WORKING PAPER

5-02

Automatic fiscal stabilisers in the euro area

Simulations with the NIME Model

**Federal
Planning Bureau**
Economic analyses and forecasts

Kunstlaan 47-49
B-1000 Brussels
Tel.: 02 507 73 11
Fax: 02 507 73 73
E-mail: contact@plan.be
URL: http://www.plan.be

Eric Meyermans

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In this paper we investigate how automatic fiscal stabilisers affect economic activity in the euro area. For this purpose we simulated the NIME model, applying different shocks to the model. The paper shows detailed quantitative results for the euro area and compares them with results for the U.S. and Japan. The simulations underline the necessity to identify the nature of the shock when one designs fiscal policies. If the shock has permanent real effects, then a policy based on automatic stabilisers is unsustainable. If the shock has only temporary effects or permanent nominal effects, then the automatic fiscal stabilisers can be used to smoothen output fluctuations. However, the evidence also indicates that automatic stabilisers may delay full adjustment.

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I Introduction[1]

In this paper, we investigate how automatic fiscal stabilisers affect economic activity in the euro area. For this purpose we apply several shocks to the NIME model, and we compare the adjustment path of the main macroeconomic variables under a regime that allows the automatic fiscal stabilisers to operate fully, with the results for a regime that tempers the working of the automatic fiscal stabilisers. We also compare the results for the euro area with results for the United States and Japan.

The empirical literature on automatic fiscal stabilisers has increased considerably since the Maastricht Treaty came into force in 1993 and the Stability and Growth Pact was adopted in 1997. See, for example, Buti and Sapir (1998), Leeftink (2000), OECD (1993), Roeger and in 't Veld (1997), and van den Noord (2000). Most of these studies find that output fluctuations are reduced significantly when automatic stabilisers are allowed to operate. Our paper provides some additional evidence based on a macroeconometric world model that has a well-defined steady state and a set of behavioural equations, allowing for an analysis of the dynamics towards the steady state.

In the second section of this paper, we briefly describe the NIME model. In the third section, we present simulation results for diverse shocks under two different fiscal regimes. Under the first regime, the automatic fiscal stabilisers are allowed to operate fully. Under the alternative regime, the working of the automatic fiscal stabilisers is tempered without compromising the long run sustainability of fiscal policies. The shocks we investigate are a temporary real demand shock, a permanent monetary shock, and a permanent supply shock. In the fourth section, we formulate some conclusions.

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1. Working Paper presented at the 4th Banca d'Italia Workshop on Public Finance, Perugia, 21-23 March 2002. Comments can be mailed to em@plan.be.

II   The NIME model

The NIME model is a macro-econometric world model developed at the Belgian Federal Planning Bureau. This model is built to make medium-term forecasts of the Belgian international economic environment and to study the transmission of the effects of economic policies and exogenous shocks on the Belgian and European economy[1].

The current version of the NIME model divides the world into six separate country blocks: Belgium (BE), the EU block consisting of the countries that adopted the euro in 1999 minus Belgium, the NE block consisting of the countries of the European Union that did not adopt the euro in 1999, the United States (US), Japan (JP) and the "rest of the world" (RW)[2]. These country blocks are linked to each other through trade and financial flows. The EU, NE, US and JP block have the same structure. In each of these country blocks, we distinguish a household sector, an enterprise sector, a public sector, and a monetary sector. For each sector we postulate the existence of a single representative agent, so that we do not consider issues of heterogeneity. A similar set of behavioural equations and accounting identities is specified for each sector across blocks, while the parameter values of the equations are obtained using econometric techniques applied to the aggregated data of the different blocks.

The NIME model makes an analytical distinction between three different time horizons: the short run that is demand driven and during which the plans of the agents are not fully realised due to the existence of adjustment costs; the medium run where the plans are realised but still changing due to lagging adjustment of the other endogenous variables and a steady state long run. In the steady state, productivity, the natural rate of unemployment, secular inflation, the real interest rate, the participation rate, and population growth are exogenous, while the steady state values of the other variables, such as potential output, are determined by these exogenous variables and the structural equations of the model.

The NIME model distinguishes four sectors per country block. First, the household sector allocates its total available means over goods and services, money balances, residential buildings, and other assets as a function of the nominal interest rate, the real interest rate, the user cost of residential buildings, and a scale variable. This scale variable consists of the assets inherited from the past, plus asset income, plus current and expected future labour income. In the short run, the

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1. A more detailed discussion of the NIME model can be found in Meyermans and Van Brusselen (2001). This paper is available on the world wide web at www.plan.be click Language, click Working Papers, or at www.plan.be/nl/pub/wp/detail_wp.stm?pub=WP0103 .
2. A new version of the model that captures the recent changes in the composition of the euro area is under preparation.

household sector is liquidity constrained so that a fraction of total private consumption is financed by disposable income. Error correction mechanisms and partial adjustment schemes are used to capture sluggish adjustment in the expenditure plans of the household sector. Second, the enterprise sector maximizes its profits by hiring production factors and selling goods and services to the final users. There are three production factors, i.e., labour, capital and intermediary imports. The production technology is a Cobb-Douglas production function with constant returns to scale. Error correction mechanisms and partial adjustment schemes are used to model short run factor demand. Price adjustment occurs sluggishly because of menu costs and incomplete information. Third, the monetary authorities set the short-term interest rate in such a way that it deviates from the steady state interest rate to the extent that the policy variables deviate from their target value. These policy variables are inflation and output (or unemployment). The long-term interest rate is determined by the short-term interest rate and the steady state interest rate. The equilibrium exchange rate equilibrates the current account. Fourth, public sector receipts are determined by endogenous tax bases and predetermined tax rates[1], while the public expenditures are to a large extent determined by the business cycle and trend growth.

In the NIME model, the automatic fiscal stabilisers are determined on the expenditure side by the unemployment benefits and interest payments on public debt, and on the revenue side by direct labour income taxes, profit taxes, social security contributions, and indirect taxes. For convenience, we summarise in Appendix A the major features of the fiscal sector. A summary of the other sectors can be found in Meyermans and Van Brusselen (2001) (MVB, henceforth).[2]

Finally, it should be noted that the expectations of the agents are partly forward looking, and partly backward looking. The forward looking expectations are quasi-rational in the sense that agents have model consistent expectations about the steady state but the speed of convergence towards this steady state is determined by a reduced form function rather than by the underlying structural parameters of the model.

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1. In the default version of the NIME model, the public debt to GDP ratio stabilises at a rate determined outside the model. It is the direct labour income tax rate which adjusts to reach this target.
2. The "rest of the world" block consists of a limited number of equations describing overall economic activity in the rest of the world. For the block describing the Belgian economy, one of the existing BFPB models will be used. These models have been developed independently from the NIME project, and they have their own specific structure, (see, for example, Bossier et al. (2000)). For this exercise the BE block is kept exogenous.

III Automatic fiscal stabilisers under diverse shocks

In this section, we use the NIME model to examine the effects of automatic fiscal stabilisers on the main macroeconomic variables of the euro area, and we compare them with the effects of a sustainable alternative regime that tempers the working of the automatic fiscal stabilisers. Three shocks are applied to the model, i.e., a temporary drop in private consumption, a permanent increase in the nominal money supply, and a permanent decline in trend productivity. A sustainable alternative scenario is defined as a scenario in which in the long run the target debt to GDP ratio and the target deficit to GDP ratio are reached, but which tempers the working of the automatic fiscal stabilisers during the adjustment process.

We start from a baseline[1], to which we apply a shock, and we simulate the model until it reaches a steady state. Depending on the nature of the shock, the new steady state may deviate from the old one. The temporary real demand shock does not affect the steady state of the economy. The monetary shock increases the nominal variables permanently, while it leaves the real variables unaffected. The permanent supply shock changes the steady state values of the real variables, leaving the general price level unchanged. As we will see, these long run effects are not without implications for the sustainability of the automatic stabilisers and for the choice of the alternative fiscal regime.

Apart from the automatic fiscal stabilisers, there are several other mechanisms that influence adjustment in the NIME model. First, there are the prices. The real factor prices adjust to reflect changes in factor productivity (see Chapter III of MVB). The relative prices of supply for final demand change to induce a reallocation between the components of final demand (see Chapter II and III of MVB). In the short run, the price level changes in response to the output gap. Second, there are the scale variables. The total real available means of the household sector change in response to changes in the (expected) non-asset income, so that household demand decreases if there is an expected decrease in future productivity. Also, the consumer price deflates the nominal scale variable in the demand equations of the household sector, so that a change in the price level affects household demand via its wealth effect (see Chapter II of MVB). Moreover, to the extent that the households are liquidity constrained, changes in disposable income may have an important impact on household expenditures. Imports also accommodate total domestic demand in the short run, while savings are used to adjust the capital

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1. We perform the shocks on a technical baseline that has been obtained simulating the model for a prolonged time until it has reached a steady state. The year in which the shock is introduced is the first year of the steady state. This implies, for example, that the equilibrium direct income tax rate is set at the level which is compatible with the fiscal targets, in particular, the debt to GDP ratio. The latter is determined outside the model at 0.60. See Chapter VI of MVB.

stocks to their equilibrium level. Third, the monetary authorities set the short-term interest rates to accommodate their targets[1] (see Chappter III of MVB).

A. A temporary real demand shock

In a first exercise, we assume that the household sector of the euro area expects a drop in its future income[2]. As a result, the household sector reallocates its expenditures, inducing in the first year a drop in private consumption by 1 percent vis-à-vis the baseline. In the second year, the household sector revises its expectations and the expected future income is again equal to its baseline level.

We will now discuss two policy responses to this temporary drop in private demand. In the first variant, the authorities let the automatic fiscal stabilisers operate. In the second variant, the fiscal authorities stabilise the fiscal *deficit* to GDP ratio in *every* period, and they adjust the direct labour income tax rate to reach this objective.

1. Automatic fiscal stabilisers operating

The simulation results of the first variant are shown in Table 1. The first 5 columns show the first 5 years of the adjustment process as percentage deviations from the baseline. The sixth column, labelled ss, shows the new steady state which is obtained simulating the model for a prolonged period. The seventh column gives an indication of the persistence of the shock[3]. The last two columns show the impact responses to a similar temporary demand shock in the US and Japan.

Since we are dealing here with a temporary shock, the steady state does not change, as is shown in column 6 of Table 1. Let us now have a closer look at the adjustment path of the main macroeconomic variables.

In the first year, future household labour income is expected to drop by 2.89 percent in the euro area. As a result, the household sector reduces its consumption of goods and services by 1 percent, while gross fixed capital formation falls by 0.32 percent. This drop in domestic activity triggers a 1.71 percent drop in imports. Exports are only modestly affected, primarily because there is not a similar shock in the other blocks. As a net result total private output declines by 0.76 percent, while GDP in constant prices falls by 0.50 percent. Private sector employment falls by 0.12 percent, while real wages fall by about 0.08 percent.[4]

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1. By default, these targets are inflation and unemployment. Under a strict monetary targeting regime there is only one target, i.e., the money supply. See section 3.2.
2. We calculated this drop in future income in such a way that it induces a 1 percent drop in private consumption in the first year.
3. Persistence is measured by the regression coefficient of the contemporaneous deviation from the baseline on the lagged deviation from the baseline, for the period ranging from t+1 till the end of the simulation, with t the period in which the shock occurs. The smaller the parameter value (in absolute terms), the lower the persistence.
4. See MVB for the equations and elasticities underlying these results.

The spill-over effects of this shock to the other country blocks are summarised in the last rows of the Table 1[1]. Here, we see, for example, that in the first year private output falls, on average, by about 0.07 percent in the other country blocks, while prices remain almost unchanged.

The last two columns of Table 1 show the impact responses to a similar shock in the US and Japan. We note that the largest responses are in the US, where private output falls by 1 percent. Of particular interest are the responses in the US labour market where we see that employment in the private sector drops by 0.5 percent, compared with about 0.1 percent in the other country blocks. This reflects to a large extent the high short run output elasticity of labour demand in the US[2]. In all country blocks, the initial response of prices is small.

In the euro area, public revenues in constant prices fall initially by 0.21 percent, mainly because indirect tax receipts in constant prices decline by 0.64 percent. Real direct labour income tax receipts decline by 0.02 percent, reflecting the modest change in the tax base. Public expenditures in constant prices remain almost unchanged in the first year. The modest increase in unemployment benefits is compensated by a decrease in subsidies to enterprises and other outlays. The fiscal deficit as a ratio to GDP increases by 0.10 percent, while the debt to GDP ratio increases by 0.46 percent.[3] We note a similar increase in the fiscal deficit to GDP ratio in Japan. For the US, the deficit to GDP ratio increases by 0.25 percent, reflecting the strong increase in outlays for unemployment benefits.

In the second year, the shock reverses and the economy starts to converge gradually to the baseline. During this adjustment process, prices change to accommodate, with a one year lag, the changes in the output gap. In the same way, the interest rates are set to accommodate the economy to its steady state. The coefficient of autocorrelation in the seventh column suggests that the adjustment towards the steady state is primarily slowed down by the sluggish adjustment of the prices and the stock of assets. The speed of price adjustment is determined by menu costs and information costs[4], while the stock of assets is rebuilt through savings.

2. Automatic fiscal stabilisers prevented

Here, the same shock is applied as in the previous variant, however, in this variant we also assume that the direct labour income tax rate is adjusted to stabilise the fiscal *deficit* to GDP ratio *in every* period. The results of this variant are shown in Table 2.

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1. The effective foreign variables are a weighted average of the corresponding variables in the other country blocks. The weights are shares in export markets.
2. Short run output elasticity for US and EU are 0.50 and 0.16, respectively. See MVB, Table III.5 in Chapter III. Note that due to the Cobb-Douglas nature of the production function the long run output elasticity is equal to 1.
3. Comparing the change in the deficit to GDP ratio with the debt to GDP ratio, the following is of some interest. Let NBG be net public borrowing, GBOND the public debt, and GDPU nominal GDP, so that NBG = d GBOND. We have that d (GBOND/GDPU) = d GBOND/GDPU – GBOND/GDPU d GDPU/GDPU, so that d (GBOND/GDPU) = NBG/GDPU – (GBOND/GDPU) (d GDPU/GDPU).
4. See section III.B of MVB.

In the first year, the direct labour income tax rate increases in the euro area. This tax increase has a direct impact on real disposable income which falls by 0.25 percent in the first year, compared with 0.08 percent in the previous variant. As a result, private consumption drops by 1.12 percent, compared with 1 percent in the previous variant. Imports fall by 1.96 percent, while gross fixed capital formation falls by 0.44 percent. Once again, exports remain almost unchanged. As a net result, private output drops by 0.86 percent, compared with 0.76 percent in the previous variant. The spill-over effects to the other country blocks do not differ much from the one we found for the first variant.

Examining the results for a similar temporary demand shock in the other country blocks, we see that the responses are strongest in the US In Japan, the alternative fiscal regime does not seem to have a big impact on total output. This is primarily because private consumption remains almost unaffected. Here it should be remembered that a (temporary) direct labour income tax increase affects private consumption primarily via disposable income, and that the impact of disposable income on private consumption is determined by the extent to which the household sector is liquidity constrained. Apparently, the latter is rather low in Japan[1].

In the second year, the shock reverses and people hold the same expectations regarding their future income as they did in the baseline. This implies that private consumption gets a boost, thereby increasing economic activity so that indirect tax revenues rise and outlays for unemployment benefits fall. In order to meet the target deficit to GDP ratio, the direct labour income tax rate will be reduced, thereby giving an additional stimulus to private consumption. The net effect is that in the second year private consumption is 0.10 percent below its baseline value, compared with 0.17 percent in the previous variant, while private output is 0.03 percent below its baseline, compared to 0.09 percent in the previous variant. This interaction between changes in the direct labour income tax rate and output will continue until the equilibrium is reached. All in all, comparing the evidence in column 7 of Table 1 and 2 suggests that adjustment in output is faster in the second variant than in the first variant. This is because in the second variant the direct labour income tax rate is used to speed up adjustment of the fiscal accounts.

Table 3 shows the degree of stabilisation by automatic stabilisers in the first year by comparing the results of Table 1 and 2[2]. We find for the euro area that output fluctuations under a regime with the automatic fiscal stabilisers fully operating, are reduced by 11.5 percent if compared with the fluctuations under a sustainable alternative regime that tempers the working of the automatic stabilisers. The highest reduction is found in the US, where the fluctuations reduce by more than 20 percent. Clearly, not all components of total demand are affected in the same way. In all country blocks, the reduction is the strongest for gross fixed capital formation.

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1. See Table II.3 of MVB. Parameter 1-cp_sb2, which is 0.19 for Japan, and about 0.55 for the US and the euro area. 1-cp_sb2 is the proportion of private consumption that is financed out of disposable income.
2. Degree of stabilisation is defined as (deviation from baseline in Table 2 – deviation from baseline in Table 1)/ deviation from baseline in Table 2.

TABLE 1 -   A temporary demand shock - automatic fiscal stabilisers operating

	euro area							US	JP
	01	02	03	04	05	SS	SA	01	01
total private output	-0.76	-0.09	0.08	0.09	0.07	0.00	0.17	-0.98	-0.74
real GDP	-0.50	-0.08	0.04	0.05	0.04	0.00	0.19	-0.72	-0.66
nominal GDP	-0.59	-0.36	-0.22	-0.18	-0.16	-0.00	0.73	-0.76	-0.70
Demand (in constant prices)									
private consumption	-1.00	-0.17	0.05	0.09	0.09	0.00	0.22	-1.00	-1.00
public consumption	-0.07	-0.10	0.00	0.04	0.03	0.00	0.50	0.03	-0.04
gross capital formation	-0.32	-0.05	0.07	0.07	0.06	0.00	0.30	-0.81	-0.37
exports	0.00	0.02	0.07	0.04	-0.00	0.00	0.78	-0.13	0.05
imports	-1.71	-0.19	0.24	0.27	0.23	0.00	0.18	-2.08	-0.92
Prices									
GDP deflator (PGDP)	-0.09	-0.28	-0.26	-0.23	-0.20	-0.00	0.95	-0.03	-0.04
consumption price/PGDP	0.08	-0.03	-0.08	-0.08	-0.08	0.00	0.83	0.03	0.04
export price/PGDP	0.09	0.29	0.27	0.25	0.22	-0.00	0.95	0.06	0.14
import price/producer price	0.03	0.13	0.04	-0.01	-0.03	-0.00	0.51	0.00	0.02
Labour market									
total employment	-0.09	-0.01	0.03	0.04	0.03	0.00	0.37	-0.43	-0.06
private sector employment	-0.12	-0.02	0.04	0.05	0.03	0.00	0.29	-0.49	-0.06
take home real wage	-0.08	0.03	0.09	0.09	0.08	-0.00	0.81	-0.07	-0.11
producer real wage	-0.03	-0.01	0.00	0.01	0.00	0.00	0.30	-0.07	-0.07
Financial sector									
short-term interest rate *	-0.09	-0.23	-0.09	-0.00	0.04	-0.00	0.65	-0.28	-0.17
long-term interest rate *	-0.09	-0.21	-0.03	0.02	0.03	-0.00	0.52	-0.10	-0.08
nominal effective exchange rate	0.03	0.09	0.08	0.04	0.00	0.00	0.80	0.10	0.29
real effective exchange rate	0.03	0.08	0.06	0.01	-0.03	0.00	0.80	0.08	0.19
nominal money stock	-0.09	-0.79	-0.34	-0.19	-0.16	-0.00	0.69	0.55	0.50
Public finance									
nominal public revenues	-0.30	-0.28	-0.21	-0.18	-0.16	-0.00	0.90	-0.38	-0.24
real public revenues	-0.21	0.00	0.05	0.05	0.04	0.00	0.21	-0.34	-0.20
real labour income tax receipts	-0.02	-0.02	-0.01	-0.00	-0.01	0.00	0.89	-0.18	-0.05
real social sec. contributions	-0.02	-0.02	-0.01	-0.00	-0.01	0.00	0.89	-0.18	-0.05
real indirect tax receipts	-0.64	-0.07	0.07	0.08	0.06	0.00	0.16	-0.84	-0.68
real profit tax receipts	-0.73	-0.08	0.08	0.09	0.07	-0.00	0.16	-0.95	-0.73
nominal public expenditures	-0.07	-0.31	-0.36	-0.27	-0.23	-0.00	0.94	0.36	-0.02
real public expenditures	0.01	-0.03	-0.10	-0.04	-0.02	0.00	0.69	0.40	0.03
real transfers to households	0.18	-0.02	-0.12	-0.12	-0.11	0.00	0.64	1.05	0.33
real interest payments	0.09	-0.36	-1.09	0.17	0.30	0.00	0.22	0.03	0.04
direct labour income tax rate *	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
deficit to GDP ratio *	0.10	-0.01	-0.07	-0.04	-0.03	0.00	0.35	0.25	0.09
debt to GDP ratio *	0.46	0.30	0.15	0.08	0.04	-0.00	0.94	0.70	0.51
Household sector									
total available means	-1.79	0.13	0.15	0.13	0.12	-0.00	-0.02	-1.86	-1.15
disposable income	-0.08	-0.03	0.09	0.09	0.09	0.00	0.86	-0.16	-0.04
savings as % of disp. inc *	0.91	0.14	0.04	0.00	-0.00	0.00	0.18	0.81	0.88
Memo items									
current account to GDP *	0.25	0.05	0.01	0.00	0.00	-0.00	0.23	0.19	0.11
total stock of real assets	-0.01	-0.01	-0.01	-0.01	-0.00	0.00	0.98	-0.03	-0.01
effec. foreign output	-0.07	0.05	0.01	-0.00	-0.01	0.00	-0.42	-0.09	-0.02
effec. foreign price level	-0.00	-0.01	-0.01	-0.01	-0.02	-0.00	0.97	0.00	0.00
effec. foreign interest rate *	-0.03	-0.07	-0.03	-0.01	0.01	0.00	0.69	-0.07	-0.01

Variables without * : deviation from baseline, in percent. Variables with * : deviation from baseline, in differences.

SS is steady state. SA is measure of persistence. The smaller the parameter value (in absolute terms), the lower the persistence.

TABLE 2 -   A temporary demand shock - automatic fiscal stabilisers prevented

	euro area							US	JP
	01	02	03	04	05	SS	SA	01	01
total private output	-0.86	-0.03	0.18	0.10	0.05	0.00	0.09	-1.27	-0.77
real GDP	-0.56	-0.04	0.10	0.06	0.03	0.00	0.12	-0.90	-0.69
nominal GDP	-0.66	-0.35	-0.16	-0.15	-0.15	-0.00	0.66	-0.95	-0.73
Demand (in constant prices)									
private consumption	-1.12	-0.10	0.17	0.11	0.07	-0.00	0.13	-1.26	-1.03
public consumption	-0.07	-0.11	0.01	0.06	0.03	0.00	0.43	0.12	-0.03
gross capital formation	-0.44	-0.00	0.16	0.09	0.06	0.00	0.18	-1.24	-0.47
exports	0.00	0.02	0.08	0.04	-0.01	0.00	0.73	-0.18	0.05
imports	-1.96	-0.05	0.49	0.32	0.20	0.00	0.10	-2.89	-0.99
Prices									
GDP deflator (PGDP)	-0.10	-0.31	-0.26	-0.21	-0.18	-0.00	0.94	-0.05	-0.04
consumption price/PGDP	0.09	-0.04	-0.10	-0.08	-0.07	0.00	0.78	0.05	0.04
export price/PGDP	0.10	0.32	0.27	0.22	0.20	-0.00	0.94	0.08	0.15
import price/producer price	0.03	0.14	0.04	-0.03	-0.04	-0.00	0.44	0.00	0.02
Labour market									
total employment	-0.10	-0.00	0.05	0.04	0.02	0.00	0.31	-0.63	-0.07
private sector employment	-0.13	-0.01	0.06	0.05	0.03	0.00	0.22	-0.71	-0.07
take home real wage	-0.24	0.08	0.22	0.14	0.09	-0.00	0.52	-0.42	-0.21
producer real wage	-0.02	-0.01	-0.00	0.00	-0.00	0.00	0.65	0.06	-0.05
Financial sector									
short-term interest rate *	-0.11	-0.25	-0.07	0.03	0.05	-0.00	0.58	-0.41	-0.18
long-term interest rate *	-0.10	-0.23	-0.01	0.04	0.04	-0.00	0.44	-0.15	-0.09
nominal effective exchange rate	0.03	0.10	0.08	0.03	-0.01	0.00	0.77	0.15	0.31
real effective exchange rate	0.03	0.09	0.06	-0.00	-0.04	0.00	0.76	0.12	0.20
nominal money stock	-0.26	-0.66	-0.19	-0.19	-0.20	-0.00	0.77	0.64	0.43
Public finance									
nominal public revenues	-0.08	-0.36	-0.38	-0.24	-0.19	-0.00	0.92	0.57	-0.02
real public revenues	0.02	-0.04	-0.12	-0.03	-0.01	0.00	0.55	0.62	0.03
real labour income tax receipts	1.36	-0.39	-1.10	-0.47	-0.23	0.00	0.25	4.66	1.09
real social sec. contributions	-0.02	-0.03	-0.01	-0.00	-0.01	0.00	0.91	-0.13	-0.03
real indirect tax receipts	-0.72	-0.02	0.15	0.09	0.04	0.00	0.09	-1.07	-0.72
real profit tax receipts	-0.82	-0.02	0.18	0.10	0.05	-0.00	0.08	-1.23	-0.77
nominal public expenditures	-0.08	-0.36	-0.38	-0.24	-0.19	-0.00	0.92	0.57	-0.01
real public expenditures	0.02	-0.04	-0.12	-0.03	-0.01	0.00	0.55	0.62	0.04
real transfers to households	0.21	-0.04	-0.16	-0.13	-0.09	0.00	0.54	1.53	0.35
real interest payments	0.10	-0.60	-1.27	0.46	0.57	0.00	0.24	0.05	0.04
direct labour income tax rate *	0.15	-0.04	-0.12	-0.05	-0.02	0.00	0.23	0.43	0.11
deficit to GDP ratio *	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.00	0.00
debt to GDP ratio *	0.39	0.21	0.10	0.09	0.09	0.01	0.70	0.57	0.44
Household sector									
total available means	-1.80	0.15	0.16	0.13	0.11	-0.00	-0.02	-1.88	-1.16
disposable income	-0.25	0.03	0.23	0.14	0.10	0.00	0.60	-0.65	-0.19
savings as % of disp. inc *	0.87	0.13	0.05	0.03	0.03	0.00	0.20	0.61	0.80
Memo items									
current account to GDP *	0.28	0.03	-0.02	-0.00	0.00	-0.00	0.13	0.27	0.12
total stock of real assets	-0.01	-0.01	-0.01	-0.00	-0.00	0.00	0.97	-0.05	-0.02
effec. foreign output	-0.07	0.06	0.01	-0.01	-0.01	0.00	-0.42	-0.12	-0.02
effec. foreign price level	-0.00	-0.01	-0.01	-0.01	-0.01	-0.00	0.97	0.00	0.00
effec. foreign interest rate *	-0.04	-0.08	-0.02	0.01	0.01	0.00	0.62	-0.11	-0.01

Variables without * : deviation from baseline, in percent. Variables with * : deviation from baseline, in differences.

SS is steady state. SA is measure of persistence. The smaller the parameter value (in absolute terms), the lower the persistence.

TABLE 3 - **Degree of stabilisation by automatic stabilisers: impact of a temporary real shock**

	euro area	US	JP
	01	01	01
total private output	11.47	21.88	4.64
real GDP	10.78	19.48	4.20
Components of aggregate demand (in constant prices)			
private consumption	10.75	20.66	2.79
gross capital formation	25.83	34.51	22.46
exports	11.97	28.01	6.35
imports	12.62	27.73	6.97

B. A permanent monetary shock

In this section, we discuss the results for the case that the monetary authorities increase the nominal money stock by 1 percent[1]. In the first variant, the fiscal authorities let the automatic fiscal stabilisers operate. In the second variant, the fiscal authorities stabilise the public *debt* to GDP ratio in *every* period, and they adjust the direct labour income tax rate to reach this objective[2].

1. Automatic fiscal stabilisers operating

The results for the variant with automatic stabilisation are shown in Table 4. The steady state results are shown in the sixth column, labelled ss. Here we see that in the long run the nominal variables increase by 1 percent, while the real variables remain unchanged. Let us now have a look at the adjustment path towards this new steady state.

Roughly speaking, the adjustment process in the euro area runs as follows. The monetary expansion reduces the short-term interest rate, which stimulates demand. When total demand exceeds the natural output level, inflation rises. Inflation erodes the real value of the nominal money balances, and the resulting excess demand for real money balances triggers an interest rate hike. However, an interest rate hike reduces also demand, so that the output gap starts to fall and the inflationary pressures reduce. This feedback between interest rates, money balances, demand for goods, and inflation continues until the economy is back in equilibrium[3].

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1. Technically speaking, in this scenario the short-term interest rate drops by the amount that is necessary to induce the household sector to hold an additional one percent of nominal money balances. Such an interest rate reaction function is obtained solving the short run money demand function, i.e., equation (II.8) of MVB, for the short-term interest rate, and evaluating this function for the target money supply. It should also be noted that this shock implies that in the steady state the general price level will increase by one percent, and that price expectations adjust accordingly. Here, we assume that the agents gradually learn about the monetary shock.
2. If compared with the alternative scenario of the previous section, we changed the fiscal objective under the alternative scenario. Indeed, the nominal shock implies that nominal GDP will increase by 1 percent in the long run. If no fiscal deficit is allowed at any time, the nominal stock of public debt will remain unchanged. In that case, the target public debt to GDP ratio will not be reached in the long run.
3. This process is further influenced by the impact of changes in the exchange rate, and by the impact of inflation expectations on the components of demand.

In the first year, the money stock increases by 1 percent, while the real money balances increase by 0.75 percent[1]. In order to induce the household sector to absorb this additional amount of real money balances the short-term interest rate has to fall by 0.5 percent point. This interest rate drop stimulates demand. Private consumption increases by 0.13 percent, while gross fixed capital formation and imports increase by 0.17 percent and 0.55 percent, respectively. At the same time the real exchange rate depreciates by 0.73 percent, stimulating exports by 0.49 percent. As a result, GDP in constant prices increases by 0.14 percent, while GDP in current prices increases by 0.36 percent. Private output increases by 0.21 percent.

The spill-over effects to the other country blocks are modest. As a result of the monetary expansion in the euro area, private output in the other country blocks increases, on average, by 0.03 percent, compared with 0.21 percent in the euro area. See the last rows of Table 4.

The last two columns of Table 4 show the impact responses to a similar permanent monetary shock in the US and Japan. Real GDP in the US and Japan increases by 0.13 and 0.05 percent, respectively, while nominal GDP increases by 0.24 percent and 0.43 percent, respectively.

Let us now have a look at the fiscal stance in the euro zone. The monetary expansion stimulates economic activity, so that public revenues measured in constant prices increase by 0.17 percent. At the same time public expenditures in constant prices remain more or less unchanged in the euro area. The net result is that the government runs a fiscal surplus equal to 0.06 percent of GDP, while the debt to GDP ratio drops by 0.28 percent. In the other areas, we see that the fiscal surplus as percent of GDP is somewhat higher, e.g., 0.11 percent in the US, this is partly due to the smaller rise in US nominal GDP.

For most variables of the euro area, the largest deviation (in absolute terms) from the baseline is reached in the first year. However, once the shock has occurred, the variables do not converge at the same speed to their equilibrium value. The prices and the stock variables have the highest persistence. Menu costs and incomplete information prevent immediate adjustment of the prices, while the household sector has to rebuild its stock of assets through its savings.

2. Automatic fiscal stabilisers prevented

In this variant we investigate the adjustment process for the case that in addition to the monetary shock the fiscal authorities also stabilise the debt to GDP ratio in every period. Note that the 1 percent increase in nominal GDP implies that if one wants to stabilise (in the long run) the debt to GDP ratio, the economy has to run at some time a fiscal deficit[2]. The results of this variant are shown in Table 5.

In Table 5, we get for the first year the same qualitative results as in the previous variant. However, the order of magnitude of the responses is now much larger. In

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1. Nominal money stock deflated by the consumer price.
2. In other words, the alternative fiscal regime of the previous section is not sustainable, since it keeps the fiscal deficit equal to zero in every period. As a result, the predetermined target debt to GDP ratio will not be reached.

the euro area, real GDP increases by 0.34 percent, compared with 0.14 percent in the previous variant. Private consumption increases by 0.57 percent compared with 0.13 percent in the previous variant. Nominal GDP increases by 0.60 percent. As discussed in the previous section, a monetary expansion will temporarily induce a drop in the debt to GDP ratio if no further action is taken. Hence to stabilise the debt to GDP ratio at its predetermined level in every period, the fiscal authorities will reduce the direct labour income tax rates. However, this tax cut is not unambiguous. It will not only reduce direct tax revenues, but it will also stimulate domestic activity, thereby raising indirect tax revenues and reducing public expenditures on unemployment benefits. Taking these feedbacks into account, the tax rate has to drop by 0.6 percent points in the euro area. Similar qualitative results are found for the other country blocks. Nevertheless, for Japan the responses remain modest in absolute terms[1].

In the second year, the prices continue to rise as the economy is producing above its long run equilibrium. Note also that because of different menu costs in price setting not all prices increase by the same amount. In the second year, the GDP deflator is 0.56 percent above the baseline, while the consumer price is 0.71 percent above the original baseline. These price developments will reduce the real value of the nominal assets and the real take home wage, thereby reducing private consumption and overall economic activity. As a consequence, the direct labour income tax rate has to be raised to counteract increased public expenditures and falling revenues. This tax increase triggers a drop in domestic activity, which in turn requires a higher tax rate to compensate for the additional loss of revenue and increased outlays on unemployment benefits. As a net result, overall spending and private output will drop below their equilibrium level. The following years, this feedback between prices, taxes, and demand will continue, causing oscillating behaviour until the new steady state is reached.

Table 6 summarises the previous results showing the degree of stabilisation by automatic stabilisers for the different blocks[2]. Here, we see, for example, that output fluctuations in the euro area are reduced by 60 percent when the automatic stabilisers are working, compared with a situation in which the debt to GDP ratio is stabilised in every period.

Finally, we also simulated the adjustment path for a temporary demand shock for the case that one assumes that the fiscal authorities stabilise the debt to GDP ratio in every period[3]. These results are shown in Appendix B. In Table 7 we show the corresponding degree of stabilisation by automatic stabilisers[4]. Comparing the results of Table 6 with the results of Table 7, we note that stabilisation in the first year is more effective in the case of the nominal shock than in the case of the real demand shock. This is due to the fact that in the case of the money supply shock, the economy is deprived from one adjustment mechanism, i.e., the short-term interest rate, so that the automatic stabilisers carry a larger part of the adjustment burden[5].

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1. But not in relative terms as will be seen in Table 6.
2. Degree of stabilisation is defined as (Table 5 – Table 4)/Table 5.
3. Remember in section 3.1, the *deficit* to GDP ratio was stabilised in every period.
4. I.e., the resullts of Table 1 compared with the results of Table B.1.
5. Note that this would not be the case if we were dealing with a money *demand* shock.

TABLE 4 -   A permamnent monetary shock - automatic fiscal stabilisers operating

	euro area							US	JP
	01	02	03	04	05	SS	SA	01	01
total private output	0.21	0.16	0.09	0.05	0.02	-0.00	0.86	0.18	0.06
real GDP	0.14	0.12	0.05	0.02	0.01	-0.00	0.87	0.13	0.05
nominal GDP	0.36	0.58	0.74	0.86	0.94	1.00	1.00	0.24	0.43
Demand (in constant prices)									
private consumption	0.13	0.05	-0.05	-0.12	-0.16	-0.00	0.96	0.15	-0.02
public consumption	0.07	0.08	0.04	0.00	-0.01	-0.00	0.76	0.04	0.07
gross capital formation	0.17	0.12	0.08	0.07	0.06	-0.00	0.94	0.27	0.09
Exports	0.49	0.58	0.64	0.68	0.68	0.00	0.96	0.14	0.41
Imports	0.55	0.34	0.29	0.18	0.08	-0.00	0.84	0.43	0.13
Prices									
GDP deflator (PGDP)	0.22	0.47	0.69	0.84	0.93	1.00	1.00	0.10	0.38
consumption price/PGDP	0.03	0.11	0.16	0.20	0.23	0.00	0.98	-0.01	-0.04
export price/PGDP	-0.19	-0.39	-0.55	-0.62	-0.63	-0.00	0.98	0.03	0.31
import price/producer price	-0.10	-0.05	-0.18	-0.16	-0.11	-0.00	0.82	-0.06	-0.19
Labour market									
total employment	0.02	0.02	0.00	-0.01	-0.01	0.00	0.88	0.08	0.00
private sector employment	0.03	0.02	-0.00	-0.01	-0.01	0.00	0.80	0.09	0.01
take home real wage	-0.03	-0.10	-0.17	-0.21	-0.24	-0.00	0.98	0.01	0.03
producer real wage	0.01	0.02	0.02	0.02	0.02	-0.00	0.96	0.01	0.00
Financial sector									
short-term interest rate *	-0.49	-0.25	-0.22	-0.20	-0.19	0.00	0.84	-0.40	-0.49
long-term interest rate *	-0.01	0.16	0.18	0.15	0.11	0.00	0.97	0.12	0.27
nominal effective exchange rate	0.77	0.84	0.92	0.98	1.02	0.99	1.00	0.63	1.98
real effective exchange rate	0.73	0.75	0.75	0.73	0.68	0.00	0.92	0.50	1.29
nominal money stock	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.99
Public finance									
nominal public revenues	0.39	0.61	0.77	0.89	0.97	1.00	1.00	0.39	0.54
real public revenues	0.17	0.15	0.08	0.05	0.04	0.00	0.82	0.29	0.16
real labour income tax receipts	0.02	0.06	0.04	0.05	0.06	0.00	0.97	0.03	-0.01
real social sec. contributions	0.02	0.06	0.04	0.05	0.06	0.00	0.97	0.03	-0.01
real indirect tax receipts	0.17	0.14	0.05	0.02	-0.00	-0.00	0.85	0.15	0.04
real profit tax receipts	0.20	0.16	0.06	0.02	0.00	-0.00	0.85	0.18	0.05
nominal public expenditures	0.25	0.56	0.85	1.05	1.19	1.00	1.00	0.05	0.37
real public expenditures	0.03	0.09	0.16	0.22	0.25	0.00	0.98	-0.05	-0.01
real transfers to households	0.01	0.10	0.16	0.21	0.24	0.00	0.98	-0.20	-0.06
real interest payments	-0.22	0.19	1.56	2.38	2.90	-0.00	0.98	-0.10	-0.38
direct labour income tax rate *	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
deficit to GDP ratio *	-0.06	-0.03	0.04	0.08	0.10	-0.00	0.97	-0.11	-0.07
debt to GDP ratio *	-0.28	-0.44	-0.49	-0.49	-0.44	0.00	0.98	-0.25	-0.33
Household sector									
total available means	-0.07	-0.16	-0.23	-0.26	-0.27	0.00	0.98	0.00	-0.08
disposable income	0.14	0.09	0.07	0.08	0.09	-0.00	0.98	0.04	0.01
savings as % of disp. inc *	0.00	0.04	0.12	0.19	0.25	-0.00	0.99	-0.10	0.07
Memo items									
current account to GDP *	-0.02	-0.02	-0.00	0.01	0.01	-0.00	0.99	-0.02	0.08
total stock of real assets	0.00	0.01	0.01	0.01	0.01	-0.00	0.99	0.01	0.00
effec. foreign output	0.03	-0.01	-0.01	-0.01	-0.00	0.00	0.43	-0.00	-0.00
effec. foreign price level	-0.01	-0.02	-0.02	-0.03	-0.03	0.00	1.00	-0.01	-0.00
effec. foreign interest rate *	-0.15	-0.09	-0.10	-0.10	-0.09	0.00	0.90	-0.08	-0.03

Variables without * : deviation from baseline, in percent. Variables with * : deviation from baseline, in differences.

SS is steady state. SA is measure of persistence. The smaller the parameter value (in absolute terms), the lower the persistence.

TABLE 5 -   A permanent monetary shock - automatic fiscal stabilisers prevented

	euro area							US	JP
	01	02	03	04	05	SS	SA	01	01
total private output	0.55	-0.06	0.05	-0.16	-0.03	-0.00	-0.03	0.92	0.18
real GDP	0.34	-0.01	0.02	-0.11	-0.03	0.00	0.08	0.59	0.15
nominal GDP	0.60	0.55	0.79	0.76	0.87	1.00	1.00	0.73	0.51
Demand (in constant prices)									
private consumption	0.57	-0.21	-0.10	-0.39	-0.23	-0.00	0.39	0.83	0.08
public consumption	0.07	0.12	0.02	-0.02	-0.05	-0.00	0.55	-0.15	0.04
gross capital formation	0.58	-0.01	0.08	-0.15	-0.04	-0.00	0.09	1.33	0.48
Exports	0.38	0.59	0.59	0.70	0.67	0.00	0.96	0.27	0.32
Imports	1.42	-0.16	0.17	-0.35	-0.07	-0.00	-0.08	2.44	0.35
Prices									
GDP deflator (PGDP)	0.26	0.56	0.76	0.87	0.90	1.00	1.00	0.14	0.36
consumption price/PGDP	-0.01	0.15	0.20	0.25	0.25	0.00	0.96	-0.04	-0.02
export price/PGDP	-0.24	-0.50	-0.64	-0.67	-0.61	-0.00	0.97	-0.04	0.17
import price/producer price	-0.12	-0.12	-0.15	-0.15	-0.06	-0.00	0.85	-0.06	-0.18
Labour market									
total employment	0.07	-0.01	-0.02	-0.04	-0.02	-0.00	0.53	0.58	0.02
private sector employment	0.10	-0.02	-0.02	-0.06	-0.03	-0.00	0.16	0.65	0.02
take home real wage	0.61	-0.22	-0.06	-0.40	-0.24	-0.00	0.43	0.83	0.40
producer real wage	-0.04	0.02	0.00	0.03	0.02	-0.00	0.50	-0.28	-0.07
Financial sector									
short-term interest rate *	0.07	-0.53	-0.04	-0.34	-0.08	0.00	0.46	-0.02	-0.23
long-term interest rate *	0.17	-0.10	0.08	-0.11	-0.02	0.00	0.35	0.10	0.18
nominal effective exchange rate	0.57	0.84	0.86	1.01	1.00	0.99	1.00	0.49	1.54
real effective exchange rate	0.55	0.77	0.73	0.79	0.69	0.00	0.94	0.38	1.00
nominal money stock	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Public finance									
nominal public revenues	-0.52	0.78	0.58	1.11	0.92	1.00	1.00	-1.84	-0.38
real public revenues	-0.78	0.21	-0.18	0.23	0.01	0.00	-0.13	-1.98	-0.74
real labour income tax receipts	-5.82	0.81	-1.30	1.37	-0.03	0.00	-0.11	-12.29	-4.60
real social sec. contributions	-0.01	0.06	0.04	0.05	0.06	0.00	0.90	-0.07	-0.08
real indirect tax receipts	0.45	-0.05	0.02	-0.16	-0.04	-0.00	0.01	0.75	0.15
real profit tax receipts	0.52	-0.06	0.02	-0.18	-0.05	-0.00	0.10	0.88	0.17
nominal public expenditures	0.26	0.71	0.89	1.07	1.06	1.00	1.00	-0.51	0.33
real public expenditures	-0.00	0.15	0.12	0.20	0.16	0.00	0.93	-0.65	-0.04
real transfers to households	-0.09	0.17	0.22	0.30	0.27	0.00	0.91	-1.51	-0.14
real interest payments	-0.26	1.19	0.32	1.53	0.79	-0.00	0.82	-0.14	-0.36
direct labour income tax rate *	-0.60	0.08	-0.14	0.14	-0.01	0.00	-0.12	-1.01	-0.42
deficit to GDP ratio *	0.36	-0.03	0.14	-0.02	0.07	0.00	0.00	0.44	0.27
debt to GDP ratio *	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	0.99	-0.00	-0.04
Household sector									
total available means	-0.03	-0.20	-0.24	-0.28	-0.26	0.00	0.97	0.15	-0.05
disposable income	0.81	-0.08	0.11	-0.23	-0.06	-0.00	0.13	1.07	0.44
savings as % of disp. inc *	0.24	0.13	0.21	0.15	0.17	-0.00	0.88	0.29	0.37
Memo items									
current account to GDP *	-0.16	0.05	-0.01	0.08	0.02	-0.00	0.48	-0.21	0.03
total stock of real assets	0.02	0.02	0.02	0.01	0.01	-0.00	0.99	0.06	0.02
effec. foreign output	0.07	-0.05	0.01	-0.02	0.01	0.00	-0.39	0.09	0.00
effec. foreign price level	-0.00	-0.00	-0.01	-0.02	-0.02	-0.00	1.00	-0.00	-0.00
effec. foreign interest rate *	0.03	-0.17	-0.03	-0.13	-0.05	0.00	0.61	-0.01	-0.01

Variables without * : deviation from baseline, in percent. Variables with * : deviation from baseline, in differences.

SS is steady state. SA is measure of persistence. The smaller the parameter value (in absolute terms), the lower the persistence.

TABLE 6 - **Degree of stabilisation by automatic stabilisers: impact of a monetary shock**

	euro area	US	JP
	01	01	01
total private output	60.22	79.35	63.58
real GDP	59.38	77.54	63.45
Components of aggregate demand (in constant prices)			
private consumption	76.47	82.38	127.64
gross capital formation	69.76	79.75	80.87
exports	-29.24	48.79	-27.62
imports	61.36	82.73	64.01

TABLE 7 - **Degree of stabilisation by automatic stabilisers: impact of a temporary real shock***

	euro area	US	JP
	01	01	01
total private output	49.47	59.65	28.01
real GDP	47.84	56.24	26.02
Components of aggregate demand (in constant prices)			
private consumption	47.66	57.86	18.76
gross capital formation	72.47	73.60	69.92
exports	51.35	67.51	35.81
imports	52.04	66.71	37.42

*   Alternative fiscal regime stabilises the public debt to GDP ratio in every period.

C. A permanent supply shock

In this section, we assume that trend productivity drops by 1 percent in the euro area, and we simulate the model until it reaches a new steady state. We start with a discussion of the variant in which the authorities take discretionary actions to stabilise the debt to GDP ratio in *every* period. The results of this variant are shown in Table 8. A closer investigation of the steady state is of particular interest since it illustrates that in the long run the target debt to GDP ratio can only be maintained if the direct labour income tax rate is increased.

1. Automatic fiscal stabilisers prevented

The steady state results can be found in the sixth column of Table 8. If trend productivity in the euro area decreases by 1 percent, then total supply and real GDP of the euro area also decrease by 1 percent[1]. Let us now investigate how this decreased supply is absorbed in the long run.

First, when labour productivity decreases permanently by 1 percent, the (future) real wage must also decrease by 1 percent, and the household sector will feel poorer. This wealth effect will lower private consumption and demand for residential buildings by 1 percent. Next, a permanent decrease in total supply requires a proportional permanent decrease in the capital stock of the enterprise

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1.   Since a similar shock does not occur in the other blocks, the steady state output in the other blocks remains unchanged.

sector. This will lower gross fixed capital formation by 1 percent. Third, while the domestic components of demand decrease, the export volume does not decrease because, in the steady state, total domestic demand and supply in the other blocks remain unchanged, so that they need the same volume of intermediary imports. Finally, taking the previous effects into account, the remaining excess demand is eliminated by a 0.27 percent increase in the relative price of private consumption[1]. As a consequence, private consumption decreases by 1.27 percent, and long run equilibrium between demand and supply is restored.

Looking at the public finance, we see that in the steady state the target public debt to GDP ratio is reached, while the direct labour income tax rate increases by 0.05 percentage points. This increase is caused by the fact that the fall in public expenditures is smaller than the fall in public revenues – at least, if the direct income tax rate does not change. Public expenditures tend to fall by less because the nominal transfers to the household sector are linked to the consumer price (see equation (A.7) of Appendix A), while most of the tax bases move in line with the GDP deflator (or an other price which follows the GDP deflator), and the GDP deflator decreases by 0.27 percent more than the consumer price.

The short run responses are shown in the first 5 columns of Table 8. Here we see a strong fall in economic activity in the first year. Real GDP falls by 1.18 percent, while nominal GDP falls by 1.25 percent. This short run overshooting of GDP is to a large extent caused by the increase in the direct labour income tax rate. This tax increase is necessary to counteract the deteriorating debt to GDP ratio, following the drop in nominal GDP. Comparing the components of demand, we see that the drop in private consumption and imports is strongest, i.e., 1.55 percent and 2.10 percent, respectively.

The evidence in Table 8 shows that a similar supply shock in the US reduces private output by 1.58 percent in the first year, and in Japan by 0.72 percent. In all country blocks the changes in prices are modest, since in the steady state the absolute price level does not change. It is only the relative price of private consumption that changes.

2. Summary

From the results in this section, we learn that, after a drop in trend productivity, the relative price of private consumption has to rise to eliminate the excess demand in the long run. We also learn that nominal public expenditures tend to fall by less than nominal public revenues because expenditures and revenues are linked to different price indices. As a consequence, an increase in the direct income tax rate is necessary to reach the target debt to GDP ratio in the long run. However, this will not happen if one lets the automatic stabilisers operate. In that case, the fall in public expenditures is smaller than the fall in public revenues, putting the economy on an unsustainable path of public debt accumulation.

It should be pointed out that the results presented in this section are partly due to the detailed modelling of the prices, and the links between the prices and public

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1. The price of private consumption adjusts to clear the goods market. See equation (III.24) of MVB.

sector expenditures and receipts. In the NIME model, the transfers to households are linked to the evolution of the consumer price index, while the other public expenditure items – together with revenues - move in line with the GDP deflator. However, other models could have more expenditure items linked to the consumer price index, or they could have all public expenditure and revenue items linked to the same price index. In the latter case, one could get as a result that there is no need to adjust the direct income tax rate, and that automatic fiscal stabilisers are sustainable in the face of a supply shock.

It should also be noted that in the current version of the NIME model, the natural rate of unemployment is exogenous. To the extent that the natural rate of unemployment is a function of the direct labour income tax rate, the tax increase will increase the natural unemployment rate, inducing an additional drop in total output in the steady state.

For the sake of completeness, we also show in Table C.1 of Appendix C the impact responses for the variant in which the automatic stabilisers are working and no further discretionary measures are taken. Initially, the responses are much smaller than the responses in Table 8. However, this policy is unsustainable, and sooner or later some discretionary measure is needed to correct the imbalances.

TABLE 8 -   A permanent supply shock - automatic stabilisers prevented

	euro erea						US	JP
	01	02	03	04	05	SS	01	01
total private output	-1.40	0.25	-1.01	-0.87	-0.76	-1.00	-1.58	-0.72
real GDP	-1.18	-0.22	-0.93	-0.88	-0.81	-1.00	-1.19	-0.75
nominal GDP	-1.25	-0.28	-0.66	-0.67	-0.54	-1.02	-1.23	-0.81
Demand (in constant prices)								
private consumption	-1.55	0.40	-1.07	-0.91	-0.81	-1.27	-1.48	-0.61
public consumption	-0.53	-0.89	-0.70	-0.88	-0.90	-1.00	0.00	-0.25
gross capital formation	-1.52	0.18	-1.03	-0.86	-0.76	-1.04	-2.23	-1.53
exports	-0.50	-0.28	-0.39	-0.54	-0.44	-0.00	-0.16	-0.31
imports	-2.10	2.13	-1.10	-0.72	-0.45	-1.00	-3.20	-0.35
Prices								
GDP deflator (PGDP)	-0.07	-0.05	0.26	0.21	0.27	-0.02	-0.05	-0.06
consumption price/PGDP	0.07	-0.12	0.08	0.12	0.11	0.28	0.05	0.06
export price/PGDP	0.05	-0.01	-0.36	-0.37	-0.48	-1.00	0.12	-0.44
import price/producer price	0.03	-0.07	-0.08	-0.05	-0.03	0.00	0.00	0.04
Labour market								
total employment	-0.04	0.20	0.04	0.01	0.02	0.00	-0.64	-0.01
private sector employment	-0.06	0.24	0.05	0.01	0.02	0.00	-0.73	-0.01
take home real wage	-2.23	0.24	-1.25	-1.09	-0.94	-1.33	-1.88	-1.55
producer real wage	-0.76	-0.96	-0.86	-0.90	-0.92	-1.00	-0.21	-0.58
Financial sector								
short-term interest rate *	-0.06	0.05	0.33	0.13	0.11	-0.00	-0.42	-0.08
long-term interest rate *	-0.07	0.03	0.32	0.04	0.08	-0.00	-0.14	-0.07
nominal effective exchange rate	-0.75	-0.33	-0.63	-0.71	-0.65	-1.02	0.35	-1.44
real effective exchange rate	-0.73	-0.28	-0.52	-0.54	-0.41	-0.00	0.28	-0.94
nominal money stock	-2.04	1.07	-1.21	-0.70	-0.55	-1.03	-0.29	-1.04
Public finance								
nominal public revenues	1.22	-2.44	-0.18	-0.63	-0.81	-0.89	2.62	1.02
real public revenues	1.30	-2.39	-0.44	-0.84	-1.08	-0.87	2.66	1.08
real labour income tax receipts	10.69	-11.18	1.81	-0.43	-1.85	-0.45	15.38	7.70
real social sec. contributions	-0.53	-0.96	-0.82	-0.88	-0.90	-0.92	-0.35	-0.47
real indirect tax receipts	-1.29	0.05	-0.96	-0.87	-0.77	-1.00	-1.36	-0.71
real profit tax receipts	-1.38	0.17	-1.00	-0.89	-0.77	-1.00	-1.54	-0.72
nominal public expenditures	-0.40	-1.16	-0.68	-0.63	-0.65	-0.89	0.46	-0.33
real public expenditures	-0.32	-1.10	-0.95	-0.85	-0.92	-0.87	0.51	-0.27
real transfers to households	0.12	-1.34	-0.94	-0.88	-0.90	-0.72	1.54	0.11
real interest payments	0.07	-1.62	-0.48	0.92	-0.49	-1.00	0.05	0.06
direct labour income tax rate *	1.27	-1.04	0.28	0.05	-0.10	0.05	1.50	0.81
deficit to GDP ratio *	-0.76	0.58	-0.23	-0.00	0.07	-0.00	-0.74	-0.52
debt to GDP ratio *	-0.00	-0.00	-0.00	-0.00	-0.00	0.00	0.00	-0.03
Household sector								
total available means	-0.41	-0.43	-0.75	-0.77	-0.80	-1.26	-0.52	-0.41
disposable income	-2.07	0.33	-1.32	-1.06	-0.93	-1.27	-2.04	-1.41
savings as % of disp. inc *	-0.51	-0.07	-0.25	-0.15	-0.12	0.00	-0.61	-0.82
Memo items								
current account to GDP *	0.23	-0.33	0.06	-0.02	-0.06	-0.00	0.31	-0.04
total stock of real assets	-0.04	-0.04	-0.06	-0.09	-0.10	-1.11	-0.10	-0.06
effec. foreign output	-0.10	0.15	-0.12	0.02	0.01	-0.00	-0.13	-0.01
effec. foreign price level	0.00	-0.00	0.01	0.02	0.02	0.01	0.00	0.00
effec. foreign interest rate *	-0.04	0.02	0.09	0.05	0.06	0.00	-0.11	-0.01

Variables without * : deviation from baseline, in percent. Variables with * : deviation from baseline, in differences.

SS is steady state.

D. Conclusion

In this paper, we used the NIME model to examine the effects of automatic fiscal stabilisers on the fluctuations of output in the euro area. In the NIME model, the automatic fiscal stabilisers are determined on the expenditure side by the unemployment benefits and the interest payments, and on the revenue side by direct labour income taxes, profit taxes, social security contributions, and indirect taxes.

First, we investigated the effects of two shocks which do not have permanent real effects, i.e., a temporary decline in private consumption and a permanent increase in the money supply. The simulations showed that the impact effects on output are smallest if one let the fiscal stabilisers operate. However, the evidence also suggested that the automatic stabilisers may delay full adjustment, if compared with an alternative regime under which the direct income tax rate is manipulated to keep fiscal balance, especially if it concerns a temporary shock.

Next, we studied the case of a permanent decline in productivity. We noted that such a shock induces in the long run a change in the relative prices, and that a change in the direct labour income tax rate – or another discretionary measure - is necessary to reach, in the long run, the target debt to GDP ratio. Therefore, we concluded that automatic stabilisers are not sustainable in the face of real shocks, and additional discretionary measures are required.

Finally, we would like to point out that our analysis has some limitations. First, we treated the euro area as having one single fiscal authority. Although with EMU and the Stability and Growth Pact the prospects for closer coordination and cooperation of fiscal policies in the euro area may have improved, it may still be worthwhile to investigate the empirical implications of the heterogeneity of the area with a more disaggregated model. Second, we did not take into account the effects of tax increases on trend productivity or on the natural rate of unemployment, nor did we consider the existence of perception and implementation lags in the design of discretionary tax policies. Last, but not least, we assumed a well-disciplined government that allows the automatic stabilisers to operate in a downturn and uses the gains in the upturn to reduce the debt.

IV   Appendix A: The fiscal sector of the NIME model

The NIME model is described in Meyermans and Van Brusselen (2000.a, 2000.b, and 2001). These papers are available on the world wide web at www.plan.be, click Language, click Working Papers.

The NIME model distinguishes 6 country blocks. In each of these country blocks are 4 sectors: the household sector, the enterprise sector, the monetary sector, and the public sector. Since this paper deals with automatic fiscal stabilisation, we will for ease of reference summarise here the main features of the public sector. Details of the other sectors can be found in Meyermans and Van Brusselen (2000.a, 2000.b, and 2001).

On the revenue side of the public sector we note the following equations.

First, direct taxes on labour income are levied according to:

(A.1) $DTH_t = DTHR_t \, (WBU_t + TRANSH_t)$,

with:
DTH: direct tax revenue from labour income,
DTHR: the direct income tax rate,
WBU: the total wage bill, in current prices,
TRANSH: public sector transfers to the household sector, in current prices.

The default version of the NIME model sets the direct labour income tax rate in such a way that the fiscal targets are reached in the long run.

Second, social security contributions are levied according to:

(A.2) $SSRH_t = SSRHR_t \, (WBU_t + TRANSH_t)$,

with:
SSRH: social security contributions,
SSRHR: the social security contributions rate.

The social security contribution rate is determined outside the model.

Third, direct taxes on capital income, DTCP, accrue according to:

(A.3) $d \ln(DTCP_t) = d \ln(GDPU_t),$

with:
DTCP: direct tax revenue from income on capital, in current prices,
GDPU: gross domestic product, in current prices.

Fourth, net indirect taxes are defined as indirect taxes minus subsidies to the enterprise sector. Net indirect taxes are generated by the following equation:

(A.4) $NITP_t = NITPR_t (ASU_t - NITP_t),$

with:
NITP: net indirect tax revenue, in current prices,
NITPR: net indirect tax rate,
ASU: total supply for final demand, in current prices.

The net indirect tax rate, NITPR, is determined outside the model.

Fifth, the net other tax revenues, OT, accrues according to:

(A.5) $OT_t = OT_{t-1} (1+G\_YNP_t) (1+G\_NPO_t) (1+G\_PCH_t),$

with:
OT: net other tax revenues, in current prices,
G_YNP: steady state growth of productivity,
G_NPO: steady state growth of population,
G_PCH: steady state growth of the general price level.

On the expenditure side we note the following equations.

First, interest payments on the public debt is equal to:

(A.6) $CGINT_t = GBOND_{t-1} LIG_{t-1},$

with:
GBOND: the stock of public debt, in current prices,
LIG: the interest rate of public debt.

Second, the public transfers to the household sector grow in line with the increase in the number of unemployed and unemployment benefits[1]:

(A.7) $d \ln(TRANSH/PCH) =$
trh_s4 d ln(UR LS)+d trend productivity+d demographic variables,

with:

TRANSH:	public sector transfers to the household sector, in current prices,
PCH :	the price of private consumption,
UR:	the unemployment rate,
LS:	total labour supply,

and with trh_s4 taking the values 0.15, 0.12, 0.18, and 0.15 for the euro area, non-eruo EU countries, the US, and Japan, respectively. It is important to note that we deflate the transfers to the household by the consumer price index, and not by the GDP deflator. This will be of particular interest when we discuss a permanent supply shock in section 3.3.

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1. Changes in real unemployment benefits are linked to changes in trend productivity. The other determinants of the growth of transfers to the household sector are the growth of the population (pensioners, children) and (one period lagged) trend productivity growth. For the present analysis these determinants are not relevant. For more details see Meyermans and Van Brusselen (2001).

V Appendix B: A temporary demand shock and stabilisation of debt to GDP ratio

TABLE 9 - **A temporary demand shock - automatic fiscal stabilisers prevented through stabilisation of debt to GDP ratio**

	euro area							US	JP
	01	02	03	04	05	SS	SA	01	01
total private output	-1.52	1.03	-0.14	-0.03	0.16	0.00	-0.49	-2.52	-1.04
real GDP	-0.96	0.58	-0.07	-0.03	0.08	-0.00	-0.46	-1.65	-0.90
nominal GDP	-1.13	0.14	-0.20	-0.24	-0.10	-0.00	0.07	-1.77	-0.94
Demand (in constant prices)									
private consumption	-1.92	1.15	-0.19	-0.04	0.19	-0.00	-0.46	-2.39	-1.24
public consumption	-0.06	-0.19	0.15	0.02	-0.00	0.00	-0.20	0.47	0.03
gross capital formation	-1.18	1.05	-0.14	-0.02	0.17	0.00	-0.53	-3.10	-1.23
exports	0.00	0.04	0.12	-0.03	-0.02	0.00	0.38	-0.41	0.07
imports	-3.61	2.55	-0.25	-0.02	0.45	0.00	-0.49	-6.38	-1.48
Prices									
GDP deflator (PGDP)	-0.16	-0.44	-0.13	-0.22	-0.19	-0.00	0.82	-0.11	-0.05
consumption price/PGDP	0.16	-0.18	-0.08	-0.05	-0.09	0.00	0.31	0.11	0.05
export price/PGDP	0.17	0.45	0.14	0.23	0.20	-0.00	0.82	0.18	0.20
import price/producer price	0.05	0.22	-0.10	-0.02	-0.01	-0.00	-0.12	0.00	0.02
Labour market									
total employment	-0.20	0.14	0.03	0.01	0.03	0.00	-0.08	-1.50	-0.10
private sector employment	-0.26	0.18	0.04	0.01	0.04	0.00	-0.37	-1.66	-0.11
take home real wage	-1.30	1.42	-0.11	-0.02	0.25	-0.00	-0.50	-1.92	-0.91
producer real wage	0.06	-0.11	0.03	0.01	-0.02	0.00	-0.55	0.60	0.08
Financial sector									
short-term interest rate *	-0.19	-0.31	0.13	0.01	0.03	-0.00	0.18	-0.93	-0.26
long-term interest rate *	-0.18	-0.29	0.23	-0.04	0.03	-0.00	-0.10	-0.33	-0.11
nominal effective exchange rate	0.06	0.14	0.02	0.01	-0.01	0.00	0.57	0.33	0.45
real effective exchange rate	0.06	0.12	-0.00	-0.02	-0.04	0.00	0.58	0.26	0.29
nominal money stock	-1.36	1.25	-0.95	-0.35	-0.04	-0.00	-0.43	1.03	-0.09
Public finance									
nominal public revenues	1.35	-2.30	0.21	-0.08	-0.42	-0.00	-0.42	4.48	1.60
real public revenues	1.51	-1.86	0.34	0.13	-0.24	0.00	-0.58	4.59	1.64
real labour income tax receipts	10.05	-12.64	1.92	0.64	-1.65	-0.00	-0.56	22.83	8.77
real social sec. contributions	0.03	-0.10	0.02	-0.00	-0.03	0.00	-0.12	0.04	0.09
real indirect tax receipts	-1.27	0.85	-0.11	-0.03	0.13	0.00	-0.49	-2.06	-0.95
real profit tax receipts	-1.46	0.99	-0.12	-0.03	0.15	0.00	-0.49	-2.41	-1.03
nominal public expenditures	-0.10	-0.63	-0.23	-0.14	-0.24	-0.00	0.71	1.43	0.05
real public expenditures	0.06	-0.19	-0.10	0.08	-0.05	0.00	-0.02	1.55	0.10
real transfers to households	0.38	-0.35	-0.11	-0.05	-0.12	-0.00	-0.12	3.44	0.53
real interest payments	0.16	-2.27	-0.81	2.12	-0.34	0.00	-0.09	0.11	0.05

	euro area							US	JP
	01	02	03	04	05	SS	SA	01	01
direct labour income tax rate *	1.12	-1.26	0.20	0.07	-0.17	-0.00	-0.56	2.26	0.86
deficit to GDP ratio *	-0.68	0.76	-0.21	-0.03	0.09	0.00	0.00	-1.07	-0.60
debt to GDP ratio *	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	1.00	0.00	-0.03
Household sector									
total available means	-1.85	0.28	0.08	0.10	0.12	-0.00	-0.10	-1.99	-1.21
disposable income	-1.35	1.47	-0.18	0.01	0.27	0.00	-0.51	-2.52	-0.92
savings as % of disp. inc *	0.56	0.32	0.01	0.04	0.08	0.00	0.49	-0.24	0.26
Memo items									
current account to GDP *	0.52	-0.32	0.08	0.03	-0.03	-0.00	-0.50	0.59	0.17
total stock of real assets	-0.03	-0.00	-0.01	-0.01	-0.00	0.00	0.81	-0.13	-0.05
effec. foreign output	-0.14	0.22	-0.12	0.01	0.01	0.00	-0.71	-0.27	-0.02
effec. foreign price level	-0.00	-0.01	-0.01	-0.01	-0.02	-0.00	0.96	0.00	0.00
effec. foreign interest rate *	-0.07	-0.09	0.04	-0.01	0.01	0.00	0.24	-0.26	-0.02

Variables without * : deviation from baseline, in percent.

Variables with * : deviation from baseline, in differences.

SS is steady state. SA is measure of persistence. The smaller the parameter value (in absolute terms), the lower the persistence.

VI Appendix C: Automatic fiscal stabilisers and a permanent supply shock

TABLE 10 - **A permanent supply shock - automatic stabilisers operating: impact responses**

	euro area 01	US 01	JP 01
total private output	-0.43	-0.45	-0.35
real GDP	-0.59	-0.48	-0.46
nominal GDP	-0.58	-0.47	-0.48
Demand (in constant prices)			
private consumption	-0.47	-0.44	-0.34
public consumption	-0.53	-0.29	-0.31
gross capital formation	-0.49	-0.54	-0.63
exports	-0.14	0.03	-0.10
import	0.28	-0.11	0.32
Prices			
GDP deflator (PGDP)	0.01	0.01	-0.01
consumption price/PGDP	-0.01	-0.01	0.01
export price/PGDP	-0.01	0.01	-0.16
import price/producer price	0.01	0.00	0.02
Labour market			
total employment	0.10	0.13	0.04
private sector employment	0.11	0.11	0.03
take home real wage	-0.87	-0.65	-0.76
producer real wage	-0.86	-0.65	-0.73
Financial sector			
short-term interest rate *	-0.14	-0.02	-0.22
long-term interest rate *	-0.25	-0.22	-0.32
nominal effective exchange rate	-0.22	0.10	-0.50
real effective exchange rate	-0.21	0.08	-0.33
nominal money stock	-0.08	0.26	0.90
Public finance			
nominal public revenue	-0.60	-0.60	-0.66
real public revenue	-0.61	-0.61	-0.64
real labour income tax receipts	-0.59	-0.50	-0.61
real social sec. contributions	-0.59	-0.50	-0.61
real indirect tax receipts	-0.48	-0.45	-0.39
real profit tax receipts	-0.45	-0.46	-0.37
nominal public expenditures	-0.37	-0.35	-0.38
real public expenditures	-0.37	-0.36	-0.37
real transfers to households	-0.12	-0.32	-0.16
real interest payments	-0.01	-0.01	0.01
direct labour income tax rate *	0.00	0.00	0.00
deficit to GDP ratio *	0.11	0.08	0.11
debt to GDP ratio *	0.46	0.37	0.39

	euro area 01	US 01	JP 01
Household sector			
total available means	-0.34	-0.43	-0.35
disposable income	-0.63	-0.47	-0.60
savings as % of disp. inc *	-0.16	-0.02	-0.26
Memo items			
current account to GDP *	-0.06	0.02	-0.06
total stock of real assets	-0.01	-0.02	-0.02
effec. foreign output	0.00	0.00	0.00
effec. foreign price level	-0.00	0.00	-0.00
effec. foreign interest rate *	-0.05	-0.05	-0.01

Variables without * : deviation from baseline, in percent.

Variables with * : deviation from baseline, in differences.

No steady state available.

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