consumption tax base in GDP. In all cases the parameter *a* is set to one, and the output gap parameter reflects differences in the share of the tax base in GDP.

We consider two types of demand shocks, hitting first a large country in the euro area (Germany) and second a small open economy (Ireland). The first demand shock is an autonomous reduction in private consumption. This negative consumption shock lowers German GDP by almost 0.5 per cent below base. It has a direct impact on VAT revenues and tax revenues are negatively affected. The deficit to GDP ratio rises by 0.16 percentage points. When the share of government purchases in GDP is adjusted in a countercyclical way, the negative impact on GDP is reduced to 0.31 per cent. The increase in expenditure however, raises the deficit to GDP ration by 0.46 percentage points. The labour tax rate is considerably less effective as a stabilisation tool, and reduces the fall in GDP to only 0.40 per cent. It also coincides with a much larger impact on the deficit to GDP ratio, of 0.55 percentage point, making the TL rule the least efficient stabilisation rule of the three rules considered here. The VAT rule, which imploes a reduction in VAT to offset the impact of the consumption shock, is as effective as the GC rule, and reduces the fall in GDP to 0.32 per cent, at the expense of a relatively small increased in the deficit ratio of only 0.42 percentage points.

For the autonomous export shock, the relative ranking of the effectiveness of the three rules is similar. The impact of this shock on the deficit is smaller than for a consumption shock, as no tax base is directly affected by this particular shock. The expenditure based fiscal rule achieves the highest degree of stabilisation, but the VAT rule is again equally effective and accompanied by a lower rise in the deficit ratio.

The results for Ireland show that the relative ranking of these three rules also applies for a small open economy. The impact of a consumption shock is considerably smaller in the case of Ireland, as a larger share of the initial shock leaks abroad. The GC rule is again the most effective stabilisation tool, but the differences among the three rules are smaller in the case of Ireland. Differences are slightly larger in the case of an exports shock, and the VAT rule is again more effective than a labour income tax rule is stabilising output.

On the whole, this comparison of the performance of these rules is in line with what could be expected from the comparison of fiscal multipliers in the model (Charts 4-7). In general, expenditure is more effective in stabilising GDP than tax changes. The impact of temporary income tax changes on output is small because the intertemporal optimising behaviour of economic agents smooths away most of it. However, changes in the VAT rate act more like a relative price change and can be a very effective stabilisation tool in the model. A reduction in the value added tax boosts consumer spending in the short term, as forward looking consumers front-load their spending to the current year in anticipation of higher indirect taxes again in following years.

Table 2 Fiscal policy rules

Consumption shock GERMANY

	No stab rule	GC	TL	VAT
GDP	-0.49	-0.31	-0.40	-0.32
Def/GDP	0.16	0.46	0.55	0.42

Export shock GERMANY

	No stab. rule	GC	TL	VAT
GDP	-0.66	-0.42	-0.53	-0.44
Def/GDP	0.04	0.45	0.56	0.40

Consumption shock IRELAND

	-	GC	TL	VAT
GDP	-0.24	-0.18	-0.22	-0.20
Def/GDP	0.18	0.34	0.38	0.34

Export shock IRELAND

	-	GC	TL	VAT
GDP	-0.53	-0.39	-0.49	-0.44
Def/GDP	0.03	0.39	0.47	0.37

5 Conclusions

This paper has illustrated the impact of alternative monetary and fiscal policy rules in the QUEST model. It has looked at the effectiveness of monetary and fiscal policy rules for stabilisation purposes. Concerning monetary rules, alternative specifications of interest rate rules were considered with different degrees of inflation targeting and their performance was analysed in the presence of misperceptions about the nature of output shocks by the central bank. If the central bank fails to recognise a permanent positive shock to potential output, a higher degree of inflation targeting proved beneficial in nthe model in terms of reducing the output gap and allowing for a faster adjustment to potential output.

Concerning fiscal rules the paper addressed the issue of stabilising country specific demand shocks in EMU and examined the relative effectiveness of expenditure versus revenue based (direct and indirect taxes) fiscal stabilisation. Though expenditure based stabilisation is generally more efficient, the specification of consumer behaviour suggests that stabilisation based on temporary changes in VAT rates could be equally efficient.