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The Hungarian Quarterly Projection Model (NEM)

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[A Negyedéves Előrejelző Modell (N.E.M.)]

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Abstract

This document gives a detailed account of the current version of the Hungarian Quarterly Projection Model (NEM). It describes the main building blocks, presents the forecast performance of the model and, finally, it illustrates the responses to the most important shocks the Hungarian economy may face. This version of the model is used to produce the Bank's quarterly projections, as well as to perform simulations and scenario analyses.

JEL classification: C50; C53; E17.
Keywords: econometric modelling, forecasting, simulation.

Összefoglaló

Jelen tanulmány részletes leírást közöl a Magyar Nemzeti Bankban jelenleg használatos Negyedéves Előrejelző Modellről (N.E.M.). Bemutatja annak általános felépítését és fő szerkezeti elemeit, előrejelző képességét, és végül viselkedését a magyar gazdaságot esetleg érő sokkok esetén. A modellt a jelen formában a negyedéves előrejelzés készítéséhez, valamint szimulációkhoz és szcenárióelemzésekhez használjuk.

1. Introduction

Generally, the models used by central banks for the purposes of forecasting and policy analysis range from time series models for short-term assessment to calibrated theoretical models and estimated structural models. This document describes the structural macroeconometric model of the Magyar Nemzeti Bank: the Quarterly Projection Model (NEM).

The origins of NEM date back to 1999, when the MNB started to include Hungary in the NIGEM global model. This was primarily used for simulations and scenario analyses; however, projections for some world variables were also gained from NIGEM. The first version of the NEM model was developed in 2003. The decision to develop a new macroeconomic model was motivated by the switch to the inflation targeting regime.

In order to achieve its inflation target, the MNB needs an assessment of the current state of the economy and a forecast for its future path. The MNB publishes its comprehensive macroeconomic projections in the *Quarterly Report on Inflation.* The forecasts are produced by using both the NEM model and other forecasting methods. The latter are comprised of expert forecasting systems using partial econometric equations, time-series techniques, indicator models and pure expert judgement, while the actual NEM model forecasts also encompass expert judgment in specifying the path of the exogenous variables and the possible add-factors that usually reflect foreseeable shocks to the economy. The model-based and expert forecasts are then harmonised, so that the final projection becomes a consensus of model-based and expert level information.

In addition to preparing the quarterly projection, NEM is used also for simulations and scenario analyses. On the one hand, these can take the form of updating the projections with changing some of the exogenous assumptions and, on the other, NEM is also used to carry out more complex policy and macroeconomic simulations.

The model was put to use in the forecast round of the February 2004 issue of the *Report.* Since then, it has been updated continuously. Jakab et al. (2004) give a short summary of the initial version of the model. This document updates and extends that paper, in that it describes the latest version of the model currently used for forecasting and simulations.

2. The structure of the model

The NEM model has the features of neo-Keynesian models in the short run and those of neoclassical models in the long run, with a vertical long run Phillips curve and short-run nominal rigidities. Most of the behavioural equations are written in error-correction form (ECM) which is a useful tool for combining the Keynesian short-run analysis with the neoclassical long-run analysis. The long-run relationships are generally set up to reflect economic theory, while the short-run dynamics result from the estimated ECM form which is capable of reflecting short-run sluggish adjustments.

In the long run, the model is determined by the supply block, where the production function has two inputs, capital and labour, with labour-augmenting technological progress. As capital and labour are not perfect substitutes, the functional form of the production is a Constant Elasticity of Substitution (CES) function. The long-run path of the model is determined by an assumed rate of labour-augmenting technological progress, a demographically given labour force, and an assumption of the Non Accelerating Inflation Rate of Unemployment (NAIRU).

The demand side of the model is relatively standard: consumption is determined by income and (financial and housing) wealth. Private demand for labour and capital (and hence for investment) is determined by profit maximisation conditions, while public employment and public capital are modelled exogenously. Exports and imports depend on relative export and import prices. On the other hand, exports are further determined by the export market share, while import demand is driven by the import-content-weighted sum of demand components.

The price and wage structure provides the links between the real and nominal side of the model. Prices and wages are set in a way that the output gap and the unemployment gap close in long run. The output gap affects domestic inflation, while the difference between actual and potential employment influences real private wages. In the long run, nominal private sector wages are given by the value of marginal product of labour derived from the production function, while producer prices are determined by unit labour costs.

Fiscal policy is modelled with four revenue items and five expenditure items. Fiscal data are based on (augmented) SNA figures, which show the fiscal stance including off-budget activities. For long-run simulation purposes, fiscal policy might follow a solvency rule, with most of the adjustment taking place with changes either in personal income taxes or government (non-wage) expenditure.

The model version described here is backward-looking, and as such, there is no role for expectations. Monetary policy might follow a standard Taylor-rule policy, an inflation targeting rule, a fixed nominal and a backward-looking fixed real short-term interest rate policy. The nominal exchange rate and interest rate are treated as exogenous variables, but we have also experimented with a forward-looking version, which is currently under development. This incorporates policy rules with forward-looking inflation and forward-looking uncovered interest rate parity condition for the exchange rate.

In the following, we describe the model structure and the equations of the model in detail. The variables denoted with STAR reflect the long-run, or equilibrium path of the variable in question.[1] The model was estimated equation by equation and not in system terms. We structured the model into six blocks: supply, demand, price and wage, trade, fiscal, and monetary sector.

2.1 THE SUPPLY SIDE AND FACTOR DEMANDS

The neoclassical relationships ensure that in the long run real equilibrium is determined by available factors of production and technological progress. The supply side of the model reflects the optimising neoclassical behaviour of the firm. The theoretical definition of aggregate output is given by equation (1a): aggregate output *(Y)* in the long run (potential output) is given by a CES production function with two factors, capital *(K)* and labour *(E),* with labour-augmenting technological progress *(λ);* The long-run demand for capital and labour (equations 1b and 1c, written in lowercase-letters that denote

[1] The full list of variables together with their definitions is presented in the Appendix.

logs) is derived from the first order condition of the profit maximising firm, given the production function (1a) and factor input prices (wage cost: wage+social security contribution *w+ssc* and the user cost of capital *r,* respectively).

$$Y = A\left[\alpha K^{\frac{\sigma-1}{\sigma}} - (1-\alpha)(\lambda E)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}, \tag{1a}$$

$$k = (\sigma-1)\log A + \sigma\log\alpha + y - \sigma r, \tag{1b}$$

$$e = (\sigma-1)\log A + \sigma\log(1-\alpha) + y - \sigma(w+ssc) + (\sigma-1)\log\lambda\,. \tag{1c}$$

There is, however, some deficiency with this form of representations of the supply side, which arises from the problem that we cannot measure private sector output directly. Therefore, the production function is written in terms of total output, total capital stock and total employment in the economy, while the factor demand equations of the NEM model reflect the optimising behaviour of the private sector. When we turn to estimating equations (1b) and (1c), in the absence of private sector output we still use total output, though only private capital stock and private employment (equations 2 and 3).

The CES functional form of the production function was confirmed by various studies on micro and macro data. The estimate for the elasticity of substitution between capital and labour *(σ)* varies across different studies: The production function in its current form assumes an elasticity of 0.367 which is the panel estimate of Kátay (2003) on the Hungarian Tax Authority Firm Database and reflects a low substitution between capital and labour.[2] The unobserved component estimate of Reppa (2005) lies below this value, while Kátay (2004) and Kátay and Wolf (2004) report a higher estimate for this parameter. Despite the various estimates for σ, none of these studies support a Cobb-Douglas functional form for the production function of the Hungarian economy.

Capital is divided into private and government capital. The accumulation of the government capital stock is determined by the exogenously given government investment and the depreciated stock from the previous period. Private capital evolves according to the first order condition of profit maximisation, given the production function and the user cost of capital (equation 1b). Equation (2) is the estimated error correction form of (1b).[3] In the long run, the private capital stock has unit elasticity with respect to potential output and -0.367 the real user cost of capital, with a very slow adjustment to the long-run equilibrium (figure 1).[4] The speed of adjustment of capital, although low, lies within the wide range of OECD country estimates of Turner et al. (1996).

$$\begin{aligned}\log(KPSTAR) &= \underset{(0.006)}{0.717} + \log(YP) \\ &\quad -0.367 * \log(USER/100) \\ D\log(KP) &= \underset{(0.0009)}{0.0018} - 0.002 * (\log(KP(-1)) - \log(KPSTAR(-1))) \\ &\quad + \underset{(0.086)}{0.843} * D\log(KP(-1)) \\ AdjR^2 &= 0.75 \quad DW = 1.37.\end{aligned} \tag{2}$$

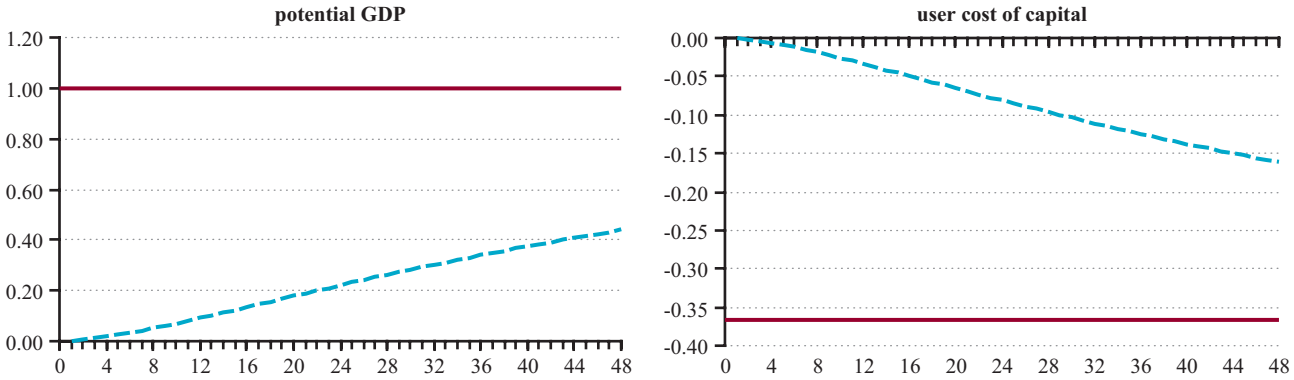
[2] Recent data show a somewhat higher degree of capital/labour substitution; therefore, this elasticity coefficient estimate might change in the future.

[3] Throughout the paper, variables suffixed with STAR denote the right-hand-side of the cointegrating equation so that (X-XSTAR) denotes the error correction term in the estimated ECM equation.

[4] The figures in this section (figure 1 to figure 12) reflect single equation responses of the left-hand side variable to changes in its explanatory variables. The horizontal axes reflect quarters.

Figure 1

The response of private capital stock to a 1% shock to its explanatory variables*



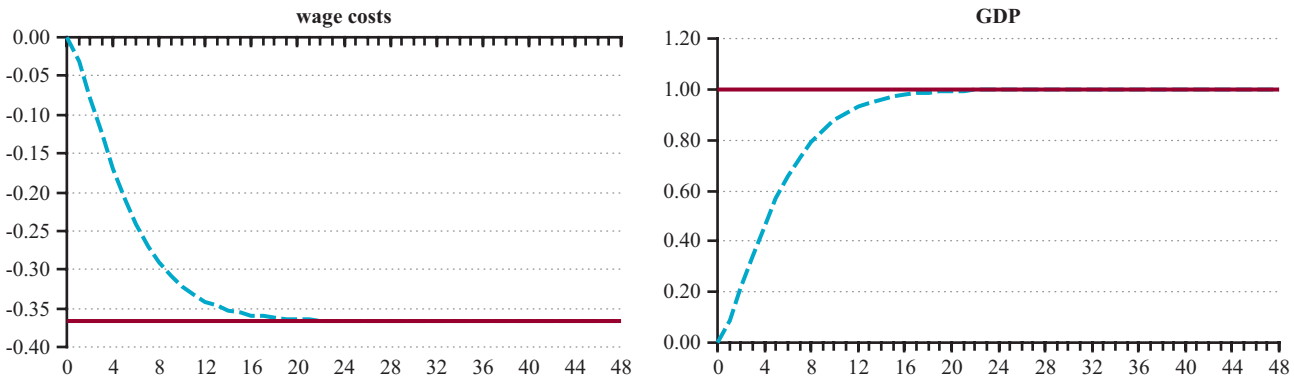
**Single equation response.*

Total employment is treated similarly to capital. It is given by the sum of private and public sector employees, where the latter is given exogenously and the former is determined by the profit maximisation condition (equation 1c). Long-run employment is determined by wage costs and aggregate demand. The most important parameter of the employment equation is the wage cost *(WCR * WP / PY)* elasticity of employment. This is identical to the elasticity of substitution between capital and labour from the CES production function (1a), and is calibrated to the value -0.367. The output elasticity of employment is imposed to one. The values of these two elasticities correspond to the theoretical form of the labour demand function (1c), which in turn results from the optimising behaviour of a firm with a CES production function. Neither output nor wage costs affect immediately private employment; rather, their effects build up gradually, as the adjustment of employment is slow (figure 2).

$$\begin{aligned} \log(EPSTAR) &= \underset{(0.002)}{4.259} + \log(Y) - 0.367 * \log(WCR * WP / PY) \\ &\quad - (1-0.367) * \log(TFP) \\ D\log(EP) &= \underset{(0.0005)}{0.00116} - \underset{(0.045)}{0.088} * (\log(EP(-1)) - \log(EPSTAR(-1))) \\ &\quad + \underset{(0.108)}{0.490} * D\log(EP(-1)) \\ &\quad \overline{AdjR^2 = 0.56 \quad DW = 2.26.} \end{aligned} \tag{3}$$

Figure 2

The response of private employment to a 1% shock to its explanatory variables*



**Single equation response.*

Potential output (equation 4), is defined in accordance with the CES production function (1a). This combines the total capital stock with the long-run level of (technology-augmented) total employment, which in turn is driven by demographic

trends (the labour force trend) and the trend rate of unemployment (filtered unemployment rate). Technology (TFP) is labour-augmenting and is specified exogenously.[5]

$$\begin{aligned} YP = & \underset{(0.018)}{0.268} * (\underset{(0.0166)}{0.907} * ((KG + KP))\text{^}((0.367-1)/0.367) \\ & + (1 - \underset{(0.0166)}{0.907}) * (LFTR * (1 - UTR/100) * TFP)\text{^}((0.367-1)/0.367)) \\ & \text{^}(0.367/(0.367-1)) \\ & \overline{AdjR^2 = 0.99 \quad DW = 0.30.} \end{aligned} \tag{4}$$

2.2 COMPONENTS OF AGGREGATE DEMAND

Aggregate demand is given by the sum of household and government consumption, investment, changes in inventories and net exports.

Household *consumption expenditure* is determined in the long run by the sector's real disposable income and real (financial and housing) wealth (equation 6). Nominal disposable income is given by the sum of compensation to employees, financial transfers received by households, interest incomes and other personal incomes, net of personal income taxes:

$$PDI = COMP + FTRAN + EII + OPI - PTAX. \tag{5}$$

The long-run income elasticity of consumption is 0.62, and the financial wealth elasticity is 0.23. The sum of income and wealth elasticities is restricted to one, so that housing wealth elasticity is 0.15. Short-run dynamics are driven by habits in consumption (lagged changes in consumption) and changes in real disposable income. The parameter of the latter is around 0.20 and is interpreted as the share of households that are liquidity constrained by consumption. While consumption responds to wealth changes with a delay, real disposable income also has an immediate effect on consumption, although its full effect appears later, with some overshooting (figure 3).

$$\begin{aligned} \log(CESTAR) = & -\underset{(0.095)}{0.879} + \underset{(0.048)}{0.620} * \log(PDI/CED) + \underset{(0.045)}{0.234} * \log(HFW/CED) \\ & + (1 - 0.620 - 0.234) * \log(HHW/CED) \\ D\log(CE) = & \underset{(0.0005)}{0.00048} - \underset{(0.0017)}{0.043} * (\log(CE(-1)) - \log(CESTAR(-1))) \\ & + (1 - 0.196) * D\log(CE(-1)) + \underset{(0.051)}{0.196} * D\log(PDI/CED) \\ & \overline{AdjR^2 = 0.93 \quad DW = 2.02.} \end{aligned} \tag{6}$$

Total consumption of households is the sum of consumption expenditure and government transfers in kind which are treated as exogenous (and usually grow in line with government consumption).

Government consumption is also treated as exogenous.

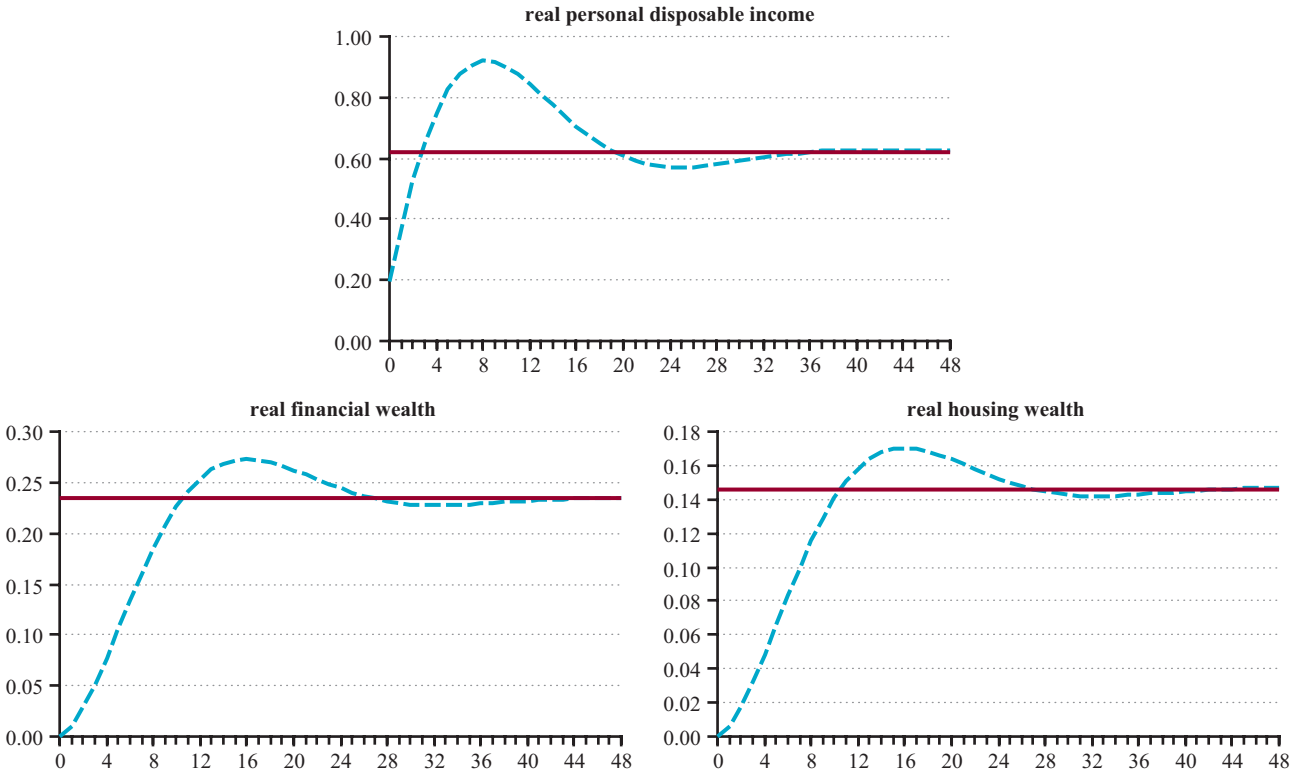
Investment is composed of corporate, household and government investment. Corporate investment is determined by the choice of the private capital stock of the profit maximising firm (equation 2). Government and household investment is treated as exogenous.

Changes in inventories are also modelled as being exogenous, and are subject to expert judgement.

[5] To illustrate the construction of the labour-augmenting technological progress series, consider a production function in its general form, assuming homogeneity of degree one in capital *(K)* and effective labour *(λE): Y = F(K, λE).* Totally differentiating and making use of the homogeneity property yields: $\frac{dY}{Y} = \omega_K \frac{dK}{K} + \omega_E \left(\frac{d\lambda}{\lambda} + \frac{dE}{E}\right)$, where ω_K and ω_E denote (the time varying) capital and labour income shares. This allows the computation of the growth rate of technological progress $\frac{d\lambda}{\lambda}$.

Figure 3

The response of consumption expenditure to a 1% shock to its explanatory variables*



**Single equation response.*

2.3 PRICES AND WAGES

The link between the real and nominal side of the model is described by the price and wage structure. There are three major mechanisms that drive the evolution of prices in the economy. The first is related to the pricing rigidities on the goods market, where the GDP deflator presents Phillips curve behaviour and is determined by demand side pressures in the short run and by unit labour costs in the long run. The second mechanism is related to the labour market, where private sector wages reflect the outcome of a bargaining process, and so they are determined as a function of the levels of productivity and unemployment in the economy. Third, prices in the economy are also influenced by the pass-through of exchange rate movements to prices of imported goods. In addition to these, there exist several other, perhaps less important pricing mechanisms that determine the evolution of other prices, e.g. export prices, corporate investment prices and housing prices.

2.3.1 The GDP deflator and the Phillips curve

The probably most important pricing mechanism of the model (written in terms of the GDP deflator) is expressed by the Phillips curve which transforms the imperfections in the goods market into price responses. The form of the GDP deflator equation has been set up in accordance to the existing Phillips curve literature

A traditional Phillips curve describes short-run inflation dynamics by lagged values of inflation and some cyclical indicator, such as the output gap, real marginal cost, etc. Contrary to these, the New Keynesian Phillips curve literature derives inflation dynamics based on the individual firm's price setting behaviour (e.g. Calvo, 1983). Such a model has been presented, among others, by Gali and Gertler (1999). According to the resulting New Keynesian Phillips curve, inflation is written in terms of past and future expected inflation and the cyclical component of real marginal cost.

The approach we take in specifying our Phillips curve differs from those presented above in the following dimensions. First, we abstract from the forward-looking inflation term. Secondly, as we maintain the assumption that firms set their

prices as a mark-up over marginal cost, the cyclical indicator we use is the difference between mark-up-adjusted nominal marginal cost and the prevailing price level. If we denote inflation by π, nominal marginal cost, mark-up and price level by *mcn*, μ and *p* (in logs), then the theoretical form of our pricing equation can be written as:

$$\pi_t = \theta_1 \pi_{t-1} + \theta_2 (mcn_t + \mu_t - p_t). \tag{7}$$

We decompose mark-up into a fixed mark-up $\overline{\mu}$ defined as the mark-up associated with flexible price equilibrium with constant demand elasticity, and a time-varying component $(\mu_t - \overline{\mu})$ which captures the cyclical component of the mark-up that is due to variations in the aggregate demand. The equation (7) can be decomposed as:

$$\pi_t = \theta_1 \pi_{t-1} + \theta_2 (mcn_t + \overline{\mu} - p_t) + \theta_2 (\mu_t - \overline{\mu}). \tag{8}$$

We assume that the fluctuations in the mark-up due to changes in aggregate demand are proportional to fluctuations in the output gap. Further, we proxy the optimal, profit maximising price for the firm $(mcn_t + \overline{\mu})$ with a constant mark-up over unit labour costs *(αULC)*.[6] Equation (8) is then written to be equivalent with an error correction form where past deviations from the desired price affect current pricing decision and is written as follows:

$$d\log(PY_t) = \theta_1 d\log(PY_{t-1}) + \theta_2 (\log(\alpha ULC_{t-1}) - \log(PY_{t-1})) + \theta_3 \log(GAP_t). \tag{9}$$

The estimated form of (9) is given by equation (10).

$$\begin{aligned} \log(PYSTAR) &= \underset{(0.003)}{-11.766} + \log(ULC) \\ D\log(PY) &= \underset{(0.0028)}{0.00695} - \underset{(0.069)}{0.229} * (\log(PY(-1)) - \log(PYSTAR(-1))) \\ &\quad + 0.15 * \log(GAP) + \underset{(0.097)}{0.687} * D\log(PY(-1)) \\ &\quad \overline{AdjR^2 = 0.81 \quad DW = 2.62.} \end{aligned} \tag{10}$$

According to this setup, in long run the GDP deflator is determined by unit labour costs. In the short run, it is influenced by the output gap and the price setting inertia (lagged values of the GDP deflator). Prices respond to changes in the output gap immediately and with some overshooting reaction, while they adjust only gradually to changes in unit labour costs (figure 4).

The parameter of the output gap is not estimated but is calibrated to 0.15. When estimating, this parameter proved to be insignificant; however, we have decided to keep this parameter as we do not expect that output gap has no effect on

Table 1

The effect of the output gap on prices in various models

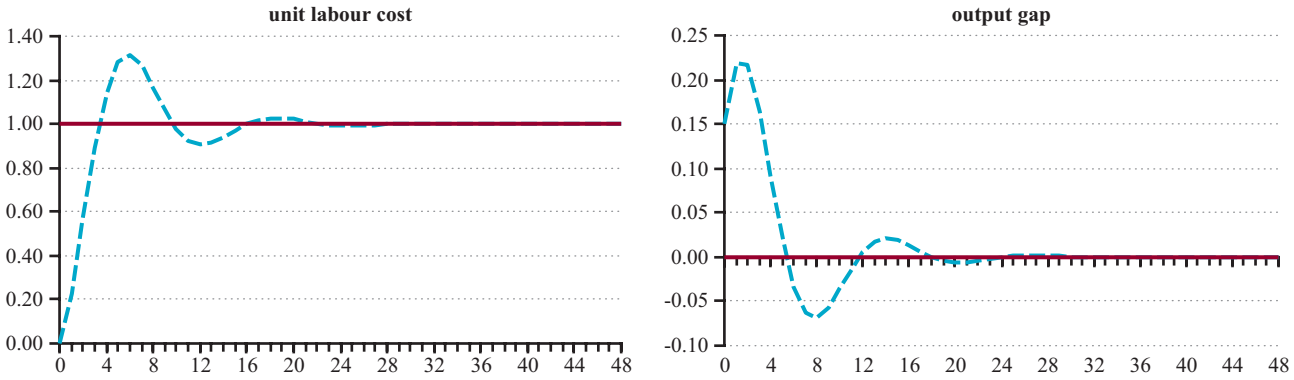
	GAP parameter	Note
Austria, MCM	-	feedback only from unemployment to wages
Netherlands, MCM	0.23	
Spain, MCM	-	feedback only from unemployment to wages
AWM	0.03	
Denmark, NIGEM	0.17	consumer price feedback from a change in capacity utilisation
Japan, NIGEM	3.66	consumer price feedback from a change in capacity utilisation
NIGEM, min-max range	0.05(AT) - 0.84(NL)	effect on wholesale prices
Hungary, NIGEM	0.167	effect on consumer pries
NEM	0.15	

[6] The assumption of constant mark-up over larger time periods might be too restrictive in transition economies.

prices. Therefore, we set a parameter value which lies within the range of international estimates (see Table 1 for estimates from various models) and is close to the output gap parameter of the Hungarian block of the NIGEM model.

Figure 4

The response of the GDP deflator to a 1% shock to its explanatory variables*



**Single equation response.*

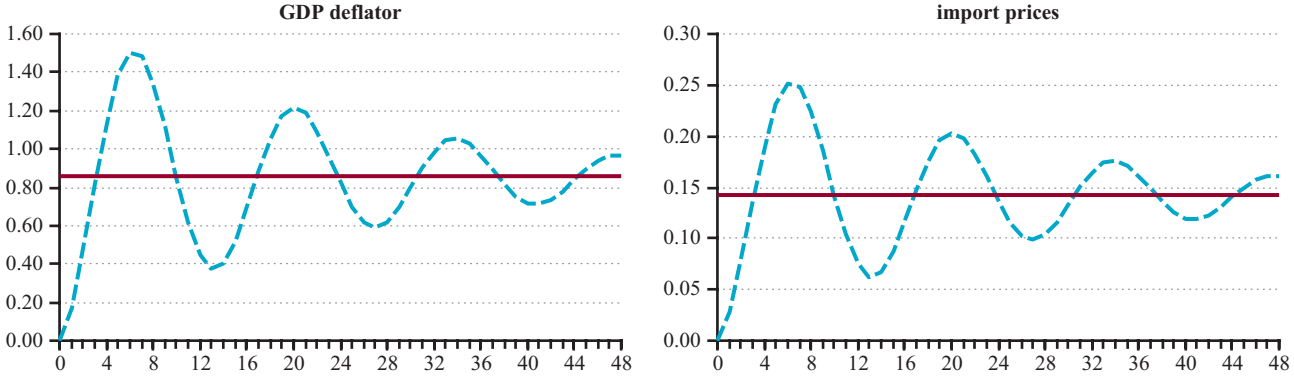
2.3.2 Consumer prices

Core inflation in the long run is defined as a weighted average of the GDP deflator and gross manufacturing import prices. As the GDP deflator is a gross price index and import prices are measured on a net basis, the latter are corrected by occasional changes in indirect taxes (VAI). The long-run elasticity of core inflation to the GDP deflator is around 85% and 15% to import prices (equation 11). In the short run, the dynamics of core inflation is heavily determined by inflation inertia. The adjustment to its new long-run equilibrium resulting from changes in GDP deflator and in import prices is gradual, with the adjustment also presenting some oscillating behaviour (figure 5).

$$\begin{aligned}\log(CORESTAR) &= \underset{(0.002)}{0.0055} + \underset{(0.012)}{0.857} * \log(PY) \\ &\quad + (1-0.857) * \log(PMG * VAI) \\ D\log(CORE) &= \underset{(0.0017)}{0.00062} - \underset{(0.075)}{0.199} * (\log(CORE(-1)) - \log(CORESTAR(-1))) \\ &\quad + \underset{(0.108)}{0.917} * D\log(CORE(-1)) \\ &\quad \overline{AdjR^2 = 0.80 \quad DW = 2.27.}\end{aligned} \tag{11}$$

Figure 5

The response of the core price level to a 1% shock to its explanatory variables*



**Single equation response.*

The *consumer price index* is finally defined as the weighted average of core inflation, and the unprocessed food price, administered price and fuel price indices (equation 12). In a forecasting exercise, the latter three price indices are set exogenously, while in simulations they may follow various rules (e.g. driven by other price indices and exchange rate movements).

$$\begin{aligned} CPI = {} & CPI(-4) * (0.676 * CORE / CORE(-4) \\ & + 0.059 * NPF / NPF(-4) + 0.203 * PG / PG(-4) \\ & + (1 - 0.676 - 0.059 - 0.203) * FUEL / FUEL(-4)). \end{aligned} \tag{12}$$

2.3.3 Export and import prices

In the long run, *manufacturing export prices* depend exclusively on manufacturing export prices abroad, expressed in the domestic currency. Consequently, the long-run elasticity of foreign prices is unity, and prices adjust very quickly to changes in foreign export prices (figure 6).

$$\begin{aligned} \log(PXGSTAR) &= \underset{(0.003)}{0.012} + \log(PXGF * EFEX) \\ D\log(PXG) &= \underset{(0.0028)}{0.0015} - \underset{(0.121)}{0.409} * (\log(PXG(-1)) - \log(PXGSTAR(-1))) \\ &\quad + \underset{(0.126)}{0.955} * D\log(EFEX * PXGF) \\ &\quad \overline{AdjR^2 = 0.65 \quad DW = 2.17.} \end{aligned} \tag{13}$$

Figure 6

The response of export prices to a 1% shock to their explanatory variables*

**Single equation response.*

The *export deflator* is defined as the weighted average of manufacturing export prices, world commodity prices, world oil prices and the domestic consumer price index.

$$\begin{aligned} PX = {} & PX(-1) + 0.766 * D(PXG) + 0.071 * D(WDC) \\ & + 0.014 * D(WDO) + 0.150 * D(CPI). \end{aligned} \tag{14}$$

Similarly to manufacturing export prices, *manufacturing import prices* are also driven by their foreign counterpart with unit long-run elasticity. The adjustment to its long-run level is also relatively quick (figure 7).

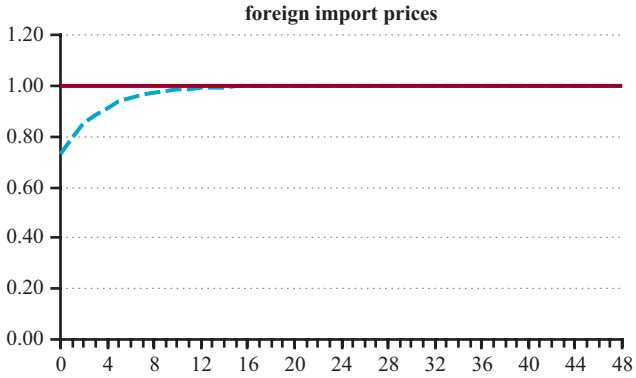
$$\log(PMGSTAR) = \underset{(0.0034)}{0.036} + \log(PMGF * EFEX)$$

$$D\log(PMG) = \underset{(0.0023)}{0.0029} - \underset{(0.100)}{0.247} * (\log(PMG(-1)) - \log(PMGSTAR(-1))) \qquad (15)$$
$$+ \underset{(0.097)}{0.733} * D\log(EFEX * PMGF)$$

$$AdjR^2 = 0.63 \quad DW = 2.07.$$

Figure 7

The response of import prices to a 1% shock to their explanatory variables*



**Single equation response.*

The *import deflator,* just as the export deflator, is defined as the weighted average of manufacturing import prices, world commodity prices, world oil prices and the domestic consumer price index.

$$PM = PM(-1) + 0.743 * D(PMG) + 0.044 * D(WDC) \qquad (16)$$
$$+ 0.061 * D(WDO) + 0.152 * D(CPI).$$

2.3.4 Corporate investment and housing prices

As investment goods can be either imported or domestically produced, *corporate investment prices* are determined by domestic prices (GDP deflator) and manufacturing import prices. The weight of GDP deflator is around only 30% in the long run, while its immediate effect is higher, around 35% (figure 8). Accordingly, reflecting the relatively high import content of investment goods, the long-run weight of import prices is 70%, while in the short run it is somewhat lower, 65%.

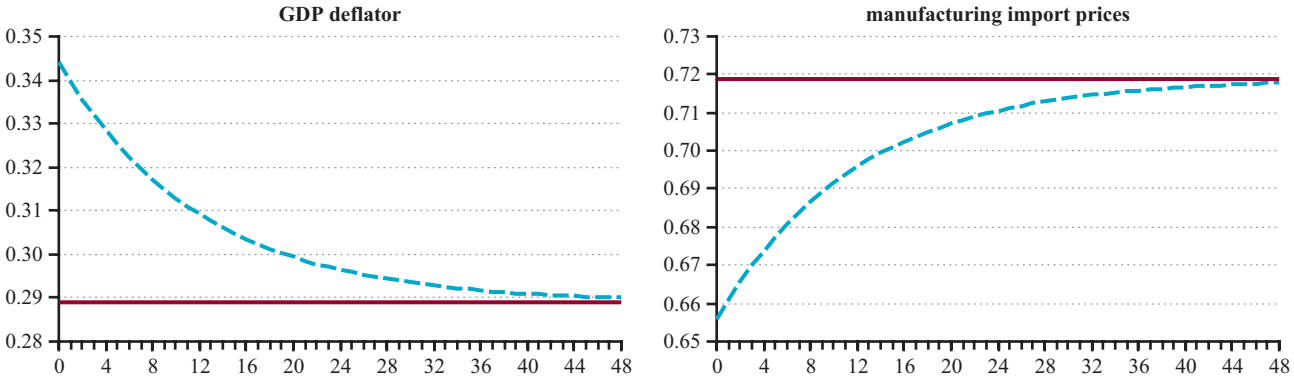
$$\log(PCISTAR) = \underset{(0.004)}{0.0297} + \underset{(0.020)}{0.289} * \log(PY) + (1 - 0.289) * \log(PMG)$$

$$D\log(PCI) = -\underset{(0.0018)}{0.00018} - \underset{(0.079)}{0.08} * (\log(PCI(-1)) - \log(PCISTAR(-1))) \qquad (17)$$
$$+ \underset{(0.076)}{0.656} * D\log(PMG) + (1 - 0.656) * D\log(PY(-1))$$

$$AdjR^2 = 0.76 \quad DW = 1.90.$$

Figure 8

The response of corporate investment prices to a 1% shock to their explanatory variables*



**Single equation response.*

Housing prices are driven by the evolution of household disposable income, with unity elasticity in the long run. This long-run relationship and the unit elasticity restriction follow Vadas (2004). The adjustment of housing prices to income occurs relatively quickly, in approximately one year (figure 9).

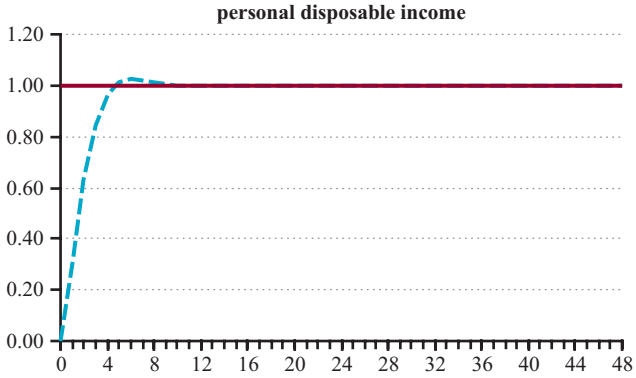
$$\log(PHSTAR) = \underset{(0.022)}{-7.503} + \log(PDI)$$

$$D\log(PH) = \underset{(0.0059)}{-0.0017} - \underset{(0.099)}{0.316} * (\log(PH(-1)) - \log(PHSTAR(-1))) + \underset{(0.163)}{0.315} * D\log(PH(-1)) \qquad (18)$$

$$AdjR^2 = 0.35 \quad DW = 1.35.$$

Figure 9

The response of housing prices to a 1% shock to personal disposable income*



**Single equation response.*

2.3.5 Labour market

In order to match the observed labour market behaviour, our model has to be able to explain non-competitive labour market outcomes, as well as movements in labour market participation, employment and unemployment.

Wages are determined through a 'right-to-manage' bargaining process, where we assume that both workers and employers possess some bargaining power. Given this wage level, firms decide upon the level of employment. The non-market-clearing wages will allow for unemployment. Wages are determined through the following bargaining equation:

$$w = \omega + \theta(y - e) + \beta(e - l) + \eta \log\lambda, \qquad (19)$$

where *y–e* denotes productivity, *e–l* the (inverse of the) unemployment rate, λ the labour-augmenting technological progress and ω the mark-up on wages. Combining the supply block equations (1a), (1b) and (1c) with the wage bargaining (19) and impose the restriction $\theta+\eta=1$ ensures a unitary long-run elasticity of wages, capital and output and zero elasticity of employment (and unemployment) to technological progress, as well as a stable wage share.

We may also impose an additional restriction, $\eta=0$ and $\theta=1$, as it performed well empirically and our estimates lied close to these restricted values. Currently, we estimate this form in equation (20), where private nominal wages in the long run are determined by the GDP deflator and labour productivity, both with unit elasticity. Actual unemployment is also included in the long-run wage equation with a -2% semi-elasticity. However, we assume that the long-run Phillips curve is vertical, as the constant of the long-run wage equation incorporates both the mark-up on wages and the equilibrium unemployment rate (as unemployment is included in level, not in deviation from its equilibrium). Unemployment is defined as the percentage difference between the labour force and total employment, where labour force follows demographic developments and is introduced exogenously. International estimates for the elasticity or semi-elasticity of unemployment vary within a relatively wide range (Table 2). Our estimate lies inside this range.

Short-run wage dynamics are driven by deviation from the long-run wage level and by past wage growth. The adjustment to the long-run equilibrium is relatively slow (figure 10).

$$\begin{aligned}\log(WPSTAR) &= \underset{(0.016)}{11.466} + \log(PY) \\ &\quad + (\log(Y) - \log(EP)) - \underset{(0.002)}{0.021} * U \\ D\log(WP) &= \underset{(0.003)}{0.0216} - \underset{(0.049)}{0.167} * (\log(WP(-1)) - \log(WPSTAR(-1))) \\ &\quad + \underset{(0.108)}{0.145} * D\log(WP(-1)) \\ &\quad \overline{AdjR^2 = 0.67 \quad DW = 1.30.}\end{aligned} \tag{20}$$

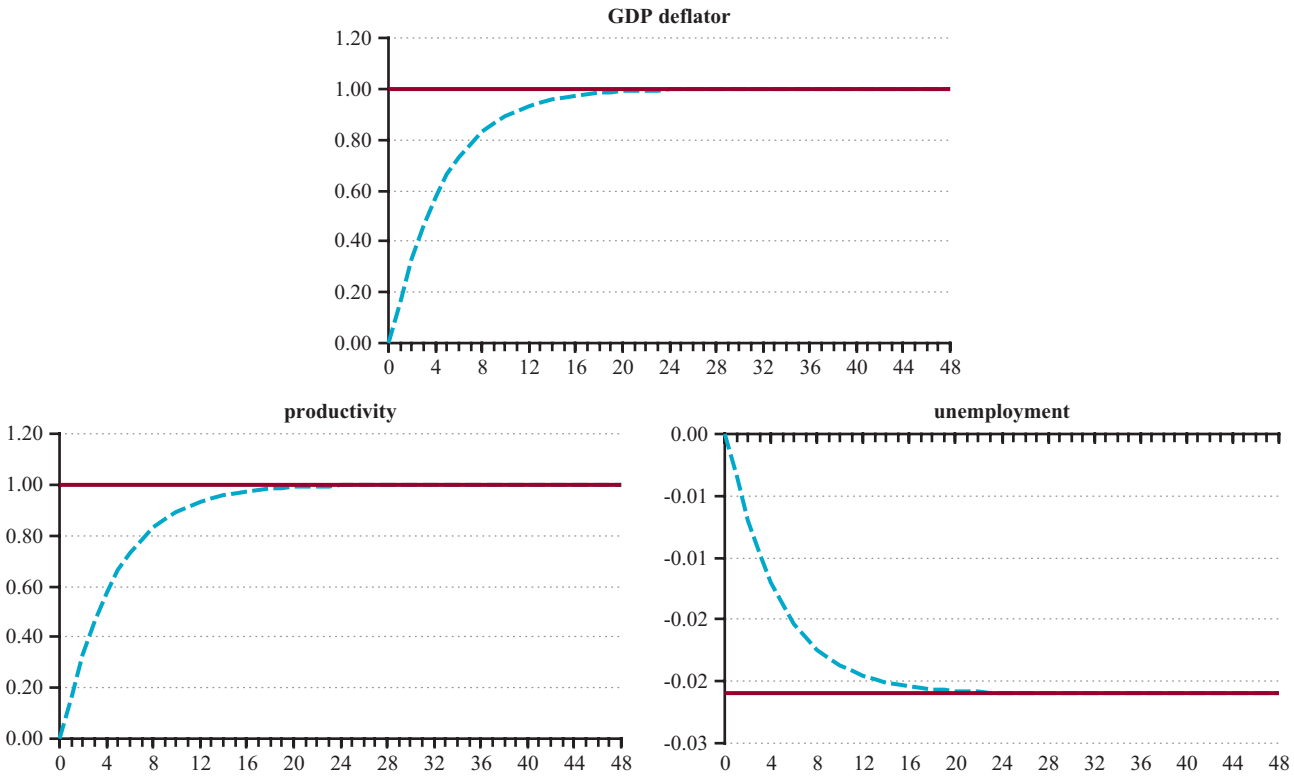
Table 2

The effect of unemployment on wages in various models

	Unemployment elasticity	Note
Austria, MCM	-0.008	(U-NAWRU) semi-elasticity
Netherlands, MCM	-0.004	(U-NAWRU) semi-elasticity
Spain, MCM	-1.04	U level, in long run
AWM	-0.015	(U-NAWRU) elasticity
NIGEM, min-max range	-0.00125(BE) - -0.083(SP)	semi-elasticity
Hungary, NIGEM	-0.03	semi-elasticity, short-term equation
NEM	-0.021	semi-elasticity

Figure 10

The response of private nominal wages to a 1% shock to their explanatory variables*



**Single equation response.*

Regarding government wages, in the forecasting exercises they are treated as exogenous, while in some simulations their dynamics might also be influenced by private sector wages.

2.3.6 Cost of capital

The user cost of capital depends on the long-term interest rate, equity premium, corporate investment prices, the GDP deflator, the depreciation rate and the corporate tax rate. It reflects the cost of holding one unit of capital: the cost of 'buying' it (the long-term interest rate adjusted with risk premium), the depreciation cost (calculated at the average depreciation rate) and capital gains/losses from changes in the price of capital. The user cost is corrected with the effective corporate tax rate and with the relative prices of capital and GDP (equation 21). For some simulations we may also consider the expected future changes in the price of capital, in a forward-looking manner.

$$USER = PCI/PY * ((LR + EQPR + (1 - CTAXR) * DEP)/4 \\ -1/4 * \sum_{i=0}^{-3} (100 * (PCI(i)/PCI(i-1) - 1)))/(1 - CTAXR). \quad (21)$$

2.4 FOREIGN TRADE

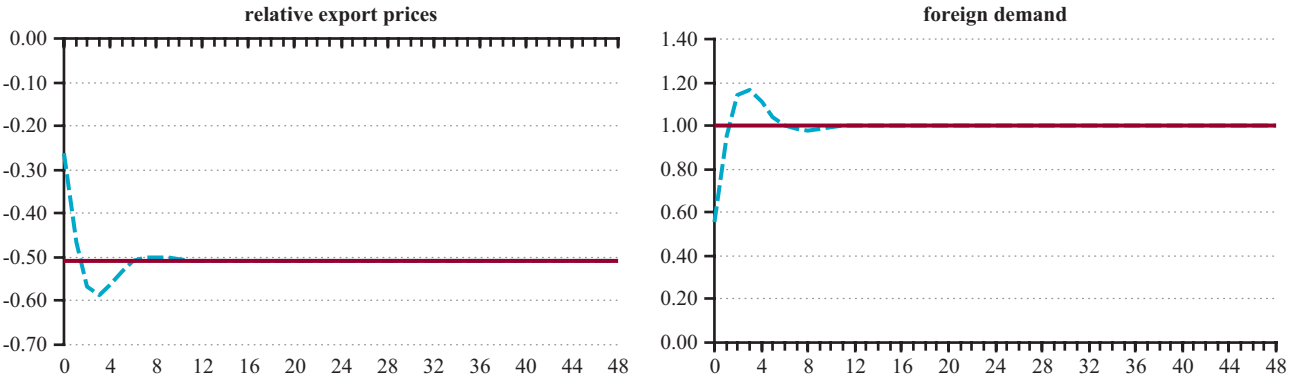
In the long run, *exports* are driven by external demand, price competitiveness and a special variable that captures integration effects (equation 22). External demand is modelled exogenously, while competitiveness is given by the real exchange rate expressed as the ratio of Hungarian export prices to competitors' prices. The intensified trade links, on the one hand, are captured by an 'integration' variable that reflects productivity developments in the economy and equals the labour-augmenting technological progress variable; on the other hand, they are further reflected by a time trend. Foreign demand and technological progress drive exports with unit elasticity, while time trend also contributes

about 0.3 per cent to export growth. The short-run dynamics are driven by changes in foreign demand, the real exchange rate and past export growth. The adjustment due to the new equilibrium is relatively fast, with some overshooting (figure 11).

$$\begin{aligned}\log(XVOLSTAR) &= \underset{(0.110)}{6.594} + \log(S) + \log(INTEGR) \\ &\quad + \underset{(0.029)}{0.330} * \log(TREND) - \underset{(0.288)}{0.508} * \log(REREXP) \\ D\log(XVOL) &= \underset{(0.005)}{0.0115} - \underset{(0.123)}{0.389} * (\log(XVOL(-1)) - \log(XVOLSTAR(-1))) \\ &\quad + \underset{(0.260)}{0.553} * D\log(S) - \underset{(0.164)}{0.261} * D\log(REREXP) \\ &\quad + \underset{(0.156)}{0.414} * D\log(XVOL(-1)) \\ &\quad \overline{AdjR^2 = 0.47 \quad DW = 2.12.}\end{aligned} \tag{22}$$

Figure 11

The response of export volumes to a 1% shock to their explanatory variables*



**Single equation response.*

Imports are driven by demand for imported goods and the competitiveness of imported goods relative to domestic goods, expressed as the ratio of the price level of imported goods relative to the aggregate domestic price level (core price index). Import demand is modelled by aggregating real GDP components weighted by their respective import content (equation 23).

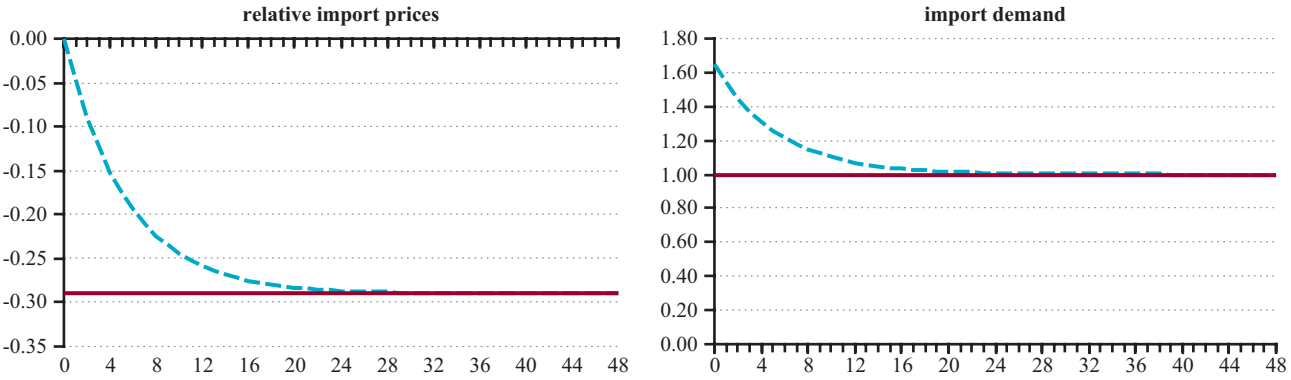
$$SM = 0.279 * HC + 0.104 * GC + 0.523 * I + 0.479 * DS + 0.580 * XVOL. \tag{23}$$

Import demand affects imports with unit elasticity, while the elasticity of the real exchange rate is around 0.3. Import dynamics are also determined by changes in import demand, and the adjustment to the new external condition is relatively slow (figure 12).

$$\begin{aligned}\log(MVOLSTAR) &= \underset{(0.007)}{0.0023} + \log(SM) - \underset{(0.037)}{0.289} * \log(RERIMP) \\ D\log(MVOL) &= -\underset{(0.002)}{0.0054} - \underset{(0.073)}{0.169} * (\log(MVOL(-1)) - \log(MVOLSTAR(-1))) \\ &\quad + \underset{(0.081)}{1.645} * D\log(SM) \\ &\quad \overline{AdjR^2 = 0.96 \quad DW = 1.25.}\end{aligned} \tag{24}$$

Figure 12

The response of import volumes to a 1% shock to their explanatory variables*



**Single equation response.*

2.5 FISCAL POLICY AND THE GOVERNMENT SECTOR

The government sector is modelled relatively simply. In the current version of the model used for forecasting purposes, there is no fiscal solvency condition, although it could be imposed for long-run simulations.

Regarding the revenue side, there are four major revenue items: personal income tax, employers' social security contribution, value added tax and other revenue items. Personal income taxes and social security contributions are determined through an average tax rate applied to households' total labour income, while value added tax is a function of household consumption. The other revenue item comprises corporate taxes, customs revenue, excise duties, EU transfers and other miscellaneous taxes.

The expenditure side comprises five items: gross direct expenditure, government investment, transfers in cash to households, interest payments and other expenditure. Gross direct expenditure consists of government consumption expenditure and transfers in kind. The other expenditure item comprises of government housing transfers, corporate subsidies and other miscellaneous expenditure. In short-run forecasts the expenditure items are modelled exogenously.

2.6 MONETARY POLICY

In the forecasting exercises interest rates and the exchange rate are treated as exogenous. For simulation purposes, the policy rate may also be driven by Taylor-type rules, while exchange rates may be driven by an uncovered interest rate parity condition with a possibly exogenous interest rate premium.

3. Forecast properties

In order to assess the forecast performance of the model, we have designed a forecast evaluation exercise for replicating the forecast rounds over a certain period. This assumes preparing the forecasts starting with each data point in turn, and then comparing with the actual performance of the economy. To fully replicate each forecast round and to compile a track record of the forecasts, we would have needed for each quarter an exogenous forecast series for every exogenous variable and we also should have fed into the model all information resulting from expert judgment and available at the time when each forecast round in turn began.

As now such a replication is practically impossible, what we can do is to measure how the model would have performed each quarter if we let it operate by itself. Regarding the exogenous variables of the model, we feed in the actual values of the exogenous series. As far as expert information is concerned, we do not introduce any extra information into the model but let the model operate by itself. In this way, the forecasts produced by the model differ from the true forecasts in two ways: first, there is an improvement effect due to the fact that we use the true values for exogenous variables, not the forecasts which include some uncertainty. Secondly, there is a worsening effect due to the fact we do not use any external expert judgement.

We construct two statistics that are capable of describing the performance of the model. The first is the Mean Error of the forecasts, and the second is the Root Mean Squared Error. We present these statistics for 1 to 12 quarters ahead forecasts of the year-on-year indices of the key variables (figure 13). As the analysis is performed over 2001Q1-2005Q2, the longer-term forecast error statistics are less reliable due to the short sample.

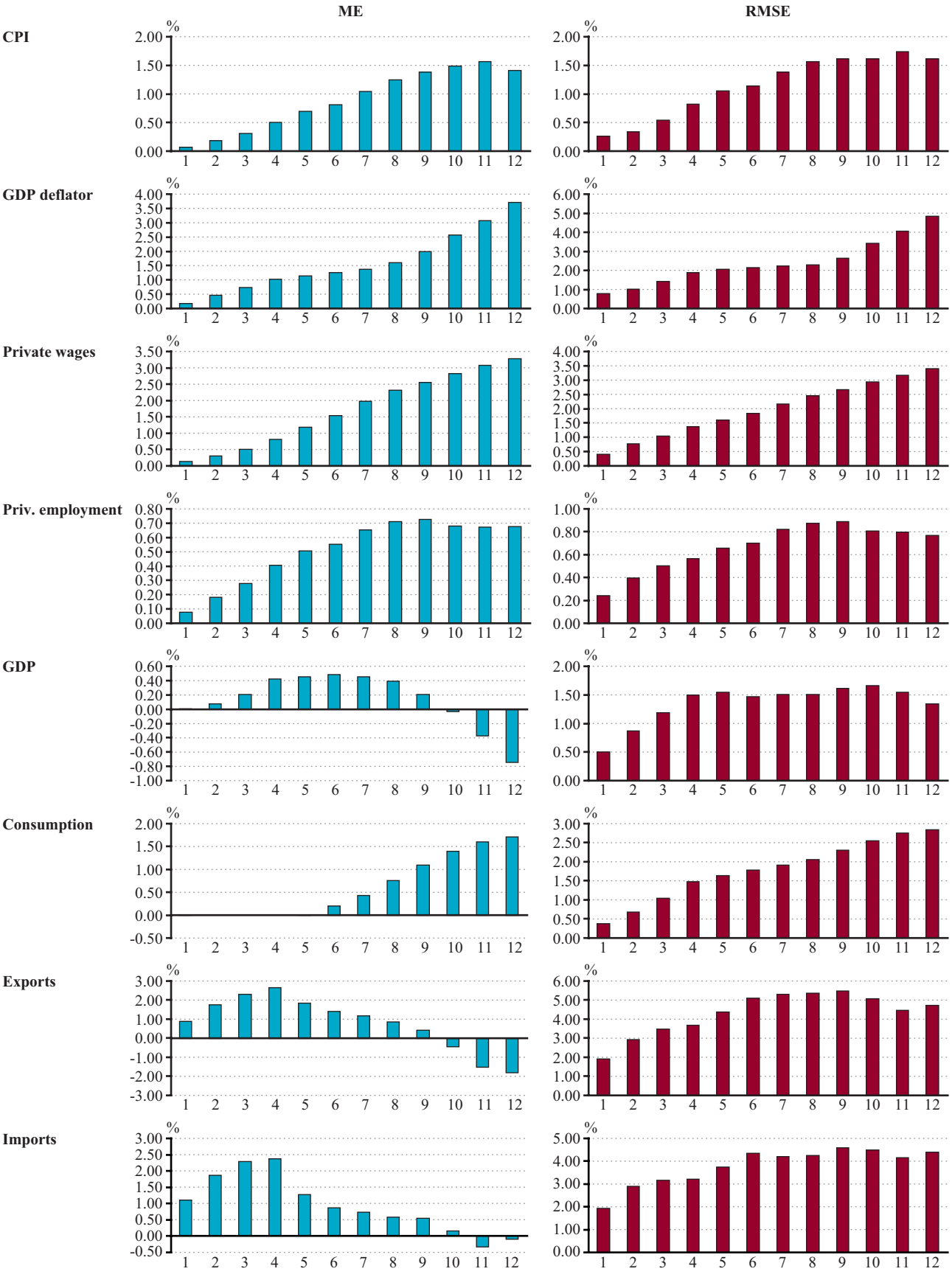
The RMSE of GDP is increasing for the first year, before stabilising. The mean error is positive, indicating that the model is overpredicting GDP on average. The RMSE of the exports and imports is larger than that of GDP, which is in line with the fact that these are the most volatile GDP components. Accordingly, the RMSE of consumption is below that of GDP, but it is constantly increasing. Consumption is correctly predicted on average in the first year, after that is overpredicted.

Private sector nominal wages and employment are slightly overpredicted, with their errors increasing over time. The forecast error of consumer prices is less than that of wages; it is still overpredicting the actual values, though its error remains below 1 percentage point even after two years. Similarly, the average errors of the GDP deflator are positive, and of bigger magnitude than those of the CPI.

Overall, the mean errors are generally positive, but their magnitudes are not significantly high, except for the price/wage variables, indicating that the model overpredicted the rate of inflation. Taking into account that the forecast properties have been tested on a deflationary period (starting with 2001), this model behaviour of not catching fully the deflationary trend is acceptable.

Figure 13

Forecast errors: ME (mean error) and RMSE (Root mean squared error) of y/y indices, 1-12 quarters ahead



4. Simulation properties

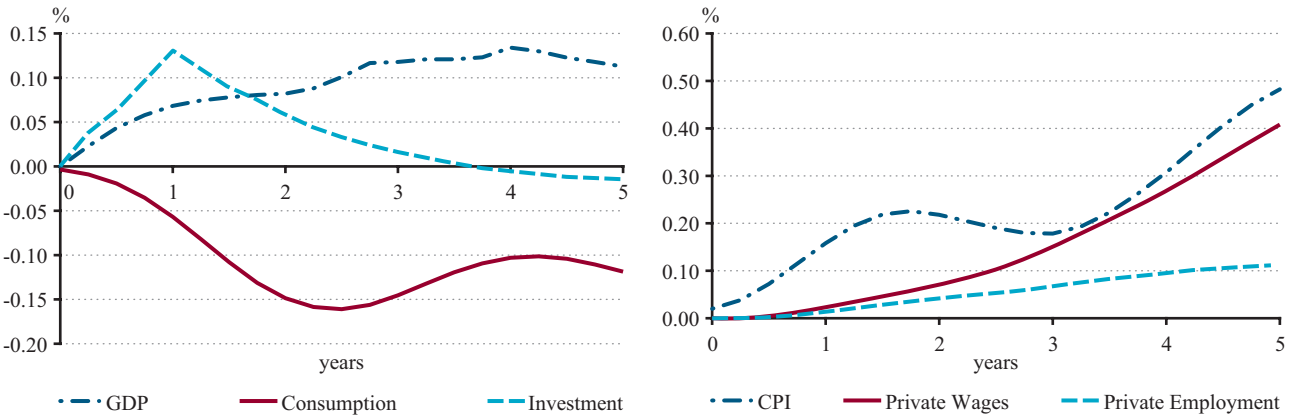
Up to this point, we discussed the structure of the model, its single-equation dynamics and its forecast performance. To illustrate the full dynamics of the model, in this section we present some simulation results that are intended to reflect the response of the model to the most important disturbances that the Hungarian economy may face. We carry out four simulations: a permanent depreciation of the exchange rate, a transitory monetary policy shock, a permanent increase in government consumption and a permanent increase in external demand.

The simulations were run over a period of ten years (over the period 1998-2007, on the actual data extended with the forecast series up to 2007).[7] Here, we illustrate the impulse responses of the first five years; the ten-year responses are included in tables 3 to 6 in the Appendix. We did not incorporate into the model any endogenous policy response, that is, the policy rate and the exchange rate were kept fixed, and there was no fiscal policy reaction considered either.

4.1 A DEPRECIATION OF THE NOMINAL EXCHANGE RATE

Figure 14

Response to a 1 per cent permanent depreciation of the exchange rate



In this scenario we simulate a 1% depreciation of the nominal exchange rate against the euro over the simulation period. This shock affects external prices expressed in the local currency and improves the competitiveness of domestic producers. On the other hand, higher import prices cause an increase in the CPI. Nominal wages adjust only slowly, so that real income drops, which drives down consumption. Due to the relative increase in foreign prices, imports drop and exports increase slightly. Investment also increases in the first year. Adding these up, the exchange rate depreciation will have a positive effect on GDP, which appears gradually and becomes persistent (figure 14).

4.2 A TRANSITORY MONETARY POLICY SHOCK

In this simulation we generate a temporary monetary policy shock, which consists of a 100 basis point increase in the short-term interest rate for 2 years. As in the current version of the model used for these simulation exercises interest rates and the exchange rate are fixed, we need to specify some exogenous hypotheses regarding the adjustment of the long-term interest rate and the nominal exchange rate. Figure 15 illustrates that after a 100 basis point increase in the policy rate we presume a 20 basis point increase in the long-term interest rate according to the expectation hypothesis, and a 2 per cent appreciation of the currency according to the uncovered interest rate parity condition. These effects die out gradually by the end of the second year.

[7] These simulations here are intended to illustrate only the short and medium-term behaviour of the model. The long-run baseline of the model that reflects a fully theory-consistent long-run steady state and ensures a smooth transition to this state is still under development.

Figure 15

Monetary policy shock: 100 bp rate increase, 20 bp long-term rate increase, 2 per cent currency depreciation

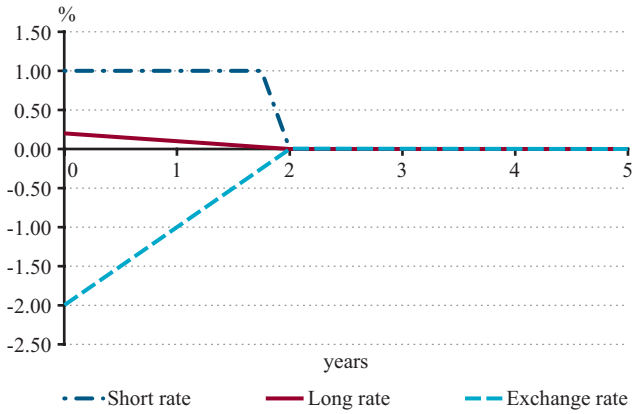
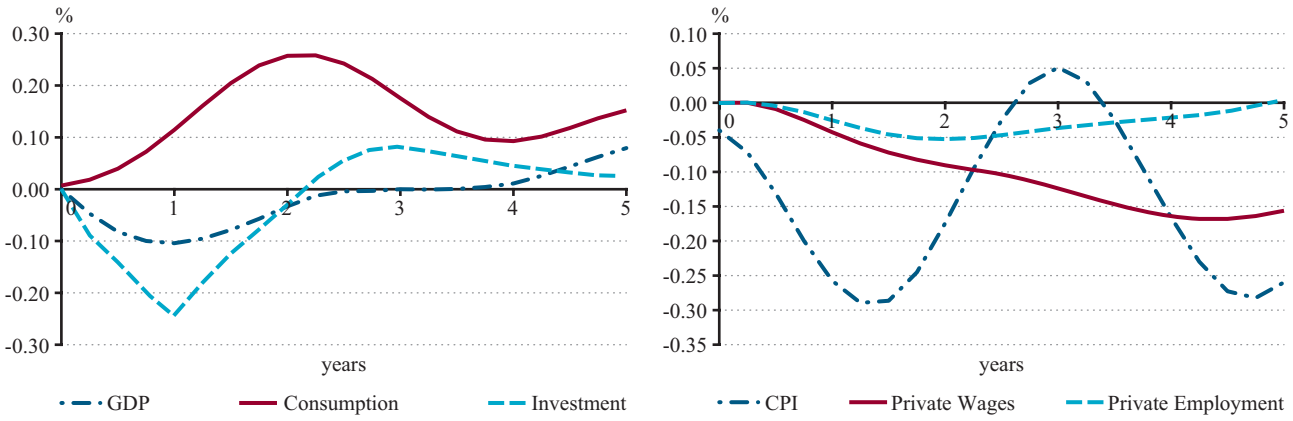


Figure 16 presents the macroeconomic effects of this monetary policy shock. The shock has a negative effect on GDP in the first three years. This is mainly due to a decrease in exports, an increase in imports and a fall in corporate investment. The main impact on foreign trade comes from exchange rate appreciation: the demand for exports falls, while the demand for cheaper imports increases. Firms reduce their investment both due to lower exports and the higher user cost of capital (higher interest rates). Due to lower internal aggregate demand, employment will fall and so will nominal wages. However, in the first two years prices fall to a greater extent than nominal wages, which causes real income to rise initially, ending up in higher private consumption.

Figure 16

Response to a two-year short-term interest rate increase of 1percentage point

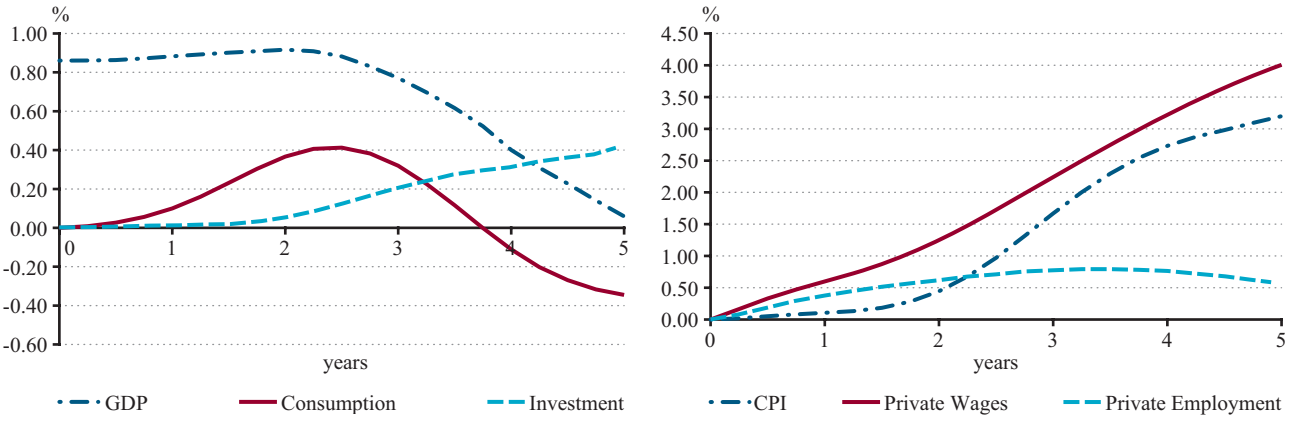


4.3 INCREASE IN GOVERNMENT CONSUMPTION

A permanent increase in public consumption of 1 % of GDP will raise GDP permanently by almost 0.9% as a primary effect; this effect remains for approximately 4 years, after which it gradually disappears due to secondary effects. Higher government spending provides a stimulus to the economy; domestic demand stimulates production and corporate investment. Employment adjusts slowly, and nominal wages and prices will go up. Higher employment and wages lead to higher personal incomes and will cause consumption to rise. Higher consumption and investment demand due their import content will increase imports permanently, while the effect on exports is insignificant. This results in a net foreign trade position that attenuates the total response of GDP. However, expanding economic activity widens the output gap that will increase the price level, which is further reinforced by price pressures resulting from an increase in labour costs (figure 17).

Figure 17

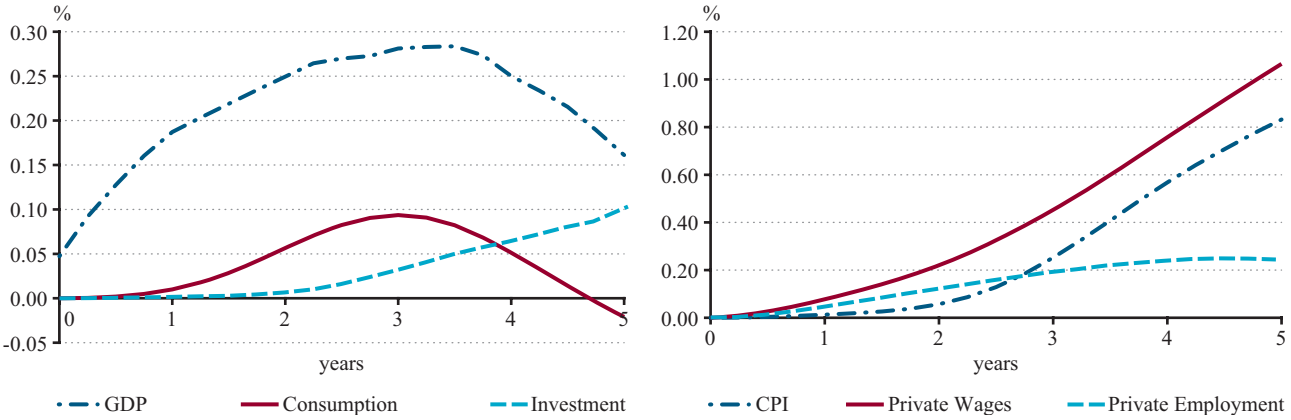
Response to a permanent 1 per cent increase in government consumption



4.4 INCREASE IN WORLD DEMAND

Figure 18

Response to a permanent 1 per cent increase in foreign demand



The permanent 1% rise in external demand increases real exports permanently by 1%, which in turn, through its high import content, also increases imports, with a positive net effect on GDP. Higher aggregate demand is equivalent to a widening output gap that gradually drives up the aggregate price level. The intensified economic activity also generates higher employment and nominal wages. Households' real income increases gradually, ending up in higher private consumption (figure 18).

5. Final remarks

This document described the current version of the Hungarian Quarterly Projection Model (NEM). We presented the main building blocks, the forecast performance of the model and, finally, we illustrated the responses to the most important shocks the Hungarian economy may face.

The model in this form is currently used for preparing the quarterly forecast and performing simulations and scenario analyses, and has already proved to be a very versatile tool across the range of models used at the Magyar Nemzeti Bank. As model development is a continuous process, this paper should be seen more as a report describing the latest version of the model which is currently in practice. However, the model is being improved continuously. The main direction for development is developing a long-run baseline that reflects a fully theory-consistent long-run steady state and ensures a smooth transition to this state.

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7. Appendix

7.1 SIMULATION RESULTS

Tables 3, 4, 5 and 6 illustrate the results of the simulations described in section 4.

Table 3

Simulation of a 10-year depreciation shock of 1%

	Y1	Y2	Y3	Y4	Y5	Y10	Y1Q1	Y1Q2	Y1Q3	Y1Q4	Y2Q1	Y2Q2	Y2Q3	Y2Q4	Y3Q1	Y3Q2	Y3Q3	Y3Q4	Y4Q1	Y4Q2	Y4Q3	Y4Q4	Y5Q1	Y5Q2	Y5Q3	Y5Q4
Prices	*Levels, percentage deviations from baseline*																									
CPI	0,06	0,20	0,20	0,21	0,38	0,84	0,02	0,04	0,07	0,12	0,16	0,19	0,22	0,23	0,22	0,20	0,19	0,18	0,18	0,19	0,22	0,26	0,31	0,36	0,41	0,45
CORE	0,05	0,20	0,20	0,22	0,41	0,93	0,00	0,02	0,06	0,11	0,16	0,20	0,22	0,23	0,23	0,21	0,19	0,18	0,18	0,20	0,23	0,27	0,33	0,38	0,44	0,48
GDP Deflator	0,00	0,01	0,08	0,18	0,32	0,91	0,00	0,00	0,01	0,01	0,01	0,01	0,01	0,03	0,04	0,06	0,09	0,11	0,14	0,16	0,19	0,22	0,26	0,30	0,33	0,37
ULC	-0,02	-0,01	0,05	0,15	0,30	0,93	0,00	-0,02	-0,04	-0,04	-0,03	-0,02	0,00	0,01	0,03	0,04	0,06	0,07	0,10	0,13	0,17	0,20	0,23	0,27	0,32	0,36
Compensation/employee	0,00	0,04	0,10	0,19	0,32	0,86	0,00	0,00	0,00	0,01	0,02	0,03	0,05	0,06	0,07	0,09	0,10	0,12	0,15	0,18	0,21	0,24	0,27	0,30	0,34	0,37
Productivity	0,03	0,05	0,05	0,04	0,02	-0,06	0,00	0,02	0,04	0,05	0,05	0,05	0,05	0,05	0,04	0,04	0,05	0,06	0,05	0,05	0,04	0,03	0,04	0,03	0,02	0,01
Export Deflator	0,83	0,87	0,88	0,87	0,89	1,01	0,80	0,81	0,85	0,85	0,85	0,86	0,88	0,89	0,88	0,88	0,88	0,88	0,87	0,87	0,86	0,87	0,88	0,89	0,88	0,89
Import Deflator	0,70	0,83	0,87	0,86	0,90	1,03	0,63	0,68	0,73	0,76	0,79	0,82	0,85	0,86	0,86	0,86	0,87	0,87	0,86	0,86	0,87	0,87	0,88	0,90	0,91	0,91
GDP and Components	*Levels, percentage deviations from baseline*																									
GDP	0,03	0,08	0,10	0,12	0,13	-0,03	0,00	0,02	0,04	0,06	0,07	0,07	0,08	0,08	0,08	0,09	0,10	0,12	0,12	0,12	0,12	0,12	0,13	0,13	0,12	0,12
Consumption	-0,01	-0,08	-0,13	-0,10	-0,09	-0,19	0,00	-0,01	-0,02	-0,03	-0,05	-0,07	-0,09	-0,11	-0,12	-0,13	-0,13	-0,13	-0,12	-0,11	-0,10	-0,09	-0,08	-0,08	-0,08	-0,09
Investment	0,05	0,10	0,04	0,01	-0,01	0,00	0,00	0,04	0,06	0,10	0,13	0,11	0,09	0,08	0,06	0,04	0,03	0,02	0,02	0,01	0,00	0,00	-0,01	-0,01	-0,01	-0,01
Of which: Residential Inv.	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Gov. Consumption	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Exports	0,01	0,00	0,00	0,00	0,00	0,00	0,01	0,02	0,01	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Imports	-0,03	-0,14	-0,21	-0,23	-0,23	-0,09	0,01	-0,02	-0,05	-0,08	-0,10	-0,13	-0,16	-0,18	-0,20	-0,21	-0,22	-0,22	-0,23	-0,23	-0,23	-0,23	-0,23	-0,23	-0,23	-0,22

Table 3

Simulation of a 10-year depreciation shock of 1% (cont'd)

	Y1	Y2	Y3	Y4	Y5	Y10	Y1Q1	Y1Q2	Y1Q3	Y1Q4	Y2Q1	Y2Q2	Y2Q3	Y2Q4	Y3Q1	Y3Q2	Y3Q3	Y3Q4	Y4Q1	Y4Q2	Y4Q3	Y4Q4	Y5Q1	Y5Q2	Y5Q3	Y5Q4
Contributions to Shock	*Percentage of GDP, absolute deviations from baseline*																									
Domestic Demand	0,00	-0,02	-0,07	-0,06	-0,06	-0,13	0,00	0,00	0,01	0,00	0,00	-0,02	-0,03	-0,05	-0,06	-0,07	-0,07	-0,07	-0,07	-0,07	-0,06	-0,06	-0,06	-0,06	-0,06	-0,07
Inventories	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Trade Balance	0,03	0,10	0,17	0,18	0,19	0,09	0,00	0,02	0,04	0,05	0,07	0,09	0,11	0,13	0,14	0,16	0,18	0,19	0,19	0,19	0,18	0,18	0,19	0,19	0,18	0,18
Labour Market	*Levels, percentage deviations from baseline, except unemployment: percentage points, absolute deviations from baseline*																									
Total employment	0,00	0,02	0,04	0,06	0,08	0,02	0,00	0,00	0,00	0,01	0,01	0,02	0,02	0,03	0,03	0,04	0,04	0,05	0,05	0,06	0,07	0,07	0,08	0,08	0,08	0,09
Unemployment rate	0,00	-0,02	-0,04	-0,06	-0,08	-0,02	0,00	0,00	0,00	0,00	-0,01	-0,02	-0,02	-0,03	-0,03	-0,04	-0,04	-0,04	-0,05	-0,06	-0,06	-0,07	-0,07	-0,08	-0,08	-0,08
Household Accounts	*Levels, percentage deviations from baseline, except the savings rate: percentage points, absolute deviations from baseline*																									
Disposable income	-0,05	-0,15	-0,11	-0,05	-0,09	-0,10	-0,02	-0,03	-0,06	-0,10	-0,13	-0,15	-0,17	-0,16	-0,14	-0,12	-0,09	-0,07	-0,05	-0,04	-0,05	-0,06	-0,07	-0,09	-0,10	-0,11
Saving rate	-0,03	-0,05	0,04	0,06	0,01	0,11	-0,01	-0,02	-0,04	-0,05	-0,06	-0,06	-0,05	-0,03	0,00	0,03	0,05	0,07	0,08	0,07	0,06	0,04	0,02	0,01	0,00	-0,01
Fiscal Ratios	*Percentage of GDP, absolute deviations from baseline*																									
Total Receipts	0,00	0,00	-0,02	-0,04	-0,04	-0,05	0,00	0,00	-0,01	-0,01	0,00	0,00	0,00	0,00	-0,01	-0,02	-0,03	-0,03	-0,04	-0,04	-0,04	-0,04	-0,04	-0,04	-0,04	-0,04
Total Expenditure	0,00	0,00	-0,04	-0,09	-0,13	-0,17	0,00	0,00	-0,01	-0,01	0,00	0,00	0,00	0,00	-0,01	-0,03	-0,05	-0,07	-0,08	-0,09	-0,09	-0,10	-0,12	-0,13	-0,12	-0,13
Budget deficit	0,00	0,00	0,03	0,07	0,12	0,12	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01	0,01	0,02	0,03	0,05	0,06	0,07	0,08	0,09	0,10	0,11	0,12	0,13
Government debt	-0,02	-0,05	-0,10	-0,20	-0,35	-0,98	0,00	-0,01	-0,03	-0,04	-0,04	-0,05	-0,05	-0,06	-0,07	-0,08	-0,11	-0,14	-0,16	-0,19	-0,22	-0,25	-0,29	-0,32	-0,36	-0,41
Financial Variables	*Percentage points, absolute deviations from baseline*																									
Short-term Int. Rates	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Long-term Int. Rates	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Foreign Demand	*Levels, percentage deviations from baseline*																									
World Demand	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Foreign Prices	*Levels, percentage deviations from baseline*																									
Effective Exchange Rate	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
Commodity Prices (euro)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Table 4

Simulation of 2-year shock of 100 bp to short-term interest rate

	Y1	Y2	Y3	Y4	Y5	Y10	Y1Q1	Y1Q2	Y1Q3	Y1Q4	Y2Q1	Y2Q2	Y2Q3	Y2Q4	Y3Q1	Y3Q2	Y3Q3	Y3Q4	Y4Q1	Y4Q2	Y4Q3	Y4Q4	Y5Q1	Y5Q2	Y5Q3	Y5Q4
Prices	*Levels, percentage deviations from baseline*																									
CPI	-0,11	-0,27	-0,07	-0,01	-0,24	0,12	-0,04	-0,07	-0,13	-0,20	-0,26	-0,29	-0,29	-0,25	-0,17	-0,10	-0,02	0,03	0,05	0,03	-0,02	-0,10	-0,17	-0,23	-0,27	-0,28
CORE	-0,09	-0,29	-0,07	-0,01	-0,27	0,14	0,00	-0,04	-0,11	-0,20	-0,27	-0,31	-0,31	-0,27	-0,20	-0,11	-0,02	0,04	0,06	0,04	-0,02	-0,10	-0,19	-0,26	-0,30	-0,32
GDP Deflator	-0,01	-0,02	-0,10	-0,17	-0,18	0,11	0,00	-0,01	-0,01	-0,01	-0,01	-0,01	-0,02	-0,04	-0,06	-0,09	-0,12	-0,15	-0,16	-0,17	-0,18	-0,18	-0,18	-0,18	-0,18	-0,18
ULC	0,04	-0,02	-0,14	-0,17	-0,22	0,14	0,00	0,05	0,07	0,06	0,04	0,00	-0,04	-0,08	-0,11	-0,14	-0,15	-0,15	-0,16	-0,17	-0,18	-0,19	-0,20	-0,21	-0,22	-0,23
Compensation/employee	-0,01	-0,06	-0,10	-0,14	-0,17	0,09	0,00	0,00	-0,01	-0,02	-0,04	-0,06	-0,07	-0,08	-0,09	-0,10	-0,10	-0,11	-0,12	-0,14	-0,15	-0,16	-0,16	-0,17	-0,17	-0,16
Productivity	-0,05	-0,04	0,03	0,03	0,05	-0,05	0,00	-0,05	-0,08	-0,09	-0,08	-0,06	-0,03	-0,01	0,02	0,04	0,04	0,04	0,04	0,03	0,03	0,03	0,03	0,04	0,06	0,07
Export Deflator	-1,35	-0,58	-0,02	0,00	-0,04	0,02	-1,59	-1,43	-1,29	-1,08	-0,88	-0,68	-0,48	-0,27	-0,05	-0,03	-0,01	0,00	0,01	0,00	0,00	-0,02	-0,03	-0,04	-0,05	-0,05
Import Deflator	-1,15	-0,64	-0,11	-0,03	-0,05	0,02	-1,26	-1,21	-1,13	-1,01	-0,88	-0,73	-0,56	-0,37	-0,17	-0,12	-0,08	-0,05	-0,04	-0,03	-0,03	-0,04	-0,04	-0,05	-0,06	-0,06
GDP and Components	*Levels, percentage deviations from baseline*																									
GDP	-0,06	-0,08	-0,01	0,00	0,04	-0,02	0,00	-0,05	-0,08	-0,10	-0,10	-0,10	-0,08	-0,06	-0,03	-0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,01	0,03	0,04	0,06
Consumption	0,03	0,14	0,20	0,10	0,09	-0,05	0,01	0,01	0,03	0,06	0,09	0,13	0,16	0,19	0,21	0,21	0,20	0,17	0,14	0,11	0,09	0,08	0,08	0,08	0,10	0,11
Investment	-0,11	-0,16	0,03	0,07	0,04	0,02	0,00	-0,09	-0,14	-0,20	-0,25	-0,18	-0,12	-0,08	-0,03	0,02	0,06	0,08	0,08	0,07	0,06	0,05	0,05	0,04	0,03	0,03
Of which: Residential Inv.	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Gov. Consumption	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Exports	-0,02	0,01	0,01	0,00	0,00	0,00	-0,02	-0,03	-0,02	-0,01	0,00	0,01	0,01	0,02	0,01	0,01	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Imports	0,06	0,21	0,19	0,10	0,04	-0,01	-0,02	0,03	0,09	0,13	0,17	0,21	0,23	0,24	0,23	0,21	0,18	0,16	0,13	0,11	0,09	0,08	0,06	0,05	0,04	0,03
Contributions to Shock	*Percentage of GDP, absolute deviations from baseline*																									
Domestic Demand	-0,01	0,06	0,13	0,08	0,07	-0,03	0,00	-0,01	-0,01	-0,01	0,00	0,04	0,07	0,10	0,12	0,14	0,14	0,13	0,11	0,09	0,07	0,06	0,06	0,07	0,07	0,08
Inventories	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Trade Balance	-0,05	-0,14	-0,14	-0,08	-0,04	0,01	0,00	-0,04	-0,07	-0,09	-0,11	-0,14	-0,15	-0,16	-0,16	-0,15	-0,14	-0,13	-0,11	-0,09	-0,07	-0,06	-0,05	-0,04	-0,03	-0,02
Labour Market	*Levels, percentage deviations from baseline, except unemployment: percentage points, absolute deviations from baseline*																									
Total employment	0,00	-0,03	-0,04	-0,02	-0,01	0,02	0,00	0,00	0,00	-0,01	-0,02	-0,03	-0,04	-0,04	-0,04	-0,04	-0,04	-0,03	-0,03	-0,03	-0,02	-0,02	-0,02	-0,01	-0,01	0,00
Unemployment rate	0,00	0,03	0,04	0,02	0,01	-0,02	0,00	0,00	0,00	0,01	0,02	0,03	0,03	0,04	0,04	0,04	0,03	0,03	0,03	0,02	0,02	0,02	0,02	0,01	0,01	0,00
Household Accounts	*Levels, percentage deviations from baseline, except the savings rate: percentage points, absolute deviations from baseline*																									
Disposable income	0,09	0,20	-0,02	-0,10	0,08	-0,06	0,04	0,06	0,11	0,17	0,21	0,22	0,21	0,16	0,09	0,01	-0,06	-0,12	-0,14	-0,13	-0,09	-0,04	0,02	0,07	0,10	0,11
Saving rate	0,05	0,02	-0,23	-0,20	-0,03	0,00	0,02	0,04	0,06	0,08	0,08	0,05	0,00	-0,07	-0,15	-0,22	-0,26	-0,28	-0,27	-0,23	-0,17	-0,11	-0,06	-0,02	-0,01	-0,02

Table 4

Simulation of 2-year shock of 100 bp to short-term interest rate (cont'd)

	Y1	Y2	Y3	Y4	Y5	Y10	Y1Q1	Y1Q2	Y1Q3	Y1Q4	Y2Q1	Y2Q2	Y2Q3	Y2Q4	Y3Q1	Y3Q2	Y3Q3	Y3Q4	Y4Q1	Y4Q2	Y4Q3	Y4Q4	Y5Q1	Y5Q2	Y5Q3	Y5Q4
Fiscal Ratios	*Percentage of GDP, absolute deviations from baseline*																									
Total Receipts	0,01	0,00	0,03	0,04	0,00	0,00	0,00	0,01	0,01	0,01	0,00	0,00	0,00	0,00	0,01	0,02	0,04	0,05	0,05	0,04	0,04	0,03	0,01	0,00	0,00	-0,01
Total Expenditure	0,01	-0,01	0,04	0,07	0,01	-0,01	-0,01	0,01	0,02	0,01	0,00	-0,01	-0,01	-0,01	0,01	0,03	0,05	0,07	0,08	0,08	0,07	0,06	0,04	0,01	-0,01	-0,02
Budget deficit	0,00	0,00	-0,02	-0,05	-0,01	0,01	0,00	0,00	-0,01	-0,01	0,00	0,00	0,00	0,00	0,00	-0,01	-0,02	-0,04	-0,04	-0,05	-0,05	-0,04	-0,03	-0,02	-0,01	0,00
Government debt	0,04	0,05	0,06	0,12	0,12	-0,11	0,00	0,03	0,05	0,06	0,07	0,06	0,05	0,04	0,04	0,05	0,06	0,09	0,10	0,12	0,13	0,13	0,13	0,13	0,12	0,10
Financial Variables	*Percentage points, absolute deviations from baseline*																									
Short-term Int. Rates	1,00	1,00	0,00	0,00	0,00	0,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Long-term Int. Rates	0,16	0,06	0,00	0,00	0,00	0,00	0,20	0,18	0,15	0,13	0,10	0,07	0,05	0,03	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Foreign Demand	*Levels, percentage deviations from baseline*																									
World Demand	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Foreign Prices	*Levels, percentage deviations from baseline*																									
Effective Exchange Rate	-1,62	-0,62	0,00	0,00	0,00	0,00	-2,00	-1,75	-1,50	-1,25	-1,00	-0,75	-0,50	-0,25	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Commodity Prices (euro)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Table 5

Simulation of a permanent shock to real government consumption equal to 1% of GDP

	Y1	Y2	Y3	Y4	Y5	Y10	Y1Q1	Y1Q2	Y1Q3	Y1Q4	Y2Q1	Y2Q2	Y2Q3	Y2Q4	Y3Q1	Y3Q2	Y3Q3	Y3Q4	Y4Q1	Y4Q2	Y4Q3	Y4Q4	Y5Q1	Y5Q2	Y5Q3	Y5Q4
Prices	*Levels, percentage deviations from baseline*																									
CPI	0,04	0,18	0,85	2,13	2,92	2,75	0,00	0,02	0,05	0,08	0,11	0,13	0,18	0,28	0,44	0,68	0,97	1,31	1,67	2,00	2,30	2,54	2,73	2,87	2,98	3,09
CORE	0,04	0,20	0,98	2,43	3,33	3,13	0,00	0,02	0,06	0,09	0,12	0,15	0,21	0,32	0,51	0,78	1,12	1,51	1,91	2,29	2,63	2,90	3,12	3,28	3,41	3,53
GDP Deflator	0,10	0,50	1,60	2,73	3,83	3,57	0,13	0,12	0,08	0,08	0,17	0,35	0,59	0,87	1,17	1,46	1,74	2,02	2,30	2,59	2,88	3,17	3,45	3,72	3,97	4,19
ULC	-0,48	0,39	1,41	2,76	3,98	3,63	-0,85	-0,61	-0,34	-0,11	0,10	0,29	0,49	0,71	0,95	1,24	1,56	1,90	2,25	2,59	2,93	3,26	3,59	3,87	4,11	4,34
Compensation/employee	0,24	0,81	1,61	2,62	3,54	3,62	0,00	0,16	0,33	0,47	0,60	0,73	0,87	1,05	1,25	1,48	1,73	1,98	2,24	2,50	2,75	2,99	3,22	3,44	3,64	3,83
Productivity	0,72	0,42	0,19	-0,13	-0,43	0,00	0,86	0,78	0,68	0,58	0,50	0,44	0,38	0,34	0,29	0,24	0,17	0,08	-0,01	-0,09	-0,18	-0,26	-0,36	-0,41	-0,45	-0,48
Export Deflator	0,01	0,03	0,13	0,34	0,51	0,56	0,00	0,00	0,01	0,01	0,02	0,02	0,03	0,04	0,07	0,10	0,15	0,20	0,26	0,31	0,37	0,42	0,47	0,49	0,53	0,56
Import Deflator	0,01	0,03	0,13	0,35	0,53	0,56	0,00	0,00	0,01	0,01	0,02	0,02	0,03	0,04	0,07	0,10	0,15	0,20	0,26	0,32	0,38	0,43	0,48	0,51	0,54	0,58
GDP and Components	*Levels, percentage deviations from baseline*																									
GDP	0,86	0,90	0,88	0,65	0,27	-0,43	0,86	0,86	0,86	0,87	0,88	0,89	0,90	0,91	0,92	0,91	0,88	0,83	0,77	0,70	0,62	0,52	0,40	0,31	0,23	0,14
Consumption	0,02	0,16	0,32	0,13	-0,18	0,19	0,00	0,01	0,02	0,04	0,08	0,13	0,19	0,24	0,29	0,33	0,33	0,31	0,26	0,18	0,09	0,00	-0,09	-0,16	-0,22	-0,26
Investment	0,00	0,02	0,11	0,25	0,35	0,40	0,00	0,00	0,01	0,01	0,01	0,02	0,02	0,03	0,05	0,08	0,12	0,17	0,21	0,24	0,27	0,30	0,31	0,34	0,36	0,38
Of which: Residential Inv.	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Gov. Consumption	9,73	9,56	9,44	8,97	8,49	8,06	9,89	9,80	9,73	9,51	9,54	9,67	9,48	9,54	9,41	9,47	9,51	9,39	9,13	8,96	8,93	8,87	8,64	8,45	8,52	8,35
Exports	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Imports	0,24	0,25	0,32	0,47	0,66	1,27	0,26	0,24	0,22	0,23	0,23	0,24	0,25	0,27	0,29	0,31	0,33	0,36	0,40	0,45	0,50	0,54	0,58	0,64	0,69	0,75
Contributions to Shock	*Percentage of GDP, absolute deviations from baseline*																									
Domestic Demand	0,01	0,11	0,22	0,15	-0,04	0,24	0,00	0,00	0,01	0,03	0,05	0,08	0,12	0,16	0,20	0,23	0,24	0,24	0,21	0,17	0,13	0,07	0,02	-0,03	-0,06	-0,08
Inventories	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Trade Balance	-0,15	-0,17	-0,25	-0,37	-0,54	-1,37	-0,16	-0,15	-0,15	-0,15	-0,15	-0,16	-0,18	-0,19	-0,21	-0,24	-0,27	-0,30	-0,33	-0,36	-0,39	-0,42	-0,48	-0,52	-0,56	-0,62
Labour Market	*Levels, percentage deviations from baseline, except unemployment: percentage points, absolute deviations from baseline*																									
Total employment	0,11	0,38	0,55	0,63	0,55	-0,34	0,00	0,06	0,14	0,23	0,30	0,36	0,41	0,45	0,49	0,53	0,57	0,60	0,62	0,63	0,63	0,62	0,60	0,58	0,54	0,50
Unemployment rate	-0,10	-0,35	-0,51	-0,59	-0,52	0,32	0,00	-0,06	-0,13	-0,21	-0,28	-0,33	-0,38	-0,42	-0,46	-0,50	-0,53	-0,56	-0,58	-0,59	-0,60	-0,59	-0,57	-0,54	-0,51	-0,47
Household Accounts	*Levels, percentage deviations from baseline, except the savings rate: percentage points, absolute deviations from baseline*																									
Disposable income	0,08	0,41	0,43	0,10	0,21	0,51	0,00	0,04	0,10	0,17	0,26	0,37	0,47	0,52	0,54	0,50	0,41	0,30	0,20	0,10	0,06	0,04	0,08	0,16	0,26	0,32
Saving rate	0,04	0,17	0,02	-0,08	0,32	0,23	0,00	0,03	0,05	0,09	0,13	0,17	0,19	0,18	0,13	0,06	-0,03	-0,08	-0,10	-0,14	-0,09	0,00	0,13	0,27	0,39	0,51

Table 5

Simulation of a permanent shock to real government consumption equal to 1% of GDP (cont'd)

	Y1	Y2	Y3	Y4	Y5	Y10	Y1Q1	Y1Q2	Y1Q3	Y1Q4	Y2Q1	Y2Q2	Y2Q3	Y2Q4	Y3Q1	Y3Q2	Y3Q3	Y3Q4	Y4Q1	Y4Q2	Y4Q3	Y4Q4	Y5Q1	Y5Q2	Y5Q3	Y5Q4
Fiscal Ratios	*Percentage of GDP, absolute deviations from baseline*																									
Total Receipts	-0,22	-0,19	-0,27	-0,25	-0,30	-0,11	-0,29	-0,26	-0,19	-0,15	-0,15	-0,17	-0,21	-0,23	-0,27	-0,28	-0,27	-0,26	-0,25	-0,24	-0,25	-0,27	-0,27	-0,29	-0,31	-0,35
Total Expenditure	0,51	0,31	-0,05	-0,13	-0,26	0,31	0,52	0,51	0,52	0,50	0,48	0,37	0,24	0,15	0,03	-0,01	-0,08	-0,13	-0,11	-0,14	-0,12	-0,15	-0,20	-0,26	-0,25	-0,34
Budget deficit	-0,67	-0,41	-0,07	0,09	0,21	-0,42	-0,75	-0,70	-0,65	-0,58	-0,57	-0,47	-0,35	-0,25	-0,17	-0,12	-0,03	0,06	0,05	0,11	0,10	0,11	0,17	0,21	0,21	0,26
Government debt	-0,10	0,17	-0,22	-0,65	-1,07	0,38	-0,37	-0,18	0,01	0,15	0,23	0,23	0,15	0,06	-0,06	-0,17	-0,26	-0,39	-0,50	-0,59	-0,72	-0,80	-0,91	-0,99	-1,11	-1,26
Financial Variables	*Percentage points, absolute deviations from baseline*																									
Short-term Int. Rates	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Long-term Int. Rates	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Foreign Demand	*Levels, percentage deviations from baseline*																									
World Demand	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Foreign Prices	*Levels, percentage deviations from baseline*																									
Effective Exchange Rate	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Commodity Prices (euro)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Table 6

Simulation of a permanent foreign demand shock of 1%

	Y1	Y2	Y3	Y4	Y5	Y10	Y1Q1	Y1Q2	Y1Q3	Y1Q4	Y2Q1	Y2Q2	Y2Q3	Y2Q4	Y3Q1	Y3Q2	Y3Q3	Y3Q4	Y4Q1	Y4Q2	Y4Q3	Y4Q4	Y5Q1	Y5Q2	Y5Q3	Y5Q4
Prices	*Levels, percentage deviations from baseline*																									
CPI	0,00	0,02	0,11	0,37	0,67	1,23	0,00	0,00	0,00	0,01	0,01	0,02	0,03	0,04	0,06	0,09	0,13	0,18	0,25	0,33	0,41	0,49	0,57	0,64	0,71	0,77
CORE	0,00	0,03	0,13	0,42	0,76	1,40	0,00	0,00	0,00	0,01	0,01	0,02	0,03	0,04	0,07	0,10	0,15	0,21	0,29	0,37	0,47	0,56	0,65	0,73	0,81	0,88
GDP Deflator	0,01	0,06	0,25	0,55	0,90	1,60	0,01	0,01	0,02	0,02	0,02	0,04	0,07	0,11	0,16	0,22	0,28	0,35	0,43	0,51	0,59	0,68	0,76	0,85	0,95	1,04
ULC	-0,07	-0,01	0,19	0,50	0,90	1,64	-0,05	-0,08	-0,09	-0,08	-0,06	-0,03	0,01	0,05	0,09	0,15	0,21	0,29	0,36	0,45	0,54	0,64	0,75	0,85	0,95	1,05
Compensation/employee	0,02	0,13	0,30	0,56	0,87	1,56	0,00	0,01	0,03	0,05	0,08	0,11	0,14	0,18	0,22	0,27	0,33	0,39	0,45	0,52	0,60	0,68	0,76	0,84	0,91	0,99
Productivity	0,09	0,14	0,11	0,07	-0,02	-0,07	0,05	0,09	0,11	0,13	0,14	0,14	0,13	0,13	0,13	0,12	0,11	0,10	0,09	0,08	0,06	0,04	0,01	-0,01	-0,03	-0,06
Export Deflator	0,00	0,00	0,02	0,06	0,12	0,25	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01	0,01	0,01	0,02	0,03	0,04	0,05	0,07	0,08	0,10	0,11	0,13	0,14
Import Deflator	0,00	0,00	0,02	0,06	0,12	0,25	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01	0,01	0,01	0,02	0,03	0,04	0,05	0,07	0,08	0,10	0,11	0,13	0,14
GDP and Components	*Levels, percentage deviations from baseline*																									
GDP	0,11	0,21	0,26	0,28	0,22	-0,12	0,05	0,09	0,13	0,16	0,19	0,20	0,22	0,23	0,25	0,26	0,27	0,27	0,28	0,28	0,28	0,27	0,25	0,23	0,22	0,19
Consumption	0,00	0,02	0,06	0,07	0,02	-0,08	0,00	0,00	0,00	0,00	0,01	0,01	0,02	0,03	0,05	0,06	0,07	0,07	0,08	0,07	0,07	0,06	0,04	0,03	0,01	0,00
Investment	0,00	0,00	0,01	0,05	0,08	0,17	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01	0,01	0,02	0,02	0,03	0,04	0,05	0,06	0,06	0,07	0,08	0,09
Of which: Residential Inv.	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Gov. Consumption	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Exports	0,95	1,03	0,99	1,00	1,00	1,00	0,55	0,96	1,14	1,16	1,11	1,04	1,00	0,98	0,98	0,99	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
Imports	0,73	0,68	0,66	0,69	0,72	1,08	0,46	0,76	0,86	0,84	0,77	0,68	0,64	0,63	0,64	0,66	0,66	0,67	0,68	0,68	0,71	0,70	0,70	0,72	0,73	0,73
Contributions to Shock	*Percentage of GDP, absolute deviations from baseline*																									
Domestic Demand	0,00	0,01	0,04	0,05	0,03	-0,01	0,00	0,00	0,00	0,00	0,01	0,01	0,02	0,02	0,03	0,04	0,05	0,05	0,06	0,06	0,05	0,05	0,04	0,04	0,03	0,02
Inventories	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Trade Balance	0,11	0,20	0,22	0,23	0,19	-0,11	0,05	0,09	0,13	0,16	0,18	0,19	0,20	0,21	0,22	0,23	0,22	0,22	0,23	0,23	0,23	0,22	0,21	0,20	0,19	0,17
Labour Market	*Levels, percentage deviations from baseline, except unemployment: percentage points, absolute deviations from baseline*																									
Total employment	0,01	0,06	0,12	0,17	0,20	-0,04	0,00	0,00	0,01	0,02	0,04	0,05	0,07	0,08	0,10	0,11	0,13	0,14	0,15	0,16	0,18	0,18	0,19	0,20	0,20	0,20
Unemployment rate	-0,01	-0,06	-0,11	-0,16	-0,18	0,03	0,00	0,00	-0,01	-0,02	-0,03	-0,05	-0,06	-0,08	-0,09	-0,10	-0,12	-0,13	-0,14	-0,16	-0,17	-0,17	-0,18	-0,19	-0,19	-0,18
Household Accounts	*Levels, percentage deviations from baseline, except the savings rate: percentage points, absolute deviations from baseline*																									
Disposable income	0,01	0,06	0,11	0,09	0,08	0,11	0,00	0,00	0,01	0,02	0,03	0,05	0,07	0,09	0,10	0,11	0,12	0,11	0,11	0,09	0,08	0,07	0,07	0,07	0,08	0,09
Saving rate	0,00	0,03	0,03	0,00	0,03	0,17	0,00	0,00	0,00	0,01	0,02	0,02	0,03	0,04	0,04	0,03	0,02	0,02	0,01	0,00	-0,01	-0,01	0,01	0,02	0,04	0,06

Table 6

Simulation of a permanent foreign demand shock of 1% (cont'd)

	Y1	Y2	Y3	Y4	Y5	Y10	Y1Q1	Y1Q2	Y1Q3	Y1Q4	Y2Q1	Y2Q2	Y2Q3	Y2Q4	Y3Q1	Y3Q2	Y3Q3	Y3Q4	Y4Q1	Y4Q2	Y4Q3	Y4Q4	Y5Q1	Y5Q2	Y5Q3	Y5Q4
Fiscal Ratios	*Percentage of GDP, absolute deviations from baseline*																									
Total Receipts	-0,03	-0,05	-0,07	-0,09	-0,10	-0,08	-0,02	-0,03	-0,04	-0,04	-0,04	-0,04	-0,05	-0,05	-0,06	-0,07	-0,07	-0,07	-0,08	-0,08	-0,09	-0,09	-0,09	-0,09	-0,10	-0,11
Total Expenditure	-0,06	-0,13	-0,22	-0,30	-0,38	-0,30	-0,03	-0,05	-0,07	-0,09	-0,11	-0,12	-0,13	-0,16	-0,18	-0,20	-0,23	-0,25	-0,27	-0,29	-0,31	-0,33	-0,35	-0,38	-0,38	-0,41
Budget deficit	0,04	0,10	0,18	0,27	0,35	0,21	0,01	0,03	0,04	0,06	0,08	0,09	0,11	0,13	0,15	0,16	0,19	0,22	0,23	0,26	0,28	0,30	0,33	0,35	0,36	0,37
Government debt	-0,08	-0,23	-0,46	-0,78	-1,14	-2,16	-0,03	-0,07	-0,10	-0,13	-0,17	-0,20	-0,25	-0,30	-0,36	-0,43	-0,49	-0,57	-0,66	-0,73	-0,83	-0,91	-1,00	-1,08	-1,19	-1,30
Financial Variables	*Percentage points, absolute deviations from baseline*																									
Short-term Int. Rates	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Long-term Int. Rates	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Foreign Demand	*Levels, percentage deviations from baseline*																									
World Demand	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
Foreign Prices	*Levels, percentage deviations from baseline*																									
Effective Exchange Rate	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Commodity Prices (euro)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

7.2 THE MODEL EQUATIONS

Current account

log(XVOLSTAR) = 6.5943223 + log(S) + log(INTEGR) + 0.3299188224 * log(TREND) - 0.5080539621 * log(REREXP)

Dlog(XVOL) = 0.01150276949 - 0.389340147 * (log(XVOL(-1)) - log(XVOLSTAR(-1))) + 0.5530862918 * Dlog(S) - 0.2612335601 * Dlog(REREXP) + 0.4139253652 * Dlog(XVOL(-1))

log(MVOLSTAR) = 0.002315353104 + log(SM) - 0.2895543795 * log(RERIMP)

Dlog(MVOL) = - 0.005449052677 - 0.1689664765 * (log(MVOL(-1)) - log(MVOLSTAR(-1))) + 1.645045046 * Dlog(SM)

XVAL = XVOL * PX / RX * 1000

MVAL = MVOL * PM / RX * 1000

IRC = 20 + (1 - 0.05) * LRF / 400 * GA(-1) * 1000

IRD = (1 - 0.4) * (LRF / 400 * (FDISC(-1) / RX * (1 - 0.4) + OGL(-1)) + GIP * DEBTF / DEBT / RX) * 1000

EQC = 0.0487441582607 * LRF / 400 * GA(-1) * 1000

EQD = 7.429421774 + 0.4 * (LRF / 400 * (FDISC(-1) / RX(-1) * (1 - 0.4) + OGL(-1)) + GIP * DEBTF / DEBT / RX) * 1000

RE = 250 + 0.4 * LRF / 400 * FDISC(-1) / RX(-1) * 1000

CBV = XVAL - MVAL + IRC - IRD + EQC - EQD + BPT - RE

CBR = CBV * RX / NOM / 10

FDISC = FDISC(-1) * (1 - 0.01) + FDI * RX / 1000

Supply

E = EP + EG

log(EPSTAR) = 4.259136227 + log(Y) - 0.367 * log(WCR * WP / PY) - (1 - 0.367) * log(TFP)

Dlog(EP) = 0.001163298243 - 0.0879697726 * (log(EP(-1)) - LOG(EPSTAR(-1))) + 0.4898060651 * Dlog(EP(-1)) + 0.002858355681 * D9801 + 0.01036092292 * D9901 - 0.007733620745 * D0402

KG = GI + (1 - 6 / 400) * KG(-1)

log(KPSTAR) = 0.7173243014 + log(YP) - 0.367 * log(USER / 100)

Dlog(KP) = 0.001761368194 - 0.002 * (log(KP(-1)) - log(KPSTAR(-1))) + 0.8428234291 * Dlog(KP(-1))

K = KP + KG

GAP = Y / YP

U = (1 - E / LF) * 100

YP = 0.2683839518 * (0.9074474507 * ((KG + KP))^((0.367 - 1) / 0.367) + (1 - 0.9074474507) * (LFTR * (1 - UTR / 100) * TFP)^((0.367 - 1) / 0.367))^(0.367 / (0.367 - 1))

Demand

Y = HC + GC + I + DS + XVOL - MVOL

HC = CE + TRAN

log(CESTAR) = - 0.8792452042 + 0.6200181465 * log(PDIR) + 0.2343855818 * log(HFW / CED) + (1 - 0.6200181465 - 0.2343855818) * log(HHW / CED)

Dlog(CE) = 0.0004789221477 - 0.04343634803 * (log(CE(-1)) - log(CESTAR(-1))) + (1 - 0.1958589675) * Dlog(CE(-1)) + 0.1958589675 * Dlog(PDIR) - 0.04368474613 * D9601 + 0.04445594186 * D9602

CI = KP - (1 - DEP / 400) * KP(-1)

I = HI + CI + GI + IERROR

NOM = Y * PY

SM = 0.279446 * HC + 0.103838 * GC + 0.522852 * I + 0.479204 * DS + 0.580059 * XVOL

Household income

PDI = COMP + FTRAN + EII + OPI - PTAX

PDIR = PDI / CED

OPI = OPI(-1) * 1 / 4 * (COMP(-1) / COMP(-2) + COMP(-2) / COMP(-3) + COMP(-3) / COMP(-4) + COMP(-4) / COMP(-5))

EII = EII(-1) * 1 / 4 * (COMP(-1) / COMP(-2) + COMP(-2) / COMP(-3) + COMP(-3) / COMP(-4) + COMP(-4) / COMP(-5))

Prices

Dlog(WDO) = Dlog(RX) + Dlog(WDOF)

Dlog(WDC) = Dlog(RX) + Dlog(WDCF)

log(PXGSTAR) = 0.01162396229 + log(PXGF * EFEX)

Dlog(PXG) = 0.001476365348 - 0.4088108037 * (log(PXG(-1)) - log(PXGSTAR(-1))) + 0.9550234816 * Dlog(EFEX * PXGF)

PX = PX(-1) + 0.071 * D(WDC) + 0.014 * D(WDO) + 0.766 * D(PXG) + 0.150 * D(CPI)

log(PMGSTAR) = 0.0356233152 + log(EFEX * PMGF)

Dlog(PMG) = 0.002854895748 - 0.2469782069 * (log(PMG(-1)) - log(PMGSTAR(-1))) + 0.7325253556 * Dlog(EFEX * PMGF)

PM = PM(-1) + 0.044 * D(WDC) + 0.061 * D(WDO) + 0.743 * D(PMG) + 0.152 * D(CPI)

log(PYSTAR) = - 11.76590562 + log(ULC)

Dlog(PY) = 0.006944826276 - 0.2287349021 * (log(PY(-1)) - log(PYSTAR(-1))) + 0.15 * log(GAP) + 0.7 * Dlog(PY(-1))

log(CORESTAR) = 0.005494230382 + 0.8574223574 * log(PY) + (1 - 0.8574223574) * log(PMG * VAI)

Dlog(CORE) = 0.0006189033156 - 0.1992029365 * (log(CORE(-1)) - log(CORESTAR(-1))) + 0.9168697165 * Dlog(CORE(-1)) + 0.005617259003 * D0401 - 0.008595879309 * D0402

Dlog(CED) = Dlog(CPI)

CPI = CPI(-4) * (0.67569 * CORE / CORE(-4) + 0.05914 * NPF / NPF(-4) + 0.2027 * PG / PG(-4) + (1 - 0.67569 - 0.05914 - 0.2027) * FUEL / FUEL(-4))

log(PCISTAR) = 0.02970115122 + 0.2886172829 * log(PY) + (1 - 0.2886172829) * log(PMG)

Dlog(PCI) = - 0.0001795214008 - 0.07979596079 * (log(PCI(-1)) - log(PCISTAR(-1))) + 0.6556836599 * Dlog(PMG) + (1 - 0.6556836599) * Dlog(PY(-1)) - 0.02672964161 * D9901

log(PHSTAR) = - 7.502740998 + log(PDI)

Dlog(PH) = - 0.00173283188 - 0.3163908541 * (log(PH(-1)) - log(PHSTAR(-1))) + 0.3145002806 * Dlog(PH(-1))

Dlog(PGC) = 0.6683070524 * Dlog(CPI) + (1 - 0.6683070524) * Dlog(WG)

PTRAN = PTRAN(-1) * PGC / PGC(-1)

Wages

log(WPSTAR) = 11.46619756 + log(PY) + (log(Y) - log(EP)) - 0.02100458285 * U

Dlog(WP) = 0.02155678369 - 0.1670267188 * (log(WP(-1)) - LOG(WPSTAR(-1))) + 0.144683335 * Dlog(WP(-1)) + 0.03384670385 * D0101 + 0.02250128916 * D0201

WC = WP * WCR

COMPP = 3 * WP * EP / 1000 / 1000

COMPG = 3 * WG * EG / 1000 / 1000

COMP = COMPP + COMPG

SSC = 3 * (WP * EP + WG * EG) * (WCR - 1) / 1000 / 1000

ULC = WC * EP / Y

Real exchange rates and the user cost of capital

CTAXR = CTAXR(-1)

USER = PCI / PY * ((LR + EQPR + (1 - CTAXR) * DEP) / 4 - 1 / 4 * (100 * (PCI / PCI(-1) - 1) + 100 * (PCI(-1) / PCI(-2) - 1) + 100 * (PCI(-2) / PCI(-3) - 1) + 100 * (PCI(-3) / PCI(-4) - 1))) / (1 - CTAXR)

REREXP = PXG / (PXGF * EFEX)

log(RERIMP) = log(PMG) - log(CORE)

Dlog(EFEX) = Dlog(RX)

EQP = EQP(-1)

Government

TGE = GDE + GICBUD + FTRAN + GIP + OGE

TTAX = PTAX + SSC + VAT + OTAX

BUD = TTAX - TGE

GBR = BUD / NOM * 100

PTAX = PTAXR * COMP

VAT = VATR * (HC * CED)

GDE = GC * PGC + TRAN * PTRAN

Dlog(FTRAN) = 0.5 * Dlog(WP) + 0.5 * Dlog(CPI) + 0.021 * d(U)

d(GIP) = d(DEBT(-1)) * LR / 400 + DEBT(-12) * d(LR(-11)) / 400

VATR = VATR(-1)

PTAXR = PTAXR(-1)

Dlog(OTAX) = Dlog(NOM)

Dlog(OGE) = Dlog(NOM)

PTAXR = PTAXR(-1)

VATR = VATR(-1)

SSCR = SSCR(-1)

Foreign wealth

GA = OGL + DEBTF / RX + FDISC / RX + NFA

NFA = CBV / 1000 + NFA(-1)

OGL = OGL(-1) - 0.7 * CBV / 1000

Household wealth

HFW = 1.732143944 + HFW(-1) + NFS + DSH * (RX / RX(-1) - 1) * HFW(-1) + ESH * (EQP / EQP(-1) - 1) * HFW(-1) + ISH * HFW(-1) * SR / 400

ESH = ESH(-1)

DSH = DSH(-1)

ISH = ISH(-1)

HHW = ((PH / CED) / (PH(-1) / (CED(-1))) * (HHW(-1) / (CED(-1))) * (1 - 0.005838889043) + HI) * CED

THW = HFW + HHW

HIS = HI / (PDIR - CE - ERROR / CED)

NFS = (1 - HIS) * (PDI - CE * CED - ERROR)

Government wealth

DEBT = DEBT(-1) - BUD

DEBTP = DEBTP(-1) + (DEBT - DEBT(-1)) * DEBTP(-1) / DEBT(-1)

DEBTF = DEBT - DEBTP

Corporate wealth

CFW = - (HFW + HHW) + NFA * RX + DEBT

7.3 LIST OF VARIABLES

BPT balance of payments transfers (million EUR)

BUD budget balance (billion HUF)

CBR current account per GDP (%)

CBV current account (million EUR)

CE consumption expenditure (billion HUF, at 2000 prices)

CED consumer expenditure deflator (2000=1)

CFW corporate financial wealth (billion HUF)

CI corporate investment (billion HUF, at 2000 prices)

COMP compensation of employees (billion HUF)

COMPG compensation of government employees (billion HUF)

COMPP compensation of private sector employees (billion HUF)

CORE core inflation (2000=1)

CPI consumer price index (2000=1)

CTAXR corporate tax rate (%)

D0101 dummy (2001Q1=1)

D0201 dummy (2002Q1=1)

D0401 dummy (2004Q1=1)

D0402 dummy (2004Q2=1)

D9601 dummy (1996Q1=1)

D9602 dummy (1996Q2=1)

D9801 dummy (1998Q1=1)

D9901 dummy (1999Q1=1)

D9902 dummy (1999Q2=1)

DEBT government debt (billion HUF)

DEBTF government debt, foreign owned (billion HUF)

DEBTP government debt, domestic owned (billion HUF)

DEP depreciation rate of private capital (%)

DS change in stocks (billion HUF, at 2000 prices)

DSH share of financial wealth denominated in foreign currency (%)

E total employment (thousands)

EG government employees (thousands)

EP private sector employees (thousands)

EFEX effective exchange rate (2000=1)

EII households equity and interest income (billion HUF)

EQC equity income, credit, balance of payments (million EUR)

EQD equity income, debit, balance of payments (million EUR)

EQP equity prices (2000=1)

EQPR risk premium of equity investments (%)

ERROR error term in personal income balance (billion HUF)

ESH share of equity in financial wealth (%)

FDI foreign direct investment (million EUR)

FDISC stock of FDI (billion HUF)

FTRAN financial transfers of the government to households (billion HUF)

FUEL fuel price in the CPI (2000=1)

GA gross foreign assets (million EUR)

GAP output gap

GBR government budget ratio (%)

GC government consumption (billion HUF, at 2000 prices)

GDE government direct expenditure (billion HUF)

GI government investment (billion HUF, at 2000 prices)

GICBUD government investment (billion HUF)

GIP government interest payments (billion HUF)

HC household consumption (billion HUF, at 2000 prices)

HFW household financial wealth (billion HUF)

HHW household housing wealth (billion HUF)

HI housing investment (billion HUF, at 2000 prices)

HIS share of housing investment in household saving

I total investment (billion HUF, at 2000 prices)

IERROR investment error term (billion HUF, at 2000 prices)

INTEGR expansion of exports due to integration

IRC interest income, credit (million EUR)

IRD interest income, debit (million EUR)

ISH share of interest bearing assets in total financial wealth

K capital stock (billion HUF, at 2000 prices)

KG government capital stock (billion HUF, at 2000 prices)

KP private capital stock (billion HUF, at 2000 prices)

LF labour force (thousands)

LFTR trend labour force (thousands)

LR long term interest rate (%)

LRF foreign long term interest rate (%)

MVAL imports of goods and services, value (million EUR)

MVOL imports of goods and services (billion HUF, at 2000 prices)

NFA net foreign assets (million EUR)

NFS net financial savings of households (billion HUF)

NOM nominal GDP (billion HUF)

NPF unprocessed food prices (2000=1)

OGE other government expenditure (billion HUF)

OGL other gross liabilities (million EUR)

OPI other personal income of households (billion HUF)

OTAX other taxes (billion HUF)

PCI corporate investment deflator (2000=1)

PDI personal disposable income (billion HUF)

PDIR real personal disposable income (billion HUF, at 2000 prices)

PG regulated prices (2000=1)

PGC government consumption deflator (2000=1)

PGI government investment deflator (2000=1)

PH housing prices (2000=1)

PM import prices (2000=1)

PMG manufacturing import prices (2000=1)

PTAX personal income taxes (billion HUF)

PTAXR personal income tax rate

PX export prices (2000=1)

PXG manufacturing export prices (2000=1)

PXGF foreign manufacturing export prices (2000=1)

PY GDP deflator (2000=1)

RE reinvested earnings (million EUR)

REREXP real effective exchange rate based on manufacturing export prices (2000=1)

RERIMP real effective exchange rate based on relative import prices (2000=1)

RX HUF/EUR exchange rate

S weighted world demand for exports (2000=1)

SM weighted import demand (billion HUF)

SR short-term interest rate (%)

SSC social security contribution (billion HUF)

SSCR social security contribution rate

TFP total factor productivity (2000=1)

TGE total government expenditure (billion HUF)

THW total household wealth (billion HUF)

TRAN transfers in kind to households (billion HUF, at 2000 prices)

TREND linear trend variable (1991Q1=1)

TTAX total taxes (billion HUF)

U unemployment rate (%)

ULC unit labour costs (HUF)

USER cost of capital (%)

UTR trend unemployment rate (%)

VAI changes in indirect taxes

VAT value added taxes (billion HUF)

VATR value added tax rate

WC private sector wage cost (HUF)

WCR wage cost rate

WDC world commodity prices in HUF (2000=1)

WDCF world commodity prices in EUR (2000=1)

WDO world oil prices in HUF (2000=1)

WDOF world oil prices in EUR (2000=1)

WG government wages (HUF)

WP private sector wages (HUF)

XVAL exports of goods and services, value (million EUR)

XVOL exports of goods and services (billion HUF, at 2000 prices)

Y GDP (billion HUF, at 2000 prices)

YP potential GDP (billion HUF, at 2000 prices)

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