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AQM
The Austrian Quarterly Model of the Oesterreichische Nationalbank

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Abstract

The modeling strategy of the Austrian Quarterly Model (AQM) is in the tradition of the "neoclassical synthesis", a combination of Keynesian short-run analysis and neo-classical long-run analysis. The short run dynamics are based on empirical evidence, the long-run relationships are derived from a neoclassical optimization framework. Adjustment processes to the real equilibrium are sluggish. Imperfections on goods and labor markets typically prevent the economy to adjust instantaneously to the long-run equilibrium. In the current version of the AQM the formation of expectations is strictly backward looking. The relatively small scale of the model keeps the structure simple enough for projection and simulation purposes, while incorporating a sufficiently detailed structure to capture the main characteristics of the Austrian economy. The main behavioral equations are estimated using the two-step Engle-Granger technique. The AQM constitutes the Austrian block of the ESCB multi-country model (MCM).

1. Introduction

Traditionally, the range of econometric models used by a central bank consists of a set of time series models for short-term assessments, calibrated theoretical models, and traditionally estimated structural models. The present paper deals with the last but currently at the OeNB most frequently used element of this range, the Austrian Quarterly Model (AQM). At the same time, the model constitutes one of the building blocks of the Multi-Country-Model (MCM) of the European System of Central Banks (ESCB). The purpose of the AQM is twofold. First, it is used in

preparing macroeconomic projections for the Austrian economy, published twice a year in June and December. Second, in scenario analysis the effects of economic shocks on the Austrian economy are simulated. The specification of the AQM is not fixed. The equations are frequently reviewed in the light of new data, information and research.

The model shares the general features of the modeling strategy of the Multi-Country Model (MCM). One element of this strategy involves the decision to build a relatively small-scale model to keep the structure simple enough for projection and simulation purposes while incorporating a sufficiently detailed structure to capture the main characteristics of the Austrian economy. Another element of the modeling strategy is to embody the "neoclassical synthesis", a combination of Keynesian short-run analysis and neoclassical long-run analysis popularized by Samuelson (1967). More precisely, the short run dynamics are estimated to conform to empirical evidence, while the long-run relationships are derived from theoretical optimization. An aggregate neoclassical production function is the central feature of the long-run behavior with a vertical supply curve. The neoclassical relationships ensure that the long-run real equilibrium is determined by available factors of production and technological progress. Therefore real output growth in the long run is independent both of the price level and of inflation. Imperfections in the markets for goods and labor prevent the economy from returning instantaneously to the long-run equilibrium. Thus, the economy converges slowly towards its equilibrium in response to economic shocks. Simulation exercises with the AQM typically show that the adjustment process is rather long, reflecting past experience in the Austrian economy and the fact that expectations formation is strictly backward-looking in the current version of the model. Extensions to include forward-looking elements in the price and wage block are straightforward.

A typical macroeconomic model for an economy with an independent monetary policy incorporates a monetary policy rule. By choosing a target level for a nominal anchor this rule ensures a nominal equilibrium by defining an appropriate feedback rule for nominal interest rates. Typical examples for nominal target variables are price levels or more recently, inflation rates. As long as monetary aggregates are not targeted by interest rate rules, there is no specific role for money in this kind of models. Thus, monetary aggregates typically influence neither output nor prices. Assuming that the velocity of money is constant, money supply can be thought of moving in line with nominal GDP. Since Austria is part of the euro area and monetary policy decisions are based on an assessment of euro-area-wide conditions, a national interest rate rule is not appropriate. Thus, interest rates are typically kept exogenous in projection and simulation exercises. The model incorporates a fiscal policy rule along a public debt criterion of 50% of GDP. However, in most cases fiscal policy is assumed to be exogenous and the fiscal

closure rule is not activated and only standard automatic fiscal stabilizers are at work.

Further important features of the AQM follow from the main behavioral equations. The long run equilibrium levels of the three main variables – investment, employment, and the GDP-deflator at factor costs – are determined simultaneously in the neoclassical supply block. The coefficients of the production function were estimated treating the supply block as a nonlinear system. The equilibrium level of investment depends on output and relative factor costs. The long-run employment equilibrium is defined by the inverse of the production function. The GDP deflator at factor costs, the key price variable, is set as mark-up over marginal costs. Foreign prices enter the model via import prices. In the long run, real wages are set in line with productivity while the short run dynamics are characterized by a Phillips curve relationship. Consistent with the permanent-income hypothesis, private consumption is a function of real disposable household income and real wealth in the long-run. Nominal short-term interest rates also determine the equilibrium level of consumers' expenditures, capturing substitution effects and credit constraints. Consumption is not further disaggregated into durables and non-durables due to data constraints. Finally, foreign trade is determined by measures of world demand, domestic demand, and competitiveness.

The main behavioral equations are estimated using the two-step Engle-Granger technique. Long-run relationships are estimated in levels and then enter the dynamic equations as error-correction terms. The simulation and projection features of the AQM are driven by 38 behavioral equations. An additional 107 equations contain linking relationships, identities and transformations to ensure consistency and a sufficiently detailed analysis. Overall 217 variables enter the model.

The paper is organized as follows. In section 2 the theoretical background and the estimation results of the supply block which determine the long-run equilibrium of the model are presented. Section 3 gives a bird eye view of the AQM-structure. Sections 4 to 6 deal with the main behavioral equations of the AQM. We start with the demand components of real GDP private consumption, investment, foreign trade and stocks. Then the estimation results for the labor market, i.e. employment and the labor force, are presented. Finally the price block concludes the presentation of the main behavioral equations. In section 7 the steady state properties of the AQM are described and illustrated by two long-run simulations. Finally in section 8 results for three standard short run simulation exercises – a fiscal policy, a monetary policy and a world demand shock – are discussed.

2. Theoretical Background and the Supply Block

Consistent with the neoclassical framework, the long-run aggregate supply curve is assumed to be vertical and the long-run equilibrium is solely supply driven. The

economy is assumed to produce a single good (YER). The technology is described by a standard constant-returns-to-scale Cobb-Douglas production function with two input factors, capital (KSR) and labor (LNN). Technological progress is exogenously given at a constant rate (γ) and enters in the usual labor-augmenting or Harrod-neutral manner. The long-run properties of the model can be derived by standard static optimization techniques. A representative firm maximizes profits (π) given the technology constraints:

$$\max \pi(YER, LNN, KSR) = YFD \cdot YER - WUN \cdot LNN - CC0 \cdot KSR$$
$$s.t. \quad YER = \alpha \cdot KSR^{\beta} \cdot LNN^{1-\beta} \cdot e^{(1-\beta)\cdot\gamma\cdot T}$$

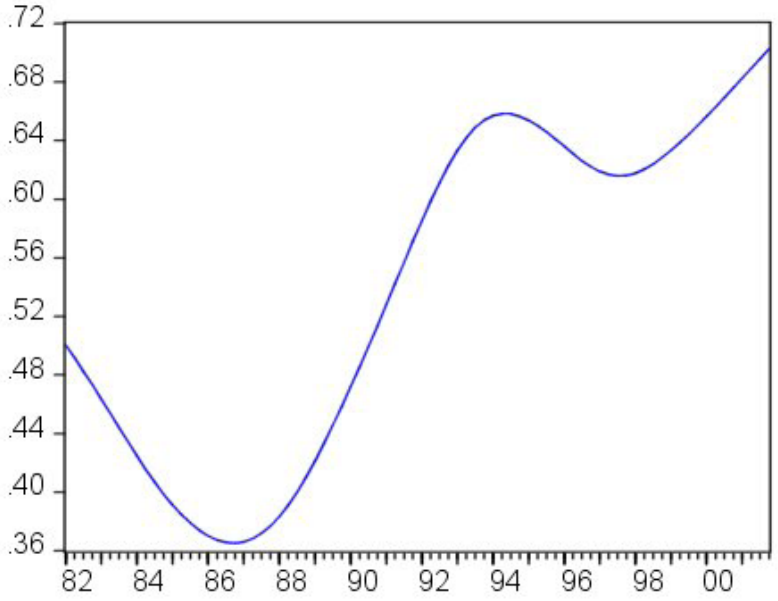
where YFD denotes the price level, WUN the wage rate, CCO the user cost of capital, α a scale parameter, β a technology parameter and T a time index. For estimation purposes we use seasonally-adjusted quarterly ESA95 data for employment, GDP, the GDP deflator and compensation to employees (as a measure of labor income). Quarterly ESA95 data are only available from 1988Q1. In order to extend the data to 1980Q1, we used growth rates from ESA79 data. This procedure causes a break in some time series around 1988 and made it necessary to introduce shift dummies in certain equations. Data for the gross capital stock were provided by Statistik Austria. Employment data include both employees and the self-employed, whereas our measure of labor income includes only employees. Therefore we used compensation per employee as a proxy for the "wages" of the self-employed to calculate total labor income. The real user cost of capital is defined as the sum of the real interest rate, the depreciation rate, and a risk premium:

$$\frac{CC0}{ITD} = \frac{LTI}{400} - infl + \delta_{KSR} + RP$$

where ITD denotes the investment deflator, LTI long-term interest rates, infl the inflation rate, δ_{KSR} the depreciation rate and RP the risk premium. The inflation rate is defined as a moving average of changes in the investment deflator over the current and the past four quarters. The risk premium is provided by the trend component of the difference between the marginal product of capital and the sum of the real interest rate and the average depreciation. The average risk premium is slightly above 0.5% per quarter and shows an increasing trend during the nineties (see chart 1). Solving the profit maximization problem of the firm leads to equations defining the static steady-state levels of prices, employment and capital, which enter the dynamic model specification via ECM-terms. The three equations were estimated as a system.

Initial estimation results indicated residual non-stationarity caused by two different data problems. First, the sample combines two data sets calculated according to different national account systems (ESA79 and ESA95). In order to address this problem, we introduced a shift dummy (D_884) running from 1980 to 1988. Secondly, since quarterly data for full-time equivalents are not available, we initially used unadjusted employment figures. As part-time employment is growing in importance, especially among the self-employed, this may also distort the estimators. Thus, we interpolated annual data for full-time equivalents using a cubic spline and constructed an employment series adjusted for full-time equivalents. Both modifications (introduction of dummies and adjustment for full-time equivalents) strongly improved the estimation results.

Chart 1: Risk Premium[1]



Finally, we introduced a permanent dummy starting in 1996Q1 in the price equation. This period was influenced by the accession to the European Union and characterized by a nationwide agreement to wage moderation. Incorporating the dummies mentioned above, the profit function becomes

[1] All numbers of charts and tables in this paper are based on authors' calculations.

$$\pi\left(\left(YER+\delta\cdot D_{884}\right),LNN^{FE},KSR\right)= \\ YFD\cdot\left(YER+\delta\cdot D_{884}\right)-WUN^{FE}\cdot LNN^{FE}-CC0\cdot KSR \tag{1}$$

The new profit maximization problem of the representative firm is given by:

$$\max_{LNN^{FE},KSR} \quad \pi\left(\left(YER+\delta\cdot D_{884}\right),LNN^{FE},KSR\right) \\ s.t. \quad \left(YER+\delta\cdot D_{884}\right)=\alpha\cdot KSR^{\beta}\cdot\left(LNN^{FE}\right)^{1-\beta}\cdot e^{(1-\beta)\cdot\gamma\cdot T} \tag{2}$$

This leads to the following system of equations for prices, employment and capital stock:

$$\ln(\mathrm{YFD}) = \ln(\eta)+\ln(\mathrm{WUN}^{\mathrm{FE}})-\gamma\cdot\mathrm{T}+\frac{\beta}{1-\beta}\cdot\ln\left(\frac{\mathrm{YER}+\delta\cdot\mathrm{D}_{884}}{\mathrm{KSR}}\right) \\ -\ln(1-\beta)-\frac{\ln(\alpha)}{1-\beta})-\ln(1-\mathrm{TIX})+\varepsilon\cdot\mathrm{D}_{961\mathrm{P}} \tag{3}$$

$$\ln(\mathrm{LNN}^{\mathrm{FE}}) = \ln(\mathrm{YER}+\delta\cdot\mathrm{D}_{884})-\beta\cdot\ln\left(\frac{\mathrm{KSR}}{\mathrm{LNN}^{\mathrm{FE}}}\right)-\ln(\alpha)-(1-\beta)\cdot\gamma\cdot\mathrm{T} \tag{4}$$

$$\ln(\mathrm{KSR}) = (1-\beta)\cdot\left[\begin{array}{c}-\ln(\mathrm{CC0})+\ln(\mathrm{WUN}^{\mathrm{FE}})-\gamma\cdot\mathrm{T}+\frac{1}{1-\beta}\cdot\ln(\mathrm{YER}+\delta\cdot\mathrm{D}_{884}) \\ +\ln\left(\frac{\beta}{1-\beta}\right)-\ln\left(\frac{\alpha}{1-\beta}\right)\end{array}\right] \tag{5}$$

YFD denotes the GDP deflator, η the mark-up, $\mathrm{WUN}^{\mathrm{FE}}$ the nominal wage per full time equivalent , YER real GDP, KSR the real capital stock, TIX the effective indirect tax rate, $\mathrm{LNN}^{\mathrm{FE}}$ total employment adjusted for full time equivalents, CCO the nominal user costs of capital, α the scale parameter in the production function, β the output elasticity of capital and γ the technological progress. According to equation (3) the GDP-deflator after indirect taxes is determined by a mark-up (η), wages and the output to capital ratio which should be constant in the long-run. Employment depends on the inverse of the production function (equation (4)) and the capital stock on relative factor costs and output (see equation (5)). The equations of the supply block have been estimated simultaneously as a system. The estimation results are reported in table 1. Firms are assumed to have a certain market power and fix their prices above marginal costs. The estimator of the mark

up (η) is slightly smaller than one (0.91) indicating that the risk premium captures all capital costs beyond the real interest rate and the depreciation of the capital stock. The output elasticity of capital is estimated to be 0.367, the scale parameter α equals 1.70 and the technological progress parameter γ is 0.0042 which implies an annual exogenous growth of 1.1%.

The residuals of the supply-side equations are shown in (chart 2), the optimal or desired equilibrium levels, labeled as "STAR" variables, in (chart 3). While the optimal values for employment and prices follow actual data quite closely, the optimal capital stock is much more volatile. This arises from the fact that the desired capital stock reacts very sensitive to changes in the user costs of capital. Therefore, in simulation exercises changes in interest and/or inflation rates typically have a strong impact on investments.

Table 1: Estimated Coefficients of the Supply Block

Coefficient	Estimate	Std Error	T-Stat
η	0.91	0.0066	138.5
β	0.37	0.0057	64.6
α	1.70	0.043	39.7
γ	0.0042	0.0002	24.6
δ	1249.7	205.3	6.1
ε	0.04	0.0055	7.3
Phillips-Perron test statistic with 8 Lags: Equation 3: −5.05323 Equation 4: −4.65435 Equation 5: −2.07279			

The residuals of the supply-side equations, i.e. the deviations of actual from desired levels, enter the dynamic specifications of the equations for the GDP-deflator at factor costs, for employment and for investment as error correction terms.

Chart 2: Residuals from the Supply Block

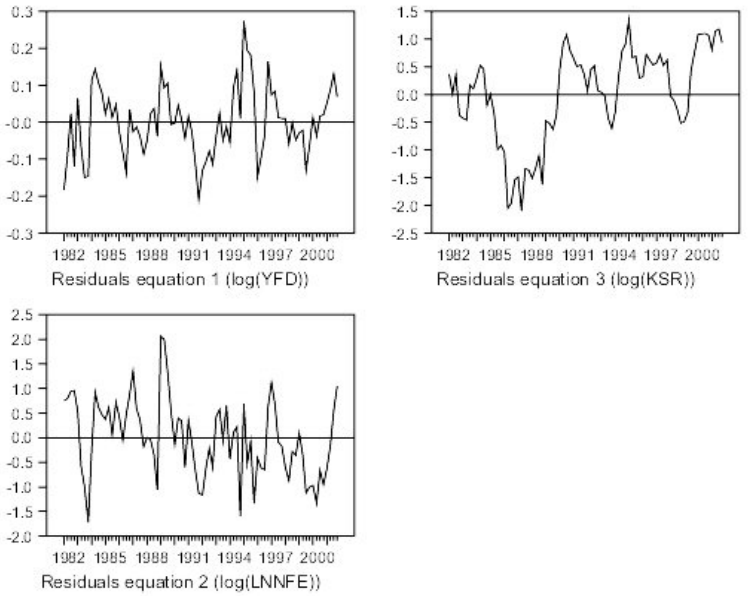


Chart 3: Actual and Optimal Values from the Supply Block

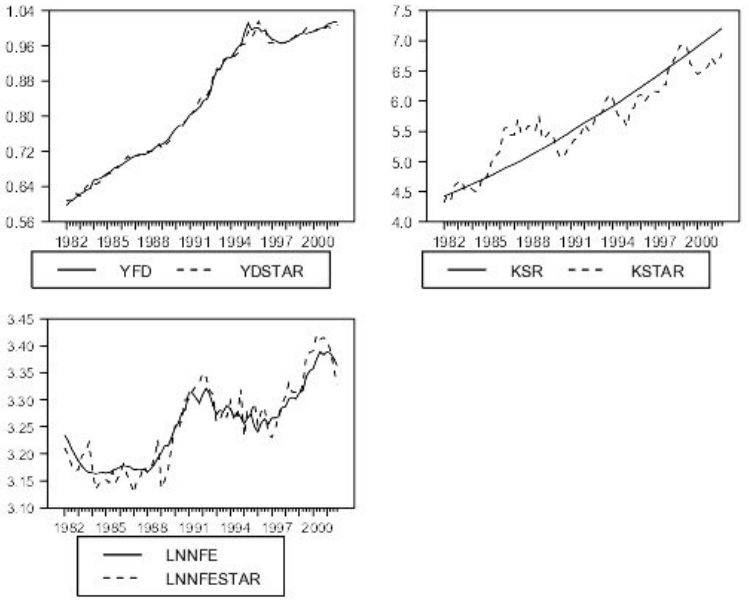
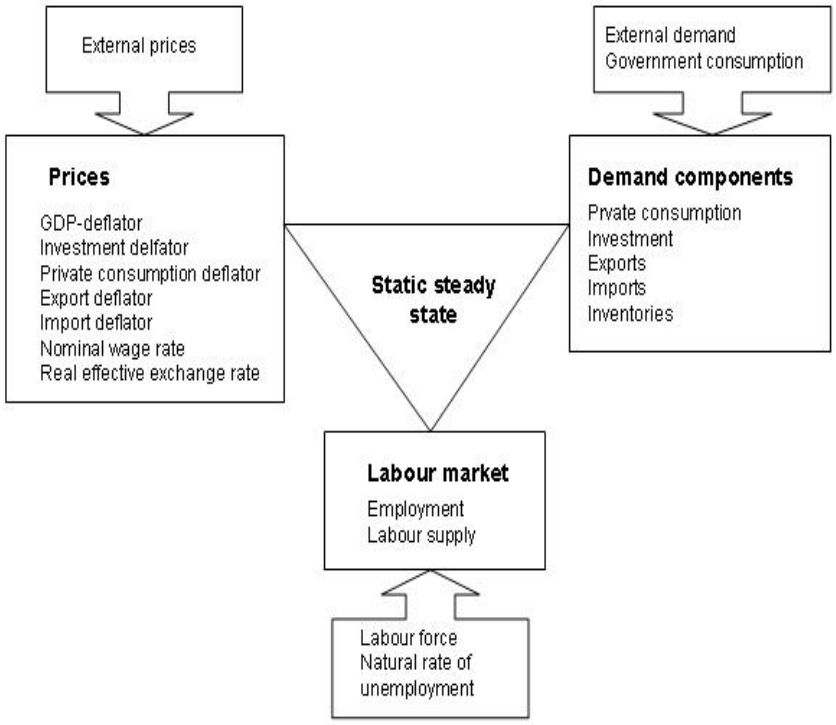


Chart 4: An Overview of the AQM Structure



3. The AQM-Structure

The theoretical foundations of the AQM were outlined in the previous section. The long-run equilibrium is determined in a static optimization framework leading to three steady state equations for the GDP deflator at factor costs, the capital stock (investments) and employment.

Within this theoretical framework the overall structure of the AQM becomes already apparent. The model consists of three major building blocks: prices, output and the labor market (see chart 4) for a graphical illustration of the model structure). The static steady state framework links these three building blocks. It determines how in the long-run changes in output feed into prices and labor demand, how changes in relative factor costs influence investment activity, output

and employment and how changes in employment trigger adjustments of prices and the capital stock.

The overall structure of the AQM is of course more complex and involves many other variables. Within the output block the crucial demand components are investment activity, private consumption, exports, imports and inventories. The price block includes the deflators for private consumption, investment, exports and imports, the nominal wage rate and the real effective exchange rate. In the labor market block the level of employment and labor supply are determined. The unemployment rate which is at its natural rate in the long only is decisive for adjustment processes in the short run. Additionally, important variables enter the AQM as exogenous components. Concerning external prices this regards nominal exchange rates, competitors' prices on the import and export side and oil and non-oil commodity prices. Interest rates are exogenous and typically held constant in simulation and forecast exercises in order to derive forecasts and simulation results for policy makers under the assumption of no monetary policy change. Also a great deal of the government sector including several tax rates and government consumption are exogenously given. Finally demand for Austrian exports is independent of domestic developments as is typically the case for small open economies.

Various transmission channels between the three building blocks and the exogenous variables have to be taken into account. Although this list is by far not complete, such mechanisms are: The affection of the disposable income of households by wages and employment. The unemployment rate triggers via the Philips curve changes in the wage rate and determines the amount of transfers paid to households. Changes in prices and interest rates cause substitution and wealth effects. Investments are sensitive to the user costs of capital. The size of exports and imports depends on the international price competitiveness of the exposed sector. Output and employment feed back via productivity on wages and prices. Moreover important transmission mechanisms appear directly between variables within building blocks. Examples are the accelerator mechanism in the case of investments, the pro-cyclical behavior of labor supply or interdependencies between wages, domestic prices and import prices.

In order to get a broad idea of the key equations, single equation responses to shocks are reported in table 2. The shocks typically constitute 10% increases in one of the explanatory variables. The dynamic specifications of the key equations incorporate the long-run behavior as error correction terms. The speed of adjustment in the single equation simulations is strongly determined by the loading factors of the error correction terms in the dynamic specifications which are listed in table 2.

The loading factors of the ECM-terms are typically around 10% implying that in single equation simulations about one third of a disequilibrium are dissolved within the first year. The speed of adjustment is significantly lower in case of

Table2: Single Equation Responses to 10% Shocks of Explanatory Variables

Endogenous variable Shocked exogenous variables	Year 1	Year 2	Year 3	Year 5	Year 10	ECM-coefficient
Private consumption						–0.094
Disposable income	2.32	6.00	7.65	8.85	9.22	
Financial wealth	0.05	0.34	0.53	0.67	0.71	
Long-term interest rates (+100bp)	–0.05	–0.29	–0.45	–0.57	–0.60	
Investment						–0.051
Output	12.5	15.50	15.00	12.6	10.3	
Wage rate	0.46	1.82	3.10	4.78	6.03	
User cost of capital	–0.45	–1.78	3.01	–4.56	5.69	
Exports						–0.226
World demand	8.50	9.39	9.72	9.94	10.00	
Export prices	–3.03	–3.27	–3.45	–3.57	–3.59	
Competitors' prices	3.10	3.36	3.54	3.67	3.70	
Imports						–0.355
Domestic demand	9.70	10.30	10.00	10.00	10.00	
Import prices	–6.03	–8.32	–8.63	–8.69	–8.69	
Oil prices	0.22	0.46	0.50	0.50	0.50	
GDP deflator at factor costs	6.09	8.35	8.67	8.71	8.71	
Employment						–0.112
Output	3.00	5.70	7.90	11.00	14.70	
Wage rate	–1.53	–1.40	–1.10	–0.68	–0.20	
GDP deflator at factor costs						–0.137
Output	0.69	2.64	3.87	5.05	5.64	
Indirect taxes to GDP ratio	0.13	0.57	0.84	1.05	1.19	
Wage rate	4.04	7.12	8.29	9.40	9.96	
Private consumption deflator						–0.117
GDP deflator at factor costs	6.98	7.72	8.17	8.61	8.85	
Import deflator	1.27	1.18	1.12	1.07	1.04	
Investment deflator						–0.412
GDP deflator at factor costs	8.04	8.26	8.29	8.29	8.29	
Import deflator	1.79	1.66	1.59	1.58	1.58	
Import deflator						–0.229
Competitors' prices	3.29	4.91	5.43	5.65	5.67	
GDP deflator at factor costs	1.14	2.85	3.39	3.62	3.63	
Oil prices	0.44	0.44	0.43	0.43	0.43	
Export deflator						–0.127
Competitors' prices	1.67	2.84	3.39	3.86	4.06	
GDP deflator at factor costs	3.35	4.97	5.30	5.58	5.70	
Nominal wage rate						–0.110
Private consumption deflator	0.00	2.57	6.24	9.36	10.00	
Labor productivity	2.95	5.29	7.67	9.61	10.00	
Unemployment rate	–0.02	–0.23	–0.43	–0.58	–0.61	

investments as the ECM term is formulated with respect to the optimal capital stock which is rather volatile (see chart 2). In the short run accelerator effects cause an overshooting of investment with respect to output. Higher than average are the loading factors in the export and import equations indicating that changes in demand and competitiveness pass through quickly to trade flows. Effects of changes in the wage rate on employment are only significant in the short run. Since the wage rate does not enter the optimal employment level directly effects are fading out over time in single equation simulations.

Table 3: Estimation of Transfers Received in % of GDP

$TRX_t = C(1) + C(2)\cdot(URX_t) + res_t^{TRX}$				
	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.224754	0.002003	112.2091	0.0000
C(2)	0.005469	0.000602	9.092174	0.0000
R-squared:	0.502027	Durbin-Watson stat:		0.296245

4. Estimation of Demand Components

4.1 Private Consumption

Households' consumption behavior is mainly determined by disposable income and financial wealth. Nominal financial wealth plays a crucial role in determining the stock-flow relations in the AQM. Under the assumption that households own all firms in the economy, it can be shown that a disaggregation of financial wealth into assets of the household sector, the government sector, the corporate sector and the foreign sector is not necessary (see William and Estrada, 2002). Financial wealth of the total economy is identical to financial wealth of the household sector and defined as the sum of the private capital stock (KSN), government debt (GDN) and net foreign assets (NFA):

$$FWN_t = KSN_t + GDN_t + NFA_t \tag{6}$$

Nominal disposable income is given by the sum of compensation to employees (WIN), other personal income (OPN) and transfers received by households (TRN) minus transfers (TPN) and direct taxes (PDN) paid by households:

$$PYN_t = WIN_t + OPN_t + TRN_t - TRP_t - PDN_t \tag{7}$$

Transfers and direct taxes paid by households are assumed to be proportional to nominal GDP during the forecasting horizon. For long-run simulations a fiscal rule prevents an unlimited increase of government debt. Transfers received by households (TRX denotes the ratio of transfers received by households to nominal GDP) are a function of the unemployment rate. An increase in the unemployment rate according to the EUROSTAT definition by 1 pp causes additional transfers to households of about 0.5% of nominal GDP (see table 3).

Compensations to employees are determined by wages and employment (see sections 5.1 and 6.2). Growth of other personal income (i.e. gross mixed income and property income) depends in the long-run on the gross operating surplus (GON), minus the depreciation of the capital stock (KSN·depr) and wealth income out of liquid assets (LTI/400·0.23·FWN).[2] While income effects of interest rate changes are captured in the equation for other personal income, substitution effects are modeled in the long-run equation for private consumption (see table 5). The short run dynamics of other personal income are only driven by changes of the gross operating surplus. As sectoral National Accounts data for other personal income are only available on an annual basis the equation is estimated in annual growth rates (see table 4).

Table 4: Estimation of other Personal Income

$\Delta_4 \ln(OPN_t) = C(1)\cdot(1/4)\cdot\sum_{i=1}^{4}(\ln(OPN_{t-i}) - \ln(GON_{t-i} - KSN_{t-i}\cdot depr + LTI_{t-i}/400\cdot 0.23\cdot FWN_{t-i})) + C(2)\cdot\Delta_4\ln(GON_t) + res_t^{OPN}$

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	–0.068575	0.041099	–1.668515	0.0991
C(2)	0.728521	0.105224	6.923521	0.0000
R-squared:	0.193119		Durbin-Watson stat:	0.419010

The long-run behavior of private consumption is based on the concept of permanent income. Given backward looking behavior by households permanent income can be approximated by current disposable income and wealth. Combining ESA95 with ESA79 data caused major problems in estimating the private consumption equation, so the sample was restricted to 1989Q1 to 2001Q4. This

[2]The share of liquid assets of households in total nominal wealth equals 0.23.

period is characterized by a pronounced decline in the household savings ratio from well above 10% to just above 5%. Although the savings ratio is subject to frequent and major revisions, these usually concern only the absolute level and not changes in the savings ratio. The decline can only be partly explained by the rise in the wealth-to-income ratio and probably reflects changes in household habits and preferences. In order to capture this shift in preferences, a negative trend was introduced in the long-run consumption equation.

The bulk of financial wealth are illiquid assets. Liquid assets amount to about one fourth of total assets. Using a weighted average of liquid and illiquid assets yields an adjusted wealth variable which corresponds to one third of the original series. This results in a reasonable asset-to-income ratio of about 2, in line with other international studies (see Muellbauer and Lattimore, 1995). Finally, real interest rates were allowed to enter the long-run specification of the consumption equation capturing substitution effects and liquidity constraints. Estimates of the long-run consumption equation indicate an average household savings ratio of 7.5%. The trend and the interest rates enter the equation with the expected negative coefficients (see table 5). Wealth effects appear in the long-run equation but are limited in size.

Table 5: Estimation of Long-run Consumption

$\ln(CSTAR_t) = C(1)\cdot\ln(PYR_t) + (1 - C(1))\cdot(0.23)\cdot\ln(FWR_t/4) + C(2)\cdot(10/Time) + C(3)\cdot(LTI_t/100)$

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.925828	0.008394	110.3019	0.0000
C(2)	–0.661674	0.082358	–8.03413	0.0000
C(3)	–0.607803	0.228308	–2.66220	0.0107
R-squared:	0.872928	Durbin-Watson stat:	0.900179	

In the dynamic specification for real private consumption the ECM term is significant with a lag of two periods. Furthermore, changes in real disposable income and an autoregressive term serve as explaining variables in the short run. Lagged growth in real private consumption captures consumer habits which offer an explanation for observed "excess smoothness" (see table 6).

Table 6: Estimation of Real Private Consumption

$\Delta \ln(PCR_t) = C(1) + C(2)\cdot(\ln(PCR_{t-2}/CSTAR_{t-2})) + C(3)\cdot\Delta\ln(PYR_{t-1}) + C(4)\cdot\Delta\ln(PCR_{t-1}) + res_t^{PCR}$

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.003444	0.000890	3.871969	0.0004
C(2)	–0.094520	0.046460	–2.03443	0.0481
C(3)	0.191638	0.050607	3.786783	0.0005
C(4)	0.263034	0.128457	2.047647	0.0467
R-squared:	0.312365	Durbin-Watson stat:	2.030268	

4.2 Investment

Modeling investment in Austria raised the well-known difficulties encountered elsewhere. Deviations of current from optimal capital stock led to poorly determined coefficients and implausible simulation results, so we used the ratio of the previous period's investment to the optimal capital stock as the ECM term. The optimal capital stock has been estimated separately in the supply block of the model. In the steady state the capital stock and real GDP must grow at the same pace (g_{STAR}) to ensure that the capital to GDP ratio remains constant over time as is typically the case in neoclassical growth models. Given a constant capital to GDP ratio, a constant investment share in GDP and a constant depreciation rate (depr), the investment to capital stock ratio converges to a constant which equals the steady state growth rate plus the depreciation rate of real capital:

$$\frac{ITR_t}{KSTAR_{t-1}} = g_{STAR} + depr$$

This ratio is used to determine the long-run behavior of investment. Since the interest rate has a strong influence on the optimal capital stock via the user cost of capital, the investment equation represents the main transmission channel of monetary policy in the model. Cost factors have a direct influence in the ECM term but are not relevant in the short-run dynamics, which are dominated by accelerator effects represented by an autoregressive term and a coefficient on real output growth that is larger than one.

Table 7: Estimation of Real Gross Investment

$\Delta \ln(ITR_t) = C(1) + C(2)\cdot \ln(ITR_{t-1}/KSTAR_{t-1}) + C(3)\cdot \Delta \ln(YER_t) + C(4)\cdot \Delta \ln(ITR_{t-2}) + C(5)\cdot \Delta \ln(ITR_{t-3}) + C(6)\cdot D_{861} + C(7)\cdot D_{862} + C(8)\cdot D_{871} + C(9)\cdot D_{872} + res_t^{ITR}$

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	–0.070303	0.026513	–2.65164	0.0098
C(2)	–0.051604	0.020203	–2.55428	0.0127
C(3)	1.110107	0.251406	4.415586	0.0000
C(4)	0.117159	0.070883	1.652843	0.1026
C(5)	0.243847	0.075193	3.242926	0.0018
C(6)	–0.077009	0.016993	–4.53172	0.0000
C(7)	0.045352	0.017221	2.633457	0.0103
C(8)	–0.122070	0.017905	–6.81749	0.0000
C(9)	0.098917	0.017472	5.661302	0.0000
R-squared:	0.687612		Durbin-Watson stat:	2.080469

4.3 Foreign Trade

In the equations for real exports and real imports, market shares with respect to foreign (WDR) and domestic demand (WER) are used as dependent variables in the long-run. Specifically, real exports are modeled with unit elasticity to demand on markets for Austrian exports. In turn, these export market shares are explained by a price-competitiveness indicator and a time trend (see table 10). Competitiveness is measured by the ratio of Austrian export prices to competitors' prices. This indicator has the expected negative impact on market shares. The trend term contributes about 0.2 percentage points to real export growth, reflecting rapidly increasing trade links.

Import demand was modeled by aggregating real GDP components weighted by their respective import content as appears in the current input-output table.

$$WER_t = 0.197 \cdot PCR_t + 0.01 \cdot GCR_t + 0.298 \cdot ITR_t + 0.477 \cdot SCR_t + 0.536 \cdot XTR_t$$

In the long-run, imports depend negatively on a competitiveness variable defined as the ratio of import prices to the deflator of GDP at factor cost. Due to the relatively high weight of exports in the domestic demand indicator, the impact of intensified trade links is better captured than in the export equation. Nevertheless, a time trend starting in 1997 had to be introduced to capture the recent surge in trade volumes. Moreover, the special role of oil prices had to be considered. Real

imports are very inelastic with respect to oil prices. To control for this fact the effect of the price competitiveness variable on real imports was corrected for oil prices. Otherwise, oil price simulations would produce the perverse result that an increase in oil prices improves the price competitiveness of the Austrian import-competing sector leading to an increase in real GDP (see table 8).

In the dynamic specifications of real imports and exports both error-correction terms are significant with rapid adjustment of 35% and 17% respectively. Changes in demand and competitiveness variables are also relevant in the short run. In the equation for real exports, a negative autoregressive term reflects the high volatility present in the data (see tables 9 and 11).

Table 8: Estimation of Long-run Relationship Imports

$\ln(MSTAR_t) = C(1) + \ln(WER_t) + C(2)\cdot[(1/(1 + C(3)))\cdot(\ln(MTD_t) + C(3)\cdot\ln(POILU_t) - \ln(YFD_t))] + C(4)\cdot TR_{971}$

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	–0.237770	0.047748	–4.979644	0.0000
C(2)	–0.888146	0.134797	–6.588753	0.0000
C(3)	–0.055182	0.018623	–2.963096	0.0041
C(4)	0.001202	8.76E-05	13.71960	0.0000
R-squared:	0.990162	Durbin-Watson stat:	1.399563	

Table 9: Estimation of Real Imports

$\Delta\ln(MTR_t) = C(1)\cdot\ln(MTR_{t-1}/MSTAR_{t-1}) + C(2)\cdot\Delta\ln(WER) + (1 - C(2))\cdot\Delta\ln(WER_{t-2}) + C(3)\cdot\Delta\ln(MTD_t/YFD_t) + res_t^{MTR}$

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	–0.351035	0.105569	–3.325150	0.0021
C(2)	0.809069	0.143118	5.653138	0.0000
C(3)	–0.374019	0.343955	–1.087408	0.2843
R-squared:	0.546213	Durbin-Watson stat:	1.839300	

Table 10: Estimation of Long-run Relationship Exports

$\ln(XSTAR_t) = C(1) + \ln(WDR_t) + C(2)\cdot TREND + C(3)\cdot\ln(XTD_t/CXD_t)$

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	8.685912	0.176453	49.22506	0.0000
C(2)	0.002383	0.000383	6.219390	0.0000
C(3)	–0.382664	0.065612	–5.832198	0.0000
R-squared:	0.988159	Durbin-Watson stat:	0.465805	

Table 11: Estimation of Real Exports

$\Delta\ln(XTR_t) = C(1)\cdot\ln(XTR_{t-1}/XSTAR_{t-1}) + C(2)\cdot\Delta\ln(WDR_t) + (1 - C(2))\cdot\Delta\ln(WDR_{t-1}) + C(3)\cdot\Delta\ln(XTD_t/CXD_t) + C(4)\cdot\Delta\ln(XTR_{t-1}) + res_t^{XTR}$

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	–0.177244	0.075987	–2.332548	0.0230
C(2)	0.759752	0.123693	6.142254	0.0000
C(3)	–0.374163	0.097573	–3.834692	0.0003
C(4)	–0.281413	0.089575	–3.141666	0.0026
R-squared:	0.501759	Durbin-Watson stat:	2.054105	

Table 12: Estimation of Long-run Stocks

$\ln(LSSTAR_r) = C(1) + C(2)\cdot\ln(YNR_t)$

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	2.871705	0.165589	17.34240	0.0000
C(2)	0.708023	0.015780	44.86771	0.0000
R-squared:	0.959030	Durbin-Watson stat:	0.107677	

4.4 Stocks

The inventories equation is derived from a theoretical framework developed by Holt, Modigliani, Muth and Simon (1960)based on a cost function that includes linear and quadratic costs of production and holding inventories. Pro- or counter-cyclical inventory behavior, depends on the relative costs of adjusting production and of holding inventories (stockout or backlog costs).

The desired long-run level of inventories (LSSTAR) is entirely determined by the normal level of production (YNR), disregarding any such cost factors, which only enter the dynamic specification. The normal or desired level of production is given by the estimated production function with the current levels of capital and employment as input factors. As reflected in the parameters of the long-run relationship, the ratio of inventories to output shows a declining trend over the nineties.

In the short run, cost factors and the economic cycle play an important role. Opportunity costs of holding inventories are approximated by the product of the normal level of production and the real interest rate (REALI). The real interest rate is defined as the average of real short-term and long-term interest rates. Differences between year-on-year changes in sales and year-on-year changes in normal output reflect the business cycle, since during an economic upswing growth of sales within the last year will exceed growth of normal output, while the reverse holds in recessions. Since we lack accurate data for sales on a quarterly basis the sum of real private consumption and real exports was used as a proxy. The positive coefficient found for this variable indicates that inventories behave procyclically in Austria. More inventories imply higher holding costs but reduce the probability of stockout or backlog costs. The level of inventories that equalizes this counteracting cost increases with economic activity, causing a simple accelerator effect.

Table 13: Estimation of Stock Building

$$\Delta(SCR)_t = C(1)\cdot(LSR_{t-1} - LSSTAR_{t-1}) + C(2)\,[\Delta_4 SALE_{t-1} - C(3)\cdot\Delta_4 YNR_{t-1}] + C(4)\cdot REALI_t\, YNR_t + C(5)\cdot D_{004} + res_t^{SCR}$$

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	–0.040781	0.008828	–4.619766	0.0000
C(2)	0.019012	0.006075	3.129633	0.0029
C(3)	0.804039	0.542437	1.482271	0.1445
C(4)	–0.000164	7.33E-05	-2.243936	0.0293
C(5)	-961.4468	30.51439	-31.50798	0.0000

R-squared: 0.956520 Durbin-Watson stat: 2.613117

Table 14: Estimation of Labor Demand

$\Delta \ln(LNN_t^{FE}) = C(1)\cdot \ln(LNN_{t-1}^{FE} / LSTAR_{t-1}) + C(2)\cdot \sum_{i=0}^{1} (\Delta \ln(WUN_{t-1}^{FE}/YFD_{t-i}) + C(3)\cdot \Delta \ln(YER_t) + C(4)\cdot D_{911} + res_t^{YFD}$

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	–0.112493	0.039393	–2.855634	0.0055
C(2)	–0.206512	0.065522	–3.151784	0.0023
C(3)	0.202497	0.040791	4.964290	0.0000
C(4)	0.009164	0.002785	3.290788	0.0015
R-squared:	0.318476	Durbin-Watson stat:		1.549794

5. Estimation of Labor Market Equations

5.1 Employment

The equilibrium level of employment depends solely on the supply side and is obtained by inverting the production function. The corresponding ECM term has the expected negative coefficient. In the short run, demand and cost factors have an impact on employment growth. The pro-cyclical response of employment to output fluctuations is captured by contemporaneous GDP growth. Wages in Austria are typically set in a highly centralized bargaining process. Given the resulting real wage, firms choose the desired level of employment. Increases in real wages in the last two quarters lead to a lower employment level.

5.2 Labor Force

In the long-run, the labor force follows demographic developments and is given exogenously by LFNSTAR In the short run, cyclical fluctuations in output lead to variations in employment but also trigger responses in labor supply. The effect of output variations on the unemployment rate is cushioned by a pro-cyclical reaction of the labor force – a pattern which was especially clear in past Austrian data. The second important short run determinant in the labor supply equation is real wage growth. As real wages in Austria are known to be very flexible, they tend to reinforce the pro-cyclical behavior of employment.

Table 15: Estimation of the Labor Force Equation

$\Delta \ln(LFN_t) = -0.025 \cdot \ln(LFN_{t-1}/LFNSTAR_{t-1}) + C(1) \cdot \Delta \ln(WUN_{t-1}/PCD_{t-1}) + C(2) \cdot \Delta \ln(LNN_t) + res_t^{LFN}$

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.079683	0.023976	3.323473	0.0014
C(3)	0.711938	0.056323	12.64033	0.0000
R-squared:	0.710998	Durbin-Watson stat:		1.321416

6. Estimation of Price Equations

The long-run properties of the price block are jointly determined by two key variables, the GDP deflator at factor costs and the nominal wage rate dealt with in section 6.1 and section 6.2, respectively. In addition, external price developments are captured by the import price deflator (see section 6.5). Other domestic price deflators like the private consumption deflator and the investment deflator feature a long-run unit elasticity with respect to these key variables. This assumption of static homogeneity implies that the corresponding error correction terms are modeled in terms of relative prices.

6.1 GDP-Deflator at Factor Costs

The long-run behavior of the GDP deflator at factor costs is given by the supply block, with the corresponding error-correction term – formulated as a moving average over the past two periods – entering the dynamic specification significantly. The ECM-coefficient implies an adjustment to the equilibrium of 14% per period. In the short run, wages, the second key domestic price component, play a prominent role. In order to rule out explosive wage-price spirals in simulation exercises, nominal wage growth enters with a one quarter lag. This also reduces the effect of wages on prices. Since Austria is a small open economy, prices should also depend strongly on foreign developments. Foreign competitors' prices were not included in the static steady-state solution of the supply block but enter through import price inflation. The estimated coefficient of 0.10 seems rather low, but import prices tend to be more volatile than domestic prices, reflecting the high volatility of exchange rates and commodity prices.

6.2 The Nominal Wage Rate

In the AQM, the nominal wage rate is approximated by average compensation per employee as recorded in National Accounts data. These quarterly data are adjusted

to full-time equivalents using interpolated annual data. During the sample period, the income share of labor dropped from almost 68% in 1980 to slightly less than 60% in 2000 (see chart 5). The rebound in 2001 mainly reflects cyclical factors in the course of the recent economic slowdown. This is inconsistent with the assumption of a constant-returns-to-scale Cobb-Douglas production function underlying the supply side of the AQM which implies constant factor income shares in equilibrium equal to the output elasticities. We therefore included a trend in the long-run wage equation starting in 1988Q1 (see table 17).

In the dynamic specification, nominal wages adjust only slowly to the long-run equilibrium, reflecting adjustment costs and bargaining (see table 18). The short-run dynamics are characterized by a Phillips curve linking wage growth to the deviation of the unemployment rate from a constant NAWRU which is exogenous to the model. However, the long-run Phillips curve is vertical. Productivity determines not only the equilibrium level of the wage rate but enters also the dynamic specification. The contemporaneous inflation rate measured by the GDP deflator at factor costs is highly correlated with nominal wage growth leading to a rigid behavior of real wages in simulation exercises. [3] We therefore decided to use only lagged inflation as this better reflects the high real wage flexibility characteristic of the centralized wage setting process in Austria.

Table 16: Estimation of GDP-Deflator at Factor Costs

$\Delta \ln(YFD_t) = C(1) \cdot 0.5 \cdot \sum_{i=1}^{2} \ln(YFD_{t-i}/YDSTAR_{t-i}) + C(2) \cdot \Delta \ln(MTD_t) + C(3) \cdot \Delta \ln(WUN_{t-1}^{FE}) + C(4) \cdot D_{841} + C(5) \cdot D_{924} + C(6) \cdot D_{952} + res_t^{YFD}$

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	–0.137458	0.046980	–2.925868	0.0045
C(2)	0.101125	0.040117	2.520774	0.0137
C(3)	0.407432	0.044078	9.243519	0.0000
C(4)	0.021604	0.005602	3.856311	0.0002
C(5)	0.022381	0.005800	3.858447	0.0002
C(6)	0.020227	0.005639	3.586923	0.0006
R-squared:	0.565859	Durbin-Watson stat:		2.334825

[3] The high correlation between inflation and nominal wage growth is mainly driven by the period from 1988 to 1995. As there is no economic reason why wage setting in this period should have been markedly different we interpret this mainly as a data problem.

6.3 Private Consumption Deflator

Within the model, we distinguish between two consumer prices: the private consumption deflator found in National Accounts data and the HICP published by Eurostat. The HICP is not modeled directly but via its two subcomponents, HICP-energy and HICP-excluding-energy, with the more volatile energy component carrying a weight of less than 10% on average in overall HICP. HICP inflation does not feed back onto other variables in the model. On the other hand, the private consumption deflator is a central variable with strong feedbacks especially via real wages and real wealth. In the long-run, the private consumption deflator depends on the GDP deflator at factor costs, with static homogeneity imposed. In the short run, the private consumption deflator is affected by changes in the GDP deflator at factor costs, in the import deflator, and in nominal wages after correcting for productivity. External price pressures are captured by the difference between the import deflator and the GDP deflator at factor cost. The HICP excluding energy turned out to be very difficult to model, with equations featuring poor statistical properties and generating implausible simulation results. Therefore we decided to let the HICP excluding energy move one-to-one with the GDP deflator at factor costs. On the other hand, the HICP energy subcomponent depends mainly on oil prices.

Chart 5: Wage Share in Austria

Table 17: Estimation of Long-run Real Wages

$\ln(WSTAR_t) = \ln(PCD_t) + \ln((1-\beta)\cdot YER_t/LNN_t^{FE}) + C(1)\cdot TR_{881} + C(2)\cdot D_{951}$

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	–0.001735	7.36E-05	–23.56229	0.0000
C(2)	0.039370	0.018052	2.180900	0.0319

R-squared: 0.772205 Durbin-Watson stat: 0.214611

Table 18: Estimation of Wages

$\Delta\ln(WUN_t^{FE}) = C(1) + C(2)\cdot\ln(WUN_{t-4}^{FE}/WSTAR_{t-4}) + C(3)\cdot 1/3\cdot\sum_{i=2}^{4}\ln(URX_{t-i}) + C(4)\cdot 1/2\cdot\sum_{i=2}^{3}\Delta\ln(YFD_{t-i}) + C(5)\cdot 1/2\cdot\sum_{i=0}^{1}\Delta\ln(PRO_{t-1}^{FE}) + C(6)\cdot D_{824} + C(7)\cdot D_{924} + C(8)\cdot D_{951} + res_t^{WUNFE}$

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	–0.021766	0.010780	–2.019104	0.0472
C(2)	–0.110036	0.050954	–2.159529	0.0341
C(3)	–0.007792	0.003133	–2.487079	0.0152
C(4)	0.397905	0.143749	2.768054	0.0072
C(5)	0.343437	0.200025	1.716969	0.0903
C(6)	0.018240	0.007941	2.297045	0.0245
C(7)	0.036907	0.007797	4.733148	0.0000
C(8)	0.032253	0.007854	4.106655	0.0001

R-squared: 0.496887 Durbin-Watson stat: 2.063025

Table 19: Estimation of Private Consumption Deflator

$\Delta\ln(PCD_t) = C(1) + C(2)\cdot\ln(PCD_{t-1}/YFD_{t-1}) + C(3)\cdot\Delta\ln(YFD_t) + C(4)\cdot\Delta\ln(MTD_t) + C(5)\cdot\ln(MTD_t/YFD_t) + C(6)\cdot\Delta\ln(WUN_{t-1}^{FE}/PRO_{t-1}^{FE}) + res_t^{PCD}$

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.001542	0.000794	1.941635	0.0562
C(2)	–0.117086	0.050117	–2.336260	0.0223
C(3)	0.684736	0.065458	10.46064	0.0000
C(4)	0.124102	0.033286	3.728411	0.0004
C(5)	0.012702	0.006309	2.013422	0.0479
C(6)	0.082176	0.039792	2.065144	0.0426

R-squared: 0.789004 Durbin-Watson stat: 2.219394

Table 20: Estimation of HICP Subcomponent Energy

$\Delta \ln(HEG_t) = C(1) + C(2)\cdot \Delta \ln(POIL_t) + C(3)\cdot \ln(HEG_{t-1}/YED_{t-1}) + C(4)\cdot \ln(POIL_{t-1}/YED_{t-1}) + res\ HEG_t^{HEG}$

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.348422	0.141734	2.458288	0.0171
C(2)	0.085448	0.015833	5.396854	0.0000
C(3)	–0.090897	0.032707	–2.779157	0.0074
C(4)	0.025025	0.009720	2.574616	0.0128
R-squared:	0.407030	Durbin-Watson stat:		2.217577

Table 21: Estimation of Private Investment Deflator

$\Delta \ln(OID_t) = C(1)\cdot \ln(MTD_{t-1}/XTD_{t-1}) + C(2)\cdot[\ln(OID_{t-1}) - C(3)\cdot \ln(YFD_{t-1}) + (1 - C(3))\cdot \ln(MTD_{t-1})] + C(4)\cdot \Delta \ln(MTD_t) + C(5)\cdot \Delta \ln(YFD_t) + C(6)\cdot D_{861\,2} + C(7)\cdot D_{871\,2} + res_t^{OID}$

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.109373	0.059783	1.829497	0.0713
C(2)	–0.412114	0.098188	–4.197205	0.0001
C(3)	0.835710	0.015924	52.48260	0.0000
C(4)	0.106517	0.058399	1.823950	0.0721
C(5)	0.790375	0.114509	6.902321	0.0000
C(6)	0.036109	0.006189	5.834523	0.0000
C(7)	0.026018	0.005781	4.500429	0.0000
R-squared:	0.722189	Durbin-Watson stat:		2.275062

6.4 Private Investment Deflator

Deflators for private and public investment are modeled separately. For the private investment deflator we impose a long-run unit elasticity with respect to the GDP deflator at factor costs and the import deflator. This reflects the higher import content of this GDP component compared to private consumption. Changes in import prices and the GDP deflator at factor costs are also relevant in the short run. In addition, a deterioration of the terms of trade has a positive impact on the private investment deflator: an increase in import prices relative to export prices tends to increase the price pressure on investment goods. Data for the government investment deflator are only available on an annual basis. The interpolated time series has much less variation than other quarterly series, rendering estimation difficult. Therefore the government investment deflator depends solely on the GDP deflator at factor costs both in the short run and in the long-run.

6.5 Import and Export Price Deflator

The export and import deflators follow competitors' export and import prices in the long-run. Competitors' import prices (CMD) are calculated as the sum of our trade partners' export prices weighted by their import shares; competitors' export prices (CXD) are a double weighted sum of the export prices of countries also exporting on Austrian export markets.

Table 22: Estimation of Long-run Import Prices

$\ln(MDSTAR_t) = C(1) + C(2)\cdot\ln(CMD_t) + C(3)\cdot\ln(YFD_t) + (1 - C(2) - C(3))\cdot\ln(POILU_t)\ C(4)\cdot D_{971P}$

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	–1.483100	0.052483	–28.25889	0.0000
C(2)	0.579128	0.031427	18.42758	0.0000
C(3)	0.375414	0.022635	16.58527	0.0000
C(4)	–0.046739	0.005866	–7.967807	0.0000

R-squared: 0.945749 Durbin-Watson stat: 0.601633

The first weight is the export share of a competing country on a specific export market. The second weight is the share of that market in total Austrian exports. In modeling the steady-state import deflator, static homogeneity was imposed with respect to competitors' import prices, the GDP deflator at factor costs and oil prices. In an unrestricted version, the coefficient on the competitors' import prices was too low, leading to an unreasonably slow transmission of external price pressures to import prices. The steady-state export deflator depends on competitors' export prices and the GDP deflator at factor costs. Both ECM terms are significant in the dynamic specifications. The short-run dynamics are determined by the growth rates of the same variables that define the steady state.

Table 23: Estimation of Import Prices

$\Delta \ln(MTD_t) = C(1)\cdot \ln(MTD_{t-1}/MDSTAR_{t-1}) + C(2)\cdot \Delta \ln(POILU_t) + C(3)\cdot \Delta \ln(CMD_{t-1}) + C(4)\cdot D_{821} + C(5)\cdot D_{804} + res_t^{MTD}$

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	–0.229327	0.062757	–3.654215	0.0005
C(2)	0.039112	0.013262	2.949068	0.0042
C(3)	0.223719	0.072768	3.074421	0.0029
C(4)	0.059505	0.012657	4.701484	0.0000
C(5)	–0.034880	0.012762	–2.733048	0.0077

R-squared: 0.394654 Durbin-Watson stat: 1.813696

Table 24: Estimation of Long-run of Export Prices

$\ln(XDSTAR_t) = C(1) + C(2)\cdot \ln(CXD_t) + (1 - C(2))\cdot \ln(YFD_t) + C(3)\cdot D_{971P}$

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	–0.973916	0.032571	–29.90154	0.0000
C(2)	0.418123	0.012278	34.05494	0.0000
C(3)	–0.056948	0.006381	–8.924267	0.0000

R-squared: 0.957776 Durbin-Watson stat: 0.436232

Table 25: Estimation of Export Prices

$\Delta \ln(XTD_t) = C(1)\cdot \ln(XTD_{t-1}/XDSTAR_{t-1}) + C(2)\cdot 1/2\cdot \sum_{i=0}^{1} \Delta \ln(CXD_{t-i}) + C(3)\cdot \Delta \ln(YFD_{t-i}) + C(4)\cdot D_{844} + C(5)\cdot D_{851} + C(6)\cdot D_{881} + res_t^{XTD}$

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	–0.127327	0.054143	–2.351679	0.0212
C(2)	0.121622	0.045425	2.677435	0.0091
C(3)	0.367228	0.088094	4.168590	0.0001
C(4)	–0.025859	0.009279	–2.786915	0.0067
C(5)	0.047503	0.009776	4.859121	0.0000
C(6)	0.029149	0.008986	3.243953	0.0017

R-squared: 0.473967 Durbin-Watson stat: 2.173595

7. The Long-run of the Model

7.1 The Theoretical Steady State

Assuming that factor markets are competitive and taking the Cobb-Douglas function in equation (2) as a starting point, the following relations must hold in the long-run:

$$\beta \cdot \frac{YER}{KSR} = \left(\delta + r + RP\right) \tag{8}$$

$$\left(1-\beta\right) \cdot \frac{YER}{LNN^{FE}} = \frac{WUN^{FE}}{YFD} \tag{9}$$

The marginal product of capital must equal the sum of the depreciation rate (δ), the real interest rate (r), and the risk premium (RP). The marginal product of labor should grow in line with the real wage rate. In equations (8) and (9) the output-capital and the output-labor ratio are determined by factor input costs. Rearranging the production function yields an expression for employment growth:

$$LNN^{FE} = \left(YER \cdot KSR^{\beta} \cdot TFT\right)^{\frac{1}{1-\beta}} \tag{10}$$

The steady state growth of labor force (LFNSTAR), trend total factor productivity (TFT), and the natural unemployment rate (URT) are set exogenously. The trend labor supply (LNT) follows from the relation

$$LNT = LFNSTAR \cdot \left(1-URT\right) \tag{11}$$

The steady state level of output follows from equations (8), (10) and (11):

$$YSTAR = TFT^{\frac{1}{1-\beta}} \cdot \left(\frac{\beta}{r+\delta+RP}\right)^{\frac{\beta}{1-\beta}} \cdot LNT \tag{12}$$

Equation (12) refers to the steady state output, which is reached when the capital stock has converged to the steady state level. The potential output (YET) which is used in the model to calculate the output gap is defined in terms of the actual capital stock instead and can be understood as a medium term concept:

$$YFT_t = TFT_t \cdot KSR_t^{\beta} \cdot LNT_t^{1-\beta} \tag{13}$$

Equations (8), (9), (10) and (13) define together with the condition that the unemployment rate equals the natural rate the steady state. Condition (8) is implemented in the error correction term of the investment equation (see table 7), condition (10) in the error correction term of the equation for labor demand (see table 14) and condition (9) in the error correction terms of the wage equation (see table 18) and the price equation (see table 16). Finally the condition that the unemployment rate must equal the natural rate of unemployment enters the wage equation in terms of the Philips curve. These four conditions ensure that output in the long-run is given by the supply side of the model.

Finally the condition that demand equals supply must be fulfilled. Actual output which in the short run is determined by the sum of the demand components enters the supply side of the model in equations (3) to (5) and bridges the gap between actual and potential output. In the long-run the components of aggregate demand must sum to the steady state level of output:

$$YSTAR = PCR + GCR + ITR + XTR - MTR + SCR \tag{14}$$

Which mechanism ensures that (equation (14)) holds in the long-run? As explained in Fagan, Henry and Maestre (2001) the equality between supply and demand is achieved by a stock flow interaction which determines the equilibrium level of the real effective exchange rate. To see this, notice that in the long-run investment is determined by the supply side, that the ratio of inventories to GDP is constant and that government consumption is given exogenously. The remaining two demand components, net exports and private consumption, are linked via the real exchange rate. Net foreign assets, defined as cumulated trade balances, enter the equation for private consumption as an integral part of wealth of households. Consistency between private consumption and net exports that ensures that equation (14) holds yields an equlibrium condition for the real effective exchange rate.

7.2 Necessary Conditions for Convergence and the Characteristics of the Steady State

In order to ensure that the model converges to its long-run equilibrium a monetary and fiscal policy rule have to be included. Regarding monetary policy, keeping

nominal interest rates exogenous and constant in simulation exercises either produces cyclical patterns or non-convergence to the steady state. We therefore introduced a Taylor rule with an inflation target (π^*) of 2%. Moreover it is assumed that the central bank keeps the nominal interest rate permanently below the equilibrium growth rate of nominal GDP (see Bossay and Villetelle, 2004).

$$STI = \{400 \cdot [\Delta \ln(YSTAR) + \Delta \ln(YDSTAR)] - 1\} + 1.5 \cdot (\pi - \pi^*) + 0.5 \cdot YGAP \quad (15)$$

Keeping nominal interest rates below the nominal growth rate of the economy rules out explosive debt paths as the debt burden grows slower than the economy. Regarding the public sector, we used a fiscal closure rule that limits growth in public debt. We calibrated the public debt to GDP ratio to be equal to 50%. Any deviation from this ratio triggers an adequate adjustment of the direct tax rate of households. As can be seen in section (7.3) the fiscal rule causes a slight cyclical pattern in the adjustment to the steady state.

To construct a steady state balanced growth path the AQM was simulated for 500 years. As outlined above potential output in the AQM follows a medium term concept and the output gap mirrors deviations of the unemployment rate from the NAIRU. To guarantee that the output gap actually closes and the unemployment rate reaches the NAIRU in the steady state, dynamic homogeneity had to be imposed on the price, wage, labor demand and labor supply equations. Otherwise the long-run solution would depend on arbitrary constants and the unemployment rate could deviate from the exogenous NAIRU. Consequently also the output gap would not close.[4]

In simulation exercises with the AQM it turned out that price elasticities in the trade block and the coefficient of the Philips curve in the wage equation are crucial for assuring convergence towards the steady state. Regarding the trade block we found that the transition to the steady state is typically much smoother and faster when the Marshall Lerner condition is satisfied, i.e. if the sum of the absolute values of the price elasticities in the static real import and export equations is larger than one. This result is not surprising. In the long-run the equilibrium is determined by supply factors and prices adjust fully. Real variables converge to their steady state values as they respond to relative price changes. The adjustment of trade

[4] An equation fulfills the condition of dynamic homogeneity if the sum of the coefficients of the explanatory variables/terms weighted by their steady state growth rates plus the constant equals the steady state growth rate of the dependent variable. Usually this implies a constraint on the constant in the estimation. Dynamic homogeneity is only imposed throughout section 7 to derive a theoretical consistent steady state baseline. For forecasting and short to medium term simulations the unconstrained version of the AQM as presented in the remaining sections is used.

variables to price changes is one main mechanism that supports the convergence towards the steady state. Furthermore, if the Philips curve coefficient in the wage equation is too high the model typically produces cycles in simulation exercises which can be explosive. A small coefficient on the other hand leads to long adjustment periods to the new equilibrium and unreasonable simulation results in the short run. [5] [6] Furthermore assumptions for the exogenous foreign variables have to be made to construct a steady state baseline. For the sake of simplicity it is assumed that the rest of the world grows at the same pace as the home economy and that real interest rates are equal. Relaxing these assumptions would make an endogenous risk premium in the exchange rate equation necessary in order to rule out an explosive path for net foreign assets. Finally, we let all residuals return to zero by using an autoregressive process of order one with an coefficient of 0.2. This constitutes a major shock to the economy and triggers an adjustment process to the steady state equilibrium.

In the steady state real variables grow by the sum of technological progress γ and growth in labor supply n, both given exogenously. The domestic inflation rate π is determined by foreign inflation π^f. As the steady state unemployment rate equals the NAIRU employment growth is equal to labor supply growth (n). Under the conditions outlined above the AQM converges to its long-run equilibrium. This steady state can be described by the following important economic ratios. The GDP shares of exports and imports rise to more than 60%, the GDP share of investment to 25%. The size of these shares crucially depends on price elasticities and the real interest rate, respectively. The output gap closes and the unemployment rate is equal to the NAIRU.

The ratio of investment to the capital stock is determined by the depreciation rate (see section 4.2) and equal to 7.6%. The capital stock to GDP and wealth (defined as the sum of physical capital, net foreign assets and public debt) to GDP

[5] For the steady state baseline and the long-run simulations a modified equation for the GDP deflator at factor costs was used in order to ensure that the output gap closes. Similar to the wage equation, the first order condition of the profit maximizing representative firm with respect to labor directly acts as the ECM-term instead of the one derived in section 2. This ECM-term in the equation for the GDP deflator at factor costs assures that the first-order-labor-demand condition holds, while the Philips curve in the wage equation assures that the unemployment rate converges to the NAIRU. By using this modified specification the long-run properties of the model become better apparent, but since the short run dynamics are less satisfying this specification will only be used in this section 7.

[6] For long-run simulations the Philips curve coefficient had to be calibrated. Its value of -0.001 is significantly lower than the estimated value and implies that a 1 percentage points deviation of the unemployment rate from the NAIRU triggers an adjustment of the wage rate of 0.1 percentage points per period.

ratios are equal 322 and 372%, respectively. Government debt is calibrated to 50% of GDP. Giving a growth rate of nominal GDP of 0.0678% per quarter, net lending of the public sector in % of GDP must equal 2.113. The trade balance and the current account in % of GDP are close to zero. The latest result is not a necessary condition for convergence but evolved by chance.

Chart 6: GDP-Shares in the Long-run

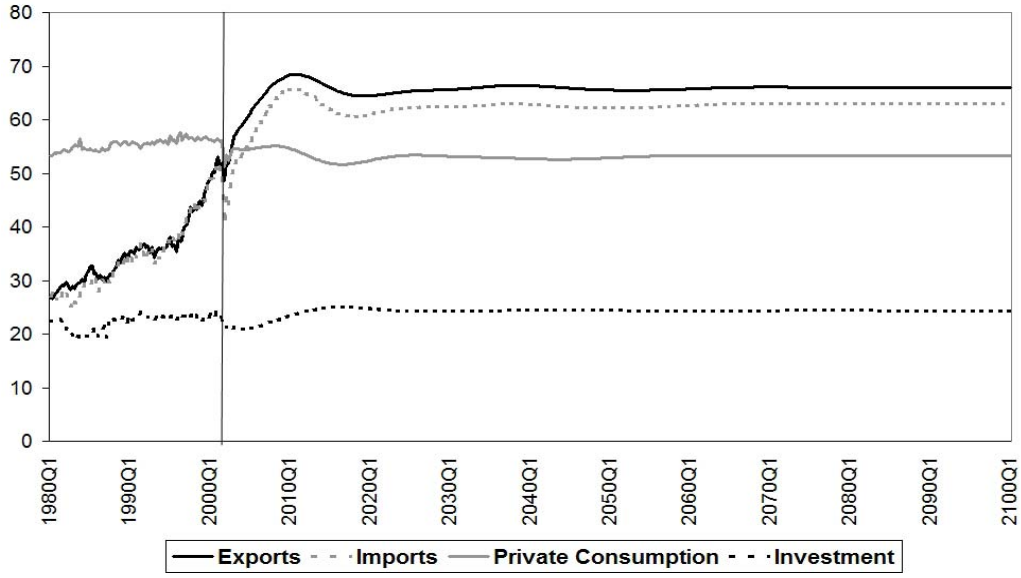


Chart 7: Unemployment Rate in the Long-run

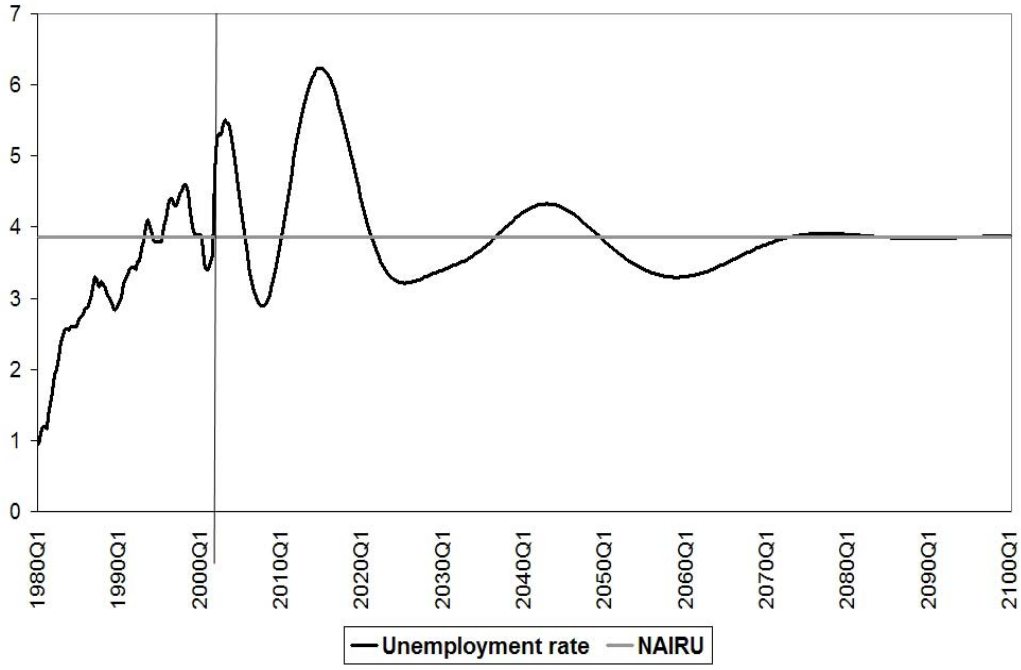


Table 26: GDP Ratios in the Steady State (in %)

	ITR/YER	PCR/YER	XTR/YER	MTR/YER	GCR/YER
1982-2001	22.3	55.6	36.7	35.8	20.3
2001Q3	22.6	56.1	52.0	50.3	19.0
steady state	24.4	53.4	66.2	63.3	19.0

Table 27: GDP Ratios in the Steady State (in %)

	(4·ITR)/ KSR	KSR/ (4·YER)	FWR/ (4·YER)	GLN/ YEN	GDN/ (4·YEN)	NFA/ (4·YEN)	BTN/ YEN	CAN/ YEN
1982–2001	6.5	347.7	407.9	–3.1	58.1	–7.86	–0.48	–1.95
2001Q3	6.6	340.4	399.5	0.3	66.2	–26.14	–0.19	–2.17
steady state	7.6	321.9	372.2	–2.1	50.0	0.53	0.00	0.022

Table 28: GDP Ratios in the Steady State (in %)

	WIN/ YEN	OPN/ YEN	TRN/ YEN	TPN/ YEN	TIN/ YEN	PDN/ YEN	ODN/ YEN
1982–2001	54.1	18.2	24.3	21.7	10.9	10.8	9.1
2001Q3	52.9	18.2	24.0	22.3	10.3	12.0	10.7
steady state	56.9	18.0	24.5	22.0	10.5	10.9	7.8

Finally in the steady state the wage share (excluding self employed incomes) rises to 57% as the effect of the ad hoc trend, introduced in the wage equation to capture the decline in the wage shares in the 1980s and 1990s, fades out. The share of transfers is determined by the evolution of the unemployment rate, the share of direct taxes by the fiscal rule. Overall, most economic ratios are remarkably stable.

7.3 Long-run Simulations

The best way to illustrate the long-run properties of a model is via simulation results. We therefore present two exemplary simulations: a foreign price shock and a labor supply shock. The foreign price shocks shows the neutrality of the model with respect to the price level and the labor supply shock demonstrates how a disequilibrium on the labor market is resolved. In all simulations interest rates are set according to the Taylor rule specified in section (7.2) while the fiscal policy rule is not activated. The Simulations are run around the steady state baseline described in section (7.2).

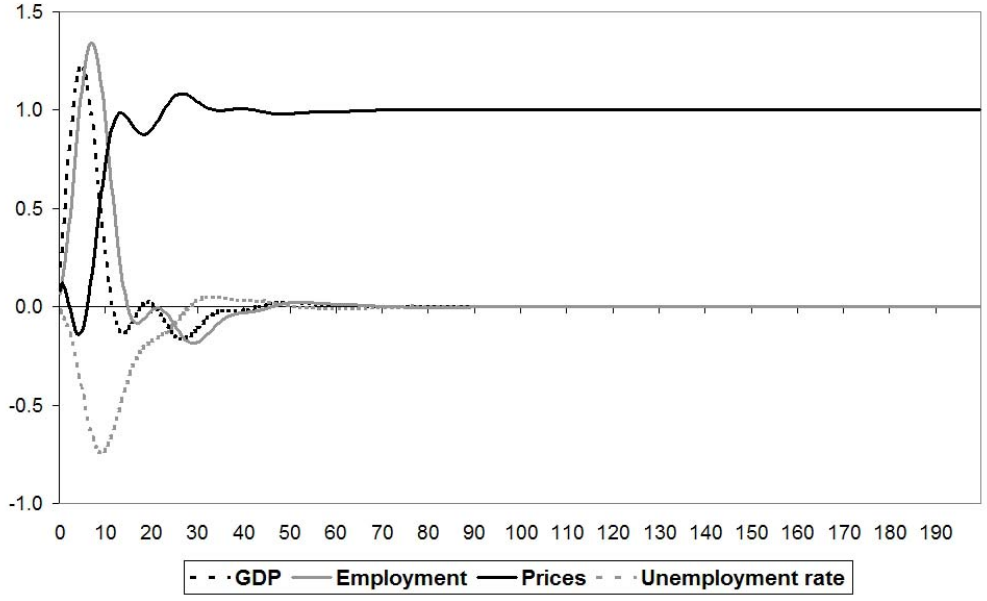
7.3.1 Foreign Price Shock

All foreign prices, i.e. competitors prices on the import and the export side and oil and non-oil commodity prices, are permanently increased by 1%. Due to rigidities on goods and labor markets domestic agents do not immediately adjust to the new equilibrium price level. Thus the international price competitiveness increases in the short run and causes output and employment to rise above baseline levels. In the long-run all domestic prices increase by 1% and real variables return to baseline. Since the supply side is not affected by the price level in the long-run there is no shift in the composition of output as regards the demand components.

7.3.2 Labor Supply Shock

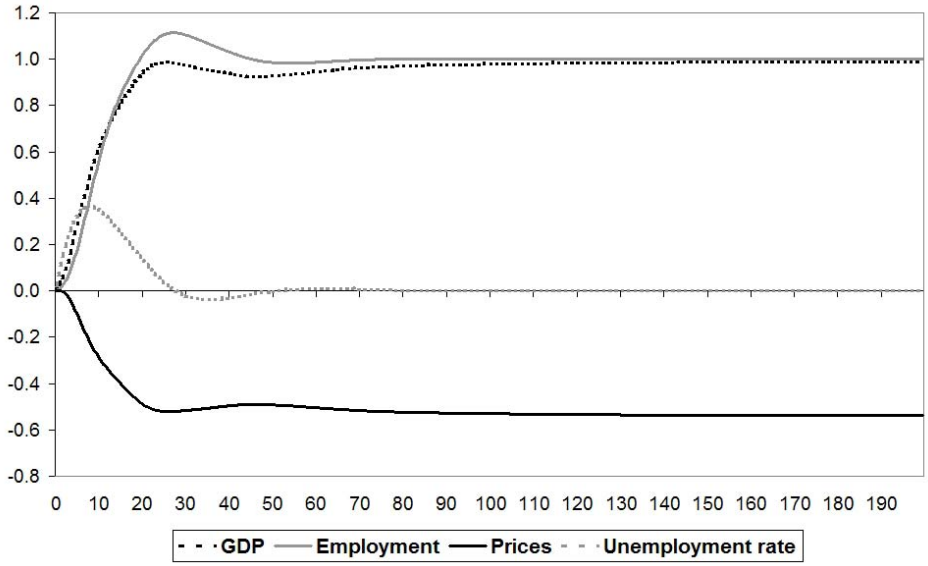
The level of labor supply is increased permanently by one percent above the baseline. To resolve the disequilibrium on the labor market nominal wages have to decline according to the Philips curve.

Chart 8: Permanent Increase of Foreign Prices by 1%



In the long-run the unemployment rate slowly returns to the NAIRU and the output gap closes. Both employment and output increase by 1%. The level of nominal wages and consequently also the overall level of domestic prices as measured by the GDP deflator at factor costs remain below baseline levels in the long-run. Since foreign prices and world demand for Austrian exports are assumed to be exogenous price competitiveness increases permanently. Consequently the composition of output changes not only in the short run but also in the long-run. Real net exports remain permanently above baseline. Nevertheless the (nominal) trade balance worsens slightly as export prices react more sensitive to domestic prices than import prices. This causes net foreign assets to fall below the baseline level. Consequently the increase in wealth and private consumption remain below 1%.

Chart 9: Permanent Increase of Labor Supply by 1%



8. Short-run Simulation Results

For a better understanding of the short-run dynamics of the AQM, three representative simulation exercises are performed to analyze fiscal, monetary and external shocks. All simulations are run without imposing the fiscal closure rule that limits growth in public debt or the monetary closure rule that stabilizes prices. Thus, interest rates and nominal exchange rates are assumed to remain constant at their baseline levels over the whole simulation horizon as well as direct taxes and transfers paid by households as a percentage of GDP. Automatic stabilizers work only through transfers received by households and are assumed to depend positively on the unemployment rate. Exogenous (i.e. constant) nominal interest rates imply that real interest rates are endogenous via changes in inflation. The backward-looking behavior of inflation expectations can thus lead to highly variable real interest rates and user costs of capital in simulations. This can generate a relatively strong reaction of real investment to a shock. All simulations are run within the sample and cover a period of 40 quarters. The following five simulations were carried out:

1) Increase of government consumption for five years.
2) Increase of short-term interest rates for two years.
3) Increase in world demand for five years.

8.1 Simulation 1: Increase of Government Consumption for FiveYears

(See table B1 and chart C1 in the Appendix)

Real government consumption which is strictly exogenous in the model is assumed to increase for five years by 1% of GDP. A surge in government consumption automatically causes an increase in output and employment is affected with a certain lag. Demand side pressures lead to an increase in inflation reinforced by the labor market via the Phillips curve. Real investment activity is boosted for two reasons. First, output expansion operates directly by the common accelerator effect and second, higher inflation rates imply lower real interest rates and therefore a lower user cost of capital. Households' real disposable income rises as employment expands and other personal income increases. This is only partly offset by slightly lower real wages in the first years. Increased prices lead to an erosion of international competitiveness which – together with higher domestic demand – reduces the contributions to growth of net exports, thereby dampening the positive output effect. After five years government consumption is assumed to return to baseline. This constitutes a major negative demand shock and reverses most of the results. Domestic demand drops, prices follow with some lag. The stickiness of prices causes long lasting dampening effects on real GDP and employment over the following five years.

8.2 Simulation 2: Increase of Short-term Interest Rates for Two Years

(See table B2 and chart C2 in the Appendix)

In the monetary policy shock the short-term interest rate is raised by 100 basis points for two years and then returned to its baseline level for the next eight years. Nominal exchange rates move according to a simple uncovered interest rate parity condition (UIP). The euro area share in total trade is approximately 40%. The long-term interest rate (10 years) is assumed to move according to a simple interest rate parity condition, by which agents trade in different maturity assets in the knowledge of future movements of short-term interest rates. The corresponding risk premia are kept at pre-shock levels. (See table 29)

Table 29: Assumptions for the Monetary Policy Shock

	Y1	Y2	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
Short-term interest rate (increase in basis points)	100	100	100	100	100	100	100	100	100	100
Long-term interest rate (increase in basis points)	16.3	6.3	20	17.5	15.0	12.5	10.0	7.5	5.0	2.5
Nominal exchange rates (appreciation in %)	1.63	0.63	2.0	1.75	1.50	1.25	1.0	0.75	0.5	0.25

The most important transmission channel of monetary policy is through the user cost of capital. Real investment reacts very sensitive to changes in capital costs and in the real long-term interest rate. The direct effect of monetary tightening on the user cost of capital via nominal interest rates is amplified by the indirect effect via lower inflation. After three years real investment levels are almost 0.7% below their baseline values. Other direct transmission channels are mainly present in the household sector. The substitution effect which reflects the increase in relative costs of present versus future consumption dominates the wealth effect which captures the fall of the market value of household's financial wealth. Income out of wealth increases as a rise in financial yields increases the disposable income of households, who are net lenders. But the overall effect of the income channel is small. The fall in households' real disposable income is mainly due to weaker employment and lower other personal incomes. Overall real private consumption falls much less than investment activity. The appreciation of the exchange rate causes a drop in net-exports in the first year of the simulation. From the second year onwards increased price competitiveness and weaker domestic demand translate into higher growth contributions of net-exports. After two years the interest rate shock is assumed to end. Prices return only slowly to their baseline levels while the effect on real GDP fades out faster. [7]

8.3 Simulation 3: Increase in World Demand for Five Years

(See table B3 and chart C3 in the Appendix)

[7] International trade spillovers of a monetary tightening in the euro area on the Austrian economy are not considered. Results in the course of the WGEM Monetary Policy Transmission Exercise show that for a small open economy like Austria the impact of these transmission channels can be substantial.

An increase in demand for Austrian exports by 1% triggers a rise in exports and in all other GDP components. Due to the high import content in exports and the increase in domestic demand, the effect on real imports of the positive foreign demand shock is also substantial. The additional contribution of net exports to GDP growth remains rather low, peaking at 0.13% in the first year. From the second year onwards, GDP is dominated by the positive effect of rising domestic demand. Private consumption grows in line with employment and investment is boosted by accelerator effects and the impact of higher inflation on the user cost of capital. Higher domestic demand and lower unemployment increase the pressure on prices. The associated loss in competitiveness gradually reduces the contribution to growth of net exports. After five years world demand is assumed to return to baseline. This negative shock triggers reverse adjustment processes. Exports fall not only because of the drop in world demand but also due to lower competitiveness caused by sticky prices. Austrian exporters lose market shares while imports remain above the baseline. This causes a small drop in output and employment. Investments are supported by lower user costs of capital over the whole simulation period as the slow adjustment of prices keeps real interest rates relatively low and financing conditions favorable. Nevertheless, weaker demand causes investments to return to baseline levels at the end of the simulation horizon.

Appendix: List of Variables

Table 30a: Endogenous Variables

ATX	Austrian Stock Index
BTN	Balance of trade of goods and services
CAN	Current account
CC0	User cost of capital
CEX	WIN / LEN
CMD	Competitor's import price in domestic currency
CPN	Credit, privat, amount outstanding, nominal
CXD	Competitor's export price in domestic currency
DDR	Domestic Demand, real
FWN	Financial wealth, nominal
FWR	Financial wealth, real
GB	Government balance
GCD	Government consumption deflator
GCN	Government consumption, nominal
GDN	Government debt, gross
GDNRAT	Ratio of government debt to nominal GDP
GID	Government investment deflator
GIN	Government investment, nominal
GLN	Government net lending
GON	Gross operating surplus
GPB	Government primary balance
GSN	Government gross savings
GTE	Government total expenditure
GTR	Government total receipts
GYN	Government disposable income
HEG	HIC - energy
HEX	HIC - non-energy
HIC	Harmonised index of consumption prices
IER	Equipment investment, real
IHR	Housing (residential) investment, real
IHX	Housing Price Index
INFA	Annual rate of inflation
INFE	Inflation expectatios, adaptive
INFQ	Quarterly rate of inflation
INN	Interest payments on government debt
IOR	Other investment, real
IPD	Private sector non-residential investment, deflator
IPN	Private sector non-residential investment, nominal

Table 30b: Endogenous Variables

IPR	Private sector non-residential investment, real
ITD	Total investment deflator
ITN	Total investment, nominal
ITR	Total investment, real
KGN	Government capital stock, nominal
KGR	Government capital stock, real
KSN	Total capital stock, nominal
KSR	Total capital stock, real
LEN	Employees
LENFE	Employees, full time equivalents
LFN	Total labour force
LNN	Total employment
LNNFE	Total employment, full time equivalents
LNNFE_W	LNNFE / LNN
LNT	Trend employment
LPN	Total employment, private sector
LSN	Self employed
LSNFE	Self employed, full time equivalents
LSNFE_W	LSNFE / LSN
LSR	Stock of inventories
LTI	Long-term nominal interest rate
LTR	Long-term real interest rate
MTD	Import deflator
MTN	Imports, nominal
MTR	Imports, real
NFA	Net foreign assets
NFN	Net factor income
NXR	Netexports, real
ODN	Other direct taxes
OID	Private investment deflator
OIN	Private investment, nominal
OIR	Private investment, real
OLN	Net lending by other private sector
OPN	Other personal income
OWN	Private compensation to employees
OYN	GON+TWN+NFN+INN - ODN+OPN+OGN)
PCD	Private consumption deflator
PCN	Private consumption, nominal
PCR	Private consumption, real
PDN	Income tax and social security contributions, paid by households
PDNB	Tax base for direct taxes
PDX	Ratio between direct taxes and its tax base
PEI	Price of energy and raw materials, domestic currency
PLN	Net lending by private sector

Table 30c: Endogenous Variables

POIL	Oil price in domestic currency
PRO	Average labour productivity
PROFE	Average labour productivity, full time equivalents
PSN	Private sector savings
PSNQ	Private sector savings ratio
PYN	Private sector disposable income, nominal
PYR	Private sector disposable income, real
REALI	The real interest rate for inventories
SALE	Sales of storable goods (PCR + XTR)
SCAN	Cumulated current account
SCD	Changes in inventories, deflator
SCN	Changes in inventories, nominal
SCR	Changes in inventories, real
SGLN	Cumulated government net lending
SMC	Short-run marginal cost of production
STI	Short-term nominal interest rate
SZD	Inventories and statistical discrepancies deflator
SZR	Inventories plus statistical discrepancies
TIN	Indirect taxes less subsidies, total
TIR	Indirect taxes less subsidies, real
TIX	Ratio between TIN and YEN
TOT	Terms of Trade
TPN	Transfers from households to government
TRN	Transfers from government to households
TPX	Ratio between TPN and YEN
TRX	Ratio between TRN and YEN
ULA	ULC adjusted (employees)
UNN	Total unemployment
URX	Unemployment rate
WER	Import demand indicator
WGN	Compensations to employees, government
WPN	Compensations to employees, private
WIN	Total compensation to employees, nominal
WUN	Compensation per employee
WUNFE	Compensation per employee, full time equivalents
WUP	Compensations per employees, private
WURPD	Real compensation per employee, with PCD deflator
WURYD	Real compensation per employee, with YED deflator
XTD	Exports deflator
XTN	Exports, nominal
XTR	Exports, real
YED	GDP expenditure deflator

Table 30d: Endogenous Variables

YEN	GDP expenditure, nominal
YER	GDP expenditure, real
YFD	GDP at factor cost deflator
YFN	GDP at factor cost, nominal
YFR	GDP at factor cost, real
YFT	Potential output
YGA	Output gap
YNR	Production using available inputs
ZYEN	Inventories and statistical discrepancies, nominal

Table 31: Definition – Variables

CSTAR	Long-run equilibrium level of private consumption
CDSTAR	Long run behaviour of Consumption deflator
GDSTAR	Long run behaviour of Government investment deflator
KSTAR	Long-run equilibrium level of capital stock
LSSTAR	Long-run equilibrium level of real stocks
LSTAR	Long-run equilibrium level of employment
MDSTAR	Nominal effective exchange rate on the import side
MSTAR	Long-run equilibrium level of imports
WSTAR	Long run wage rate
XDSTAR	Government investment, real
XSTAR	Long-run equilibrium level of exports
YDSTAR	Long-run equilibrium level of GDP deflator at factor costs

Table 32: Exogenous Variables

CMD_EX	Competitor's import price - extra Euro Area
CMD_IN	Competitor's import price - intra Euro Area
CXD_EX	Competitor's export price - extra Euro Area
CXD_IN	Competitor's export price - intra Euro Area
D8	Change in net equity of households in pension funds reserves (D.8)
EEN	Nominal effective exchange rate on the export side
EEN0	Nominal effective exchange rate on the import side
GCR	Government consumption, real
GDNRAT	Ratio of Gov. debt to nominal GDP
GIR	Government investment, real
HICWE	Weights for HICP
IHN	Housing investment (private and gov't), nominal
IPX	Industrial production to GDP ratio
LEX	Employees to employment ratio
LFNSTAR	Total labour force, hp filtered with lamda = 40
LGN	Government employment
OGN	Other sector transfers to/from government
PEX	Ratio between MTD and WUN, exogenous in forecast
POILU	Oil price in USD
RP	Risk premium
TWN	Transfer from rest of the world
URT	Trend unemployment rate
USD	Exchange Rate US dollar for 1 Euro
WDR	World demand indicator
WDR_EX	World demand indicator - extra Euro Area
WDR_IN	World demand indicator - intra Euro Area
WUG	Compensation per goverenment employee
ZCC0	Statistical discrepancy on user cost of capital
ZGDN	Statistical discrepancy on government debt
ZGYN	Discrepancy in gov disp income equation
ZHIC	Discrepancy in HICP equation
ZKGN	Statistical discrepancy on gov capital stock, nominal
ZKGR	Statistical discrepancy on capital stock
ZKSN	Statistical discrepancy on capital stock, nominal
ZKSR	Statistical discrepancy on capital stock
ZUNN	Statistical discrepancy on labour force
ZNFA	Statistical discrepancy on net foreign assets
ZPSN	Statistical discrepancy on private saving
ZURX	Statistical discrepancy on unemployment rate
ZYER	Statistical discrepancy on GDP expenditure

Appendix B: Simulation Results – Tables

Table B1: Simulation 1: Increase of Government Consumption for Five Years

	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
Prices	*Levels, percentage deviations from baseline*									
HICP	0.20	0.63	1.10	1.57	2.01	2.21	2.12	1.93	1.68	1.44
Consumption Deflator	0.13	0.54	1.02	1.52	1.98	2.28	2.25	2.05	1.79	1.53
GDP Deflator	0.08	0.54	1.03	1.52	1.97	2.31	2.22	2.00	1.73	1.48
Investment Deflator	0.14	0.51	0.94	1.36	1.77	1.98	1.94	1.75	1.53	1.31
ULC	-0.59	-0.09	0.53	1.21	1.93	3.14	3.27	3.09	2.77	2.40
Compensation per employee	0.16	0.42	0.88	1.38	1.93	2.33	2.55	2.54	2.43	2.31
Productivity	0.75	0.51	0.35	0.17	0.00	-0.79	-0.69	-0.53	-0.33	-0.09
Export Deflator	0.04	0.23	0.46	0.72	0.97	1.18	1.21	1.16	1.05	0.92
Import Deflator	0.01	0.11	0.26	0.43	0.60	0.76	0.82	0.80	0.73	0.64
GDP and Components	*Levels, percentage deviations from baseline*									
GDP	1.12	1.30	1.48	1.57	1.55	0.47	0.14	-0.13	-0.32	-0.41
Consumption	0.17	0.49	0.71	0.88	0.99	0.89	0.60	0.33	0.10	-0.07
Investment	1.40	2.12	2.88	3.64	4.06	2.96	2.14	1.23	0.39	-0.19
Of which: Residential Inv.	1.13	1.71	2.32	2.94	3.27	2.38	1.74	0.99	0.32	-0.15
Gov. Consumption	5.04	4.87	4.70	4.56	4.50	0.00	0.00	0.00	0.00	0.00
Exports	-0.01	-0.06	-0.13	-0.21	-0.28	-0.35	-0.37	-0.36	-0.34	-0.30
Imports	0.83	1.30	1.70	2.03	2.20	1.52	1.05	0.67	0.38	0.25
Contributions to Shock	*Percentage of GDP, absolute deviations from baseline*									
Domestic Demand	1.41	1.73	2.02	2.28	2.42	1.20	0.84	0.47	0.15	-0.08
Inventories	0.01	0.05	0.09	0.10	0.06	-0.01	-0.10	-0.16	-0.14	-0.05
Trade Balance	-0.30	-0.47	-0.63	-0.81	-0.93	-0.72	-0.60	-0.45	-0.33	-0.28
Labour Market	*Levels, percentage deviations from baseline, except unemployment: percentage points, absolute deviations from baseline*									
Total employment	0.37	0.79	1.13	1.40	1.55	1.27	0.84	0.40	0.01	-0.32
Employees in employment	0.37	0.79	1.13	1.40	1.55	1.27	0.84	0.40	0.01	-0.32
Unemployment rate	-0.09	-0.24	-0.38	-0.52	-0.63	-0.63	-0.55	-0.45	-0.32	-0.19
Household Accounts	*Levels, percentage deviations from baseline, except the savings rate: percentage points, absolute deviations from baseline*									
Disposable income	0.74	0.89	1.06	1.16	1.18	0.51	0.22	-0.02	-0.18	-0.24
Saving rate	0.48	0.36	0.33	0.25	0.18	-0.36	-0.36	-0.33	-0.27	-0.17

Table B2: Simulation 2: Increase of Short-term Interest Rates for Two Years

	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
Prices	*Levels, percentage deviations from baseline*									
HICP	-0.04	-0.10	-0.16	-0.19	-0.19	-0.17	-0.14	-0.13	-0.12	-0.11
Consumption Deflator	-0.06	-0.11	-0.16	-0.19	-0.20	-0.18	-0.16	-0.13	-0.12	-0.11
GDP Deflator	-0.06	-0.12	-0.17	-0.20	-0.20	-0.18	-0.15	-0.13	-0.12	-0.11
Investment Deflator	-0.06	-0.12	-0.16	-0.18	-0.18	-0.16	-0.13	-0.11	-0.10	-0.10
ULC	0.05	0.01	-0.12	-0.22	-0.27	-0.27	-0.23	-0.19	-0.16	-0.15
Compensation per employee	-0.02	-0.08	-0.15	-0.20	-0.22	-0.23	-0.22	-0.21	-0.20	-0.20
Productivity	-0.08	-0.09	-0.04	0.02	0.05	0.04	0.01	-0.02	-0.04	-0.04
Export Deflator	-0.16	-0.20	-0.16	-0.15	-0.13	-0.12	-0.10	-0.09	-0.08	-0.07
Import Deflator	-0.19	-0.18	-0.10	-0.08	-0.08	-0.08	-0.07	-0.06	-0.05	-0.05
GDP and Components	*Levels, percentage deviations from baseline*									
GDP	-0.12	-0.19	-0.17	-0.11	-0.05	-0.02	-0.01	-0.02	-0.03	-0.02
Consumption	-0.02	-0.09	-0.13	-0.12	-0.10	-0.07	-0.04	-0.03	-0.03	-0.03
Investment	-0.23	-0.57	-0.68	-0.59	-0.42	-0.28	-0.17	-0.11	-0.07	-0.04
of which: Residential Inv.	-1.88	-2.15	-0.55	-0.47	-0.34	-0.23	-0.14	-0.09	-0.05	-0.03
Gov. Consumption	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Exports	-0.18	-0.05	0.03	0.04	0.04	0.04	0.03	0.03	0.03	0.02
Imports	-0.11	-0.17	-0.20	-0.15	-0.08	-0.04	-0.05	-0.08	-0.11	-0.09
Contributions to Shock	*Percentage of GDP, absolute deviations from baseline*									
Domestic Demand	-0.07	-0.18	-0.23	-0.21	-0.15	-0.10	-0.07	-0.04	-0.03	-0.02
Inventories	-0.03	-0.05	-0.02	0.03	0.06	0.06	0.02	-0.02	-0.05	-0.05
Trade Balance	-0.03	0.04	0.08	0.07	0.04	0.03	0.03	0.05	0.06	0.06
Labor Market	*Levels, percentage deviations from baseline, except unemployment:percentage points, absolute deviations from baseline*									
Total employment	-0.04	-0.10	-0.14	-0.13	-0.10	-0.05	-0.02	0.00	0.02	0.03
Employees in employment	-0.04	-0.10	-0.14	-0.13	-0.10	-0.05	-0.02	0.00	0.02	0.03
Unemployment rate	0.01	0.03	0.05	0.05	0.05	0.04	0.03	0.02	0.02	0.01
Household Accounts	*Levels, percentage deviations from baseline, except the savings rate: percentage points, absolute deviations from baseline*									
Disposable income	-0.05	-0.12	-0.13	-0.10	-0.05	-0.02	-0.01	-0.02	-0.02	-0.02
Saving rate	-0.03	-0.02	0.00	0.02	0.04	0.04	0.03	0.01	0.01	0.01

Table B3: Simulation 3: Increase in World Demand for Five Years

	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
Prices	*Levels, percentage deviations from baseline*									
HICP	0.04	0.13	0.23	0.33	0.42	0.46	0.45	0.41	0.37	0.33
Consumption Deflator	0.03	0.11	0.22	0.32	0.42	0.48	0.47	0.43	0.39	0.35
GDP Deflator	0.04	0.13	0.24	0.34	0.44	0.48	0.47	0.43	0.38	0.34
Investment Deflator	0.03	0.10	0.20	0.29	0.37	0.42	0.41	0.37	0.34	0.30
ULC	-0.12	-0.03	0.10	0.25	0.40	0.64	0.67	0.63	0.57	0.52
Compensation per employee	0.03	0.09	0.18	0.29	0.40	0.48	0.52	0.53	0.51	0.50
Productivity	0.15	0.12	0.08	0.04	0.00	-0.16	-0.14	-0.10	-0.06	-0.01
Export Deflator	0.01	0.05	0.11	0.16	0.22	0.26	0.26	0.25	0.23	0.21
Import Deflator	0.00	0.02	0.05	0.09	0.13	0.16	0.17	0.17	0.16	0.14
GDP and Components	*Levels, percentage deviations from baseline*									
GDP	0.23	0.28	0.32	0.34	0.33	0.11	0.05	0.00	-0.02	-0.04
Consumption	0.04	0.11	0.16	0.21	0.23	0.22	0.16	0.10	0.06	0.04
Investment	0.28	0.45	0.61	0.76	0.85	0.63	0.46	0.29	0.14	0.04
Of which: Residential Inv.	0.23	0.37	0.49	0.62	0.69	0.51	0.38	0.24	0.12	0.03
Gov. Consumption	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Exports	0.85	0.93	0.94	0.94	0.93	0.06	-0.02	-0.05	-0.06	-0.06
Imports	0.51	0.70	0.79	0.85	0.88	0.39	0.23	0.18	0.15	0.13
Contributions to Shock	*Percentage of GDP, absolute deviations from baseline*									
Domestic Demand	0.09	0.17	0.23	0.29	0.33	0.27	0.20	0.13	0.07	0.03
Inventories	0.01	0.03	0.02	0.01	-0.01	-0.03	-0.04	-0.02	0.00	0.03
Trade Balance	0.13	0.09	0.06	0.03	0.01	-0.13	-0.11	-0.10	-0.10	-0.10
Labour Market	*Levels, percentage deviations from baseline, except unemployment: percentage points, absolute deviations from baseline*									
Total employment	0.07	0.17	0.24	0.30	0.33	0.28	0.19	0.11	0.04	-0.02
Employees in employment	0.07	0.17	0.24	0.30	0.33	0.28	0.19	0.11	0.04	-0.02
Unemployment rate	-0.02	-0.05	-0.08	-0.11	-0.14	-0.14	-0.12	-0.10	-0.08	-0.06
Household Accounts	*Levels, percentage deviations from baseline, except the savings rate: percentage points, absolute deviations from baseline*									
Disposable income	0.16	0.21	0.24	0.26	0.26	0.12	0.06	0.02	0.00	-0.01
Saving rate	0.11	0.09	0.07	0.05	0.03	-0.09	-0.09	-0.08	-0.06	-0.05

Appendix C: Simulation Results – Charts

Chart C1: Simulation 1: Increase of Government Consumption for Five Years

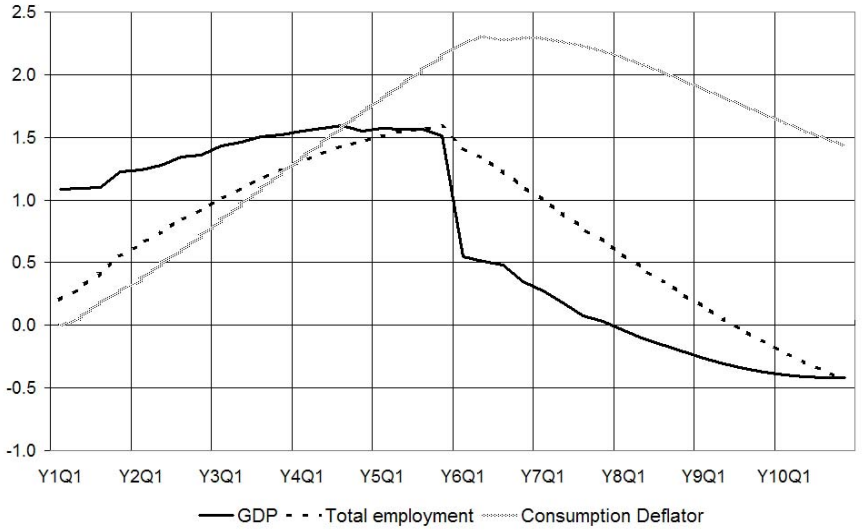


Chart C2: Simulation 2: Increase of Short-term Interest Rates for Two Years

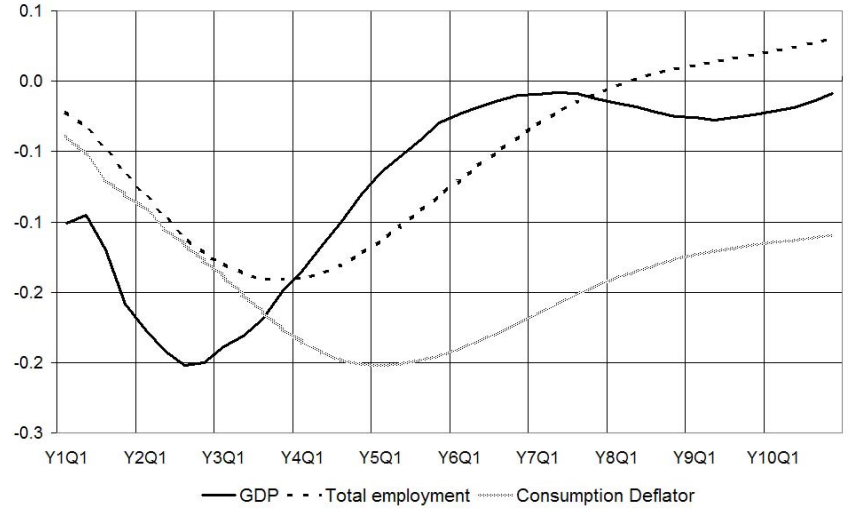
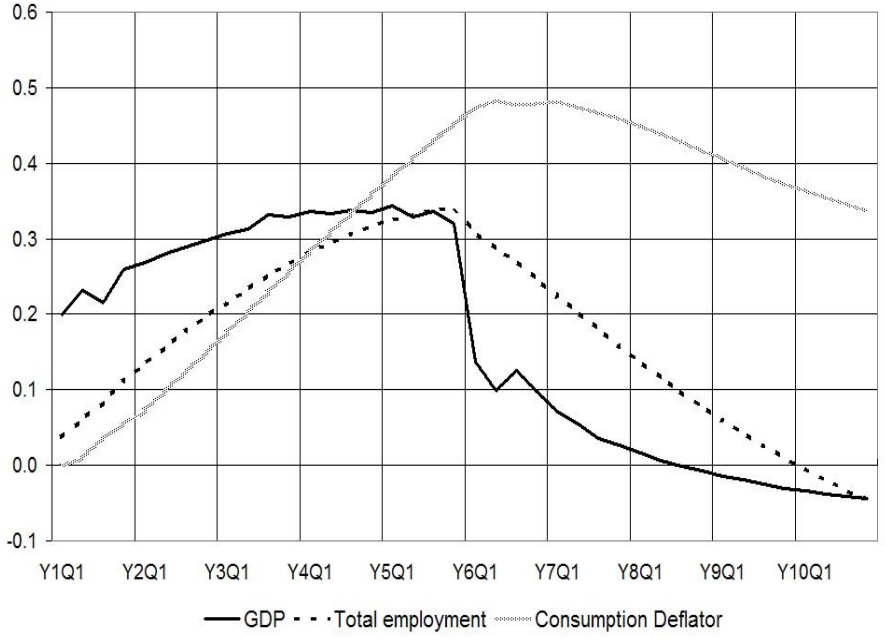


Chart C3: Simulation 3: Increase in World Demand for Five Years



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