OESTERREICHISCHE NATIONALBANK

Stability and Security.

# WORKING PAPER 132

# AQM-06: THE MACROECONOMIC MODEL OF THE OENB

MARTIN SCHNEIDER AND MARKUS LEIBRECHT

EUROSYSTEM

**Statement of Purpose**

The Working Paper series of the Oesterreichische Nationalbank is designed to disseminate and to provide a platform for discussion of either work of the staff of the OeNB economists or outside contributors on topics which are of special interest to the OeNB. To ensure the high quality of their content, the contributions are subjected to an international refereeing process. The opinions are strictly those of the authors and do in no way commit the OeNB.

Imprint: Responsibility according to Austrian media law: Guenther Thonabauer, Secretariat of the Board of Executive Directors, Oesterreichische Nationalbank

Published and printed by Oesterreichische Nationalbank, Wien.

The Working Papers are also available on our website (http://www.oenb.at) and they are indexed in RePEc (http://repec.org/).

# Editorial

This paper gives an overview of the current version of the quarterly macroeconomic model of the Oesterreichische Nationalbank for Austria. The model is a small to medium size macroeconomic model. It is in the tradition of the neoclassical synthesis and is therefore in line with most models used by euro system central banks. The model has been extended in several ways compared with the previous version. The most important changes concern the use of oil and import competitor's prices in the supply block, a more detailed treatment of government receipts, the use of tax rates as policy instruments as well as a dynamic import demand indicator. In the empirical part, the paper presents some simulation results to show the impact of tax increases on the Austrian economy and the reaction of the model to five standard macroeconomic shocks: Increases of the value added tax, the personal income tax and the corporate income tax by the same amount have different effects on the Austrian economy. The reaction of the model to macroeconomic shocks is characterized by a high demand multiplier and a low negative impact of price competitiveness on exports.

September 18, 2006

# *AQM-06: The Macroeconomic Model of the OeNB*

*Martin Schneider and Markus Leibrecht*[1]

**Abstract**

This paper gives an overview of the current version of the quarterly macroeconomic model of the Oesterreichische Nationalbank for Austria. The model is a small to medium size macroeconomic model. It is in the tradition of the neoclassical synthesis and is therefore in line with most models used by euro system central banks. The model has been extended in several ways compared with the previous version. The most important changes concern the use of oil and import competitor's prices in the supply block, a more detailed treatment of government receipts, the use of tax rates as policy instruments as well as a dynamic import demand indicator. In the empirical part, the paper presents some simulation results to show the impact of tax increases on the Austrian economy and the reaction of the model to five standard macroeconomic shocks: Increases of the value added tax, the personal income tax and the corporate income tax by the same amount have different effects on the Austrian economy. The reaction of the model to macroeconomic shocks is characterized by a high demand multiplier and a low negative impact of price competitiveness on exports.

JEL classification: C3, C5, E1, E2.
Keywords: Macro econometric model, Austria.

# I. INTRODUCTION AND OVERVIEW

Macroeconometric modelling in the Oesterreichische Nationalbank (OeNB) started in the mid 90s with the development of an annual macroeconomic model for Austria for the analysis of the transmission channels of monetary policy. The first quarterly model, which was used on a regular base for forecasting and simulation exercises, was developed in 1998 (Fritzer, Glück, Rünstler and Wehinger, 1998) and updated in 2001. The current version builds heavily on AQM (Austrian Quarterly Model), which was developed in 2002 and 2003 (Fenz and Spitzer, 2004, 2005). The model has been used extensively for forecasting and scenario analysis and has proved its value. Nevertheless, there were several needs for revising and extending the model. First of all, there has been

[1] Work on the current version of the model was done by Markus Leibrecht (WU Wien, mleibrec@wu-wien.ac.at) during his research sabbatical at the Oesterreichische Nationalbank (OeNB) in 2005 and by Martin Schneider (OeNB, martin.schneider@oenb.at).The authors are indebted to Gerhard Fenz, Walpurga Köhler-Töglhofer and Christian Ragacs for helpful comments. The views presented in this paper are entirely those of the authors and do not necessarily present those of the OeNB.

an urgent necessity to reestimate the model due to substantial changes in the quarterly national accounts data (introduction of chain-linking, exclusion of the irregular component of seasonally adjusted series). Furthermore, some extensions have been implemented (see below).

This paper presents the current version of the model. It is a small to medium size macroeconomic model and consists of 107 equations, with 38 of them being behavioural equations. 217 variables from different data sources are included in the model. The basic modelling principles are fairly standard and are in line with the multi-country model (MCM), developed jointly by the central banks of the euro system and the ECB (Fagan and Morgan, 2005). The Austrian economy is modelled as an open economy producing one single good. The theoretical basis of the model is the neoclassical synthesis. The model combines neoclassical long-run behaviour with Keynesian short-run dynamics. The long-run equilibrium is described by a neoclassical production function with the available production factors determining the level of output irrespective of prices. This yields a vertical supply curve. The model is purely backward looking.

The model consists of five main building blocks. The *supply block* describes the steady state behaviour. It consists of equations for the long-run levels of the production factors (capital, labour and oil) and the GDP deflator and links the other building blocks. The *demand block* is linked to the supply block via the long-run level of the capital stock which determines investment. Within the *price block*, the equations for the GDP deflator and the wage rate play the dominant role. Wages follow a Phillips curve relation with an implicit NAIRU in the short run. In contrast to the previous version, prices abroad directly feed into the GDP deflator. The *labour market block* describes the evolution of employment, labour supply and unemployment with long-run employment being determined by the inverted production function. The *government block* describes government receipts and spending for the main categories. It is linked with the demand block via the impacts of transfers and direct household taxes on disposable household income. The model also incorporates a fiscal and a monetary policy rule. These policy rules are usually turned off for simulation exercises.

There are five main differences to the previous version which are worth being mentioned. First, the use of oil and import competitor's prices in the supply block. Second, the public sector is modelled in more detail and contains selected tax rates as policy instruments. Third, import demand is constructed using dynamic weights instead of constant weights for the demand components. Fourth, the user costs of capital now include corporate taxes. Fifth, changes in inventories are modelled to achieve a constant ratio of stocks of inventories to GDP in the long run.

The remainder of the paper is organized as follows. In section II, the data set and the estimation techniques are described. Section III presents the supply side of the model. In section IV to VIII, the demand components (IV), prices and wages (V), the labour market (VI), the public sector (VII), and the policy rules (VIII) are presented. Section IX presents simulation results for five macroeconomic shocks. Section X concludes.

# II. DATA SET AND ESTIMATION

The data set used for estimation of the model ranges from 1983Q1 to 2004Q4. It is mainly based on seasonally adjusted ESA-95 data. ESA-95 data are available since 1988Q1. The series were extended backwards using ESA-79 growth rates. Series which are available at an annual frequency only (such as the capital stock, fiscal variables, other personal income and the savings ratio) were interpolated to quarterly frequency using a cubic spline.

The four equations of the supply side were estimated as a system, whereas all other equations were estimated by OLS. For the behavioural equations, a two-step Engle-Granger procedure has been utilized. Restrictions have been imposed to guarantee consistency with economic theory or to preserve dynamic homogeneity for some equations.

Some dynamic specifications were calibrated to improve the simulation behaviour of the model. The use of chain-linked data causes non-additivity, i.e. components do not add up to the aggregate. One solution to minimize the discrepancy would be to use the Laspeyres approximation formula (see section IV.2) to rewrite definitions. In that case, the growth rate of an aggregate is computed as the weighted sum of the growth rates of its components with the nominal share of the respective component of the previous period as weights. One serious caveat of this method is that it can not be used for changes in inventories, since they can be close to zero. This would result in enormous growth rates, disturbing the growth rate of the aggregate. Another drawback of this approach is the irreversibility problem. Knudsen and Sethi (2004) have shown that a macroeconomic model with a chain index aggregation formula might not return back to baseline and delivers permanent effects of temporary shocks. Hence we have refrained from changing the identities to chain index aggregation formulas. Instead of this, we have included a variable that accounts for that discrepancy. Two additional arguments favour our approach. First, we work at a high aggregation level. Second, forecasting is usually done close to the reference year. Both arguments suggest that the aggregation discrepancy is small.

# III. THE SUPPLY SIDE

## 1. Theoretical Aspects

The supply side of the model is given by a Cobb-Douglas production function with constant returns to scale and exogenous labour-augmenting technological progress. The supply curve is vertical in the long-run, i.e. the behaviour of the model is purely supply-driven. GDP at factor costs (YFR) is given by

$$YFR_t = \alpha * KSR_t^{\beta} * LNNFE_t^{(1-\beta-\vartheta)\gamma T} * OIL_t^{\vartheta},$$

where KSR denotes the capital stock, LNNFE employment at full time equivalents and OIL crude oil used in production.

The structure of the supply side follows the standard MCM formulation (Fagan and Morgan, 2005) with two exceptions: First, oil has been introduced as an additional production factor. Second, the impact of foreign competitor's prices on the domestic price system has been modelled similar to Willman and Estrada (2002). Firms are assumed to have some market power that allows them to set their prices above their marginal costs. Since Austria is a small open economy, foreign prices should play a role in determining domestic prices. An increase of the prices of competitor's abroad (CMD) reduces the competitive pressure domestic firms face und gives them room to raise their mark-up ($\eta$).

The solution of the cost-minimisation problem of the firm gives us equations for demand for labour (LSTAR), capital (KSTAR) and oil (OILSTAR) as well as an equation for the GDP deflator at factor costs (YDSTAR). See Fenz and Spitzer (2004, 2005) for further aspects of the supply-side.

$$\log(KSTAR_t) = (1-\beta-\theta)/(1-\theta)*(log(WUNFE_t)+log(YFR_t)/(1-\beta-\theta)-log(OIL_t)*\theta/(1-\beta-\theta)$$
$$-log(1-\beta_t-\theta_t)-log(\alpha_t)/(1-\beta-\theta)-\gamma*TIME_t+log(\beta)-log(CC0_t))$$

$$\log(LSTAR_t) = exp((log(YFR_t)-log(\alpha)-\beta*log(KSR_t)-\theta*log(OIL_t)$$
$$-(1-\beta-\theta)*\gamma*TIME_t)/(1-\beta-\theta)+0.003*TR001_t$$

$$\log(OILSTAR_t) = (1-\beta-\theta)/(1-\beta)*(log(WUNFE_t)+(log(YFR_t)-log(\alpha)-log(KSR_t)*\beta)/(1-\beta-\theta)$$
$$-\gamma*TIME_t+log(\theta)-log(1-\beta-\theta)-log(POIL_t)$$

$$\log(YDSTAR)_t = (1-\nu)*(log(WUNFE_t)-log(1-\beta-\theta)+((\beta+\theta)*log(YFR_t)-\beta*log(KSR_t)$$
$$-\theta*log(OIL_t)-log(\alpha))/(1-\beta-\theta)-\gamma*TIME_t+log(\eta))$$
$$+\nu*log(CMD_t)+0.006*TR001_t$$

| | |
|---|---|
| α: | Scale parameter |
| β: | Share of capital |
| η: | Mark-up |
| γ: | Technological progress |
| ν: | Weight of foreign prices |
| θ: | Share of oil |
| CMD: | Competitor's import prices (in EUR) |
| KSR: | Total capital stock, real |
| KSTAR: | Equilibrium level of capital stock |
| LSTAR: | Equilibrium level of labour demand |
| OIL: | Oil demand (mill. barrel) |
| OILSTAR: | Long-run level of oil demand |
| POIL: | Oil price in domestic currency |
| TIME: | Time trend |
| TR0001: | Trend from 2000Q1 onwards |
| WUNFE: | Compensation per employee in full time equivalents |
| YDSTAR: | Equilibrium level of producer prices |
| YFR: | GDP at factor cost, real |

## 2. Estimation

The *user costs of capital* are determined by the real interest rate ($LTI_t$-100*($YED_t$/$YED_{t-1}$-1)/400), the depreciation of the capital stock, the effects of corporate taxation plus a remaining risk premium.

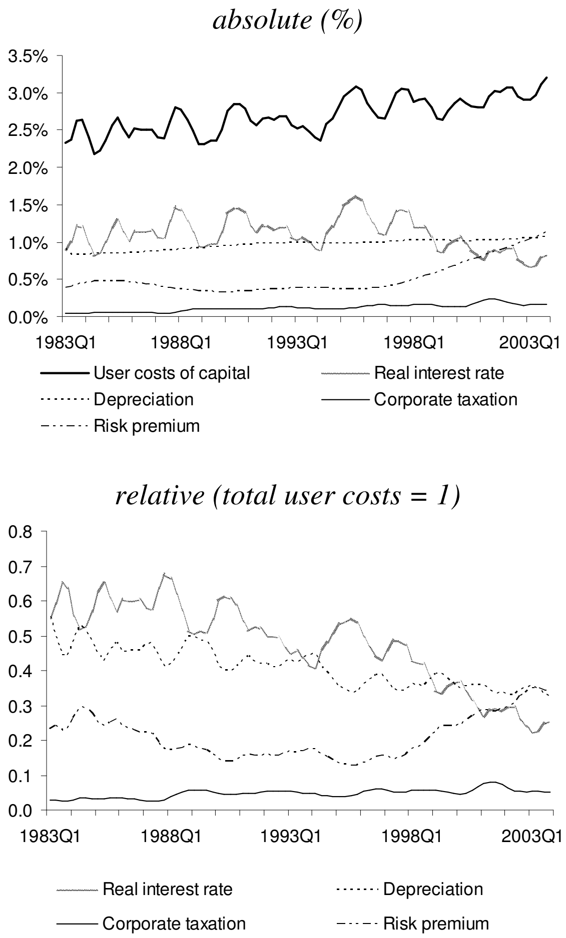
$$CC0_t = ITD_t*((LTI_t-100*(YED_t/YED_{t-4}-1))/400$$
$$+DEPKSR_t+CTXN_t*MPC_t+RP_t/100)$$

| | |
|---|---|
| CC0: | User costs of capital |
| CTXN: | Ratio of corporate income tax relative to total capital costs |
| DEPKSR: | Time-varying depreciation rate for real capital stock (total economy) |
| ITD: | Total investment deflator |
| LTI: | Long-term nominal interest rate |
| MPC: | Marginal product of capital |
| RP: | Risk premium (HP filtered) |
| YED: | GDP expenditure deflator |

The time-varying *depreciation of the capital stock* has been constructed using the perpetual inventory method given data for the capital stock and investment and HP-filtering the result. The resulting quarterly depreciation rate shows a steady increase from 0.83% in 1983 to 1.07% in 2003. The effects of corporate taxation are captured by the variable CTXN, multiplied by the marginal product of capital (MPC). The risk premium has been computed by assuming that in equilibrium the real user costs equal the real average product of capital, which is given by real GDP minus real compensation for labour and oil, divided by the real capital stock. Then, the risk premium has been constructed as the HP-filtered difference between the capital product and user costs.

Figure 1 shows the composition of the real user costs of capital and its evolution since 1983. Overall, there is an increase from slightly below 2.5% in the beginning of the eighties to 3% in 2003. The second panel of figure 1 shows the composition of the user costs. The role of both the real interest rate and of capital depreciation fell during the last two decades. The role of corporate taxation is rather limited, although its share in total user costs increased from 3% in 1983 to 5% in 2003. By its construction as a (HP-filtered) residual, the risk premium shows a corresponding increase since the mid-90s.

*Figure 1: Composition of real user costs of capital*




The four equations of the supply side have been estimated as a system in RATS using the nlsystem function. The estimation results are reported in table 1. The values of most of the parameters are in line with our expectations. β has a reasonable value given national accounts data. The parameter value of 0.006 for γ implies an annual rate of technology growth of 1.5% $(=1+\gamma(1-\beta-\vartheta)^4-1)$.

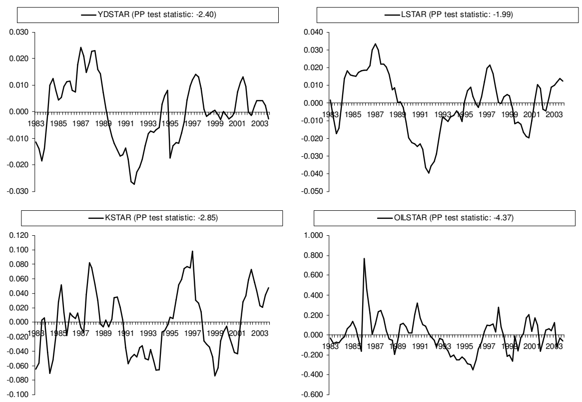
The mark-up η is smaller than one. This is caused by the fact that we have introduced an explicit risk premium. The elasticity for oil (0.006) lies in a reasonable range, given that the share of nominal oil to GDP fluctuates between 0.5 and 1% since the mid 80ies after having reached values between 2 and 3% in the first half of the eighties. All parameters are significant at the 1% level.

*Table 1: Estimated parameters of the supply side*

| | | |
|---|---|---|
| α: | Scale parameter | 1.36 |
| β: | Share of capital | 0.38 |
| η: | Mark-up | 0.78 |
| γ: | Technological progress | 0.006 |
| ν: | Weight of foreign prices | 0.04 |
| θ: | Share of oil | 0.006 |

Albeit significance of the parameter estimates, the estimation suffered from data problems. To overcome the most severe problems, a general time trend has to be added to all equations (plus a partial trend in the YDSTAR equation from 2000Q1 onwards).

*Figure 2: Residuals of the supply side*




The long-run equilibrium errors are shown in figure 2. The residuals show a clear mean reverting behaviour. We have additionally performed a Phillips-Perron (PP) test for stationarity of the residuals (e.g. Phillips and Ouliaris 1990). The null of non-stationarity can not be rejected according to this test. As the PP test is aimed to test for cointegration in single-equation models and not in simultaneous models its power to reject the null hypothesis may be very limited. Therefore and due to the clear mean-reverting behaviour of the equilibrium error, the residuals are used as error-correction terms in the dynamic equations.

# IV. DEMAND COMPONENTS

## 1. Foreign trade

In the long run, *exports* are assumed to develop in line with world demand (with unit elasticity) and price competitiveness. The increasing degree of internationalisation (especially with the Central and Eastern European Countries) is accounted for by a deterministic time trend. The dynamic specification includes the same driving forces. The estimation results show a fast convergence to the long-run equilibrium level. We find a rather low price elasticity of exports to price competitiveness of -0.28 in the long run. A comparison with estimation results of the De Nederlandsche Bank (2000) in their EUROMON model for eleven European countries plus US and Japan shows elasticities ranging from - 0.2 to -0.3 (Spain, Netherlands, Sweden, Japan, Austria, Denmark) over -0.5 to -0.6 (Belgium, Italy) up to -0.7 to -0.9 (Germany, Finland, France, UK, US).

*Imports* are modelled using a composite import demand indicator. This indicator was constructed using data from the national input-output tables 1983, 1990, 1995 and 2000. The years between these years have been interpolated.

Figure 3 shows that the import content of most demand categories increased over time. This holds especially for exports. The strong decrease of the import content of changes in inventories should not be overstated, since they act as a residual category.

$$\log(XSTAR_t) = 8.928 + log(WDR_t) + 0.002 * TIME_t - 0.282 * log(XTD_t / CXD_t)$$

$$\Delta log(XTR_t) = 0.008 - 0.271 * (log(XTR_{t-1} / XSTAR_{t-1})) + 0.437 * \Delta log(WDR_t) - 0.157 * \Delta log(XTD_t / CXD_t) + res_t^{XTR}$$

$$\log(MSTAR_t) = -0.11 + log(WER_t) - 0.332 * (1/(1-0.091)) * log(MTD_t) - 0.091 * log(POILU_t) - log(YFD_t)$$

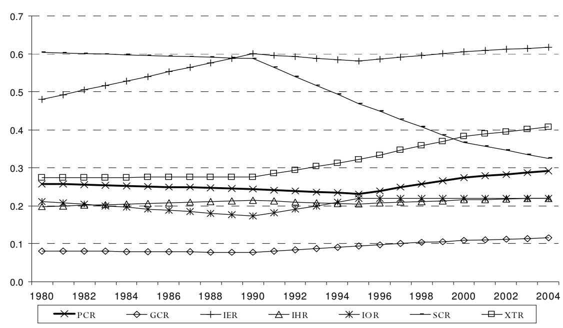
$$\Delta log(MTR_t) = 0.005 - 0.194 * (log(MTR_{t-1} / MSTAR_{t-1})) + 0.468 * (\Delta log(WER_t)) - 0.091 * \Delta log(MTD_t / YFD_t) + res_t^{MTR}$$

$$WER_t = w_t^{pcr} * PCR_t + w_t^{gcr}{}_t * GCR_t + w_t^{ier}{}_t * IER_t + w_t^{ihr} * IHR_t + w_t^{ior} * IOR_t + w_t^{scr} * SCR_t + w_t^{xtr} * XTR_t$$

| | |
|---|---|
| CXD: | Competitor's export price in domestic currency |
| GCR: | Government consumption, real |
| IER: | Equipment investment, real |
| IHR: | Housing investment, real |
| IOR: | Other investment, real |
| MSTAR: | Equilibrium level of import demand |
| MTD: | Import deflator |
| MTR: | Imports, real |
| PCR: | Private consumption, real |
| POILU: | Oil price in USD |
| SCR: | Changes in inventories, real |
| TIME: | Time trend |
| w: | Weights for demand components |
| WDR: | World demand indicator |
| WER: | Import demand indicator |
| XSTAR: | Equilibrium level of export demand |
| XTD: | Exports deflator |
| XTR: | Exports, real |
| YFD: | GDP at factor cost deflator |

Similar to the export side, imports develop with unit elasticity to import demand in the long run. A correction factor has been introduced to correct for a perverse effect of oil price changes. Without that correction factor, an oil price increase leads to decreasing imports (via its effect on the import deflator) and hence to an increase in GDP. Since the price elasticity of oil is considerably below that of aggregate imports, the decline of real oil imports in case of an oil price increase can be expected to be very modest.

*Figure 3: Weights of demand components for the import demand indicator*



## 2. Investment

Total investment consists of three sub-categories, equipment investment, housing investment, and other investment. In the long run, total investment is determined by the equilibrium capital stock derived from the cost minimising behaviour of the firm (see section III).

Besides the error correction term, investment in the short-run depends on GDP, on the user-costs of capital and on the effective exchange rate.

$$\Delta log(ITR_t) = -0.136 - 0.033 * log(ITR_{t-3}/KSTAR_{t-3}) + 1.255 * \Delta log(YER_{t-1}) - 0.050 * \Delta log(CC0_{t-1}) + 0.140 * \Delta log(EEN_t) + res_t^{ITR}$$

$$IOR_t = ITR_t - IER_t - IHR_t + ZIOR_t$$

| | | | |
|---|---|---|---|
| CC0: | User costs of capital | ITR: | Total investment, real |
| EEN: | Nominal eff. exchange rate (export side) | KSTAR: | Equilibrium level of capital stock |
| IER: | Equipment investment, real | YER: | GDP expenditure, real |
| IHR: | Housing investment, real | ZIOR: | Statistical discrepancy for housing investment |
| IOR: | Other investment,real | | |

The subcategories equipment investment and housing investment and their deflators are modelled directly by a two-step error-correction formulation, whereas other investment is obtained as a residual category. Due to the non-additivity of chained data, a variable for the statistical discrepancy has to be included.

## 3. Inventories

Data on changes in inventories are obtained as a residual category in the quarterly SNA that capture the difference between GDP from production and demand side. Since the introduction of chain-linked data in Austria in autumn 2004 no data on real changes in inventories are available. Therefore these series had to be constructed as a difference between gross capital formation and gross fixed capital formation. We use the Laspeyres approximation (see e.g. Liu, Hamalainen and Wong, 2003) for this purpose. The basic approach to calculate sums (or differences) of chain-linked series according to the Laspeyres approximation method is that the growth rate of the aggregate is a weighted sum of the growth rates of its components with the shares of the nominal values of period t-1 as weight. The drawback of this method is that it cannot be used for series with non-positive numbers like the changes in inventories series. We have overcome this problem by first cumulating the series for gross capital formation and gross fixed capital formation. This gives us strictly positive values and enables us to apply the Laspeyres approximation method. The growth rate of the cumulated real changes in inventories series (SCR) is given by the growth rate of real gross capital formation (IGR) minus gross fixed capital formation (ITR) weighted with the nominal share of gross fixed capital formation of period t-1, divided by the inverse share of the nominal changes in inventories series in nominal gross capital formation of period t-1.

$$\frac{\Delta SCR_t^{cum}}{SCR_{t-1}^{cum}} = \left(\frac{\Delta IGR_t^{cum}}{IGR_{t-1}^{cum}} - \frac{\Delta ITR_t^{cum}}{ITR_{t-1}^{cum}} * \frac{ITN_{t-1}}{IGN_{t-1}}\right) * \frac{IGN_{t-1}^{cum}}{SCN_{t-1}^{cum}}$$

After having calculated the cumulated series, changes of inventories are obtained as first differences of that series.

Changes in inventories are modelled in a simple fashion to obtain a constant ratio of inventories to GDP in the long run. In the historical period, however, this ratio exhibits a negative trend. Hence, the long run equilibrium level of the stock of inventories includes this time trend. The dynamic equation for the stock of inventories includes GDP as driving variable besides the error correction term. Changes in inventories are calculated as the first difference of the stock of inventories.

$$LSSTAR_t = YER_t * 4 * (1.03 - 0.004 * TIME_t)$$

$$\Delta log(LSR_t) = 0.001 - 0.019 * log((LSR_{t-1}/(LSSTAR_{t-1}))) + 0.11 * \Delta log(YER_t) + res_t^{LSR}$$

$$SCR_t = \Delta LSR_t$$

| | |
|---|---|
| LSR: | Stock of inventories, real |
| LSSTAR: | Equilibrium level of inventory stock, real |
| SCR: | Changes in inventories, real |
| TIME: | Time trend |
| YER: | GDP, real |

## 4. Private consumption

The theoretical foundation of the consumption equation is the permanent income hypothesis. According to this hypothesis consumption expenditures depend not only on actual, but also on expected future income. Since our model is strictly backward-looking, expected permanent income is proxied by real disposable income and financial wealth. Both terms determine the desired level of consumption. In the long-run, dynamic homogeneity is assumed. The long-term interest rate enters with a negative sign, reflecting intertemporal substitution effects. Short-run dynamics are driven by real disposable income and lagged consumption. Disposable household income consists of labour income, other personal income and transfers from government minus transfers to the government and direct household taxes. Other personal income includes income of self-employees as well as net property income. Income of self-employees equals the gross operating surplus less the depreciation of the capital stock in the long run.

$$\log(CSTAR_t) = 0.901 * log(PYR_t) + (1-0.901) * 0.23 * log(FWR_t) - 0.916 * LTI_t/100 + 0.68$$

$$\Delta log(PCR_t) = -0.103 * log(PCR_{t-2}/CSTAR_{t-2}) + 0.293 * \Delta log(PYR_t) - 0.103 * \Delta log(PYR_{t-1}) + 0.691 * \Delta log(PCR_{t-1}) - 0.316 * \Delta log(PCR_{t-2}) + 0.002 + res_t^{PCR}$$

$$PYR_t = PYN_t / PCD_t$$

$$PYN_t = WIN_t + OPN_t + TRN_t - TPN_t - PDN_t$$

$$\Delta log(OPN_t) = -0.082 * log(OPN_{t-1}/OPNSTAR_{t-1}) + 0.514 * \Delta log(GON_t) + res_t^{OPN}$$

$$\log(OPNSTAR_t) = -0.463 + log((GON_t - KSN_t * DEPKSN_t) + (LTI_t/400 * 0.23 * FWN_t))$$

$$FWN_t = KSN_t + GDN_t + NFA_t$$

$$FWR_t = KSR_t + (GDN_t + NFA_t)/PCD_t$$

| | |
|---|---|
| CSTAR: | Equilibrium level of private consumption |
| DEPKSN: | Time-varying depreciation rate for nominal capital stock (total economy) |
| FWN: | Financial wealth, nominal |
| FWR: | Financial wealth, real |
| GDN: | Government debt, gross |
| GON: | Gross operating surplus |
| KSN: | Total capital stock, nominal |
| KSR: | Total capital stock, real |
| LTI: | Long-term nominal interest rate |
| NFA: | Net foreign assets |
| OPN: | Other personal income (self employed and property income) |
| OPNSTAR: | Long-run level of other personal income |
| PCD: | Private consumption deflator |
| PCR: | Private consumption, real |
| PDN: | Direct taxes paid by households (excl. SOSEC) |
| PYN: | Private sector disposable income, nominal |
| PYR: | Private sector disposable income, real |
| SOSEC: | Social security contributions |
| TPN: | Transfers from households to government (incl. SOSEC) |
| TRN: | Transfers from government to households |
| WIN: | Total compensation to employees, nominal |

Net property income is proxied by interest payments for liquid assets, which amount to 23% of total financial wealth. Short-run dynamics are caused by the gross operating surplus. We assume that private households own all assets in the economy. Under this assumption, real financial wealth is measured by the sum of the capital stock, government debt and net foreign assets. Government consumption is treated as exogenous in the model.

# V. PRICES AND WAGES

The price block describes the determination of prices and wages. Within the price block, the GDP at factor cost deflator and the wage rate are most important for the behaviour of the model. All other deflators (import, export, private and government consumption and investment) as well as the HICP are driven by the two central prices. Since Austria is a small open economy, foreign prices play an additional role in determining domestic prices.

## 1. Deflators

The GDP at factor cost deflator is the central price index in the model. Its long-run level (YDSTAR) is derived from the supply side (see section III). The short-run dynamics are driven by deviations from equilibrium and unit labour costs. The estimated version shows a very sluggish reaction of the GDP deflator to deviations from its equilibrium level. Therefore we decided to calibrate the speed of adjustment to a reasonable value (-0.2), which ensures appropriate price reactions in simulations.

$$YDSTAR_t = exp((1-\nu)*(log(WUNFE_t) - log(1-\beta-\theta) + ((\beta+\theta)*log(YFR_t) - \beta*log(KSR_t)$$
$$-\theta_t*log(OIL_t) - log(\alpha))/(1-\beta-\theta) - \gamma*TIME_t + log(\eta)) + \nu*log(CMD_t) + 0.006*TR001_t$$

$$\Delta log(YFD_t) = -0.2*(log(YFD_{t-1}) - log(YDSTAR_{t-1})) + 0.30*\Delta log(ULA_t) + res_t^{YFD}$$

| | |
|---|---|
| α: | Scale parameter |
| β: | Share of capital |
| η: | Mark-up |
| γ: | Technological progress |
| ν: | Weight of foreign prices |
| θ: | Share of oil |
| CMD: | Competitor's import price (in EUR) |
| KSR: | Total capital stock, real |
| OIL: | Oil demand (mill. Barrel) |
| TIME: | Time trend |
| TR001: | Partial trend from 2000Q1 onwards |
| ULA: | Unit labour costs, adjusted |
| WUNFE: | Compensation per employee full time equivalents |
| YFD: | GDP at factor cost deflator |
| YDSTAR: | Equilibrium level of producer prices |
| YFR: | GDP at factor cost, real |

All other deflators are mainly driven by the GDP deflator and foreign prices. Import and export prices are determined both by the domestic price level as measured by the GDP deflator and foreign prices as measured by the respective (import or export) competitor's prices. Import prices are additionally driven by oil prices. The investment deflator is determined by the GDP deflator and the import deflator, assuming dynamic homogeneity. The private consumption deflator is mainly determined by the GDP deflator at market prices. In addition, import prices and the oil price plays a role. The government consumption deflator is closely linked to the private consumption deflator. The HICP consists of the two components HICP excluding energy and the HICP energy. Whilst the HICP energy is solely driven by oil prices, HICP excluding energy is determined by the deflators for GDP at factor costs, private consumption and imports.

## 2. Wages

The long run behaviour of wages with respect to inflation and productivity is calibrated to unit elasticity. Hence, real wages depend on productivity. This is a necessary condition to ensure that the income share of labour (relative to capital and oil) remains constant in the long run.

$$\log(WSTAR_t) = log(PCD_t) + log(1-\beta) + log(YER_t / LNNFE_t) + 0.017 + 0.001 * TIME_t - 0.004 * TR911_t$$

$$\Delta log(WUNFE_t) = 0.016 - 0.089 * log(WUNFE_{t-2} / WSTAR_{t-2}) - 0.459 * log(URX_t)/100 + 0.115 * \Delta log(PCD_{t-1}) + res_t^{WUNFE}$$

| | |
|---|---|
| LNNFE: | Total employment (in full time equivalents) |
| PCD: | Private consumption deflator |
| TIME: | Time trend |
| TR911: | Trend from 1991Q1 onwards |
| URX: | Unemployment rate |
| WSTAR: | Equilibrium level of wages |
| WUNFE: | Compensation per employee full time equivalents |
| YER: | GDP expenditure, real |

The dynamic specification of wages implies some sluggishness in the reaction of wages to changes in inflation. Consumer prices enter the dynamic equation via the error correction term as well as directly. The lag of the error correction of two quarters reflects some adjustment costs. In addition, a Phillips curve relation causes wages to react to tensions on the labour market in the short-run. Note that the NAIRU is included in the constant. In the long-run, the Phillips curve is vertical.

*Figure 4: Impulse responses of the wage equations*


Figure 4 shows the speed of adjustment of the wage equations (with the rest of the model set exogenous) to a 1% increase of consumer prices and productivity and a 1 percentage point increase in the unemployment rate (from 5% to 6%[2]). It takes almost two years until half of an increase in consumer prices is translated into wages. The increase in the unemployment rate (without further adjustments in labour demand) causes wages to fall by 0.8% in the long-run, whereas the error-correction term stabilises wages.

[2] Since the unemployment rate enters the wage equation in logs, the initial level plays a role. The higher the initial level of the unemployment rate, the weaker is the reaction of wages (given the same change in percentage points).

# VI. LABOUR MARKET

The labour market block determines the level of labor supply and employment (labour demand) as well as the unemployment rate.

## 1. Labour supply

Labour supply in Austria is characterized by strong procyclical behaviour (see e.g. Hofer 2006). The European Commission (2002) estimated the Austrian elasticity of labour supply with respect to employment to be 2 ½ times higher than the euro area average.

In our model, this behaviour is reflected in a high coefficient of employment (0.776) in the dynamic equation of labour supply. In addition, real wages play a role. In the long run, total labour force follows demographic developments and is hence given exogenously.

## 2. Labour demand

Equilibrium employment (LSTAR) is determined in the supply block of the model. More specifically, it is derived by inversion of the production function. Hence it is a function of output, total capital stock, oil used in production and of technological progress (see section III).

In the short run employment growth is determined by growth of real wages and output. The estimated speed of adjustment coefficient carries the correct negative sign, but the estimated magnitude (estimate of -0.12) is relatively large which would lead to an implausible rapid adjustment of short run labour demand to shocks in simulations and hence no productivity effects. Hence the speed of adjustment coefficient was calibrated to -0.02. The coefficient on output growth carries a positive sign capturing the pro-cyclical nature of labour demand. Real wage growth impacts negatively on employment.

### 3. Unemployment

Total unemployment is specified as an identity. Specifically, total unemployment is the difference between the endogenously determined labour supply and labour demand. The unemployment rate then is based on the ratio of total unemployment and labour supply. Since unemployment figures are based on ESA data and our unemployment rate is based on Eurostat definition, a statistical discrepancy had to be included.

$$\Delta log(LFN_t) = -0.064 * log(LFN_{t-2}/LFNSTAR_{t-2}) + 0.144 * \Delta log(WUN_t/PCD_t) + 0.776 * \Delta log(LNN_t) + res_t^{LFN}$$

$$\Delta log(LNNFE_t) = -0.02 * log(LNNFE_{t-1}/LSTAR_{t-1}) - 0.3 * \Delta log(WUNFE_t/YFD_t) + 0.382 * \Delta log(YER_t) + res_t^{LNNFE}$$

$$URX_t = 100 * (UNN_t/LFN_t) + ZURX_t$$

| | |
|---|---|
| LFN: | Total labour force |
| LFNSTAR: | Total labour force, hp filtered |
| LNN: | Total employment |
| LNNFE: | Total employment (in full time equivalents) |
| LSTAR: | Equilibrium level of labour demand |
| PCD: | Private consumption deflator |
| URX: | Unemployment rate |
| WUN: | Compensation per employee |
| WUNFE: | Compensation per employee full time equivalents |
| YER: | GDP expenditure, real |
| YFD: | GDP at factor cost deflator |
| ZURX: | Statistical discrepancy for unemployment rate |

# VII. THE PUBLIC SECTOR

The aim of the public sector block is twofold. First, it should improve our understanding of the reaction of government receipts to a changing macroeconomic environment. Second, it is used to investigate macroeconomic implications of tax changes.

### 1. General structure

The public sector block is constructed bottom up, i.e. the government balance is defined as government's total receipts minus total expenditures and interest payments.

The components of the revenue side are modeled endogenously. The majority of the equations are based on the 2-step-Engle-Granger-cointegration methodology. This represents a main difference to the previous version of the model, where government receipts (as well as expenditures) were modeled in less detail. Due to the discretionary character of government expenditures, the real expenditure side remains widely exogenous. Table 2 gives an overview of government receipts and expenditures.

### 2. Total receipts

Government total receipts (GTR) are made up of tax revenues (TAXREV), transfers from households (TPN), transfers from firms (TPF) and transfers from other sectors (OGN).

#### *(a) Tax receipts*

The majority of the tax revenues of the Austrian general government is derived from four taxes: the part of personal income tax paid by employees and retired persons (30,0 bill EUR or 45.0% of total tax revenues in 2004), value added tax (18.6 bill EUR or 27.8%), corporate income tax (5.0 bill EUR or 7.4%) and petroleum tax (3.6 bill EUR or 5.4%). These taxes are therefore modeled separately. The remaining taxes (9.6 bill EUR or 14.4%) are modeled jointly.

The long-run elasticities of tax receipts with respect to macro-economic (indicator) variables have been calibrated to one to ensure proper behavior of the model in long-run simulation, whilst short-run elasticities and adjustment coefficients have been estimated. Table 3 gives an overview of the results. The short-run behavior varies substantially between the various types of taxes. Moreover, step dummies, capturing large tax law changes (e.g. tax reforms 1984 (value added tax), 1989 (personal and corporate income tax), 1992 (value added tax), 1994 (corporate income tax), 1995/1996 (value added tax) and 2000 (personal income tax)), are included in the dynamic equations. The magnitudes of the short-run elasticities estimated are in line with those used by the Austrian Ministry of Finance (see Leibrecht 2004 for details) for tax revenue forecasting and in line with those estimated by Url (2000). The adjustment coefficients seem to be relatively low at a first sight, but one has to remember that our model is based upon quarterly data. Hence, our coefficients ranging from -0.06 to -0.2 are in line with studies using annual data (e.g. Grossmann and Prammer 2005).

For the *personal income tax* two indicator-variables, one capturing the developments of employees (in full-time equivalents) and the other capturing developments in wages, are used. This separation is necessary due to the progressive tax scale of the personal income tax. The calibrated short-run elasticity on employment of one reflects the assumption of a time-invariant wage structure in Austria. The relatively high elasticity with respect to wages captures the progressive tax scale of the personal income tax.

The estimated short run elasticity of the *value added tax* below one is partly due to developments which erode the link between private consumption and VAT revenues (e.g. low value added tax rate on rental fees and increasing attempts to avoid the value added tax by firms and local governments) in the short-run.

For the *petroleum tax* real gross domestic product is used as indicator variable as the petroleum tax is a quantity tax.

For the *other taxes* nominal values are used as these taxes are predominantly ad valorem taxes. According to historical data, direct taxes constitute about 40% of these revenues, with firms and households each paying half of these revenues. 60% of revenues of other taxes are indirect taxes.

### *(b) Other receipts*

Besides taxes, the government earns revenues from transfers (from households and firms), profits and capital gains. Transfers from households include employee's social security contributions as well as remaining transfers. Transfers from firms represent the part of social security contributions paid by the employer (53% on average for the years 1988 to 2003).

*Social security contributions* depend on total compensation to employees with a calibrated unit elasticity in the long run and a short-run elasticity slightly above one. The remaining receipts (remaining transfers from households, profits and capital gains) are exogenous.

## 3. Government expenditures

Government expenditures consist of four components: government consumption, government gross investment, transfers from general government to households and government interest payments. According to the discretionary character of real government consumption and investment, they are treated as exogenous, whilst transfers to households and interest payments are determined endogenously.

*Table 2: Overview of government receipts and expenditures*

## Government balance

$$GB_t = GTR_t - GTE_t$$

## Government receipts

$$GTR_t = TAXREV_t + TPN_t + TPF_t + OGN_t^{exo}$$

$$TAXREV_t = VAT(PCN)_t + PIT(LNNFE, WUNFE, WIN)_t + PETTAX(YER)_t + CIT(GON)_t + TAXREST(YEN)_t$$

| | From firms | from households |
|---|---|---|
| Direct taxes | $PDF_t = CIT(GON)_t + 0.2 * TAXREST(YEN)_t$ | $PDN_t = PIT(LNNFE, WUNFE, WIN)_t + 0.2 * TAXREST(YEN)_t + ZPDN_t^{exo}$ |
| Indirect taxes less subsidies | $TIN_t = VAT(PCN)_t + PETTAX(YER)_t + 0.6 * TAXREST(YEN)_t - SUB_t^{exo}$ | |
| Transfers | $TPF_t = 0.53 * SOSEC(WIN)_t$ | $TPN_t = 0.43 * SOSEC(WIN)_t + TPNREST_t^{exo}$ |

## Government expenditures

$$GTE_t = GCN_t + GIN_t + TRN_t + INN_t$$

$$GCN_t = GCR_t^{exo} * GCD(PCD)_t$$

$$GIN_t = GIR_t^{exo} * GID(ITD)_t$$

$$TRN_t = TRX(URX)_t * TRNB_t * PROFE_t * YED_t, \quad TRX_t = 0.184 + 0.3 * URX_t/100 + 0.00047 * TIME$$

$$INN_t = (1/400) * (1/5) * (LTI_{t-1} + LTI_{t-5} + LTI_{t-9} + LTI_{t-13} + LTI_{t-17}) * GDN_{t-1}$$

| | | | |
|---|---|---|---|
| CIT: | Corporate income tax | SOSEC: | Social security contributions |
| GB: | Government budget balance | SUB: | Subsidies |
| GCD: | Government consumption deflator | TAXREST: | All other tax revenues |
| GCN: | Government consumption, nominal | TIN: | Indirect taxes less subsidies |
| GCR: | Government consumption, real | TAXREV: | Total revenues from taxes and social security contributions |
| GDN: | Government debt, gross | | |
| GID: | Government investment deflator | TPF: | Transfers from firms to government |
| GIN: | Government investment, nominal | TPN: | Transfers from households to government (incl. SOSEC) |
| GIR: | Government investment, real | | |
| GON: | Gross operating surplus | TPNREST: | Transfers from households to government other than SOSEC |
| GTE: | Government total expenditure | | |
| GTR: | Government total receipts | TPX: | Ratio between TPN and YEN |
| INN: | Government interest payments | TRN: | Transfers from government to households |
| ITD: | Total investment deflator | TRNB: | Base for TRN (equals LNNFE) |
| LNNFE: | Total employment (in full time equivalents) | TRX: | Ratio between TRN and YEN |
| LTI: | Long-term nominal interest rate | URX: | Unemployment rate |
| OGN: | Other government receipts | VAT: | Value added tax |
| PCD: | Private consumption deflator | WIN: | Total compensation to employees, nominal |
| PCN: | Private consumption, nominal | WUNFE: | Compensation per employee at full time equivalents |
| PDF: | Direct taxes paid by firms | | |
| PDN: | Direct taxes paid by households (excl. SOSEC) | YED: | GDP expenditure deflator |
| | | YEN: | GDP expenditure, nominal |
| PETTAX: | Petroleum tax | YER: | GDP expenditure, real |
| PIT: | Personal income tax of employees | ZPDN: | Statistical discrepancy for direct taxes |
| PROFE: | Average labour productivity (full time equivalents) | | |

*Table 3: Determinants of government tax revenues: indicator variables and elasticities*

| | *Long-run elasticities and indicator variable* | *Short-run elasticities ($\alpha$), speed of adjustment coefficients ($\gamma$) and indicator variables* |
|---|---|---|
| *Personal income tax (PIT)* | 1.00 WIN | $\gamma$ = -0.13<br>$\alpha_1$ = 1.00 LENFE<br>$\alpha_2$ = 1.63 WUNFE |
| *Corporate income tax (CIT)* | 1.00 YEN | $\gamma$ = -0.10<br>$\alpha$ = 1.10 (1/4(GON(-4:-7))) |
| *Value added tax (VAT)* | 1.00 PCN | $\gamma$ = -0.18<br>$\alpha$ = 0.85 PCN |
| *Petroleum tax (PETTAX)* | 1.00 YER | $\gamma$ =-0.10<br>$\alpha$ = 0.99 YER |
| *Other tax revenue (TAXREST)* | 1.00 YEN | $\gamma$ =-0.16<br>$\alpha$ = 0.68 YEN |
| *Social security contributions (SOSEC)* | 1.00 WIN | $\gamma$ =-0.06<br>$\alpha$ = 1.05 WIN |

GON: Gross operating surplus
LENFE Number of employees, full time equivalents
PCN: Private consumption
VAT: Value added tax
WIN: Total compensation to employees, nominal
WIN: Total compensation to employees, nominal
WUNFE: Compensation per employee, full time equivalents
YEN: GDP expenditure, nominal
YER: GDP expenditure, real

Government consumption and investment are included in the model in both nominal and real terms. Whilst real government consumption resp. investment are exogenous variables, their nominal values are derived from the real values times the government consumption (investment) deflator, which is determined as a behavioral equation in the price block of the model.

Transfers from general government to households include unemployment benefits, pension payments and other social transfers (e.g. child care benefits, transitional assistance). They are determined by multiplying an implicit transfer ratio with nominal GDP. The transfers to GDP ratio depends on the unemployment rate and a time trend, reflecting the steady historical increase of this ratio.

For simulation purposes, nominal GDP is divided into its components GDP deflator, labor productivity and employment. We assume that only changes in the GDP deflator and in productivity influence transfers to households. To implement this assumption, employment is replaced by a separate variable TRNB, which is held on its base line levels in simulations.

Government interest payments of year *t* are derived on basis of government debt in year *t-1* and a weighted average of the long-term interest rate of the last five years. The last five years are used to capture the average maturity of government debt in Austria.

## 4. Tax revenue data

Tax revenues are based on annual ESA 95 data from Statistics Austria. As our model is based on quarterly data, revenue data have to be interpolated to quarterly data using a cubic spline.

## 5. The reaction of government receipts and expenditures to macroeconomic shocks

In this section we will demonstrate the reaction of government receipts and expenditures to changes in the macroeconomic environment. Therefore we simulate two different shocks, a demand and a supply shock. The demand shock is implemented by an increase of foreign demand for Austrian exports (by 1.7%). The supply shock consists of a decrease of the oil price by 67.1%. The size of the shocks has been scaled in a way that real GDP increases by 1% after three years.

These two shocks result in totally different behavior of government receipts and expenditures. The differences are mainly driven by the movement of prices, which increase for the demand shock and decrease for the supply shock. Government receipts increase by 1.4 bill EUR (=0.56% of GDP) for the demand shock, whilst the supply shock causes a decrease of 0.1 bill EUR (=-0.04% of GDP). Government expenditures also show a movement into opposite directions (+0.7 bill EUR for the demand shock, -1.5 bill EUR for the supply shock). The overall government balance improves for both shocks, but with different magnitude (+0.7 bill EUR for the demand shock, +1.4 bill EUR for the supply shock).

## 6. Effects of tax increases on the Austrian economy

We simulate the effects of an increase of the (implicit) tax rate of the three most important taxes (value added tax, personal income tax and corporate tax) on the Austrian economy. Therefore we perform three separate simulations. The magnitude of the increase of the implicit tax ratio for each tax is calculated in a way that the initial effect on the tax revenue of that tax in the first year equals one bill. EUR. All simulations are performed with monetary and fiscal policy rules (see section VIII) switched off. The additional government receipts are not spend. The effects on the economy are reported as percentage deviations from baseline levels after three years.

*Table 4: Effects of macroeconomic shocks on the government balance (effects after three years)*

| | Demand shock a) | Supply shock b) |
|---|---|---|
| | *Deviations from baseline in mill. EUR* | |
| **Government receipts** | 1372 | -100 |
| Total tax revenues | 953 | 42 |
| Value added tax | 234 | -20 |
| Personal income tax | 261 | -135 |
| Corporate income tax | 129 | 114 |
| Petroleum tax | 33 | 33 |
| Other tax revenues | 296 | 49 |
| Social security contributions | 419 | -142 |
| Other transfers from househol | 0 | 0 |
| **Government expenditures** | 664 | -1475 |
| Government consumption | 236 | -1018 |
| Government investment | 14 | -29 |
| Transfers from government to | 446 | -359 |
| Government interest payment | -32 | -69 |
| Subsidies | 0 | 0 |
| **Government balance** | 709 | 1375 |
| **Output (real)** | *Deviations from baseline in %* | |
| GDP | 1.00 | 1.00 |
| Private consumption | 0.84 | 1.99 |
| Investment | 1.55 | 0.83 |
| Exports | 1.56 | 0.09 |
| Imports | 1.42 | 0.69 |
| **Prices** | | |
| Consumption deflator | 0.55 | -2.07 |
| GDP deflator | 0.70 | -0.81 |
| **Other** | | |
| Employment | 0.61 | 0.53 |
| | *Deviations from baseline in percentage points* | |
| Unemployment rate | -0.27 | -0.19 |

a) = Increase of world demand for Austrian exports by 1.7%
b) = Decrease of oil price by 67.1%

### *(a) Value added tax*

An increase of the implicit tax rate of the value added tax causes prices to increase and dampens demand. The effects of the VAT increase on prices are implemented in the model via the GDP deflator (at market prices) and the consumption deflator. It is assumed that the increase of the VAT tax rate feeds into consumer prices without delay. Wages react to the increase of the overall price level, triggering second round effects.

Overall government receipts are driven by two opposite effects: the increase of the tax rate dampens activity and increases prices. After three years, output falls by 0.22%, whilst the overall price level (as measured by the GDP deflator) increases by 0.52%. Increasing wages offset the decline in employment, causing total compensation of employees to rise. Consequently, revenues from the personal income tax and from social security contributions also rise, leading to an overall increase of tax revenues by 1.1 bill. EUR. On the expenditure side, higher inflation leads to an increase of nominal government consumption (with constant real government consumption) by 0.33 bill EUR. Transfers to households increase by 0.36 bill EUR, driven both by higher inflation and unemployment. The overall government balance increases by 0.47 bill EUR.

### *(b) Personal income tax*

The transmission of the increase of the personal income tax is straightforward. Under the assumption that households bear the full burden, the increased tax rate causes disposable income to fall which dampens consumption and output. Compared with the increase of the value added tax, the additional government receipts levied are rather small. Falling output and prices erode the tax base of all taxes as well as the social security contributions, offsetting roughly 2/3 of the additional tax revenues. Since expenditures decline also, the government balance improves by 0.73 bill EUR.

### *(c) Corporate income tax*

The impact of an increase of the corporate income tax on economic activity is much more indirect than the effects of the value added tax and the personal income tax.

Corporate taxes matter for location decisions of firms (effective average tax rate), for scale adjustments of existing firms (effective marginal tax rate) as well as for the tax planning behaviour of existing firms (statutory tax rate; see Keuschnigg, 2005). We have only included the effect of corporate taxes on scale adjustment. Specifically, the scale effect is captured via the impact of a proxy for the effective marginal tax rate on the user costs of capital (see section III). Increasing user costs of capital decrease the optimal equilibrium capital stock and trigger an adjustment process via lower investment.

*Table 5: Effects of tax increases by 1 bill. EUR on the Austrian economy (cumulated effects after three years)*

| | Value added tax | Personal income tax | Corporate income tax |
|---|---|---|---|
| **Scenario definition** | *Baseline level* | | |
| Implicit tax rate | 0.1384 | 0.1506 | 0.0532 |
| | *Deviations from baseline in percentage points* | | |
| Implicit tax rate | 0.0528 | 0.0550 | 0.1922 |
| | *Deviations from baseline in mill. EUR* | | |
| Initial tax revenues | 1000 | 1000 | 1000 |
| **Scenario results** | | | |
| **Government receipts** | 1104 | 386 | 952 |
| Total tax revenues | 1048 | 546 | 968 |
| Value added tax | 981 | -189 | -8 |
| Personal income tax | 52 | 905 | -9 |
| Corporate income tax | -33 | -43 | 998 |
| Petroleum tax | -7 | -13 | -2 |
| Other tax revenues | 55 | -114 | -11 |
| Social security contributions | 56 | -160 | -15 |
| Other transfers from households | 0 | 0 | 0 |
| **Government expenditures** | 637 | -346 | -119 |
| Govenrment consumption | 327 | -85 | -5 |
| Government investment | 3 | -5 | 0 |
| Transfers from gov. to househol | 360 | -179 | -18 |
| Gov. debt interest payments | -53 | -76 | -95 |
| Subsidies | 0 | 0 | 0 |
| **Government balance** | 467 | 732 | 1071 |
| **Output (real)** | *Deviations from baseline in %* | | |
| GDP | -0.22 | -0.41 | -0.05 |
| Private consumption | -0.50 | -0.90 | -0.04 |
| Investment | 0.07 | -0.60 | -0.26 |
| Exports | -0.02 | 0.03 | 0.00 |
| Imports | -0.12 | -0.42 | -0.06 |
| **Prices** | | | |
| Consumption deflator | 0.66 | -0.20 | -0.01 |
| GDP deflator | 0.52 | -0.25 | -0.02 |
| **Other** | | | |
| Compensation per employee | 0.40 | -0.17 | -0.01 |
| Employment | -0.19 | -0.23 | -0.02 |
| | *Deviations from baseline in percentage points* | | |
| Unemployment rate | 0.07 | 0.10 | 0.01 |

This adjustment process is rather slow in the model, implying only very low macroeconomic effects in the short run. Hence, *this scenario is not strictly comparable to the first two tax scenarios*, which impact heavily on the domestic economy already in the short-run.

# VIII. MONETARY AND FISCAL POLICY RULES

Our monetary policy rule is a standard Taylor rule, linking the short term interest rate to deviations of inflation from an inflation target and the output gap. The long-term interest rate adjusts to the movements of the short-term rate.

$$STI_t = 4 + 1.5 * (100 * (HIC_t / HIC_{t-1} - 1) - 2) + 0.5 * YGA_t$$

$$\Delta LTI_t = -0.027 * (LTI_{t-1} - STI_{t-1}) + 0.315 * \Delta STI_t - 0.126 * \Delta STI_{t-1} + 0.394 * \Delta LTI_{t-1} - 0.208 * \Delta LTI_{t-2} + res_t^{LTI}$$

| | |
|---|---|
| HIC: | Harmonized index of consumer prices |
| LTI: | Long-term interest rate |
| STI: | Short-term interest rate |
| YGA: | Output gap |

To avoid exploding government debt in long-run simulations, a fiscal rule is an essential ingredient. Most applied macroeconomic models adjust government receipts to achieve a debt target. Johnson (2001) provides a survey of different types of fiscal reaction rules. Our fiscal rule adjusts the implicit tax rate on the value added tax according to the deviation of the government debt to GDP ratio relative to a predefined level of 60%. The adjustment coefficient is calibrated to ensure a smooth adjustment path.

$$VATX_t = VATX_{t-1} + 0.2 * (GDN_{t-1} / (4 * YEN_{t-1}) - 0.6)$$

| | |
|---|---|
| GDN: | Government debt |
| VAT: | Value added tax |
| VATX: | Adjustment factor value added tax |
| YEN: | GDP expenditure, nominal |

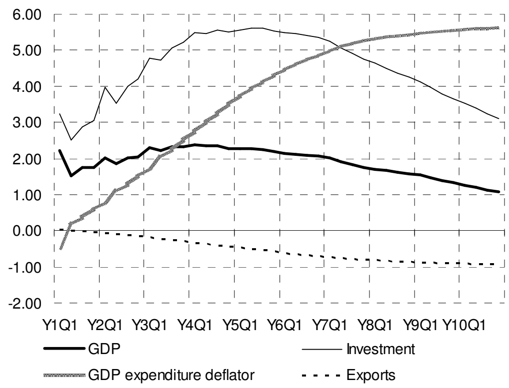
# IX. SIMULATION RESULTS

This section presents the results of some standard simulations to demonstrate the properties of the model. We have concentrated on five standard shocks, a government spending shock, an exchange rate shock, a monetary policy shock, an oil price shock and a world demand shock. All shocks are simulated under the assumption of unchanged fiscal and monetary policy and constant nominal exchange rates. Hence, the simulation results can not be regarded as the most likely outcome of the shocks in reality. The partial character of the simulations is further accentuated by assuming an unchanged international environment, a caveat which is especially important for the global shocks. Tables with detailed simulation results can be found in the appendix.

## 1. Government spending shock

The first simulation analyses the behaviour of the model for a demand shock. Real government consumption is increased by 1% of initial real GDP permanently. The immediate effect on output is amplified by increases in investment and private consumption. Investment increases directly due to the accelerator effect. In addition, the assumption of an unchanged monetary policy causes a somewhat counter intuitive effect via the real user costs of capital. According to the scenario design, the central bank does not account for prices pressures and leaves the nominal interest rate unchanged. Hence, increasing inflation causes the real user costs of capital to fall which further boosts investment. The additional employment increases household income and hence consumption. In addition, the savings ratio goes up.

*Figure 5: Effects of a permanent increase of government spending of 1% of initial real GDP (deviations from baseline levels in %).*



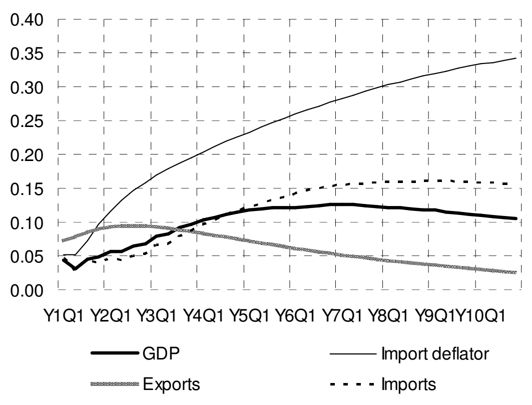

Since the model is strictly backward-looking, households do not show Ricardian behaviour. No further tax increases or government spending cuts are anticipated. Demand-side pressures lead to a continuous rise in prices, which deteriorates international competitiveness and dampens export activity.

The model shows a strong reaction to the shock. Although this reaction also shows up in other models of the Austrian economy, it seems to be an unusual result for a small open economy. One should not forget the artificial nature of the government spending shock by increasing government consumption, which consists to a large extent of wages for government employees and has very low import content (1990: 8%; 2000: 11%). Exports decline due to worsening price competitiveness, although the magnitude of this decline is rather small. In addition, the assumption of exogenous monetary policy leads to the above-mentioned overreaction of investment.

## 2. Exchange rate shock

In this simulation, a permanent depreciation of the euro against all other currencies by 1% is assumed. Considering trade shares with the extra-euro area, this implies a depreciation of the nominal-effective exchange rate of 0.51% on the export and 0.33% on the import side. These changes are implemented by increases of the prices of the competitors of Austrian exporters (importers) by 0.51% (0.33%).

*Figure 6: Effects of a permanent depreciation of the euro against all other currencies by 1% (deviations from baseline levels in %).*




The depreciation works through the model via its effects on price competitiveness of exports and imports. The pass-through effect on import prices is low in the short run (import deflator +0.07% in the first year), but completed after 10 years (import deflator +0.34%). Consumer prices adjust slower than import prices. Since Austria has a larger trade share with the extra-euro area on the export than on the import side, the terms of trade improve slightly.

GDP increases due to improving export performance, amplified by accelerator and consumption effects. Although the worsening price competitiveness of imported commodities and services relative to domestic ones suggests a dampening effect on imports, increasing domestic production causes imports to rise. The nominal trade balance improves, although the improvement is very small. The stimulating effect of the depreciation on exports diminishes over time due the gradual erosion of competitiveness. The output gain reaches its maximum after six years and falls afterwards. In the long-run, output returns to its baseline levels, while the price level is permanently higher.

## 3. Monetary policy shock

The monetary policy shock follows the specification used by van Els et al. (2003) in the Monetary Transmission Network exercise undertaken by euro system central banks in 2002. It consists of an increase of short-term interest rates by 100 basis points for two years. After that, the short term interest rate returns to its baseline level. The long-term interest rate follows the expectations hypothesis, while the exchange rate is determined by an uncovered interest parity (UIP) condition. No international spillovers between euro area countries are considered.

*Table 6: Assumptions about the development of interest rates and the exchange rate (deviations from baseline levels in percentage points (interest rates) resp. % (exchange rate)).*

| | Short-term interest rate | Long-term interest rate | Nom.-effective exchange rate |
|---|---|---|---|
| Y1Q1 | 1.000 | 0.199 | 2.010 |
| Y1Q2 | 1.000 | 0.174 | 1.757 |
| Y1Q3 | 1.000 | 0.149 | 1.504 |
| Y1Q4 | 1.000 | 0.124 | 1.025 |
| Y2Q1 | 1.000 | 0.100 | 1.000 |
| Y2Q2 | 1.000 | 0.075 | 0.749 |
| Y2Q3 | 1.000 | 0.050 | 0.499 |
| Y2Q4 | 1.000 | 0.025 | 0.249 |
| Y1 | 1.000 | 0.162 | 1.574 |
| Y2 | 1.000 | 0.062 | 0.624 |

Source: van Els et al. (2003).

The transmission of a monetary policy shock works via various channels (see van Els et al., 2003). The following channels are considered in our simulation:

*The cost-of-capital channel:* The rise in the real interest rate directly affects the user costs of capital, which lower the optimal capital stock and hence the accumulation of capital via investment.

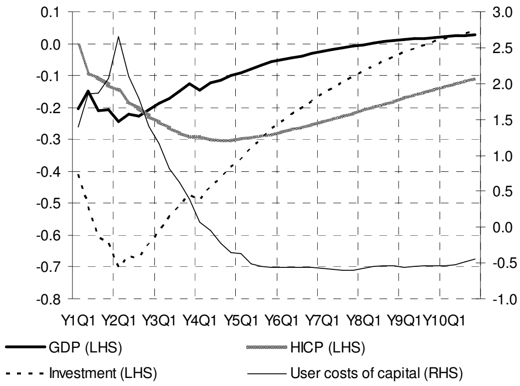
*The exchange rate channel*: A monetary policy tightening leads to an appreciation of the domestic currency until the expected returns of domestic and foreign assets are equalised. Since the exchange rate is exogenous in our model, we use the assumptions in table 6.

*The substitution effect in consumption channel*: Higher interest rates increase the pay-off of savings and cause consumers to increase their propensity to save, which negatively impacts on current consumption.

*The income channel:* Rising yields increase income of net lenders and decrease income of net borrowers. Since Austrian households are net lenders in the economy, rising yields lead to an increase of disposable household income.

In addition, there are also channels which have not been considered in our simulation, namely the *cash-flow channel (*impact of interest rates on the cash-flow of firms), the *wealth channel* (impact of borrowing conditions on the discounted value of future expected payoffs of assets) and the *international spill-over channel* (responses of the other euro area countries to the monetary shock).

*Figure 7: Effects of an increase of the short-term interest rate by 100 bp for two years (exogenous monetary policy, deviation from baseline in %)*



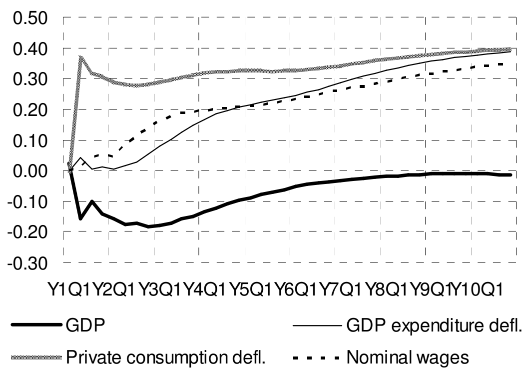

The monetary policy tightening leads to a sudden fall in output, which is mainly driven by a slump in investment due to rising real user costs of capital. The fall in employment dampens household income and hence consumption. Exports decline due to the appreciation of the domestic currency. After two years, the shock disappears by definition and activity goes back to its baseline levels gradually. Prices react stronger, but more sluggish than activity. The strongest price decline can be obtained after five years.

## 4. Oil price shock

An oil price shock impacts on the domestic economy via several channels. The increasing price of imported oil pushes up inflation immediately, causing real disposable income to fall. Investment is affected by two effects which work in opposite directions. On the one hand, the contraction of output causes investment to fall. On the other hand, investment is boosted by the fall of the real user costs of capital caused by increasing inflation. In our model, the negative accelerator effect dominates. Besides the direct impact on prices, an oil price shock may cause second round effects depending on the reaction of wages to higher consumer prices.

As shown in section V.2, the reaction of wages is rather sluggish. Consumer prices go up almost immediately by 0.2-0.3%, but wages increase only gradually. Prices also react stronger and faster than output. The maximum loss in GDP occurs at the end of the second year. After that, output begins to converge to its new equilibrium level determined by the supply side (which is very close to the old equilibrium level). Unemployment increases in the medium-run, but decreases slightly in the first year, caused by strong procyclical behaviour of the labour force.

*Figure 8: Effects of a permanent increase of the oil price of 10% (exogenous monetary policy, deviation from baseline in %)*




A structural macroeconometric model like ours is not capable to cover all channels that work in reality. The reactions of the model are symmetric and linear, but there is strong evidence that oil prices affect the economy in an asymmetric and non-linear way. Sectoral reallocation of production resources may magnify negative effects of oil price increases, which cannot be accounted for in a single-sector model. The surprise content of oil price changes plays a role. Surprising and large prices have larger effects than changes that reverse past movements. See Schneider (2005) for a discussion of these issues. Ignoring the reaction of the international environment in a single-country model is nearly always an important source of error. In the case of a global shock like the oil price shock, there are at least three effects coming from abroad which partly offset each other. On the one hand, output loss in other countries reduces demand for Austrian exports and hence amplifies the domestic effects. On the other hand, the negative effect on exports via price competitiveness is dampened when the reaction of the rest of the world is considered. In addition, increasing imports of oil producing countries may lead to a small offset of the output losses.

Two points are of utmost importance in determining the reaction to an oil price shock. First, monetary policy. In the short run, the central bank faces the trade-off to fight inflation or to minimise output losses. Second, the magnitude of second-round effects via wage increases. Therefore we have conducted four simulations with exogenous resp. endogenous monetary policy and exogenous resp. endogenous wages.

Figure 9 presents the results of the simulations. Simulation A) depicts the baseline simulation presented above with exogenous interest rates and endogenous wages. Turning on the monetary policy rule gives us simulation B). In simulation C), both interest rates and prices are assumed to be exogenous, while in simulation D) exogenous wages are combined with endogenous interest rates. With endogenous monetary policy, the central bank raises interest rates within the first year after the shock, reacting to annual inflation in the monetary policy rule. Since the price level begins to fall rapidly one year after the shock, the central bank cuts interest rates even below baseline levels.

We have calculated the average GDP loss over 10 years to obtain a proxy for total welfare losses (see table 7). Allowing wages to react endogenously dampens the output losses somewhat in the medium run. This effect is stronger for exogenous monetary policy, since the increase of the price level is not dampened by interest rate increases. Endogenous monetary policy has a small negative effect on output when wages are endogenous. When wages are exogenous, this difference becomes negligible.

*Figure 9: Effects of the oil price shock for exogenous/endogenous monetary policy and wages (deviations from baseline levels in %).*

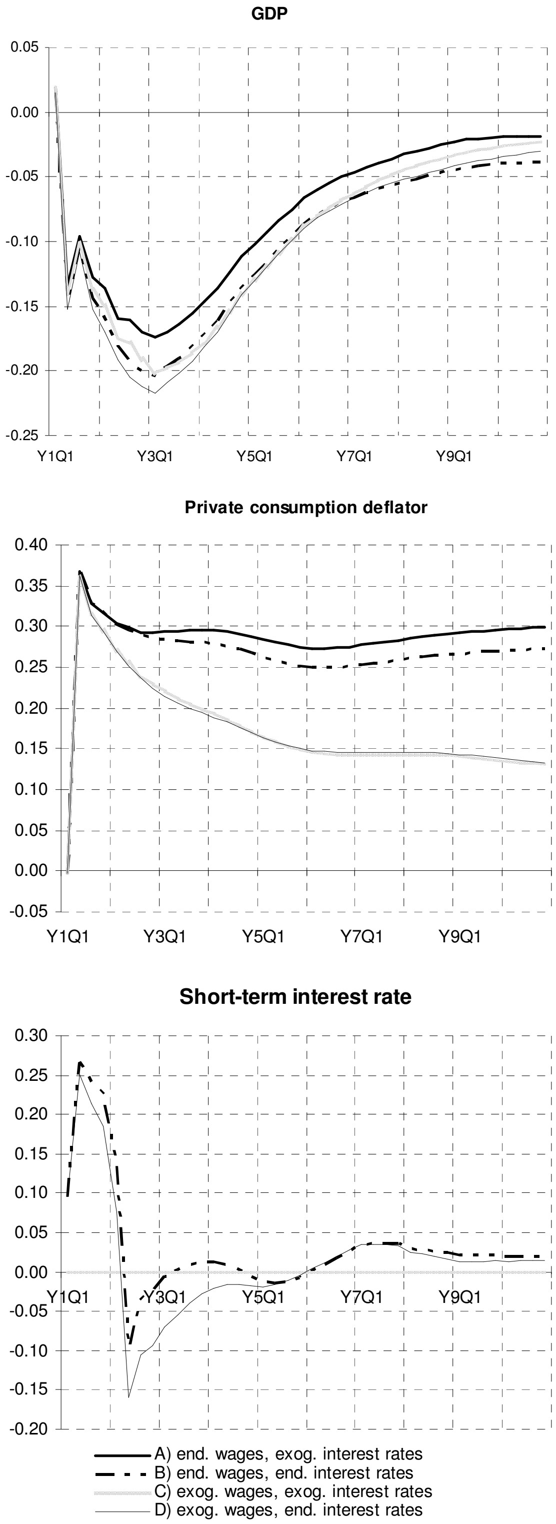



*Table 7: Cumulated GDP loss for exogenous resp. endogenous monetary policy and wages (percentage deviation from baseline, cumulated over 10 years)*

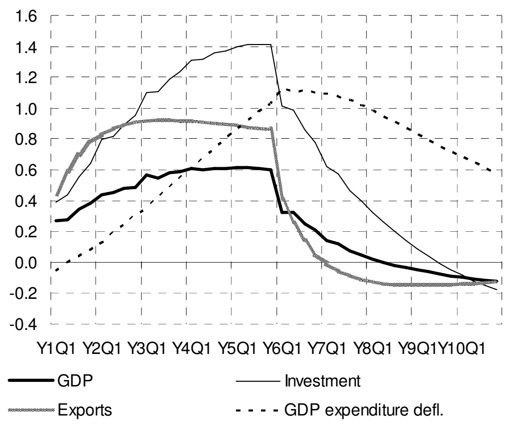
| | | Interest rates | |
|---|---|---|---|
| | | Exogenous | Endogenous |
| Wages | Endog. | A) -3.2 | B) -4.0 |
| | Exog. | C) -3.8 | D) -4.1 |

While the picture is rather ambiguous for output, it is clear for prices. Wage setting behaviour plays the dominant role, while the impact of monetary policy is limited. This limited impact can be explained by the interest rate path (short steep increase followed by moderate but long-lasting decline) in combination with the sluggish reaction of prices.

## 5. World demand shock

In this simulation, world demand for Austrian exports is increased by 1% for five years. Exports reach their maximum after two years. Investment and private consumption gain momentum as the foreign demand stimulus spills over to the domestic economy. Investment is additionally boosted via the effect of the increasing price level on the real user costs of capital.

*Figure 10: Effects of a temporary increase of world demand by 1% (deviations from baseline levels in %).*




Due to the high import content of exports and equipment investment, the contribution to GDP growth of net exports remains small. The fall in the unemployment rate causes wages to increase. The increasing price level deteriorates price competitiveness and dampens export growth. After five years, the demand stimulus vanishes. Due to the sluggishness of prices, activity falls even below baseline levels.

# X. SUMMARY

Summing up the behaviour of the model obtained by the simulations, we can notice the following main properties. The reaction of the model to macroeconomic shocks is in line with our expectations and with simulations of other models for Austria (previous versions of the OeNB model, models from WIFO (Baumgartner et al., 2005) and IAS (Hofer and Kunst, 2005)) and the euro area (see appendix). Nevertheless, there are some specific properties. The model shows relative strong reactions to shocks to government spending, but relatively weak reactions of output to changes in international competitiveness (due to exchange rate changes).

Foreign prices still play only a small role for determining the domestic price level[3]. The inclusion of oil in the production function has an effect on the long-run equilibrium level after an oil price shock. However, this effect is not very large, given the low share of oil in the production function. The inclusion of the public sector block proved to be a valuable extension of the model, since it allows not only to assess the impact of macroeconomic shocks on the government budget, but also to get estimates of the macroeconomic implications of tax rate changes.

Obviously, there is always plenty of room for improvements on such a model. One important way forward would be the inclusion of forward-looking elements. To make the model more suitable for the projection exercises, some variables (foreign trade, other personal income) could be disaggregated.

[3] See the comments of Zwiener (2005) and Warmedinger (2005) at the OeNB workshop on "Macroeconomic Models and Forecasts for Austria" in November 2004 on the previous version of the model.

# XI. REFERENCES


Baumgarnter, J., F. Breuss and S. Kaniovski (2005): WIFO-Macromod – An econometric model of the Austrian economy. In *Macroeconomic Models and Forecasts for Austria*. Proceedings of OeNB Workshops, No. 5, 61-86.

De Nederlandsche Bank (2000): *EUROMON: The Nederlandsche Bank's multi-country model for policy analysis in Europe*. Monetaire Monografieen, Amsterdam.

European Commission (2002): *Economic forecasts Spring 2002*. European Economy. No. 2/2002.

Fagan, G. and J. Morgan (eds.) (2005): *Econometric models of the euro-area central banks*. Cheltenham: Edward Elgar.

Fenz, G. and M. Spitzer (2004): *AQM The Austrian Quarterly Model of the Oesterreichische Nationalbank.* OeNB Working Paper No. 104.

Fenz, G. and M. Spitzer (2005): AQM The Austrian Quarterly Model of the Oesterreichische Nationalbank. In *Macroeconomic Models and Forecasts for Austria*. Proceedings of OeNB Workshops, No. 5, 11-60.

Fritzer, F., H. Glück, G. Rünstler and G. Wehinger (1998): *The Austrian Part of ECB's Multy-Country Model. First Version*. Oesterreichische Nationalbank, mimeo.

Grossmann, B. and D. Prammer (2005): Ein disaggregierter Ansatz zur Analyse öffentlicher Finanzen in Österreich, *Geldpolitik & Wirtschaft* Q4/05, 67 – 83.

Hofer, H. and R. Kunst (2005): The Macroeconometric Model LIMA. In *Macroeconomic Models and Forecasts for Austria*. Proceedings of OeNB Workshops, No. 5, 87-116.

Hofer, H. (2006): The Austrian Labor Market: Model of Success or Increased Need for Reforms? In *Growth and Employment Strategies* *for Austria*. Proceedings of OeNB Workshops, No. 10 (forthcoming).

Johnson, R. (2001): *Fiscal reaction rules in numerical macro models*. Federal Reserve Bank of Kansas City Working Paper No. 01-01.

Keuschnigg, C. (2005): Company taxation and growth: the role of small and large firms. In *Capital taxation after EU enlargement*. Proceedings of OeNB Workshops, No. 6, 73-95.

Knudsen D. and F. Sethi (2004): *Chain indexing in a macro model – aggregation and irreversibility*. Danmarks Nationalbank Working Papers No. 21/2004.

Leibrecht, M. (2004): *Steuerschätzung in Österreich*. Wiesbaden: Deutscher Universitäts-Verlag.

Liu, Y., N. Hamalainen and B.S. Wong (2003): *Economic Analysis and Modelling using Fisher Chain Data*. Canadian Department of Finance Working Paper No. 13.

Phillips, P.C.B. and S. Ouliaris (1990): Asymptotic properties of residual-based tests for cointegration. *Econometrica* 58, 165-193.

Schneider, M. (2005): The impact of oil prices changes on growth and inflation. Oesterreichische Nationalbank: *Monetary Policy & The Economy* Q2/04, 27-36.

Url, T. (2000): *Report on Cyclically Adjusted Budget balances: The Case of Austria*. Austrian Institute of Economic Research, WIFO study commissioned by the Oesterreichische Nationalbank.

van Els, P., A. Locarno, J. Morgan and J.-P. Villetelle (2003): The effects of monetary policy in the euro area: evidence from structural macroeconomic models. In Angeloni, I., A. Kashyap and B. Mojon (eds.) (2003): *Monetary policy transmission in the euro area*. Cambridge: Cambridge University Press, 91-106.

Warmedinger, T. (2005): 2nd comment on "The Austrian Quarterly Model of the OeNB, WIFO-Macromod and Macroeconometric Model LIM (IHS)". In *Macroeconomic Models and Forecasts for Austria*. Proceedings of OeNB Workshops, No. 5, 120-125.

Willman, A. and A. Estrada (2002): The Spanish Block of the ESCB-Multi-Country Model. *ECB Working Paper* No. 149.

Zwiener, R. (2005): 1st comment on "The Austrian Quarterly Model of the OeNB, WIFO-Macromod and Macroeconometric Model LIM (IHS)". In *Macroeconomic Models and Forecasts for Austria*. Proceedings of OeNB Workshops, No. 5, 117-119.

# APPENDIX

## 1. Government spending shock: permanent increase of real government consumption by 1% of initial real GDP

| | Y1 | Y2 | Y3 | Y4 | Y5 | Y10 |
|---|---|---|---|---|---|---|
| Prices | *Deviation from baseline levels in %* | | | | | |
| HICP | 0.07 | 0.77 | 1.32 | 1.85 | 2.33 | 3.71 |
| Consumption deflator | 0.06 | 0.70 | 1.22 | 1.74 | 2.23 | 3.77 |
| GDP deflator | 0.09 | 0.90 | 1.52 | 2.12 | 2.66 | 4.14 |
| Investment deflator | -0.02 | 0.47 | 1.12 | 1.69 | 2.15 | 3.44 |
| ULC | -0.88 | -0.21 | 0.37 | 1.11 | 1.83 | 4.42 |
| Compensation per employee | 0.04 | 0.54 | 1.10 | 1.72 | 2.35 | 4.63 |
| Productivity | 0.94 | 0.75 | 0.72 | 0.60 | 0.51 | 0.20 |
| Export deflator | 0.04 | 0.41 | 0.74 | 1.08 | 1.40 | 2.48 |
| Import deflator | -0.01 | 0.06 | 0.27 | 0.51 | 0.75 | 1.54 |
| GDP and components | *Deviation from baseline levels in %* | | | | | |
| GDP | 1.61 | 1.69 | 1.88 | 1.87 | 1.82 | 1.20 |
| Consumption | 0.61 | 1.00 | 1.36 | 1.58 | 1.72 | 1.80 |
| Investment | 2.05 | 2.55 | 3.19 | 3.51 | 3.63 | 2.89 |
| Of which: equipment inv. | 2.27 | 2.91 | 3.67 | 4.08 | 4.25 | 3.42 |
| Gov. Consumption | 5.34 | 5.21 | 5.05 | 4.91 | 4.77 | 4.31 |
| Exports | 0.00 | -0.08 | -0.17 | -0.27 | -0.35 | -0.67 |
| Imports | 1.22 | 1.54 | 2.01 | 2.27 | 2.41 | 2.22 |
| Contributions to shock | *Deviation from baseline levels in % of baseline GDP* | | | | | |
| Domestic demand | 1.82 | 2.15 | 2.50 | 2.69 | 2.76 | 2.47 |
| Inventories | 0.22 | 0.11 | 0.11 | 0.08 | 0.08 | 0.01 |
| Net exports | -0.43 | -0.57 | -0.73 | -0.90 | -1.02 | -1.28 |
| Labour market | *Deviation from baseline levels in %* | | | | | |
| Total employment | 0.67 | 0.93 | 1.15 | 1.26 | 1.30 | 1.00 |
| Employees in employment | 0.86 | 1.18 | 1.46 | 1.59 | 1.64 | 1.26 |
| Unemployment rate [1)] | -0.17 | -0.36 | -0.53 | -0.68 | -0.80 | -0.96 |
| Household accounts | *Deviation from baseline levels in %* | | | | | |
| Disposable income | 1.17 | 1.34 | 1.65 | 1.82 | 1.96 | 1.96 |
| Savings rate [1)] | 0.44 | 0.21 | 0.16 | 0.06 | 0.16 | 0.08 |
| Fiscal ratios | *Percentage of GDP, absolute deviation from baseline* | | | | | |
| Total receipts | 0.38 | 0.81 | 1.20 | 1.48 | 1.79 | 2.43 |
| Total expenditure | 1.20 | 1.45 | 1.75 | 1.97 | 2.20 | 2.35 |
| Budget deficit | -0.82 | -0.64 | -0.55 | -0.49 | -0.41 | 0.08 |
| Government debt | 0.52 | 1.18 | 1.71 | 2.14 | 2.51 | 2.27 |
| Interest rates | *Deviation from baseline in percentage points* | | | | | |
| Short-term interest rate | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Long-term interest rate | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| External developments | *Deviation from baseline levels in %* | | | | | |
| World demand | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Effective exchange rate | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Export competitor's prices | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

1) Deviation from baseline level in percentage points

## 2. Exchange rate shock: permanent depreciation of the euro against all other currencies by 1%

| | Y1 | Y2 | Y3 | Y4 | Y5 | Y10 |
|---|---|---|---|---|---|---|
| Prices | *Deviation from baseline levels in %* | | | | | |
| HICP | 0.03 | 0.06 | 0.10 | 0.13 | 0.16 | 0.28 |
| Consumption deflator | 0.05 | 0.08 | 0.11 | 0.13 | 0.16 | 0.28 |
| GDP deflator | 0.01 | 0.05 | 0.09 | 0.13 | 0.17 | 0.30 |
| Investment deflator | 0.01 | 0.05 | 0.10 | 0.15 | 0.19 | 0.30 |
| ULC | -0.02 | 0.01 | 0.04 | 0.07 | 0.11 | 0.28 |
| Compensation per employee | 0.01 | 0.04 | 0.07 | 0.11 | 0.15 | 0.31 |
| Productivity | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 |
| Export deflator | 0.10 | 0.15 | 0.19 | 0.22 | 0.25 | 0.35 |
| Import deflator | 0.07 | 0.14 | 0.18 | 0.21 | 0.23 | 0.30 |
| GDP and components | *Deviation from baseline levels in %* | | | | | |
| GDP | 0.05 | 0.06 | 0.08 | 0.09 | 0.10 | 0.10 |
| Consumption | 0.00 | 0.00 | 0.02 | 0.05 | 0.07 | 0.13 |
| Investment | 0.13 | 0.16 | 0.20 | 0.23 | 0.25 | 0.24 |
| Of which: equipment inv. | 0.15 | 0.18 | 0.23 | 0.27 | 0.29 | 0.28 |
| Gov. Consumption | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Exports | 0.08 | 0.09 | 0.09 | 0.08 | 0.08 | 0.05 |
| Imports | 0.05 | 0.05 | 0.06 | 0.07 | 0.09 | 0.11 |
| Contributions to shock | *Deviation from baseline levels in % of baseline GDP* | | | | | |
| Domestic demand | 0.03 | 0.04 | 0.06 | 0.08 | 0.10 | 0.13 |
| Inventories | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 |
| Net exports | 0.01 | 0.02 | 0.01 | 0.00 | 0.00 | -0.03 |
| Labour market | *Deviation from baseline levels in %* | | | | | |
| Total employment | 0.02 | 0.03 | 0.05 | 0.06 | 0.07 | 0.08 |
| Employees in employment | 0.02 | 0.04 | 0.06 | 0.07 | 0.09 | 0.10 |
| Unemployment rate [1)] | -0.01 | -0.01 | -0.02 | -0.03 | -0.04 | -0.06 |
| Household accounts | *Deviation from baseline levels in %* | | | | | |
| Disposable income | 0.00 | 0.01 | 0.04 | 0.07 | 0.09 | 0.15 |
| Savings rate [1)] | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| Fiscal ratios | *Percentage of GDP, absolute deviation from baseline* | | | | | |
| Total receipts | 0.02 | 0.04 | 0.06 | 0.08 | 0.10 | 0.17 |
| Total expenditure | 0.01 | 0.03 | 0.04 | 0.06 | 0.07 | 0.09 |
| Budget deficit | 0.00 | 0.01 | 0.01 | 0.02 | 0.03 | 0.08 |
| Government debt | 0.00 | -0.01 | -0.02 | -0.04 | -0.06 | -0.35 |
| Interest rates | *Deviation from baseline in percentage points* | | | | | |
| Short-term interest rate | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Long-term interest rate | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| External developments | *Deviation from baseline levels in %* | | | | | |
| World demand | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Effective exchange rate | 0.51 | 0.51 | 0.51 | 0.51 | 0.51 | 0.51 |
| Export competitor's prices | 0.51 | 0.51 | 0.51 | 0.51 | 0.51 | 0.51 |

1) Deviation from baseline level in percentage points

## 3. Monetary policy shock: increase of short-term interest rate by 100 bp for two years

| | Y1 | Y2 | Y3 | Y4 | Y5 | Y10 |
|---|---|---|---|---|---|---|
| **Prices** | *Deviation from baseline levels in %* | | | | | |
| HICP | -0.08 | -0.17 | -0.19 | -0.19 | -0.18 | -0.10 |
| Consumption deflator | -0.14 | -0.17 | -0.16 | -0.17 | -0.16 | -0.11 |
| GDP deflator | -0.04 | -0.18 | -0.23 | -0.23 | -0.20 | -0.11 |
| Investment deflator | -0.03 | -0.18 | -0.30 | -0.30 | -0.22 | -0.10 |
| ULC | 0.08 | -0.04 | -0.15 | -0.19 | -0.21 | -0.16 |
| Compensation per employee | -0.03 | -0.12 | -0.18 | -0.21 | -0.22 | -0.17 |
| Productivity | -0.11 | -0.08 | -0.03 | -0.01 | 0.00 | -0.01 |
| Export deflator | -0.33 | -0.30 | -0.19 | -0.17 | -0.15 | -0.08 |
| Import deflator | -0.34 | -0.47 | -0.31 | -0.18 | -0.13 | -0.06 |
| **GDP and components** | *Deviation from baseline levels in %* | | | | | |
| GDP | -0.19 | -0.19 | -0.12 | -0.08 | -0.05 | 0.01 |
| Consumption | -0.02 | -0.15 | -0.18 | -0.14 | -0.10 | -0.02 |
| Investment | -0.55 | -0.50 | -0.36 | -0.30 | -0.22 | -0.03 |
| Of which: equipment inv. | -0.61 | -1.17 | -1.47 | -0.97 | -0.47 | -0.04 |
| Gov. Consumption | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Exports | -0.26 | -0.13 | 0.01 | 0.04 | 0.04 | 0.03 |
| Imports | -0.17 | -0.20 | -0.20 | -0.16 | -0.12 | -0.03 |
| **Contributions to shock** | *Deviation from baseline levels in % of baseline GDP* | | | | | |
| Domestic demand | -0.14 | -0.20 | -0.19 | -0.15 | -0.11 | -0.02 |
| Inventories | -0.03 | -0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| Net exports | -0.03 | 0.02 | 0.07 | 0.07 | 0.06 | 0.02 |
| **Labour market** | *Deviation from baseline levels in %* | | | | | |
| Total employment | -0.08 | -0.11 | -0.09 | -0.07 | -0.05 | 0.01 |
| Employees in employment | -0.10 | -0.14 | -0.12 | -0.09 | -0.06 | 0.02 |
| Unemployment rate [1)] | 0.03 | 0.04 | 0.05 | 0.05 | 0.05 | 0.01 |
| **Household accounts** | *Deviation from baseline levels in %* | | | | | |
| Disposable income | -0.02 | -0.10 | -0.13 | -0.12 | -0.10 | -0.02 |
| Savings rate [1)] | 0.01 | 0.05 | 0.06 | 0.03 | 0.01 | 0.00 |
| **Fiscal ratios** | *Percentage of GDP, absolute deviation from baseline* | | | | | |
| Total receipts | -0.06 | -0.12 | -0.14 | -0.13 | -0.11 | -0.05 |
| Total expenditure | -0.03 | -0.05 | -0.05 | -0.04 | -0.02 | -0.01 |
| Budget deficit | -0.03 | -0.07 | -0.09 | -0.10 | -0.09 | -0.04 |
| Government debt | 0.02 | 0.07 | 0.15 | 0.24 | 0.32 | 0.54 |
| **Interest rates** | *Deviation from baseline in percentage points* | | | | | |
| Short-term interest rate | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Long-term interest rate | 0.16 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 |
| **External developments** | *Deviation from baseline levels in %* | | | | | |
| World demand | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Effective exchange rate | -1.55 | -0.62 | 0.00 | 0.00 | 0.00 | 0.00 |
| Export competitor's prices | -1.55 | -0.62 | 0.00 | 0.00 | 0.00 | 0.00 |

1) Deviation from baseline level in percentage points

## 4. Oil price shock: permanent increase of the oil price by 10%

| | Y1 | Y2 | Y3 | Y4 | Y5 | Y10 |
|---|---|---|---|---|---|---|
| Prices | *Deviation from baseline levels in %* | | | | | |
| HICP | 0.15 | 0.18 | 0.21 | 0.24 | 0.25 | 0.32 |
| Consumption deflator | 0.25 | 0.30 | 0.29 | 0.29 | 0.28 | 0.30 |
| GDP deflator | 0.02 | 0.04 | 0.10 | 0.15 | 0.17 | 0.28 |
| Investment deflator | 0.06 | 0.10 | 0.14 | 0.18 | 0.21 | 0.30 |
| ULC | 0.09 | 0.18 | 0.22 | 0.22 | 0.20 | 0.25 |
| Compensation per employee | 0.05 | 0.12 | 0.15 | 0.15 | 0.16 | 0.22 |
| Productivity | -0.04 | -0.07 | -0.08 | -0.06 | -0.04 | -0.03 |
| Export deflator | 0.01 | 0.02 | 0.05 | 0.07 | 0.09 | 0.17 |
| Import deflator | 0.17 | 0.23 | 0.27 | 0.29 | 0.32 | 0.37 |
| GDP and components | *Deviation from baseline levels in %* | | | | | |
| GDP | -0.09 | -0.16 | -0.17 | -0.13 | -0.09 | -0.02 |
| Consumption | -0.15 | -0.27 | -0.29 | -0.24 | -0.18 | 0.00 |
| Investment | -0.10 | -0.18 | -0.14 | -0.05 | 0.02 | 0.11 |
| Of which: equipment inv. | -0.11 | -0.20 | -0.17 | -0.07 | 0.02 | 0.13 |
| Gov. Consumption | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Exports | 0.00 | 0.00 | -0.01 | -0.02 | -0.02 | -0.05 |
| Imports | -0.12 | -0.16 | -0.15 | -0.10 | -0.06 | 0.05 |
| Contributions to shock | *Deviation from baseline levels in % of baseline GDP* | | | | | |
| Domestic demand | -0.11 | -0.20 | -0.21 | -0.16 | -0.10 | 0.02 |
| Inventories | -0.02 | -0.01 | -0.01 | 0.00 | 0.00 | 0.00 |
| Net exports | 0.04 | 0.06 | 0.05 | 0.03 | 0.01 | -0.04 |
| Labour market | *Deviation from baseline levels in %* | | | | | |
| Total employment | -0.04 | -0.09 | -0.09 | -0.07 | -0.05 | 0.01 |
| Employees in employment | -0.05 | -0.12 | -0.11 | -0.09 | -0.06 | 0.01 |
| Unemployment rate 1) | -0.02 | 0.01 | 0.03 | 0.04 | 0.05 | 0.02 |
| Household accounts | *Deviation from baseline levels in %* | | | | | |
| Disposable income | -0.30 | -0.35 | -0.29 | -0.22 | -0.16 | 0.00 |
| Savings rate 1) | -0.14 | -0.07 | 0.00 | 0.02 | 0.02 | 0.00 |
| Fiscal ratios | *Percentage of GDP, absolute deviation from baseline* | | | | | |
| Total receipts | 0.00 | -0.01 | -0.01 | 0.01 | 0.03 | 0.11 |
| Total expenditure | 0.03 | 0.06 | 0.09 | 0.12 | 0.13 | 0.15 |
| Budget deficit | -0.02 | -0.07 | -0.10 | -0.10 | -0.10 | -0.04 |
| Government debt | 0.01 | 0.06 | 0.15 | 0.24 | 0.34 | 0.58 |
| Interest rates | *Deviation from baseline in percentage points* | | | | | |
| Short-term interest rate | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Long-term interest rate | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| External developments | *Deviation from baseline levels in %* | | | | | |
| World demand | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Effective exchange rate | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Export competitor's prices | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

1) Deviation from baseline level in percentage points

## 5. World demand shock: Increase for demand for Austrian exports by 1% for five years

| | Y1 | Y2 | Y3 | Y4 | Y5 | Y10 |
|---|---|---|---|---|---|---|
| Prices | *Deviation from baseline levels in %* | | | | | |
| HICP | 0.00 | 0.14 | 0.28 | 0.43 | 0.56 | 0.46 |
| Consumption deflator | 0.00 | 0.13 | 0.26 | 0.40 | 0.53 | 0.49 |
| GDP deflator | 0.00 | 0.17 | 0.33 | 0.49 | 0.64 | 0.50 |
| Investment deflator | -0.01 | 0.08 | 0.23 | 0.38 | 0.51 | 0.43 |
| ULC | -0.17 | -0.10 | 0.03 | 0.20 | 0.38 | 0.72 |
| Compensation per employee | 0.00 | 0.09 | 0.22 | 0.38 | 0.54 | 0.66 |
| Productivity | 0.17 | 0.19 | 0.19 | 0.17 | 0.15 | -0.06 |
| Export deflator | 0.00 | 0.07 | 0.16 | 0.25 | 0.33 | 0.34 |
| Import deflator | 0.00 | 0.01 | 0.05 | 0.11 | 0.17 | 0.24 |
| GDP and components | *Deviation from baseline levels in %* | | | | | |
| GDP | 0.29 | 0.40 | 0.47 | 0.50 | 0.50 | -0.05 |
| Consumption | 0.10 | 0.22 | 0.32 | 0.39 | 0.45 | 0.07 |
| Investment | 0.36 | 0.58 | 0.76 | 0.88 | 0.94 | 0.04 |
| Of which: equipment inv. | 0.39 | 0.65 | 0.87 | 1.01 | 1.10 | 0.06 |
| Gov. Consumption | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Exports | 0.63 | 0.88 | 0.93 | 0.93 | 0.91 | -0.10 |
| Imports | 0.34 | 0.53 | 0.69 | 0.80 | 0.87 | 0.12 |
| Contributions to shock | *Deviation from baseline levels in % of baseline GDP* | | | | | |
| Domestic demand | 0.14 | 0.26 | 0.37 | 0.44 | 0.48 | 0.05 |
| Inventories | 0.04 | 0.03 | 0.03 | 0.02 | 0.02 | -0.01 |
| Net exports | 0.10 | 0.11 | 0.08 | 0.03 | 0.00 | -0.10 |
| Labour market | *Deviation from baseline levels in %* | | | | | |
| Total employment | 0.11 | 0.21 | 0.28 | 0.32 | 0.35 | 0.00 |
| Employees in employment | 0.15 | 0.27 | 0.35 | 0.41 | 0.44 | 0.01 |
| Unemployment rate 1) | -0.03 | -0.07 | -0.12 | -0.16 | -0.20 | -0.09 |
| Household accounts | *Deviation from baseline levels in %* | | | | | |
| Disposable income | 0.21 | 0.31 | 0.40 | 0.47 | 0.52 | 0.06 |
| Savings rate 1) | 0.08 | 0.07 | 0.05 | 0.03 | 0.05 | -0.01 |
| Fiscal ratios | *Percentage of GDP, absolute deviation from baseline* | | | | | |
| Total receipts | 0.06 | 0.17 | 0.27 | 0.35 | 0.44 | 0.24 |
| Total expenditure | 0.03 | 0.07 | 0.12 | 0.17 | 0.21 | 0.09 |
| Budget deficit | 0.04 | 0.10 | 0.15 | 0.18 | 0.23 | 0.14 |
| Government debt | -0.02 | -0.09 | -0.21 | -0.37 | -0.57 | -1.42 |
| Interest rates | *Deviation from baseline in percentage points* | | | | | |
| Short-term interest rate | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Long-term interest rate | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| External developments | *Deviation from baseline levels in %* | | | | | |
| World demand | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.00 |
| Effective exchange rate | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Export competitor's prices | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

1) Deviation from baseline level in percentage points

## 6. Comparison of simulations properties of different models for Austria (deviations from baseline levels in % after three years)

| | GDP | Consumption deflator |
|---|---|---|
| Government spending shock | | |
| AT-OeNB 2006 | 1.88 | 1.22 |
| AT-OeNB 2005 | 1.48 | 1.02 |
| AT-OeNB 2002 | 1.38 | 1.10 |
| AT-WIFO | 1.31 | 0.34 |
| AT-IAS | 1.56 | 0.72 |
| EU-12 | 1.12 | 0.83 |
| Exchange rate shock | | |
| AT-OeNB 2006 | 0.08 | 0.10 |
| AT-OeNB 2002 | 0.23 | 0.22 |
| EU-12 | 0.13 | 0.15 |
| Monetary policy shock [a)] | | |
| AT-OeNB 2006 | -0.19 | -0.17 |
| AT-OeNB 2005 | -0.19 | -0.11 |
| AT-OeNB 2002 | -0.29 | -0.17 |
| AT-WIFO | -0.07 | 0.07 |
| AT-IAS | -0.07 | -0.01 |
| EU-12 | -0.35 | -0.22 |
| Oil price shock | | |
| AT-OeNB 2006 | -0.17 | 0.21 |
| AT-OeNB 2002 | -0.02 | 0.20 |
| EU-12 | -0.12 | 0.22 |
| World demand shock | | |
| AT-OeNB 2006 | 0.47 | 0.28 |
| AT-OeNB 2005 | 0.32 | 0.22 |
| AT-OeNB 2002 | 0.28 | 0.15 |
| AT-WIFO | 0.55 | 0.10 |
| AT-IAS | 0.85 | 0.29 |
| EU-12 | 0.40 | 0.20 |

a) Results after two years

AT-OeNB 2006 … current version of the Austrian model

AT-OeNB 2005 … 2005 version of the Austrian model (Fenz and Spitzer, 2005)

AT-OeNB 2002 … 2002 version of the Austrian model (Fagan and Morgan, 2005)

AT-WIFO … WIFO macromodel (Baumgartner et al., 2005)

AT-IAS … Macromodel of Institute for Advanced Studies (LIMA, Hofer and Kunst, 2005)

EU-12 … Average reaction of euro area country models (Fagan and Morgan, 2005)

# Index of Working Papers:

| | | | |
|---|---|---|---|
| July 11, 2005 | Claudia Kwapil, Josef Baumgartner, Johann Scharler | 100 | The Price-Setting Behavior of Austrian Firms: Some Survey Evidence |
| July 25, 2005 | Josef Baumgartner, Ernst Glatzer, Fabio Rumler, Alfred Stiglbauer | 101 | How Frequently Do Consumer Prices Change in Austria? Evidence from Micro CPI Data |
| August 8, 2005 | Fabio Rumler | 102 | Estimates of the Open Economy New Keynesian Phillips Curve for Euro Area Countries |
| September 19, 2005 | Peter Kugler, Sylvia Kaufmann | 103 | Does Money Matter for Inflation in the Euro Area? |
| September 28, 2005 | Gerhard Fenz, Martin Spitzer | 104 | AQM – The Austrian Quarterly Model of the Oesterreichische Nationalbank |
| October 25, 2005 | Matthieu Bussière, Jarko Fidrmuc, Bernd Schnatz | 105 | Trade Integration of Central and Eastern European Countries: Lessons from a Gravity Model |
| November 15, 2005 | Balázs Égert, László Halpern, Ronald MacDonald | 106 | Equilibrium Exchange Rates in Transition Economies: Taking Stock of the Issues |
| January 2, 2006 | Michael D. Bordo, Peter L. Rousseau (comments by Thorvaldur Gylfason and Pierre Siklos) | 107 | Legal-Political Factors and the Historical Evolution of the Finance-Growth Link |
| January 4, 2006 | Ignacio Briones, André Villela (comments by Forrest Capie and Patrick Honohan) | 108 | European Banks and their Impact on the Banking Industry in Chile and Brazil: 1862 - 1913 |
| January 5, 2006 | Jérôme Sgard (comment by Yishay Yafeh) | 109 | Bankruptcy Law, Creditors' Rights and Contractual Exchange in Europe, 1808-1914 |

| | | | |
|---|---|---|---|
| January 9, 2006 | Evelyn Hayden, Daniel Porath, Natalja von Westernhagen | 110 | Does Diversification Improve the Performance of German Banks? Evidence from Individual Bank Loan Portfolios |
| January 13, 2006 | Markus Baltzer (comments by Luis Catão and Isabel Schnabel) | 111 | European Financial Market Integration in the Gründerboom and Gründerkrach: Evidence from European Cross-Listings |
| January 18, 2006 | Michele Fratianni, Franco Spinelli (comments by John Driffill and Nathan Sussman) | 112 | Did Genoa and Venice Kick a Financial Revolution in the Quattrocento? |
| January 23, 2006 | James Foreman-Peck (comment by Ivo Maes) | 113 | Lessons from Italian Monetary Unification |
| February 9, 2006 | Stefano Battilossi (comments by Patrick McGuire and Aurel Schubert) | 114 | The Determinants of Multinational Banking during the First Globalization, 1870-1914 |
| February 13, 2006 | Larry Neal | 115 | The London Stock Exchange in the 19th Century: Ownership Structures, Growth and Performance |
| March 14, 2006 | Sylvia Kaufmann, Johann Scharler | 116 | Financial Systems and the Cost Channel Transmission of Monetary Policy Shocks |
| March 17, 2006 | Johann Scharler | 117 | Do Bank-Based Financial Systems Reduce Macroeconomic Volatility by Smoothing Interest Rates? |
| March 20, 2006 | Claudia Kwapil, Johann Scharler | 118 | Interest Rate Pass-Through, Monetary Policy Rules and Macroeconomic Stability |
| March 24, 2006 | Gerhard Fenz, Martin Spitzer | 119 | An Unobserved Components Model to forecast Austrian GDP |
| April 28, 2006 | Otmar Issing (comments by Mario Blejer and Leslie Lipschitz) | 120 | Europe's Hard Fix: The Euro Area |

| | | | |
|---|---|---|---|
| May 2, 2006 | Sven Arndt (comments by Steve Kamin and Pierre Siklos) | 121 | Regional Currency Arrangements in North America |
| May 5, 2006 | Hans Genberg (comments by Jim Dorn and Eiji Ogawa) | 122 | Exchange-Rate Arrangements and Financial Integration in East Asia: On a Collision Course? |
| May 15, 2006 | Petra Geraats | 123 | The Mystique of Central Bank Speak |
| May 17, 2006 | Marek Jarociński | 124 | Responses to Monetary Policy Shocks in the East and the West of Europe: A Comparison |
| June 1, 2006 | Josef Christl (comment by Lars Jonung and concluding remarks by Eduard Hochreiter and George Tavlas) | 125 | Regional Currency Arrangements: Insights from Europe |
| June 5, 2006 | Sebastian Edwards (comment by Enrique Alberola) | 126 | Monetary Unions, External Shocks and Economic Performance |
| June 9, 2006 | Richard Cooper<br><br>Michael Bordo and Harold James<br><br>(comment on both papers by Sergio Schmukler) | 127 | Proposal for a Common Currency among Rich Democracies<br><br>One World Money, Then and Now |
| June 19, 2006 | David Laidler | 128 | Three Lectures on Monetary Theory and Policy: Speaking Notes and Background Papers |
| July 9, 2006 | Ansgar Belke, Bernhard Herz, Lukas Vogel | 129 | Are Monetary Rules and Reforms Complements or Substitutes? A Panel Analysis for the World versus OECD Countries |
| August 31, 2006 | John Williamson (comment by Marc Flandreau) | 130 | A Worldwide System of Reference Rates |

| | | | |
|---|---|---|---|
| September 15, 2006 | Sylvia Kaufmann, Peter Kugler | 131 | Expected Money Growth, Markov Trends and the Instability of Money Demand in the Euro Area |
| September 18, 2006 | Martin Schneider, Markus Leibrecht | 132 | AQM-06: The Macroeconomic Model of the OeNB |