

ANIKÓ BÍRÓ, PÉTER ELEK, JÁNOS VINCZE

**THE PM-KTI MACROECONOMIC MODEL:
RELATIONSHIPS AND SIMULATIONS**

WORKING PAPERS IN PUBLIC FINANCE

19.

May 2007

Authors: Anikó Bíró
Péter Elek
*Ministry of Finance
Economic Research Division*
János Vincze
*Corvinus University of Budapest and
Institute of Economics, Hungarian Academy of Science*

Editor-in-Chief: István Síklaki
*ELTE Faculty of Social Sciences
Department of Social Work and Social Policy*

Editors: Zoltán Lakner
*ELTE Faculty of Social Sciences
Department of Social Work and Social Policy*
Ágota Scharle
*Ministry of Finance
Economic Research Division*

The Working Papers in Public Finance series serves to disseminate the results of research concerning public finance in Hungary. Its primary focus is on empirical research to support government decisions on economic policy and particularly on the analysis of the incentive effects and the redistributive impact of existing policies and proposals.

The new series replaces the Finance Ministry Working Paper series started in 2003. From January 2007 it is published by the ELTE Institute for Empirical Studies with the support of the Ministry of Finance. All papers in the series reflect the views of the authors only.

Summary

The Ministry of Finance (MoF) regularly prepares forecasts about the macro-economic situation and looks into the effects of economic policy measures and the underlying causes of economic trends. These tasks will be supported by the new quarterly macroeconomic model developed in cooperation with the Institute of Economics of the Hungarian Academy of Sciences. The model describes the macro-level mechanisms of the Hungarian economy, relying on historical data and theoretical economic relationships. It can be used to forecast key economic processes in the short and medium term and to quantify the expected impact of economic policy measures and of changes in the external environment.

The model contains approximately twenty behavioural equations which describe the decisions of economic actors, and a much larger number of accounting identities; thus it is similar to the medium-sized macroeconomic models used by other ministries of finance, international institutions and central banks. To allow for the needs of the Ministry of Finance and to the specific behavioural patterns of the Hungarian labour market and households, the government, consumption and labour market blocks are more detailed than usual for such models.

The model relies partly on estimates and assumptions, but the resulting uncertainty can be measured fairly well. In the case of two fundamental processes, the adjustment of wages and of household consumption, we investigated in detail how the uncertainty of estimates affects forecasts. Another source of uncertainty lies in the inaccuracy of the forecasts for the external environment (external demand, exchange rate, import prices). Our calculations show that the real variables of the model are most sensitive to changes in the external business cycle, but any unexpected movement in the exchange rate or import prices also affect them in the medium term.

Finally, to illustrate the model's potential for impact assessment of government measures, we examine how a 1% increase in wages in the public sector would affect macro-level processes. We find that, in the medium term, GDP would increase by 0.05% at most, and the general government deficit to GDP ratio would also rise; but due to the indirect effects that can be quantified by the model, this increase is smaller than the direct effects on a 2-3 year time horizon.

1 Introduction*

In practically all OECD member countries, ministries of finance and central banks develop macroeconomic models that cover the entire economy (i.e. not just a single sector),¹ and international institutions likewise use similar models.² In the case of Hungary, the two best known structural econometric models are the Hungarian version of the NIGEM model developed by the London-based National Institute of Economic and Social Research (NIESR) (Jakab and Kovács, 2002), and the Quarterly Projection Model (henceforth denoted by N.E.M.) of the National Bank of Hungary (MNB), which is used for preparing inflation forecasts and simulations (for a description of this model, see Benk et al. (2006)).

In international practice, modelling tends to have two objectives. Firstly, beyond ensuring accounting consistency, econometric models help satisfy the consistency of forecasting in the “economic” sense, too. That is, the interrelated processes underlying the projections can be presented in a structured format, relying on economic relationships. Naturally, to take account of one-off, short-term effects, the models are always combined with expert information, leading finally to a “consensus” forecast.³ Expert information significantly improves projections (see e.g. Fildes and Stekler, 2002).

Secondly, the models are also used for simulations and sensitivity analyses during ex ante evaluation of economic policy decisions, and to establish which factors represent the main sources of forecast uncertainty. The fan-chart “probability” forecasts widely used by central banks rely on econometric models even more than point forecasts do.

The model presented in this paper, which has been developed jointly by the Economic Policy Department of the Ministry of Finance and the Institute of Economics of the Hungarian Academy of Sciences, can also be

*The modelling effort was assisted by several colleagues of the MoF and the Institute of Economics who provided information and contributed valuable comments. We are particularly indebted to Gábor Békés, Réka Firlé, Tímea Kovács, Mariann Rigó, László Sándor and Hajnalka Tarjáni for their contributions. The comments of Zoltán M. Jakab (National Bank of Hungary) helped a lot in finalising the model.

¹See e.g. Allard-Prigent et al. (2002), and Bourquart et al. (2005) on the two models developed by the French Ministry of Economy and Finance, or, for a smaller member country, the paper by Drew and Hunt (2000) on the model used by the Ministry of Finance of New Zealand. An even greater number of central bank models are accessible in detail: almost all central banks regularly publish the updated versions of their econometric models.

²See e.g. Roeger and Veld (1997) on the QUEST II Model of the European Commission.

³See e.g. Jakab et al. (2006) on the model-based forecasting work of the MNB.

used for short- and medium-term forecasts and simulations. (However, because of its structure, it is currently less suitable for analysing supply side shocks and the long-term effects of structural reforms.) In terms of size and structure, it is similar to the econometric models mentioned above. The structures of the production, investment, price and foreign trade blocks essentially correspond to those used in similar sized open economy models. However, the general government, consumption and labour market blocks are more detailed than is customary, to allow for the specific needs of the Ministry of Finance and also for the particular behavioural patterns of the Hungarian labour market and households.

Section 2 of the paper describes the fundamental principles followed during model building. Section 3 explains the structure and relationships of the main blocks (production, foreign trade, investments, prices, labour market, households and budget), and identifies areas where, due to Hungarian peculiarities, custom-made solutions have been used. Section 4 illustrates the response of the model to certain shocks in the broad sense. Taking into account the complex relationships between the various areas of the economy, we analyse the short and medium term effects of these shocks on the GDP, its components, the general government deficit and the public debt. The final section deals with the possibilities for further development, and a list of variables appears in the Appendix.

The econometric terms used in the paper are explained in Ramanathan (2003), while the model is described in simplified terms by Bíró et al. (2007).

2 Modelling principles

2.1 Methodological considerations

Our modelling foundations are essentially the same as those applied in comparable models, but the special needs and circumstances mean that there are some peculiar features. As an important starting point, we regard the modelling process essentially as a communication between policy makers and model builders. It is, therefore, not really appropriate to talk of “the model”; instead, we should refer to a series of model variants (hypothetical scenarios) which arise in the course of communication. We do not know what the “real” model is: we only offer alternative scenarios that users can choose from. Hence, there is no absolute distinction between parameters, exogenous and endogenous variables either. (Naturally, the differentiation is relevant for each specific model or hypothetical scenario.)

The choice of scenarios and sensitivity analyses is part of the procedure. We should not believe that all the versions logically possible are actually meaningful, and nor do we believe that there is a single system that can provide reasonable and convincing answers to all possible questions in every respect. For instance, the purpose of this model is to build short- and medium-term forecasts and scenarios; therefore it cannot be expected to identify all the intricacies of the supply side of the economy, including the long-term effects of structural reforms. The latter objectives would require a different model.

Identification of long-term relationships. There is general consensus in today’s economic theory that the economy has neoclassical features in the long run, but due to various frictions it also has Keynesian attributes in the short and medium terms. Following this approach, attempts are often made to create models that have a long run growth path showing neoclassical (Walrasian) features, but depart from such a path because of business cycle dynamics – largely due to the existence of adjustment costs. Pragmatic model builders can seldom resist the temptation to insert ad hoc dynamic considerations into the system, which makes the whole model a mixture of theoretical and ad hoc elements.⁴

Simple assumptions about the processes driving the economy may indeed result in a model where there is long-term equilibrium growth, or, between certain variables, long-term equilibrium relationships. To facilitate a more comprehensive consideration of short-term dynamics, these relationships are generally described in statistical terms with a cointegration (or error correction) model. However, from a pragmatic forecast perspective, it is often useful to disregard the long-run relationships in levels (which are difficult to identify) and, instead, to define the equations directly for the growth rates of variables (see Hendry and Clements, 2003). On the other hand, the elimination of long-run relationships often yields absurd results in simulations: the natural non-negativity of variables may be compromised, an explosive debt and wealth path may evolve, or the model may lead to an unrealistically effective economic policy (free lunch). Therefore, models with long-run relationships are more appropriate for economic policy purposes than are models defined for growth rates.

Even though our model has an economic policy angle, it cannot dispense with some basic predictive capacity for the time horizon of at least a few years. Therefore, the choice between the above alternatives is not clear.

⁴See the Bank of England core and non-core models (Harrison et al., 2005).

Eventually, for practical purposes, in most areas important for medium-run simulations (e.g. wages, prices, consumption), we decided to maintain long-run relationships, often allowing for a relatively slow return to equilibrium.⁵

However, we have not defined any long-term equilibrium growth path for the entire model because, due to the transition nature of the Hungarian economy, we have encountered several trends that are important in the medium term but unsustainable in the long run (e.g. the growth of exports markedly exceeding the growth of internal consumption). The model would have a long-run equilibrium path if the exogenous trends were selected appropriately, but these would be different from the current – local – trends.

Treatment of expectations. Economic policy relevance might be undermined by the fact that, in our models, there are no rational expectations and there is no formalised learning process for decision makers either. Nevertheless, there are a number of experimental and empirical studies apparently showing that the rationality of expectations is not always present, and it is particularly compromised in the vicinity of major changes or in non-stationary environments. Thus, in the time horizon examined, the procedure used in similar econometric models appears to be appropriate, whereby the – ex post – expectations are modelled implicitly and incorporated in the dynamics of the equations.

Choice of form of the equations. In models with theoretical foundations, the choice of certain forms of functions has necessary implications for forms of other functions. For instance, the Cobb-Douglas production function yields a Cobb-Douglas form of cost (price) function, and the assumptions concerning substitutability in the fields of production or preferences will have consequences for the form of price (dual) functions. However, we shall depart from strict adherence to this principle on several occasions; below, we list general arguments to support this approach. (In individual cases, we shall explain our choice in detail.)

First, the theoretical relationships are generally not valid on the aggregate level unless certain restrictive assumptions are made. (The restrictive assumptions are often identical to the representative agent assumption.) For instance, the fact that the individual (or sectoral) production functions take the CES form (have constant elasticity of substitution) does not mean

⁵The greatest problem is that certain relative prices, e.g. real exchange rates or profit margins behave close to random walk, i.e. are slow to adapt to long-term relationships.

that the aggregate production function also takes the CES form; indeed, without additional assumptions, it does not even exist. (That is, there does not necessarily exist any functional relationship between aggregate labour, aggregate capital and aggregate output, as the latter also depends on the sectoral distribution of labour and capital.) Therefore, the applied functional forms are considered as approximations, where, for the sake of manageability, we tend to use linear or loglinear forms. (Both types are effectively local, first-order Taylor approximations.) In models with a steady state, the approximation would naturally be around that state, but we do not necessarily define such a state.

Secondly, we also do not insist on the theoretically “expected” functional forms because the data themselves do not meet such requirements. For instance, the so-called logarithmic distortion problem arises while calculating the consumer price index, or the recently introduced GDP chain indices themselves fail to satisfy the condition of addibility of parts.

On the whole, our functions are to be considered as generalised averages, and we have little reason to believe that we should insist on any specific functional form.

Estimation or calibration of parameters. In selecting the parameters of equations, our philosophy differs slightly from the approach adopted during the development of the Hungarian version of NIGEM or the N.E.M. In our view, the short (mostly less than 40 quarters long) available Hungarian macro time series, the frequent methodological corrections and the substantial non-stationarity of the variables of converging economies (e.g. structural breaks) together mean that the parameters of equations (and in particular of long-run relationships) can be estimated only with a high degree of inaccuracy. (This problem is also present in advanced economies – see, for example, Brainard and Perry (2000).) Therefore, when defining the parameters, we have departed from the above models and applied more times calibration based on international experience, in addition to statistical estimates. In order to underline the importance of this issue, some of our simulations investigate the sensitivity of results to parameter uncertainty.

Data. The data for the model mostly come from the national accounts and other Central Statistics Office (CSO) publications (wage and labour statistics, housing loan surveys, etc.), but we have also used data from the financial accounts of households and from other MNB publications, such

as from the ones concerning retail interest rates. In the initial phase of model building, we attempted to use micro-level databases (CSO household budget survey, wage tariff database, labour force survey) extensively. But eventually, due to aggregation issues, we could go through with disaggregated modelling only in the case of employment. Thus the micro-level data used come exclusively from the CSO labour force survey.

As the model is of quarterly frequency, we had to generate quarterly data by smoothing annual figures in a number of cases. Wherever possible, we used actual quarterly information to approximate changes within the year. In the course of parameter estimation, we used data from the 1998-2006 period, whenever they were available.

2.2 Economic considerations

On the whole, we are dealing with a small, open economy, where the country is a price-taker with respect to foreign prices, and national economic policy is unable to influence international interest rates. In the short term, demand determines output in the economy, but the tensions represented by the capacity utilisation indicator (the equivalent of the “output gap”) feed back into the model. The adjustment of prices and wages takes time. As an important general principle, the allocative function of relative prices is manifested mainly in the long run; therefore in our model, designed primarily for the medium term, the identification of some relative price effects is not important. Examples include capital costs and, as a related factor, real interest rates. Fiscal policy is mostly exogenous, but some expenditure items are affected by inflation in the medium term.

What do we think specifically about the operation of the Hungarian economy? In the long term, the growth of all economies depends on the quality and growth rate of inputs and the technology used. Hungary is in the process of technological convergence, which is attributable to the improvement of qualification of labour, the technological adaptation through international integration and the growth of the capital stock. Because of these factors, the growth rate may temporarily be higher than in the wealthier Member States. Due to the liberalisation of capital markets, there may only be temporary growth constraints on the side of capital formation. (The temporary growth constraint does not contradict the temporarily higher growth rate. Without the growth constraint, GDP growth would have been even faster.) Growth is limited more by the low qualification of the population – something that is naturally slow to change. A higher growth rate could

be achieved by increasing the participation rate of the population, mainly its less qualified groups, or by channelling the activity into the “white” economy, as well as by reducing unemployment. (Unemployment and inactivity are difficult to tell apart.) The activation of people with low qualifications would also have a positive effect through improving the position of the general government.

The stabilisation measures set out in the convergence programmes of September and December 2006 substantially changed the course followed up until then by the Hungarian economy. A reduction in government demand and the increase in tax and contribution rates lead to a temporary decline in demand, which, all other things being equal, reduces capacity utilisation and employment. By reducing the share of labour and capital in the national income, stabilisation also results in a (multiplied) drop in consumption and investment. The growth of the demand for housing construction is certain to drop off; this follows both from its dynamic growth in previous years and from the mode of its financing. (By nature, there is negative autocorrelation in the growth of demand for durable goods.) The relative decline is inevitable mostly in consumption; the impacts are less substantial on investments, where access to EU funds may have a considerable mitigating effect. Net export is expected to become a permanently positive item within GDP. On the whole, we expect the economy to remain below its “potential” as well as its “natural” level in the immediate future.⁶

3 The model

Our model consists of approximately 20 behavioural equations and considerably more accounting identities, thus it is similar to the medium-sized macroeconomic models used by other ministries of finance, central banks and international institutions (European Commission, OECD). Unless stated otherwise, all the variables below are quarterly figures adjusted by the TRAMO-SEATS method, and real variables are calculated at 2005 prices. The PR index denotes the private sector, the G index the government sector, and H is for households. CR means macro-aggregates at current prices. $X(-1)$ indicates a one-quarter lagged value of variable X , and $d\log(X)$ is the difference in its logarithm. Considering that changes are

⁶Theoretical literature distinguishes between the potential and natural outputs of the economy. The latter is the price flexible equilibrium level around which the economy fluctuates, while the former means the “ideal” output level without any tax or competition distortions. Empirical literature often uses the two terms interchangeably.

not all that big, the latter effectively means a percentage growth rate:

$$d\log(X) = \log(X) - \log(X(-1)) \approx X/X(-1) - 1.$$

Table 1 contains the main macro variables of the blocks of the model and the drivers of the variables, without specifying dynamic effects. The detailed explanation of the relationships will be the subject of the next sections. (Budgetary variables are described in a separate table in section 3.9.) For ease of understanding, the list of variables is given in the Appendix.

3.1 Private and government output, GDP and imports

Private and government output. As compared to other similar models, our model has the important feature of consistently distinguishing between the output of the business and the public sectors. Thus, in modelling the production, pricing and wage-related decisions of the business sector, we take into consideration only the GDP produced by that sector, rather than the total GDP. (For the sake of simplicity, we consider private GDP to mean the GDP produced by sectors A-K, and public GDP to mean that of sectors L-O. Hence the latter includes public administration, education, healthcare and other community services.) This is potentially important because, as shown in Figure 1, in most of the past six years, the growth rate of GDP was significantly different in the two sectors, and the gap is expected to widen in the near future as a result of the implementation of the stabilisation measures outlined in the convergence programme.

Within the framework of the model, we approximate private and public GDP from the expenditure side, taking into account that the various items there create different levels of demand for the “products” of the two sectors. As a first step, based on the latest available (year 2000) Input-Output Tables (IOT), we find the following relationship between private (Y^{PR}) and government (Y^G) output⁷ and the expenditure side items:

$$Y^{PR} = 0.24 * Y^G + 0.78 * CE + 0.14 * TRK + 0.11 * G + 0.67 * I + 0.97 * X \quad (1)$$

$$Y^G = 0.02 * Y^{PR} + 0.11 * CE + 0.81 * TRK + 0.89 * G + 0.00 * I + 0.01 * X \quad (2)$$

where CE is real consumption expenditure of households, TRK is social transfers in kind, G is government consumption, I is gross capital formation

⁷In the following we understand output as net output, i.e. net of material input.

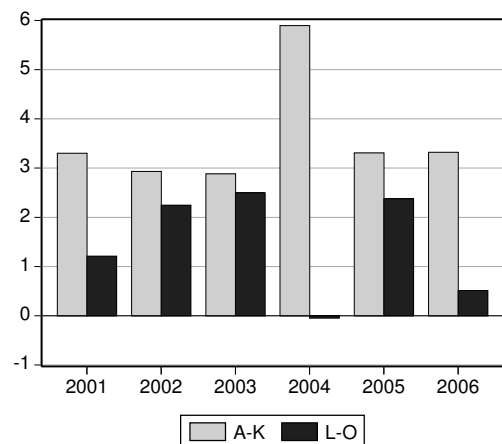
Table 1: Main variables and relationships

Macro variable	Explanatory variable
<i>Production block</i>	
Capacity utilisation	private GDP, capital stock, employment
Private GDP	GDP expenditure side items
Imports	GDP expenditure side items
<i>Exports block</i>	
Exports	export markets, real labour cost
<i>Investment block</i>	
Private capital stock	private GDP, exports
Private investment	private capital stock, amortisation
<i>Price block</i>	
Export and import deflator	foreign prices, exchange rate
Core inflation with constant tax rate	unit labour cost, import deflator
Consumption expenditure deflator	core inflation with constant tax rate, indirect taxes, one-off effects
Private investment deflator	core inflation with constant tax rate, import deflator
Other investment deflator	core inflation with constant tax rate
<i>Labour market block</i>	
Activity	demography, qualification
Skilled employment	skilled activity
Unskilled employment	unskilled labour cost, capacity utilisation
Average wage in private sector	nominal private productivity
Unskilled wages	average wage in private sector, minimum wage
<i>Household block</i>	
Household income	wage bill, taxes, transfers, other income
Other income	nominal GDP
Household consumption expenditure	household income, wealth
Household investment	household income, exogenous factors

and X is exports. (Thus, based on the equations, both sectors have material inputs from the outputs of the other two sectors.) The solution to this equation system returns, in every quarter, the estimated output of the private and government sectors, based on the components of demand.⁸

⁸Naturally, due to the variability of the coefficients, the output indicators thus received will

Figure 1: Annual growth rate of private (sectors A-K) and public (sectors L-O) GDP, 2001-06

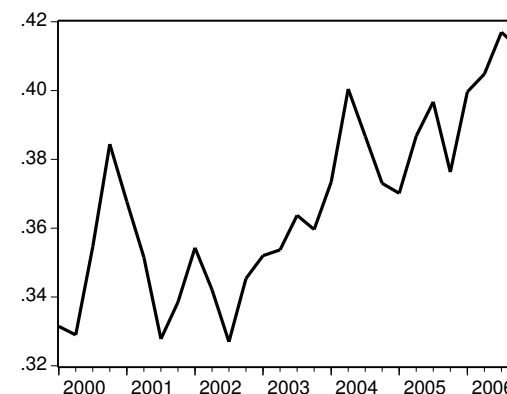


Import. In the model, private and government production, as well as final use (household consumption, investment and government consumption) all have import requirements. The import coefficients were also estimated on the basis of the year 2000 IOT model. However, assuming a constant import ratio over time for all areas in the expenditure side, a smaller import was derived for the years after 2000 than was actually the case. Therefore we reconciled the data with the constant import coefficient assumption by increasing the direct import requirement of private production over the years – in line with the observed imports. We then extrapolate that trend (with a 0.8% annual growth) in the projection period as well. Import growth is likely to be related to integration; that is why we attribute the entire import ratio growth to the growth of the intermediate import ratio.⁹ Thus the equation works out as follows (M is the real value of imports and

only approximate the output data published by the CSO for the years after 2000.

⁹A number of studies prove that, mostly due to the activities of multinational companies, an increasing percentage of world trade comes from the importation of intermediate inputs, see e.g. Navaretti and Venables (2004), pp. 14-15.

Figure 2: Estimated import ratio of private production



m is the direct import ratio of private production):¹⁰

$$M = 0.12 * CE + 0.05 * TRK + 0.35 * I + 0.02 * X + m * Y^{PR} + 0.04 * Y^G. \quad (3)$$

Figure 2 shows the production import coefficient m resulting implicitly from the above equation for the period 2000-06. On the whole, the 0.2% average quarterly growth rate is in line with past data; therefore in the forecast period, m was modelled as follows:

$$m = 1.002 * m(-1). \quad (4)$$

Our assumptions (use of price-independent import coefficients) also mean that we consider the substitution elasticity between domestic products and imports, both in production and in final consumption, to be zero. That is, the relative import prices have no allocative function in the model. In the absence of data, we cannot make any estimates concerning the price elasticity of the import content of final consumption; while in production, negligible substitution elasticity is a traditional assumption of the literature.

¹⁰Naturally, the total import requirement of the expenditure side items (CE, TRK, I, X) – due to indirect importation through production – is considerably greater than the direct multipliers in the equation.

Private and government GDP. Ultimately, in the spirit of the constant coefficient input-output model, and taking account of the coefficients of equations (1), (2) and (3), the calculation of private and government GDP takes place as follows:

$$GDP^{PR} = (1 - m - 0.02) * Y^{PR} + DEV \quad (5)$$

$$GDP^G = (1 - 0.04 - 0.24) * Y^G \quad (6)$$

where *DEV* indicates exogenously given changes in inventories and statistical discrepancies.

The main thing is to determine approximately the private and public portions of total GDP, given that the various expenditure side items generate varying demands for output from the private and government sectors, respectively. In the model, the national economy GDP indicator is defined as the sum of the two components, and satisfies the usual relationship by construction:

$$GDP = CE + TRK + G + I + X - M + DEV. \quad (7)$$

3.2 Production side

The form of the aggregate production function of the private sector is Cobb-Douglas,¹¹ but it also includes a capacity utilisation variable (*UTI*). Thus, denoting the capital stock of the private sector by K^{PR} and employment in the private sector by L^{PR} :

$$GDP^{PR} = UTI * TFP * (K^{PR})^{0.4} * (L^{PR})^{0.6}. \quad (8)$$

According to our assumptions, output is equal to demand in every period, and assuming fixed capital in the short term (a quasi fixed factor), equilibrium is achieved by the adjustment of capacity utilisation and of labour input. As for which of these adjusts more in the short term, depends on the relative cost of unskilled labour and capital. We consider the former to be identical to wages, and the latter to be proportionate to the value of capital at replacement cost. (For more details, see section 3.6.) Thus, in our view, the fluctuation in capacity utilisation is part of the economic processes, which can be regarded as a Keynesian approach; but it is also an important element of modern real business cycle theory (see King and Rebelo, 2000). The cost of capacity utilisation is proportionate to the cost

¹¹The government sector has no production function.

of capital, effectively through amortisation; but for the time being we do not model this in detail.

We think, for two reasons, that it is reasonable to assume Cobb-Douglas technology instead of a more sophisticated production function. First, on such an aggregate level, the production function does not necessarily exist: sector-level balance sheet data indicate that the capital-labour ratio differs greatly in the various sectors, and it may also change substantially over the years even within a single sector. (On the issue of aggregation, see Basu et al. (2001).) Therefore, since the most important thing for us is to have the output growth limited by input growth, rather than going for the more complex production function, we opted for the simplest form that suited our purpose – the Cobb-Douglas function.

Secondly, even though it is commonly thought that the Cobb-Douglas technology fails to realistically express the substantial substitutability between capital and labour, this problem does not appear overly important to us due to the treatment of investments (see section 3.4). The ex ante substitutability of capital and labour, as expressed by the Cobb-Douglas function, is probably greater than the ex post substitutability, which explains the lower estimates of substitution elasticities in the literature.

In line with the private sector labour share figures we calculated, we chose the parameter of labour in the production function to be 0.6. This is slightly less than the value of approximately 0.65 generally used for the entire economy, but we must take into account that it only relates to the private economy (and in the government sectors, the share of labour is typically greater than in the private sector).

We chose the growth rate of total factor productivity (*TFP*) to be 1.8% per annum, which means the following when translated into quarters:

$$TFP = 1.0045 * TFP(-1). \quad (9)$$

This is slightly higher than the 1.6-1.7% assumption in the convergence programme of December 2006, but the difference is easily explained by the fact that the technological development of the private sector is likely to be faster than that of the economy as a whole. It is not our aim to model the TFP process for the period reviewed, but naturally we can also generate scenarios by changing the exogenous growth rate.

These assumptions in aggregate yield a 3% annual growth on a long-term growth path where the labour input is constant. In the past 10 years, the average annual approximate growth of private GDP has been 4.3%, while private sector employment has increased by 1.1% per year on average.

Our assumptions reflect the growth trend of the past 10 years if the growth of capital input in the private sector was 4.6% per annum in this period. We have no figures to support this, only estimates, which are by and large in line with that value; however, investments did increase faster than GDP, and so the hypothesis is not absurd.

On the whole, we consider the production function and the capacity utilisation variable, calculated from the production function and from the inputs, to be mainly tools for testing the model. (If the model forecasts a capacity variable with trend, we may expect trouble in the longer term.) On the other hand, there is also feedback to the other parts of the model, as the capacity utilisation variable affects employment.

3.3 Export

Hungarian export trends are determined by the growth rate of our export markets (i.e. the weighted import demand of our foreign trade partners) and the profitability of exports. The demand in our export markets ($WDEM$) is an exogenous factor, and, in the baseline scenario, is the same as the assumption used in the convergence programme of December 2006. In the course of calibration, we take into consideration the fact that, in the medium term, Hungarian exports grow faster and show greater fluctuations than the above export demand indicator, mostly due to market acquisitions in the fast-growing new EU Member States and in non-EU European countries. Based on data from the recent past, we chose the elasticity with respect to foreign export demand to be 1.5.¹²

The effects of profitability, which we approximated using a real labour cost indicator ($RWCOST$, wage cost / export price), are protracted over time. Using international experiences of small open economies, we calibrated the long-term elasticity parameter to be -0.36. (The NEM model of the MNB uses a stronger -0.5 elasticity for exports with respect to the exchange rate.) The export price expressed in euros is exogenous.

As we do not expect the increased import requirement to be detrimental to the profitability of exports (more imports do not reduce the productivity of labour in exporting sectors; indeed, we suspect that they may improve

¹²The greater-than-one cyclical elasticity of our exports can result from market acquisition alone. Furthermore, the imports of converging economies, where our market acquisitions mostly occur, show stronger fluctuations and a greater dependence on global cyclical developments than the imports of old Member States do. Therefore, the standard deviation of our export demand indicator is expected to be greater than that of the EU-15 imports, which may be very important when we come to sensitivity analyses.

it), we did not incorporate the increase in import requirements when calculating profitability.

Thus, the long-term equation (where $XSTAR$ is the long-run equilibrium level of export) is:

$$\log(XSTAR) = 1.5 * \log(WDEM) - 0.36 * \log(RWCOST) - 14.43 \quad (10)$$

where $RWCOST$ is the quotient of the wage cost in the private sector ($WCOST^{PR}$) and the export price in HUF (P^X):

$$RWCOST = WCOST^{PR} / P^X. \quad (11)$$

Short-term adjustment works out as follows:

$$\begin{aligned} d\log(X) = & 1.5 * d\log(WDEM) - \\ & - 0.1 * (\log(X(-1)) - \log(XSTAR(-1))). \end{aligned} \quad (12)$$

3.4 Investment

Investment is described in essence by the accelerator theory, which can be derived, given constant interest rates, from a Cobb-Douglas production function model in the long term. Adjustment is slow, which corresponds to a flexible accelerator model. As investments have recently been growing faster in the export sector than in the entire private economy, we have assigned a coefficient to the export different from that of the GDP in the accelerator model. This solution again reflects only short-term trends, which we know to be unsustainable in the long run.

Our original problem was to define the (macro-level) cost of capital. If we assume that uncovered interest rate parity is valid, the nominal cost of capital can be calculated for either HUF interest rates or foreign interest rates converted into HUF. This assumption, however, does not seem to be satisfied either on Hungarian data or other data, at least not in the short term. The currency composition of borrowing also indicates that the differences in relative yields cause substantial fluctuations; therefore we can discard the “neutrality” caused by uncovered interest rate parity using indirect arguments, too. On the other hand, the usual solution – designation of domestic interest rates as opportunity cost – does not appear to be reasonable in a world where there is free movement of capital and a large part of output comes from multinational companies. (Of course, individual cost of capital is different from the aggregate cost of capital, but we have been unable to explicitly look into risk factors.)

We also attempted to define the cost of capital indirectly; that is, we tried to trace back, from the time series of investment, the cost of capital that generated the given investment series. Of course, this method relies on a number of implicit assumptions (for instance, Cobb-Douglas technology and disregarding adjustment costs). We tried to connect the time series thus obtained for implicit capital costs with the interest rates and exchange rate changes, but we got no meaningful results. As investments and GDP (and export growth) seem to show a close link, eventually we opted for the simple, cost-independent accelerator model. This mechanism is essentially similar to the one we postulated for consumption: the objective is to achieve the desired output-capital ratio over the long term. We can argue for the accelerator model, saying that investors make their decisions based on constant long-run interest rate and real wage trends.

We took the real value of corporate capital stock from Pula (2003), then carried it on using the investment data series – assuming an annual amortisation rate of 6.5% –, and finally converted it to 2005 prices. In the forecasting stage, we used the following equation to define the capital stock:¹³

$$K^{PR} = 0.952 * K^{PR}(-1) + 0.365 * (0.65 * GDP^{PR} + 0.35 * X). \quad (13)$$

Private investments are defined by an implicit investment equation:

$$I^{PR} = K^{PR} - (1 - 0.065/4) * K^{PR}(-1). \quad (14)$$

Government investment is exogenous, while the method of modelling household investments is described in the household block.

3.5 Prices

Export and import prices. Export and import prices in euro terms are exogenous (in the baseline scenario, the growth rate of euro export prices is 0.9% per annum; that of import prices is 1.2%), and, multiplied by the exchange rate, they yield the export (P^X) and import (P^M) price level in HUF terms. Thus, we assume that external prices immediately appear in the import and export deflators. (This assumption is essentially in line with the assumption used in the NEM model, where pass-through in the first quarter is already 95% for export prices and 80% for import prices.)

$$P^X = EUR^X * HUF_{EUR} \quad (15)$$

$$P^M = EUR^M * HUF_{EUR}. \quad (16)$$

¹³Given the value of the long-run capital stock increase, the equation can be used to calculate the equilibrium ratio of the weighted average of GDP and export to the capital stock.

Consumer prices. In our model, the price level corresponding to core inflation, net of tax effects, (P^{COREV}) is defined through a markup on the unit cost (that is, on the combination of the unit labour cost - ULC - and import price - P^M):¹⁴

$$MUP = \log(P^{COREV}) - 0.65 * \log(ULC) - 0.35 * \log(P^M). \quad (17)$$

We define the core inflation equation in an error correction form. If the markup is greater than its long-term value, this exerts a downward pressure on prices, while a too narrow markup pushes prices upwards. Due to persistence, the right-hand side of the equation also contains the delayed value of price changes. Moreover, the change in the import deflator is reflected directly as well, as experience shows that import prices are faster to pass through to prices than labour costs:

$$\begin{aligned} \text{dlog}(P^{COREV}) = & 0.0066 - 0.1278 * (MUP(-1) - 0.02) + \\ & + 0.064 * \text{dlog}(P^M) + 0.474 * \text{dlog}(P^{COREV}(-1)). \end{aligned} \quad (18)$$

Our equation may be in line with the assumption of monopolistic competition, or we may interpret it to mean that the markup only represents the exogenous cost of capital. As in the approach we used for exports, we disregarded the import demand growth here as well, for the reasons described in that section. Adjustment is slightly faster than in the N.E.M. model.

In our model, the consumption expenditure deflator (P^{CE}) is different from the core inflation indicator net of tax effects due to indirect taxes, one-off regulatory price measures and oil prices. For the sake of simplicity, we approximate oil prices with the import deflator value (and borrow its weight from the N.E.M. model). Thus we have the following equation:

$$\begin{aligned} \text{dlog}(P^{CE}) = & \text{dlog}(P^{COREV}) + \text{dlog}(1 + IDTRATE) + \\ & + \text{dlog}(D) + 0.067 * \text{dlog}(P^M) \end{aligned} \quad (19)$$

where $IDTRATE$ is our estimated implicit indirect tax rate, and D denotes the one-off (regulatory) measures.

Investment prices. We approximate the household and government investment price index with the core inflation price index, and the price of

¹⁴We are indebted to Zoltán Gyenes and Zoltán M. Jakab for making available the core inflation time series, net of tax effects, as calculated by the MNB.

private investments (P^{IPR}) is derived from a combination of the core inflation price level and import prices, since such investments have different import content:

$$\text{dlog}(P^{IPR}) = 0.7 * \text{dlog}(P^{COREV}) + 0.3 * \text{dlog}(P^M). \quad (20)$$

Finally, the investment deflator (P^I) is obtained as the weighted average of the individual investment deflators.

Private GDP at current prices. After this, we derive the nominal private sector output (YCR^{PR}) and GDP ($GDPCR^{PR}$) as the weighted sums of the products of the relevant real indicators and price indices. Here the real consumption expenditures are multiplied by the core inflation indicator net of tax effects, rather than by the consumption expenditure deflator. (Under this arrangement, the changes in indirect taxes and regulatory price measures do not affect the nominal productivity of the private sector.) Thus:

$$YCR^{PR} = 0.81 * CE * P^{COREV} + 0.33 * (TRK + G) * P^{GTRK} + 0.68 * I * P^I + 0.97 * X * P^X \quad (21)$$

$$GDPCR^{PR} = (1 - 0.02) * YCR^{PR} - m * Y^{PR} * P^M. \quad (22)$$

The model also includes the price index of government consumption expenditure (i.e. of the aggregate of government consumption and in-kind social transfers) (P^{GTRK}); its calculation is described in section 3.9.4.

3.6 Labour market

The characteristics of the Hungarian labour market and its role in macroeconomic contexts justify the special attention devoted to the labour market block in our model.

In Hungary, the employment rate is 8 percentage points lower than in the EU-15, and 7 percentage points below the EU-25 average, even though that in the last 10 years we have seen a 4 percentage point increase in the rate. Inactivity is high, but unemployment is not outstandingly high, while regional differences are great, and mobility is limited. Sectoral employment ratios have shifted as a trend towards the service sector, while the number of government employees has shown substantial fluctuations over the past decade.

Wage agreements are not binding and are unlikely to have any substantial influence on wages. Average wages adjust to productivity in the long term, and sectoral wages in the private sector also move together in the short term. The increase in the minimum wage is likely to have reduced the employment of unskilled labour. There is an "atom" ("spike") at the minimum wage in the wage distribution, that is, a high proportion of people is employed at the minimum wage.

To set up the block, first we tried to estimate wage and employment equations by sector and qualification, using the CSO labour force survey. However, we were unable to come up with meaningful aggregate equations on this basis. Therefore we chose the following method.

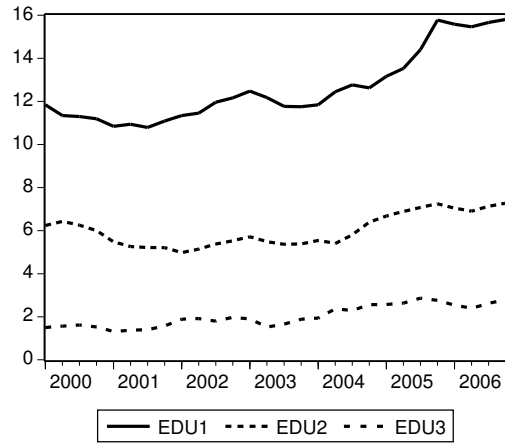
Private sector wages, at least in the medium term, are set in accordance with labour productivity, so that the equilibrium share of labour depends on the level of unemployment. The wages of unskilled labour are affected by the minimum wage as well. Wages are determined in advance; within a period, the demand for unskilled labour is adjusted depending on capacity utilisation. The supply of skilled labour is exogenous, and it is always exploited. (More precisely, the share of skilled labour employed is in line with observations.)

In essence, our model corresponds to a model where there is monopsony-type competition for skilled labour, while on the unskilled labour market there is oversupply due to the minimum wage.

3.6.1 Activity and employment

Activity. We distinguish between three grades of qualification: persons with at most primary education (hereinafter denoted as EDU1), with secondary (EDU2) and tertiary (EDU3) education. We forecast the numbers in the various qualification categories by cohort and sex up to 2014, then we determine activity from this, based on the assumption that the participation rate within the various cohort-sex-qualification cells is constant at the 2005 level. (The ratios come from the labour force survey.) We depart from this only in the case of older age cohorts, where we also take into account the expected effects of the rise in the age of retirement. Thus we get a forecast for the number of active persons in the various qualification categories (ACT^{EDU1} , ACT^{EDU2} , ACT^{EDU3}) that reflects the expected increase in activity due to the replacement effect in forthcoming years.

Figure 3: Unemployment rate (%) in three qualification groups, 2000-2006



Employment. Empirical studies confirm that the wage elasticity of labour demand is considerably stronger in the unskilled than in the skilled segment (e.g. Köllő, 2001). The disaggregation of employment modelling by qualification is also justified by Figure 3, which shows that the unemployment rate of the group with the lowest qualification is considerably higher and more volatile than unemployment in the other two groups. (We get similar figures if we depict the unemployment of the various qualification classes within a given cohort-sex cell.) On this basis, we have arrived at the following equations.

We assume that skilled (EDU2 and EDU3) labour is in essence a fixed production factor, unemployment in these categories is only frictional, and skilled active persons will find employment sooner or later. The estimated equilibrium unemployment is 2.2% in the tertiary category and 6% in the secondary one. Job search is much more effective in the tertiary than in the secondary group; that is, in the former segment employment is considerably faster to adapt to an activity shock. The form of the equations:

$$L_0^{EDU2} = 0.381 * ACT^{EDU2} + 0.595 * L_0^{EDU2}(-1) \quad (23)$$

$$L_0^{EDU3} = 0.921 * ACT^{EDU3} + 0.060 * L_0^{EDU3}(-1) \quad (24)$$

where L_0^{EDUi} ($i = 2, 3$) means employment of the two qualification classes without the adjustments required due to layoffs in the government sector

(see below).

Fluctuations in the demand on the goods market alter only demand for unskilled labour, so that the change of capacity utilisation (UTI) and unskilled employment (L_0^{EDU1}) brings the demand and supply sides of the economy into equilibrium in each period. The equation is:

$$\begin{aligned} d\log(L_0^{EDU1}) = & d\log(UTI) - \\ & - 0.05 * (\log(L_0^{EDU1}(-1)) - \log(LS^{EDU1}(-1))) \end{aligned} \quad (25)$$

where LS^{EDU1} is the equilibrium value of unskilled unemployment:

$$\begin{aligned} \log(LS^{EDU1}) = & \log(UTI) + \log(P^I) + \log(K^{PR}) - \\ & - \log(WCOST^{EDU1}) + 8.40 - 0.011 * TIME. \end{aligned} \quad (26)$$

Thus the relative proportion of unskilled employment and capacity utilisation depends on the value of capital at replacement cost ($P^I * K^{PR}$), and on the unskilled wage cost ($WCOST^{EDU1}$). As the latter is affected by the minimum wage, all other things being equal a minimum wage increase reduces employment in the unskilled segment. The $TIME$ variable is included in the equation because of the negative trend in unskilled employment.

Effects of government layoffs. We estimate the effects of the layoff or retirement of government employees based on the labour force survey panel data base, using the propensity score-matching method (for more details about the method, see Dehejia and Wahba, 2002). The essence of the method is that we compare the labour market flow of persons laid off from the government sector (e.g. their re-entry into employment) with the labour flow of persons who are similar to the dismissed group in their observable characteristics but who have not been laid off. The difference between the two flows will be the net effect of the layoffs on the labour market. We also examine the consequences of retiring people in a similar manner.

Naturally, it is relevant whether staff reductions are implemented primarily through layoffs or through retirement. In the case of layoffs, the negative employment effect is quicker to reduce initially than in the case of retirements (as most of the dismissed persons will soon find employment). In contrast, the long-term effect is less favourable, because a significant proportion of those dismissed will become permanently inactive before reaching the retirement age, while persons sent into early retirement would have become pensioners within a few years anyway.

Thus, if we make assumptions (or have data) concerning the ratio of layoffs and retirements, we can estimate the temporal effect on total employment of the exogenously given staff reduction in the government sector.

Aggregate indicators. Thus the aggregate employment indicators work out as follows. The government-employed population (L^G) is exogenous, and the equation for the number of the total employed population is:

$$L = L_0^{EDU1} + L_0^{EDU2} + L_0^{EDU3} - CORR^G \quad (27)$$

where $CORR^G$ is the correction due to layoffs in the government sector calculated as explained above.

Private sector employment (L^{PR}) and the number of employees of private businesses with at least five employees (L_{INST}^{PR}) is:

$$L^{PR} = L - L^G \quad (28)$$

$$L_{INST}^{PR} = 0.62 * L^{PR}, \quad (29)$$

that is, we assume the ratio of the number of employees (of businesses with at least five workers) and employed persons in the private sector to be constant.

The number of unemployed persons (U) and the unemployment rate (URATE) can be calculated in an obvious manner.

3.6.2 Wages

Calculation of different wage and wage bill indicators. Before going into the details of wage equations, we should define the main wage indicators to be used. The gross average wage (GW^{PR}) and the net average wage (NW^{PR}) of the private sector are linked by the tax and contribution system, and the same is true of the gross (GW^G) and net (NW^G) wages of the government sector. (The methodology to model government wages is described in section 3.9.) Then the gross (GW) and net (NW) wages in the national economy are defined as the weighted average of private and government average wages. The wages and salaries indicator, which is relevant for the household block, is calculated in the private and government sectors using the number of employees, the gross wage and a correction multiplier (different for the two sectors), then the sum of the two indicators yields the wages and salaries for the whole national economy (quarterly data are

derived by multiplying monthly earnings by 3):

$$WINC^{PR} = 3 * 1.695 * GW^{PR} * L_{INST}^{PR} \quad (30)$$

$$WINC^G = 3 * 1.166 * GW^G * L^G \quad (31)$$

$$WINC = WINC^{PR} + WINC^G. \quad (32)$$

The 1.695 multiplier for the private sector also reflects the fact that the "number of employees" category of the institutional data collection does not include the employees of companies with fewer than five persons. (By contrast, if we use the "employed persons" data from the labour force survey, deducting the number of government employees, we get a correction factor smaller than 1, because this broader category also contains self-employed persons, etc., whose income is not included in our wage bill indicator.)

The compensation of employees in the private and government sectors ($COMP$) is calculated using the employers' social security contribution rates ($SCERATE$), where we also used correction factors:

$$COMP^{PR} = (1 + SCECORR^{PR} * SCERATE) * WINC^{PR} \quad (33)$$

$$COMP^G = (1 + SCECORR^G * SCERATE) * WINC^G \quad (34)$$

$$COMP = COMP^{PR} + COMP^G. \quad (35)$$

The $SCECORR^{PR}$ és $SCECORR^G$ correction factors change from year to year, and are around 0.75 for the private sector and around 0.96 for the public sector.

The average labour cost per person in the private sector is calculated as follows:

$$WCOST^{PR} = (1 + SCECORR^{PR} * SCERATE) * GW^{PR}. \quad (36)$$

The unit labour cost (ULC) is calculated as the ratio of the compensation of employees in the private sector and the real private GDP:

$$ULC = COMP^{PR} / GDP^{PR}. \quad (37)$$

Finally, the share of labour in private GDP ($WRATIO$, wage ratio for short) is defined as the ratio of the private compensation from employment and the estimated private GDP at current prices:

$$WRATIO = COMP^{PR} / GDP^{PR}. \quad (38)$$

Thus, our wage ratio indicator is not the same as the one traditionally calculated from national account data (which is defined as the ratio of compensation of employees in the private sector to corporate GDP, see e.g. Kátay et al., 2004), since the denominator contains the estimated private GDP rather than corporate GDP. Even though the two indicators obviously have different values, they show similar trends (apart from the continuous growth of the ratio of corporate to private GDP), and that is sufficient for us for modelling purposes.

Productivity-dependent wage equation. In the private sector, the growth rate of the average wage is essentially the same in the long term as the growth rate of the nominal labour productivity of the private sector. In fact, there is even more to this: in the long run, the share of labour in private GDP (the wage ratio) depends only on the unemployment rate (higher unemployment reduces the equilibrium wage ratio by undermining the bargaining position of employees). If $NOMP$ is the nominal productivity of the private sector:

$$NOMP = GDPCR^{PR} / L_{INST}^{PR}, \quad (39)$$

technically, the wage equation is the following:

$$\begin{aligned} d\log(GW^{PR}) = & \\ = -0.033 * (0.656 + \log(WRATIO(-1)) + 1.34 * URATE) + & \\ + (1 - 0.15) * d\log(GW^{PR}(-1)) + 0.15 * d\log(NOMP). & \quad (40) \end{aligned}$$

Considering that the wage ratio, assuming unchanged contribution rates, is by definition proportionate to $GW^{PR}/NOMP$, the equation assures the so-called dynamic homogeneity; that is, the long-run equilibrium level of the wage ratio does not depend on the long-run growth rate of real productivity or of the GDP deflator. (This is not the case in every econometric model designed for the medium term, see also Kattai (2007).)

The mechanism of adjustment of wages to productivity is as follows. Let us assume a positive shock to nominal GDP (be it real demand or price shock). In this case, the wage ratio falls below its equilibrium level, which, according to the equation, places an upward pressure on wages. This ensures that the wage ratio returns to the long-term level.

The adjustment of wages to the equilibrium level of the wage ratio takes time; they are immediately affected by changes in nominal productivity

with only a 15% elasticity. The speed of adjustment is illustrated below, in Figure 4, where the ceteris paribus development of wages is shown in the case of a 1% change in nominal productivity,¹⁵ as compared to the corresponding figure of the N.E.M. model (Figure 10 of Benk et al, 2006). The half-life of the wage response – the time required to reach the 0.5% relative wage level – is three quarters in our model, whereas it is four quarters in the N.E.M. model; thus adaptation is faster than in the N.E.M. model. (In the N.E.M. equation, the wages start climbing one quarter after the shock, while in our model this occurs immediately.) There are two reasons for this difference: firstly, our model contains private GDP, whereas the N.E.M. model uses total GDP – wages are likely to respond faster to changes in the former than in the latter. Secondly, recent trends may indicate an acceleration in wage adjustment (e.g. Kovács, 2005), and we used an estimation period for our equation that ends later than (but is overlapping with) the one used for N.E.M. It should also be noted that, in our model, there is overshooting in respect of the wage – productivity relationship.

Instead of estimating the effect of the unemployment rate on the equilibrium wage ratio, we calibrated it to 1.34; that is, a 1 percentage-point growth in the unemployment rate reduces the equilibrium wage ratio by 1.34%. (This is the median of the similar parameters in the country-specific parts of the NiGEM model; for the parameters, see Tables F4-10 in Jakab and Kovács (2002).)

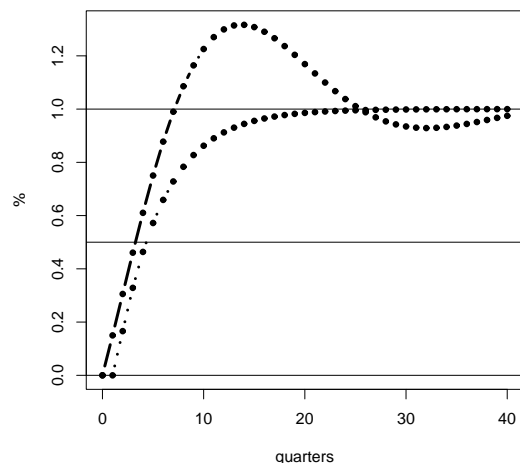
We should note that the persistence of wages refers to gross wages, while the long-term relationship applies to the wage ratio calculated on the basis of the total wage cost. Thus, a change in the employers' contribution rate is not reflected immediately in the changes in gross wages.

In addition to the baseline parameterisation, we also prepared simulations using different assumptions for the speed of adjustment, altering the error correction parameter, which describes the speed of adjustment to the level. Details are presented in section 4.

Wage of unskilled labour. We need the wage of unskilled labour because unskilled employment is determined by labour demand. In the current version of the model, the average wage of this segment is approximated by the weighted average of the minimum wage and the average wage in the

¹⁵The figure shows the partial response arising from the wage equation – due to its presentation in logarithmic form, the partial effect of the 1% shock is identical at every point in time.

Figure 4: Changes in private sector wages in case of a 1% nominal productivity shock in our model (continuous line) and in the N.E.M. (dashed line)



private sector, where the weights are determined on the basis of the wage tariff surveys of previous years. We are aware, however, that this is only an approximation, and in reality, due to the high number of minimum wage earners, unskilled wage is a more complex function of the minimum wage and the (skilled or national economy) average wage.

$$GW^{EDU1} = 0.62 * MINW + 0.38 * GW^{PR} \quad (41)$$

The average wage cost of unskilled employees ($WCOST^{EDU1}$) is calculated following correction using the employers' contribution rate:

$$WCOST^{EDU1} = (1 + SCECORR^{PR} * SCERATE) * GW^{EDU1}. \quad (42)$$

3.7 Households

The income, consumption, investments and wealth accumulation of households are determined in the household block. As a special feature, the block treats the elements of the wealth of households in a disaggregated manner,

which allows, for instance, for better analysis of the impacts of exchange rate changes through the wealth channel.

3.7.1 Consumption function

The most important behavioural equation of the block is the consumption function, which determines, inter alia, how much households smooth their consumption; that is, to what extent they “look beyond” a temporary income shock.

Traditionally, macro-models analyse household consumption in the spirit of the life-cycle theory, which, if certain criteria are satisfied, can be transcribed into an error correction form, where consumption depends on income and wealth in the long run, while the speed of short-term adjustment gives the extent of consumption smoothing. Our investigations, however, indicated that the “buffer stock” theory may provide a more appropriate framework for analysing the growth in propensity to consume that has been seen in the first years of the century. According to that theory, and in contrast to the classical versions of the life-cycle hypothesis, the imperfections of the capital market do not allow households to manage their entire life-cycle income. Consequently, in the course of consumption or saving decisions, households are motivated primarily by impatience and prudence: they strive to consume as much as possible due to impatience, while prudence prevents them from accumulating too little reserve in the form of financial wealth. As a net result of the two conflicting motives, consumers often behave as if they were accumulating a wealth buffer, the level of which they determine as a ratio of the income considered to be permanent. Hence the name: “buffer stock” model. (For a summary of the model, see Carroll (1997).) In accordance with the theory, we understand income to mean the freely disposable (“liquid”) income of the household, and wealth to mean the liquid financial wealth, i.e. the part of the wealth that the household can influence by managing its consumption. (Liquid income is denoted by $LIQI$, and its definition is provided in equation (47). Liquid wealth is denoted by $LIQW$, see equation (48).)

In the course of practical implementation, we also have to model the adjustment to the target value of the $LIQW/LIQI$ ratio, and we must take account of the fact that the target value may change over time as credit constraints are relieved and as future income uncertainties change. We envisage adjustment to the long-run ratio to be of polynomial speed, and we use dummy variables to model the likely increase of the target value

that occurred in the first years of the century. Thus, the equilibrium level of consumption expenditure (*CESTAR*) is:

$$\log(CESTAR) = TIME + 0.9 * \log(LIQI) + 0.1 * \log(LIQW) \quad (43)$$

where *TIME* is the constant changed in the sample period. When describing short-term dynamics, we also include in the equation the lag of consumption change and the change in real disposable income in the period concerned in a way to satisfy dynamic homogeneity (i.e. the sum of the coefficients of the two variables is 1). Thus we get the following relationship:

$$\begin{aligned} d\log(CE) = & -0.05 * (\log(CE(-1)) - \log(CESTAR(-1))) + \\ & + (1 - 0.34) * d\log(CE(-1)) + 0.34 * d\log(PDICON) \end{aligned} \quad (44)$$

where $PDICON = PDI/P^{CE}$ is the real household disposable income (see also equation (46)). In the section on simulation, we also generate scenarios by changing the 0.34 parameter of the above equation.

3.7.2 Household income

Households have not only labour income but also transfers from the government and from non-profit institutions, property income and other income; furthermore, they pay taxes and social security contributions to the budget.

The calculation of wages and salaries (*WINC*) (based on the private and government average wage and number of employees) was presented in the labour market block (equation (32)), while the definition of transfers (*PENS* and *TRCASH*), the personal income tax (*PIT*) and contributions payable by the employee (*SCWH*) is given in the budget block. Therefore, here we limit ourselves to defining property income and other income.

Property income. Property income of households (*PROPINC*) consists of three components: we must deduct the interest paid on the debt of the household (where we distinguish HUF- and forex-denominated home and other loans) from the sum of the yield of liquid assets and dividend income. We calculate the interest on each instrument (asset or loan) by adding an interest margin to a weighted average of the 3-month and 5-year interest rate for the relevant currency. The exact form is determined on the basis of historical data and expert opinions on the behaviour of the interest margin, and in order to ensure consistency with the income account of households,

it is also necessary to employ finally correction multipliers (e.g. due to FISIM allocation). For the sake of simplicity, we define dividend income as a percentage of household disposable income.

Other income. The other income (*OINC*) items – mixed income and operating surplus – increase in line with GDP at current prices:

$$OINC = OINC(-1) * GDPCR/GDPCR(-1). \quad (45)$$

Disposable income, liquid (“freely disposable”) income. The disposable income of households (*PDI*) comes from the above items:

$$\begin{aligned} PDI = & WINC + PENS + TRCASH + PROPINC + OINC - \\ & - PIT - SCWH. \end{aligned} \quad (46)$$

When modelling consumption, the so-called liquid income plays an important role, which denotes the “freely disposable” income of households. For its calculation, we deduct from disposable income the asset transactions considered to be exogenous (e.g. private pension fund transactions), add the liability transactions considered to be exogenous (e.g. other liabilities transactions), deduct housing investments, but add housing loan transactions. The inclusion of correction items is based on the consideration that the household had in effect decided about them before the consumption decision (e.g. housing investment) or has not made a decision at all (e.g. private pension fund). Thus:

$$LIQI = PDI - INVCR^H + MORTTR + EXOG \quad (47)$$

where *LIQI* is liquid income, *INVCRH* denotes the nominal investments of households, *MORTTR* the transactions in housing loans, and *EXOG* the exogenous transactions in the wealth of households.

3.7.3 Household investments

Within the capital formation of households, housing investments represent the largest item; other items have been modelled exogenously.

As a result of regulatory changes and the relaxation of lending constraints, home investments showed a steep increase until 2004; then, from 2005, they declined in nominal terms. On account of the obvious change of regime reflected in the data, time series-based techniques cannot be

used here; so we assume that the ratio of housing investments to income converges to a long-run value that is around international levels. In the short term, the number of building permits and expert information can also be taken into account.

3.7.4 Wealth accumulation

Liquid wealth, consumption loans. Within financial wealth, so-called liquid wealth plays a major role; this is the part of wealth that the household can influence directly through managing its consumption. As the accounting reflection of liquid income (*LIQI*), liquid wealth is defined as the difference between the stock of liquid assets (cash, deposits, securities other than shares, quoted shares and mutual fund shares) and the stock of consumption and other (hereinafter collectively: consumption) loans¹⁶. Due to the definition of liquid income and wealth, particularly as a result of the consistent treatment of housing investments and housing loans, transactions in liquid wealth (*LIQWTR*) can be defined, based on accounting identity, as the difference between liquid income (*LIQI*) and consumption expenditure at current prices (*CECR*) :

$$LIQWTR = LIQI - CECR + ERROR \quad (48)$$

where the *ERROR* term is necessary only because the actual time series of net financing capacity derived from the financial accounts of households (bottom-up) and from the income account (top-down) are not identical, due to accounting problems. (In our model, the *ERROR* variable is exogenous.)

Furthermore, the household also decides which combination of change in liquid assets and consumption loans it uses to achieve the above amount of liquid wealth transactions. Here we assume that a *CRCDR* share of current-price consumption expenditure (*CECR*) is financed from newly borrowed forex consumer credit and a *CRCHR* share is financed from newly borrowed HUF consumer credit. The amount of consumer credit repaid is determined as 0.1 times the consumer credit stock of the previous period.¹⁷ Thus, the stock of consumer loans (*CRC*, or, by denomination,

¹⁶These essentially mean non-housing loans.

¹⁷For estimating these ratios, we took the sum of the consumption credit borrowed in the reference period from the table found on the MNB website, and compared it to the credit transactions and stocks in the financial accounts. Even though the two data sources have different coverage, and the date of the survey may also be different, the 0.1 quarterly repayment

CRCHUF and *CRCDEV*) develops as follows, taking account of revaluation:

$$CRCHUF = 0.9 * CRCHUF(-1) + CRCHR * CECR \quad (49)$$

$$CRCDEV = HUF EUR / HUF EUR(-1) * 0.9 * CRCDEV(-1) + CRCDR * CECR \quad (50)$$

$$CRC = CRCHUF + CRCDEV, \quad (51)$$

and consumer credit transactions are given by

$$CRCTR = (CRCDR + CRCHR) * CECR - 0,1 * CRC(-1). \quad (52)$$

Transactions in liquid assets result from *LIQWTR* + *CRCTR*.

Housing loans. We have information about the volume of housing loans taken out and their breakdown by purpose of borrowing from the semi-annual CSO publication Retail Home Lending. In the forecast phase, we assume that the sum of loans taken out for construction and new home purchase is given as a proportion of housing investments (calibrating the ratio based on the latest year's data), while the sum of the borrowings for second-hand dwelling purchase, renovation or other purposes changes in the long run parallel with disposable income. (In the short term, we may also take into account expert information.) Thus, we can model the value of total housing loans borrowed in a quarter, which we then also break down by denomination, as in the case of consumption loans.

For the calculation of housing loan transactions (*MORTTR*), we also need to approximate the amount of repayment. Here, we calibrated the quarterly repayment rate at 0.02; thus repayment amounts to 2% of the stock of the previous period. Then, the stock of HUF and forex housing loans is derived as in the case of consumption loans.

Other transactions. Transactions in assets other than liquid assets and transactions in liabilities other than housing and consumptions loans are considered to be exogenous. With this assumption, the income and financial accounts of households are consistent in the financial sense.

rate we arrived at is a credible estimate. Consumption loans include, in our categorisation, also car purchase loans, loans for purchase of goods and overdraft credit.

3.8 Monetary policy

To model monetary policy, we need to determine interest rates and exchange rates. It is customary to build a monetary policy which determines short-term interest rates into the models (see Woodford, 2003), and then to supplement it with an uncovered interest rate parity equation, possibly adjusted for a risk premium, which can be considered as the implicit equation to determine the exchange rate. This solution raises several problems.

First, the uncovered interest rate parity is notorious for being inaccurate in describing, at least in the short term, the relationship between interest rates and exchange rates. The so-called Fama-regressions, where the interest rate differential is regarded as a predictor of future exchange rate changes, often yield a sign that runs counter to theory; that is, they indicate that a positive interest rate differential predicts an appreciation rather than a depreciation (see Cochrane, 1999). Many researchers have tried to solve this “puzzle”, but no consensus has yet been reached. One possible solution is to take into account the time-varying risk premium. This, however, if exogenous, is a completely meaningless hypothesis, as any exchange rate path is explicable on this basis; that is, we are unable to explain anything with it in reality.

Our empirical studies have shown that the interest rate and exchange rate behaviour of HUF is essentially inexplicable quantitatively, or at least is impossible to predict. On the other hand, other interest rates can be predicted from short-term interest rates (see e.g. the interest transmission of household deposits and credits). Accordingly, by default, short-term interest rates and exchange rates are regarded as exogenous, but we can also run versions assuming certain interest rate rules.

3.9 General government

We have modelled general government in more detail than other models tend to do. It remains true, however, that there is no fiscal rule that would stabilise the public debt in some way. Thus we consider the fiscal policy proposed for the forthcoming years to be essentially given, e.g. we consider tax rates to be exogenous variables. (Of course, alternative scenarios can be generated by changing the tax rates.)

When structuring the general government block, we made no theoretical assumptions; we defined and estimated the equations for the various variables based on economic rationale. The model is based on quarterly figures, and therefore we had to convert the annual accrual-based gen-

eral government variables to quarterly levels. This was often performed mechanically, with smoothing; as a result, the distribution of fiscal results within the year is not informative.

When compiling the general government block, we had to rely on several criteria in deciding what detail of breakdown we should use for revenue and expenditure items. It is desirable to reduce the “other” category as much as possible, because in that way the mechanisms become more transparent and the analysis of budgetary processes becomes easier. In contrast, if the breakdown is too detailed, the estimates may become more uncertain. In order to reduce inaccuracies, we worked with wide but homogeneous revenue and expenditure categories as far as possible.

As our general government block is not a detailed budget planning model, we start from the premise that we should be able to obtain the general government indicators budgeted in the convergence programme of December 2006 if the macroeconomic path outlined in the programme occurs.¹⁸ For us, the only important thing is to know how much a departure of macro-variables from the projected path would alter budget items. For some items, the influencing macro-indicators are clear (e.g. social security contribution revenues depend on the wage bill); while for others, mainly on the expenditure side, we had to make assumptions concerning the response of the budget (e.g. to an inflationary shock).

Thus, for a number of expenditure items (e.g. compensation of employees, certain cash benefits, in-kind benefits, investments, intermediate consumption, other expenditure), for consideration for goods and services and for other revenues we used the following approach. For these budget items, our database contains nominal growth as proposed in the convergence programme and real growth as calculated based on the inflation rate assumed there. For a year in advance, we consider nominal growth to be given; then, after a gradual transition, from the third year on, the real growth is given, and the nominal value is calculated from the endogenous inflation rate in our model. (In the second year, we use a 50-50 combination of the two methods.) Thus, if the inflation rate proposed in the programme is met, these items will numerically be identical to the values proposed in the programme; but, importantly for simulations, we also take into consideration that, in the case of an inflation path substantially higher than expected, keeping expenditure at a nominally constant rate may be difficult

¹⁸Additional assumptions are needed for the period beyond the forecast horizon of the programme (see below), and the implicit budgetary parameters calculated on the basis of the convergence programme can be amended at any time in light of new information.

in the medium term. Naturally, we may also generate scenarios assuming a different type of adjustment.

For the period after 2010, which is outside the scope of the convergence programme, we assume implicit tax rates and implicit interest rate to be constant at the 2010 level; while for expenditure items, we generally fix them in real terms. In these years, government wages will increase in parallel with private sector wages according to our assumption.

Table 2 provides an overview of the fiscal items and the macro-variables that they depend on. A more detailed explanation follows below.

Table 2: General government revenues and expenditures

General government item	Macroeconomic variable
Personal income tax	Wages and salaries
Social security contributions	Wages and salaries
Indirect taxes	Nominal consumption expenditure
Corporate tax, simplified business tax	Total profits
Local taxes	Nominal GDP
EU transfers	Exchange rate
Consideration for goods and services	*
Other revenues	*
Compensation of employees	*
Pensions	Net wages, inflation
Sick pay	Gross wages
Interest subsidy for housing purposes	–
Unemployment benefit	Gross wages, unemployment rate
Other social benefits	*
Intermediate consumption	*
Investments	*
EU transfers and financial contribution	Exchange rate
Payment into EU budget	Exchange rate, nominal GDP
Interest expenditure	Exchange rate, implicit interest rate
Other expenditures	*

*: items given in the short run in nominal terms and adapted to inflation in the medium run

3.9.1 Revenues

Revenue side items include: personal income tax, employee and employer contributions, indirect taxes, corporate tax, simplified business tax, local

taxes, EU transfers, consideration for goods and services and other revenues.

PIT. For personal income tax revenues (*PIT*), we bundle together the revenues collected by the central budget and the revenues assigned to local governments. The implicit tax rate (*PITRATE*) is derived as the quotient of the revenue figures and the gross wage and salary bill projected in the convergence programme. (Between 2007 and 2010, the implicit rate is around 20-21% and rising slightly.) In the econometric model, we calculate *PIT* revenues as the product of this implicit tax rate and the gross wage bill estimated in the model:

$$PIT = PITRATE * WINC. \quad (53)$$

The calculation could be improved by taking into account the non-linearity of the tax system and by differentiating according to private or government sector. (The “average” marginal tax rate estimated from the wage distribution is considerably higher than the above implicit tax rate, and differs significantly between the private and government sectors.)

Employer and employee contributions. Social security contribution revenues are estimated based on the same gross wage and salary bill as *PIT* revenues. For the calculation of employer contribution payments (*SCE*), in line with equations (33) and (34), we distinguish the private and government sectors:

$$SCE = SCECORR^{PR} * SCERATE * WINC^{PR} + SCECORR^G * SCERATE * WINC^G \quad (54)$$

where *SCERATE* is the nominal employer contribution rate. (The average rate of the lump sum health contribution was determined based on the average wage.) The correction factors change slightly from year to year as well: they are around 0.75 for the private sector and around 0.95 for the public sector.

The employee contribution revenues (*SCW*) are calculated similarly, except that we use the same correction factor in the two sectors:

$$SCW = SCWCORR * SCWRATE * WINC. \quad (55)$$

The figures for the employee contribution revenues of the general government do not contain contributions paid into private pension funds,

whereas these payments must be deducted from gross wages when calculating the disposable income of households. Therefore, we also calculate a correction factor for the “total” employee social security contributions (*SCWH*):

$$SCWH = SCWCORRH * SCWRATE * WINC. \quad (56)$$

Indirect taxes. In our model, this tax category (*IDT*) comprises VAT, consumption and excise tax revenues. Indirect taxes are also estimated using an implicit tax rate (*IDTRATE*), which, in the model, is used to multiply household consumption expenditure at current prices (*CECR*). We have data in the tables of the convergence programme for expected tax revenues and household consumption expenditure as well; their quotient yields the implicit tax rate (which, according to the current convergence programme, will be around 20-21% from 2006 all the way through 2010).

$$IDT = IDTRATE * CECR. \quad (57)$$

Corporate income tax. Corporate income tax is calculated as the product of the corporate profit estimated in the model and the implicit tax rate. For the purposes of estimating the profit, the wage expenditure of the private sector and the depreciation expense are deducted from the nominal private GDP. Similarly, we estimate the corresponding profit based on the path outlined in the convergence programme, and thus we obtain the implicit tax rate by dividing the projected corporate tax income by this value.

Simplified business tax. The amount of general government revenue collected from the simplified business tax is calculated using the method described for corporate income tax; that is, the implicit tax rate is again calculated based on estimated profits.

Local taxes. We assume that local tax revenues change in proportion to GDP at current prices. Accordingly, we estimate them by multiplying GDP at current prices calculated in the model by the implicit tax rate, which is the quotient of the local tax revenue projected in the convergence programme and the nominal GDP of the programme.

EU transfers. The EU transfers supplied under chapter-managed appropriations are included in the model as items given in euros.

Consideration for goods and services and other revenues. For forecasting these revenue items, we used the method described earlier in the section. That is, in the short term, their nominal growth is exogenous; then, after a gradual transition, in the longer term their real change is exogenous. The inclusion of consideration for goods and services as a separate revenue item is justified by the fact that we need it to compile the final government expenditure as part of GDP. The expected value of other revenues is derived from the consolidated total revenue forecast of the convergence programme, after deducting the revenue items listed above (other revenues represent some 6-8% of total revenues).

3.9.2 Expenditures

The items on the expenditure side are: compensation of government employees, pensions, sick pay, interest subsidy for housing purposes, unemployment benefit, other cash transfers, in-kind benefits, intermediate consumption, investments, interest expenditures, EU-related expenditures and other expenditures. In the absence of clear relationships, the treatment of most of these items as endogenous is more uncertain than in the case of revenue items. Therefore we consider changes in other cash transfers, in-kind benefits, intermediate consumption, government investments and other expenditures to be nominally exogenous in the short run and exogenous in real terms in the longer run.

Compensation of employees. The government-employed population (L^G) is considered to be exogenous. The growth of gross wages in the government sector (GW^G) is exogenous in the short term, but later it is corrected if the actual inflation rate is different from the projected one. (In the long term, beyond the coverage of the convergence programme forecast, government wages increase in line with the wages paid in the private sector.) Of these variables, the wages and salaries indicator and the compensation of employees are derived in the manner explained in section 3.6.2.

Pensions. In our model, pension payments are estimated in a simplified manner: the effects of the 13th month salary, pension adjustment, replacement and headcount changes are taken into account in aggregate, as a multiplier to correct the Swiss indexation. The Swiss indexation is an average of the change in the net nominal average wage (on a quarterly basis in our model) and of the inflation rate, which is calculated endogenously.

This index is then multiplied by the correction factor that is defined using the annual growth of pensions envisaged in the convergence programme and the inflation and nominal average wage figures of the programme.

Sick pay. Sick pay expenditures are determined by the wages of the previous period; therefore, in our model its growth depends on the average wage increase and an additional exogenous rate of change.

Interest subsidy for housing purposes. We consider the nominal value of interest subsidy expenditures for housing purposes to be exogenous because the nominal decrease projected for the forthcoming years results mostly from the reform of the subsidy system in 2003. (The interest period of subsidised loans is typically five years, and the first interest period of most loans taken out during the lending boom will expire in 2007-08.)

Unemployment benefit. We modelled the cash benefits paid by the Labour Market Fund assuming that their growth depends on the growth of the product of the gross average wage and unemployment, and an additional exogenous rate of change (which is calculated from the projection set out in the convergence programme).

Other social benefits in cash, social benefits in kind, intermediate consumption, investments, other expenditures. The rate of change of these items is nominally given for the first year; while from the third year on, their real change is exogenous (along a path that can be determined from the convergence programme). In the second year, we use a 50-50 combination of the two methods.

The *TRCASH* variable in the household income definition (equation (46)) is defined as all the cash transfers other than pensions, i.e. as the sum of sick pay, interest subsidy for housing purposes, unemployment benefit and other cash benefits.

Interest expenditure. The interest payable in respect of the endogenously determined (see later) stock of gross debt is calculated using the implicit interest rate included in the convergence programme.

EU-related expenditure. In our model, the value of EU transfers is exogenous in euro terms; that is, it is sensitive to the exchange rate (EU transfers

are present on both the revenue and the expenditure sides). By contrast, in the case of the local co-financing element of EU transfers, we took the HUF value to be exogenous. For modelling payments into the EU budget, we take account of the fact that they are determined in proportion to GNI, and we approximate the latter by making its growth dependent on nominal GDP growth and an additional exogenous rate of change.

3.9.3 General government deficit and public debt

The general government deficit results as the difference between expenditure and revenue, and naturally we also calculate its ratio to nominal GDP. In the model, we use a definition of debt consistent with the Maastricht criterion (i.e. without adjustment for private pension fund payments). For the calculation of future public debt, we consider that 30% of it is in foreign currency, and therefore that portion is sensitive to exchange rate changes. Thus, in each period, the current deficit and a correction amount are added to the debt stock revalued along these lines. The correction amount is included to reflect the other factors affecting the debt in the convergence programme (mostly privatisation proceeds), and in our model its value is exogenous.

3.9.4 Determination of government consumption expenditure

When compiling GDP, general government expenditures are fed into two variables: social transfers in kind and government consumption. (Their real value is indicated by *TRK* and *G*, respectively.) The sum of these two items is final government consumption expenditure; in our model, we only need this aggregate value at current prices. For the calculation of the nominal value, we add up the compensation of employees in the government sector, intermediate consumption, social transfers in kind, the amortisation of the government capital stock (which, for the sake of simplicity, is considered exogenous), and the likewise exogenous in-kind social benefits from non-profit institutions; then we deduct from this sum the consideration received for goods and services. (The reasons for the latter deduction is that it is also included in the household consumption expenditure item of GDP.) At constant prices, government consumption expenditure (*TRK + G*) is exogenous in our model, therefore its deflator (P^{GTRK}) can be determined as the quotient of its current-price and constant-price value.

3.10 Global equations

The model contains a consistent system of national accounts, but no wealth account. Changes in inventories (*DEV*) are treated as exogenous, on the premise that they only represent statistical discrepancies in the national accounts. We calculate the trade balance but not the current account. We define the usual macro-aggregates (e.g. total GDP) only for presentation purposes; these have limited feedback into the solution of the model. (For instance, the wage and price equation contains estimated private GDP rather than aggregate GDP.)

4 Simulations and sensitivity analyses

In this section, using simulations and sensitivity analyses, we illustrate the behaviour of the model in respect of some uncertainty factors (defined in the broad sense) affecting the economy. The baseline scenario is the “raw” (i.e. without residual correction) path resulting from the exogenous assumptions (exchange rate, growth of export markets, etc.) of the December 2006 convergence programme.¹⁹ Of course, in numerical terms, the baseline path is not identical to the macroeconomic path of the convergence programme, but they are similar. In 2007, following the budgetary stabilisation measures, household consumption will decline, inflation will rise, and the generally flagging GDP growth will be driven by net exports as the resultant of dynamic exports and declining imports. Eventually, economic growth will gradually come to resume its former higher rate in the 2008-10 period. (As usual in international practice, we do not disclose the raw output of the model, as it should be subjected to residual corrections in order to take into consideration one-off effects before the final forecast is arrived at.)

In the environment of a given economic policy, there are two types of risks:

1. uncertainty of the response of economic actors to shocks (which may be quantified as the uncertainty of the coefficients of the model – e.g. the parameters of the wage or consumption equation);
2. uncertainty of forecasting exogenous variables (external demand, exchange rate, external prices).

¹⁹Updated Convergence Programme of Hungary, 2006-2010, Budapest, December 2006

For both types of risks, the macroeconomic and fiscal effects can be quantified in two steps. First, the magnitude of the uncertainty of the model parameter or exogenous factor must be quantified. (This can be done by determining – for exogenous factors – the forecast error variance or using expert risk assessment.) As a second step, we must assess how (to what extent, and in what time frame) the important macro and fiscal variables are changed as compared to the baseline scenario if we change a coefficient or exogenous factor in proportion to the magnitude of the uncertainty. Of course, the effects of various uncertainties are not independent of each other: as we will see the response of the economy to an exchange rate shock, for instance, fundamentally depends on the speed of the wage adjustment.

In addition to analysing the effects of the two kinds of uncertainties mentioned above, the model can also be used to perform impact assessments of economic policy decisions. Below, based on this, we have classified simulations into three sections.

In the course of analyses, we always present the percentage change of the levels of major variables as compared to the baseline across the eight-year time horizon. The departure of the growth rate of variables from the baseline scenario is indicated by the slope of the level graphs: when the slope is negative, the growth rate of the variable is smaller than in the baseline scenario; and when it is positive, the growth rate is greater.

4.1 Parameter uncertainty

Here, we looked at two uncertainty factors important for the medium-term development of macro-variables: the risks entailed in wage adjustment and consumption smoothing.

4.1.1 Wage adjustment

Based on equation (40), we assume in the model that, after a shock affecting the wage ratio, the share of labour in private GDP gradually returns to its equilibrium value. Naturally, taking into account the variance of the estimation error, we may change the parameter of the speed of adjustment (technically the error correction parameter, which, by default, is -0.033).

In 2007, as a result of declining GDP growth, the wage ratio will necessarily rise temporarily as, due to persistence, wages adjust to lower GDP growth with some delay. The parameter variants differ only in the speed of return to the equilibrium value. For instance, if we choose the error correction parameter to be -0.01, then wages will be slow to adjust, the

wage ratio will return to its long-term level very slowly, and therefore the real value of consumption expenditure will be higher than in the baseline case for 5 years, and the growth rate of consumption expenditure will exceed the baseline scenario for 3-4 years. This, however, does not result in substantively higher GDP because, due to higher wages (deteriorating competitiveness), exports are lower than in the baseline scenario. From 2010 onwards, we see a lower real GDP (Figure 5/a shows the percentage deviation of major real variables from the baseline under this parameterisation). Because of the higher wages and the resulting higher consumption, the general government deficit to GDP ratio is 0.1 percentage points lower in 2008, 0.3 percentage points lower in 2009 and 0.5 percentage points lower in 2010 in the slow-wage-adjustment scenario than in the baseline case.

In contrast, in a faster-adjustment scenario (where the error correction parameter is -0.10), the level of consumption is lower and exports are higher than in the baseline scenario until 2010 (see Figure 5/b), while the general government deficit is greater.

Thus, simulations allow us to estimate the risk posed in the medium term to growth components and general government deficit by the uncertainty of the speed of wage adjustment.

4.1.2 Consumption smoothing

According to equation (44), consumption smoothing is determined by the error correction parameter of the return to the long-run level (its value in the baseline scenario is -0.05) and the coefficient of the growth rate of real income (in the baseline case: 0.34). In our two alternative scenarios, we modify this latter parameter by (approximately) twice its estimated standard error to 0.54 and 0.14. According to Figure 6/a, in the lower-smoothing (0.54 coefficient) version, the level of consumption and GDP is lower for two years (as is their growth rate for over one year) than in the baseline parameterisation; thereafter, however, there is a change in the opposite direction. (The level of export is effectively unchanged.) As a quasi-mirror image of this, Figure 6/b shows that, in the greater-smoothing version, consumption and GDP are higher than in the base case for almost three years, but a later overshooting in the other direction is also present.

Consumption smoothing in itself has limited effect on the general government deficit, as it influences primarily the base of indirect taxes.²⁰ Our

²⁰In contrast, the uncertainty of wage adjustment significantly affects income taxes and

greater-smoothing scenario reduces GDP-proportionate deficit by 0.1 percentage points in 2007 and 0.2 percentage points in 2008, while in our less-smoothing scenario, the deficits of both years increase by around 0.1 percentage points.

4.2 Uncertainty of exogenous factors

4.2.1 External demand

Forecasts for the growth of export markets are rather uncertain – for the simple reason that the import forecasts for the main foreign trade partners are also very uncertain. By way of illustration, Figure 7 shows the errors over recent years in the projection of the Economic and Financial Affairs Directorate General of the European Commission (DG ECFIN) for the imports of the EU-15 for one and two years ahead. The variance of the deviations is more than 3 percentage points, and the median of absolute values is also 2 percentage points; that is, we should be prepared for a 2 percentage point lower growth in export markets than expected. On the other hand, it is also clear that the errors in the forecasts made one- and two-year ahead do not really move together (in some years the two errors have different signs; in others, identical signs); so a smaller growth in one year does not necessarily have any effect on the forecast for the next years. In light of this, a 2% correction in the level of export markets in one year is a possible scenario. The shock examined is precisely the following: the growth rate of export markets continuously declines from mid-2007 to mid-2008, so that the level of the variable is 2% lower than in the original scenario by mid-2008; and then the growth rate originally projected takes over.

The impact of the exogenous shock on GDP components is shown in Figure 8. It is clear that the level of exports declines by more than 2%, and, due to the drop in demand, wages also shift downwards, which goes hand in hand with lower consumption than in the baseline scenario. The decline of consumption takes place only gradually, on account of the smoothing behaviour of households. (Incidentally, imports also decline due to the lower levels of exports and consumption.) On the other hand, as a secondary effect, the lower wage level improves competitiveness; consequently, after the level correction, exports start a slow climb, which partly offsets the effect of the initial wage decrease. On the whole, consumption bottoms out two years after the shock, and GDP slightly earlier. The adverse ex-

contributions directly, as well as indirect taxes, other tax types and inflation indirectly.

ternal business climate has a negative effect on the general government balance through wages and consumption, and increases the deficit by 0.4 percentage points in 2008 and by 0.5-0.6 percentage points in 2009.

4.2.2 Exchange rate

We look at the effect of a 1% devaluation early in 2007, with the proviso that we assume no interest rate response by the monetary authority. Thus, this scenario as it stands is unlikely to occur. Still, the mechanisms of macro-models are often examined through the effects of exchange rate changes, because this can be used to illustrate the existence and degree of nominal rigidities in the economy. (Benk et al. (2006) analyse in detail the effects of a permanent exchange rate change in the N.E.M., and therefore the outcomes of our models can be directly compared to their analyses.)

Figure 9 shows the effects of the exchange rate change on nominal and real variables in the baseline parameterisation, while Figure 10 displays the same in the slower-wage-adjustment case examined in section 4.1.1 (where the error correction parameter is -0.01). With the baseline parameters, external prices pass through fully into internal prices, through the wage and import price channels, in 4 years, raising domestic price levels by 1% (Figure 9/b). As the prices of products traded internationally (including market energy) increase rapidly and nominal wages take time to adjust, the real wages of the private sector are lower for about two years than in the non-devaluation scenario. Thereafter, however, the trend temporarily reverses because of the “overshooting” mentioned in discussion of the wage equation. In contrast, if a greater wage persistence is chosen, the pass-through is somewhat slower, and for a long time the real wages in the private sector are lower as a result of the depreciation (Figure 10/b).

As a real effect (Figures 9/a and 10/a), exports will be higher and household consumption expenditure lower based on both parameterisations. The drop in consumption expenditure is explained by the real wage decline in the private sector, by the income and wealth effects due to foreign currency borrowings,²¹ and by the fact that, according to our assumptions concerning general government, wages in the public sector (and, because of Swiss indexation, also pensions to some degree) respond to an increased inflation rate to a limited extent and with a delay. As a result of higher

²¹The stock of the foreign currency-denominated liabilities of households now exceeds their foreign currency asset stock. Therefore this channel, all other things being equal, reduces consumption in the event of a depreciation both through net interest income and the reduction of net assets.

exports and lower consumption (equation (3)), imports will be slightly greater initially, and smaller 3-5 years after the shock, than they would have been without the depreciation. On the whole, according to the baseline parameters of our model, in the four-year time horizon the GDP level is only slightly increased by a depreciation without a monetary response (the peak of growth is around 0.03%). In the parameterisation with slower wage adjustment – that is, slower pass-through – the real effect is somewhat more protracted.

On the whole, the general government deficit is improved by the depreciation through higher nominal wages, nominal consumption and inflation: in three years' time, the deficit would reduce as a percentage of GDP by some 0.1-0.15 percentage points. Initially, the public debt/GDP ratio increases due to the revaluation of the foreign currency debt, but subsequently it starts declining because of the reduced deficit and nominal GDP growth. (In three years, the decline amounts to 0.3-0.5 percentage points.)

It should be noted, however, that the above simulation does not reckon with a monetary response by the central bank, with forward-looking expectations and any credibility issues that may arise as a result of the depreciation. All these factors are likely to attenuate the effects of an actual depreciation on the real variables, and reduce the improvement envisaged in the general government deficit.

As compared with the quarterly projection model of the MNB, our model shows a substantially smaller real effect as a result of a depreciation. This is partly due to the fact that, in the N.E.M., exports have greater exchange rate elasticity (in absolute terms), and imports also have exchange rate elasticity, while the pass-through effect is slower due to greater wage rigidity.

4.2.3 Import prices

As the last external factor, we looked at the effect of a temporary 1% rise in import price levels (starting early in 2007 and lasting for one year). (This is a one-sided import price shock, thus export prices develop in accordance with the baseline scenario.) Figure 11 shows the percentage change of real and nominal variables as compared to the baseline. As a result of the shock, consumer prices would increase by approximately 0.2% in a year, while nominal GDP would decline, due to higher current-price imports, by around 0.7%, which would reduce gross nominal wages in the private sector

by some 0.5% in a year. As a consequence of growing inflation and declining nominal wages, real consumption expenditure and real GDP would both be reduced. When, after one year, import prices resume their level indicated in the baseline scenario, consumer prices “overshoot”, and, for a while, fall below the baseline level. Real consumption regains its original level two years after the end of the shock.

4.3 Simulation of policy decisions

Finally, to illustrate the models’ potential for impact assessment of economic policy decisions, we investigate a permanent 1% increase in the average wages of the public sector early in 2007 as compared to the baseline scenario. Figure 12 shows the relative development of the major real and nominal variables. As a direct effect of the wage increase, taking into account also the pension increase due to Swiss indexation, the disposable income of households would immediately increase by around 0.15%, which automatically triggers a gradual increase in consumption expenditures. Furthermore, as an indirect effect, private sector wages also start to rise because of the increased demand, and therefore in three years’ time the consumption level will be over 0.2% higher than in the baseline scenario. In contrast, exports would decline because of the worsened competitiveness, and imports would be generally greater, thus the balance of trade would worsen. The GDP level would be only 0.05% higher in 2-3 years (and this surplus gradually disappears over time).

It is interesting to note the effect of this decision on the budget. As a direct result, higher wage expenditures plus contributions would increase the deficit as a percentage of GDP by 0.11 percentage points; but of this, an amount corresponding to 0.07% of GDP would immediately be recovered by the budget as tax and contribution revenues, even if we disregard the progressive nature of the taxation system. As a result of the additional pension payments, the deficit as a percentage of GDP would increase by approximately 0.01 percentage points, but the additional tax revenues collected due to higher consumption would result in a decrease of similar magnitude. Thus “direct” effects altogether would increase the deficit by some 0.04 percentage points.

However, simulations performed with the macro-model can also take into account indirect effects. Figure 13 illustrates the dynamics of the change of the balance. We can see that the immediate rise in the deficit (0.05 percentage points) is higher than the figure calculated above, which is

mostly because of the delayed response of consumption to income growth. Subsequently, however, the deviation in the deficit starts to narrow, and in a three-year timeframe it amounts to only 0.02-0.03 percentage points due to the indirect effects. Thereafter, however, the adverse effects of worsening competitiveness dominate, and the gap in the deficit starts to widen again.

5 Directions for future research

Based on the experiences gained with simulations so far, the model may be worth developing further in several directions. We have already mentioned some areas, e.g. the more sophisticated treatment of expectations or linking investments to the cost of capital; to conclude, we should highlight four more groups of issues.

Differentiation of tradeable and non-tradeable sectors. The differentiation of the tradable and non-tradable sectors would be important in almost all areas. The significant difference between the growth of producer and consumer prices and the divergence of the producer prices of the tradable and non-tradable sectors are well known. This is generally attributed to the Balassa-Samuelson effect; as one of its consequences, producer real wages increase faster in the non-tradable than in the tradable sector.

As an even more obvious problem, without the tradable differentiation, we are unable to provide differentiated treatment of the effect of the export demand on the economy. However, this may be particularly relevant for Hungary at the moment, as there is every indication that the export sector is much more import intensive than the non-tradable sector or final consumption.

Another area where, in the absence of multisectoral breakdown, ad hoc intervention has been needed in the current version of the model is the treatment of private sector investments. Exports have a more marked effect on investment demand than the total demand for domestic products have, and this problem can be addressed in the investment equation only by inserting ad hoc terms.

It may be a less obvious problem, but without the tradable differentiation our model cannot explain the stylised fact that employment in the non-tradable sectors increases markedly as compared to employment in the tradable sectors. This also means that the employment effects of the various components of demand are different.

Consistent disaggregation by types of labour. In the current version of the model, we distinguish various types of labour, by qualification, in the field of employment and partly in the area of wages, but the labour input is not disaggregated in the production function. Linked to some extent to the previous point, we also do not model the fact that the various components of total demand have different effects on the wages and employment of the various qualification groups. Due to the high ratio of minimum wage earners and the nonlinearity of the tax system, this has clear consequences for aggregate wage trends and the budget in the present period, when the export and domestic demand trends are markedly different.

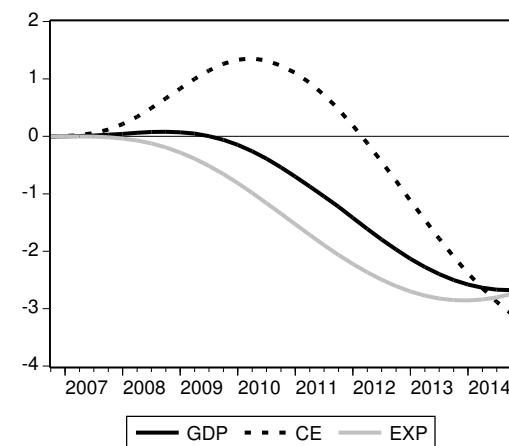
Improvement of the general government block. It would be necessary to take into account the nonlinearity of the PIT system and to determine different marginal tax rates for the private and public sectors, and, within the private sector, for the three qualification groups.

At present, we do not model the factors influencing the implicit interest rate payable on the public debt, even though it is affected by e.g. the position of the budget.

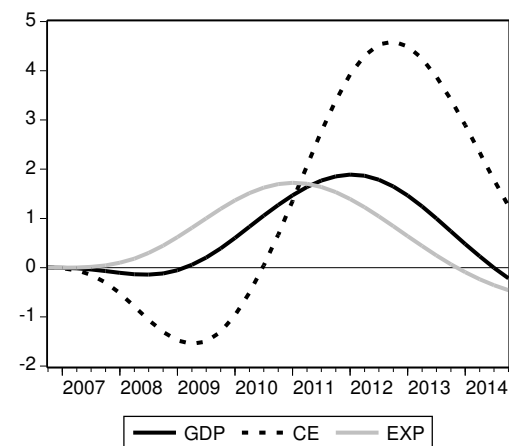
In our model, pension expenditures are calculated based on the Swiss indexation and an exogenous correction factor, whereas we would be able to endogenously project the number of pensioners from the labour market block. It is questionable, however, whether we wish to incorporate into the model a detailed pension projection, given that such calculations are already performed in the Ministry of Finance.

Modelling the effects of EU transfers. Finally, it would be appropriate to model in more depth the effects of EU transfers on the macroeconomy (e.g. their linkages with private investments). For such analyses, however, it may also be necessary to endogenise the TFP process; see, for example, the model of Varga (2005).

Figure 5: Effect of the speed of wage adjustment

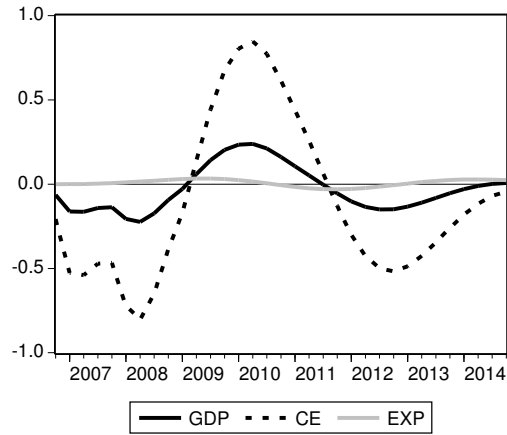


(a) Percentage deviation of real variables (GDP, consumption expenditure and exports) from the baseline in case of slower wage adjustment

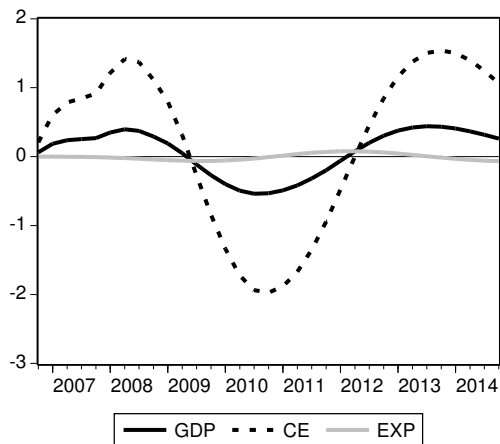


(b) Percentage deviation of real variables (GDP, consumption expenditure and exports) from the baseline in case of faster wage adjustment

Figure 6: Effect of the degree of consumption smoothing



(a) Percentage deviation of real variables (GDP, consumption expenditure and exports) from the baseline in case of smaller consumption smoothing



(b) Percentage deviation of real variables (GDP, consumption expenditure and exports) from the baseline in case of greater consumption smoothing

Figure 7: Error in one- and two-year ahead DG ECFIN projections for import growth in the EU-15, percentage points

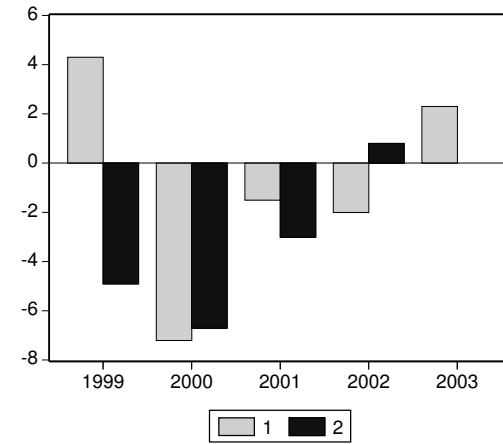


Figure 8: Effect of an adverse external cyclical situation: percentage deviation of real variables (GDP, consumption expenditure and exports) from the baseline

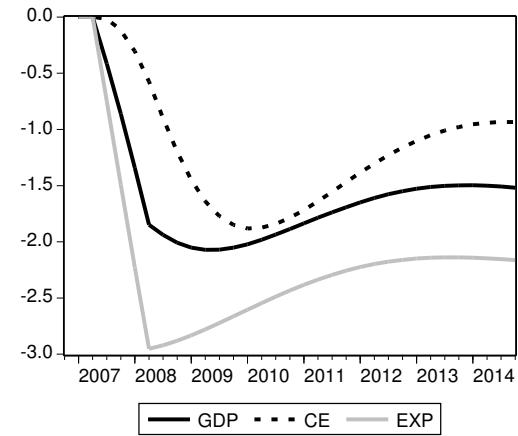
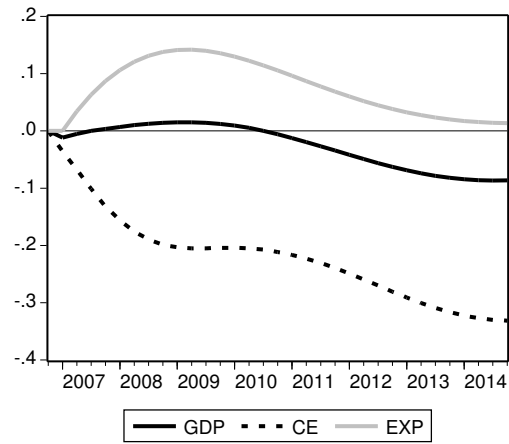
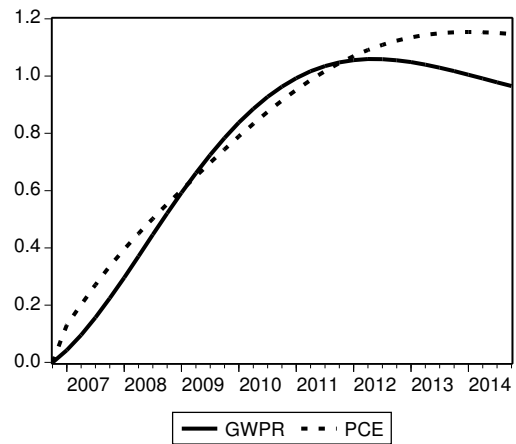


Figure 9: Effect of a 1% currency depreciation, with wage adjustment according to the baseline parameters

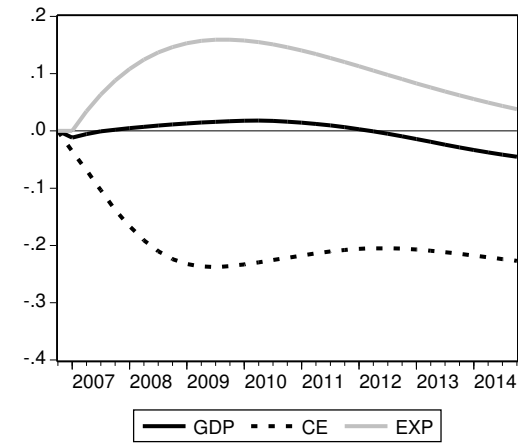


(a) Percentage deviation of real variables (GDP, consumption expenditure and exports) from the baseline

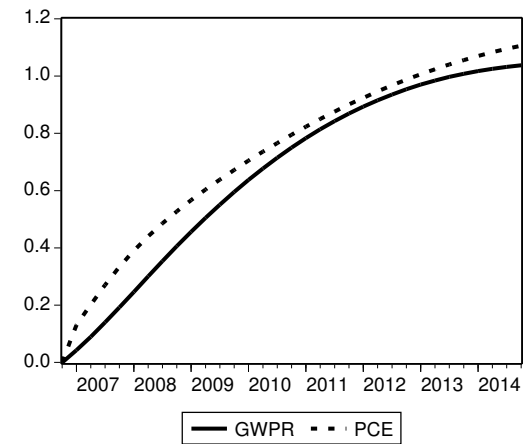


(b) Percentage deviation of nominal variables (gross wages in the private sector (GWPR) and consumer prices (PCE)) from the baseline

Figure 10: Effect of a 1% currency depreciation, with slow adjustment of wages

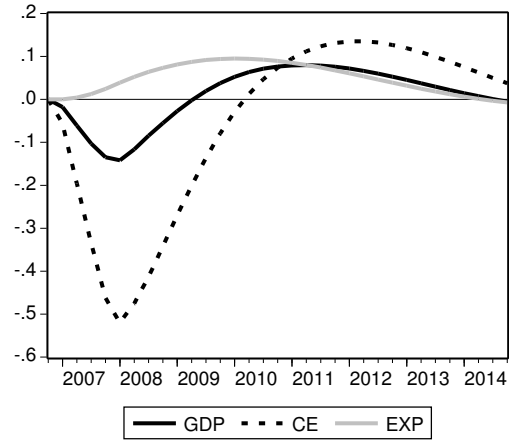


(a) Percentage deviation of real variables (GDP, consumption expenditure and exports) from the baseline

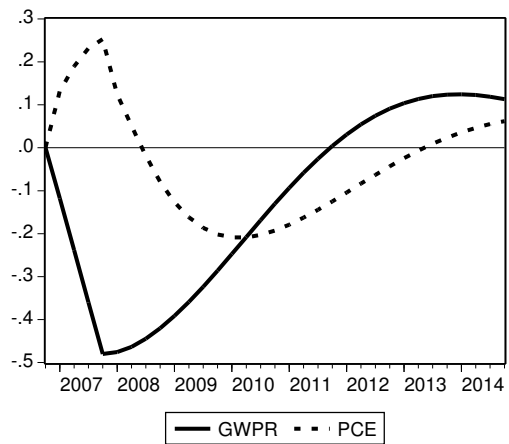


(b) Percentage deviation of nominal variables (gross wages in the private sector (GWPR) and consumer prices (PCE)) from the baseline

Figure 11: Effect of a 1% import price shock lasting for one year

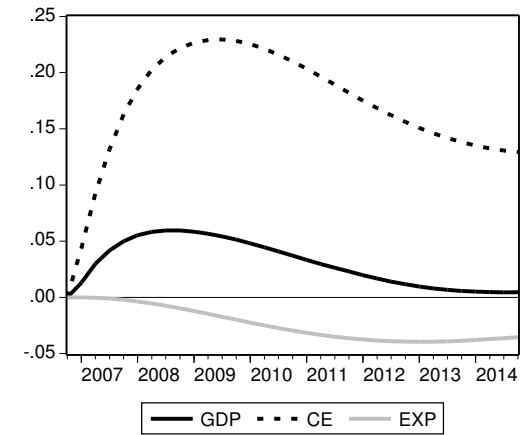


(a) Percentage deviation of real variables (GDP, consumption expenditure and exports) from the baseline

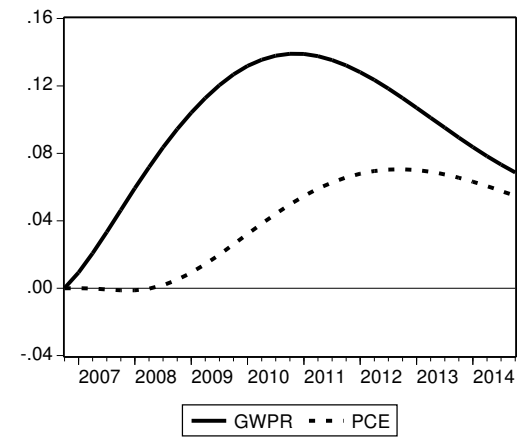


(b) Percentage deviation of nominal variables (gross wages in the private sector (GWPR) and consumer prices (PCE)) from the baseline

Figure 12: Effect of a permanent 1% increase in government wages

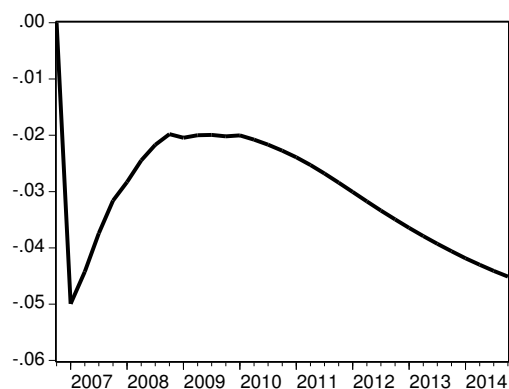


(a) Percentage deviation of real variables (GDP, consumption expenditure and exports) from the baseline



(b) Percentage deviation of nominal variables (gross wages in the private sector (GWPR) and consumer prices (PCE)) from the baseline

Figure 13: Effect of a permanent increase of government wages: deviation of the general government balance as a percentage of GDP from the baseline, in percentage points



References

- [1] Allard-Prigent, C., Audenis, C., Berger, K., Carnot, N., Duchene, S. and Pesin, F. (2002) Présentation du modèle MESANGE: Modèle économétrique de simulation et d'Analyse générale de l'économie, Document de travail, Minefi, Paris.
- [2] Basu, S., Fernald, J.G. and Shapiro, M.D. (2001) Productivity growth in the 1990s: technology, utilization, or adjustment? NBER Working Paper No. 8359, National Bureau of Economic Research.
- [3] Benk, Sz., Jakab, M.Z., Kovács, M.A., Párkányi, B., Reppa, Z. and Vadas, G. (2006) The Hungarian Quarterly Projection Model (NEM), MNB Occasional Papers, OP 60.
- [4] Bíró, A., Elek, P. and Vincze, J. (2007) Sensitivity of the Hungarian economy to international shocks, and adjustment mechanisms, *Külgazdaság*, 2007/5-6, 4-20 (in Hungarian).
- [5] Bourquard, V., Carnot, N., Deruennes, A. and Pamies-Sumner, S. (2005) Une maquette de prévision à court terme pour la France, Document de Travail, Minefi, Paris.
- [6] Brainard, W. and Perry, G. (2000) Making policy in a changing world, in: *Economic Events, Ideas and Policies: The 1960's and After*, Brookings Institute, Washington D.C.
- [7] Carroll, C. (1997) Buffer-stock saving and the life cycle / permanent income hypothesis, *The Quarterly Journal of Economics* 112(1), 1-55.
- [8] Cochrane, J. (1999) New facts in finance, NBER Working Paper No. 7169, National Bureau of Economic Research.
- [9] Dehejia, R.H. and Wahba, S. (2002) Propensity score matching methods for non-experimental causal studies, *Review of Economics and Statistics* 84(1), 151-161.
- [10] Drew, A. and Hunt, B. (2000) A comparison of the properties of NZM and FPS, DP 2000/02, Reserve Bank of New Zealand.
- [11] Fildes, R. and Stekler, H. (2002) The state of macroeconomic forecasting, *Journal of Macroeconomics* 24, 435-468.
- [12] Harrison, R., Nikolov, K., Quinn, M., Ramsey, G., Scott, A. and Thomas, R. (2005) The Bank of England Quarterly Model, Bank of England.
- [13] Hendry, D.F. and Clements, M.P. (2003) Economic forecasting: some lessons from recent research, *Economic Modelling* 20, 301-329.
- [14] Jakab, M.Z., Kiss, G. and Kovács, M.A. (2006) What are we studying? The role of central-bank forecasts in Hungarian inflation targeting in the first five years, *Közgazdasági Szemle* 53, 1101-1134 (in Hungarian).
- [15] Jakab, M.Z. and Kovács, M.A. (2002) Hungary in the NiGEM model, NBH Working Papers, 2002/3.
- [16] Kátay, G., Kovács, M.A. and Pula, G. (2004) Some interrelationships between national and international wage shares, In: *Report on financial stability, June 2004*, MNB.

- [17] Kattai, R. (2007) Constants do not stay constant because variables are varying, Bank of Estonia Working Paper Series 1/2007.
- [18] King, R.G. and Rebelo, S.T. (2000) Resuscitating real business cycles, NBER Working Paper No. 7534, National Bureau of Economic Research.
- [19] Kovács, M.A. (2005) How does the exchange rate operate? The lessons of the 1995 stabilisation and our current knowledge, MNB Background Studies, 2005/6 (in Hungarian).
- [20] Köllő, J. (2001) Contribution to an omitted debate on the minimum wage, Közgazdasági Szemle 48, 1064-1080 (in Hungarian).
- [21] Navaretti, G.J. and Venables, A.J. (2004) Multinational Firms in the World Economy, Princeton University Press.
- [22] Pula, G. (2003) Capital stock estimation in Hungary: A brief description of methodology and results, MNB Working Paper, 2003/7.
- [23] Ramanathan, R. (2002) Introductory Econometrics with Applications, Harcourt College Publishers.
- [24] Roeger, W. and Veld, J. (1997) QUEST II. A multi-country business cycle and growth model, Economic Papers. No. 123., European Commission, Brussels.
- [25] Varga, A. (2005) A complex macro-regional model for the analysis of development policy impacts on the Hungarian economy, Final report to the project No. 370/2005 sponsored by the National Development Agency. Preprint, University of Pécs.
- [26] Woodford, M. (2003) Interest and Prices, Princeton University Press.

Appendix: Variables used in the paper

<i>ACT^{EDU1}</i>	economically active population with at most primary education
<i>ACT^{EDU2}</i>	economically active population with secondary education
<i>ACT^{EDU3}</i>	economically active population with tertiary education
<i>CE</i>	household consumption expenditure at 2005 prices
<i>CECR</i>	household consumption expenditure at current prices
<i>CESTAR</i>	equilibrium level of real household consumption expenditure
<i>COMP</i>	compensation of employees in the whole economy
<i>COMP^G</i>	compensation of employees in the government sector
<i>COMP^{PR}</i>	compensation of employees in the private sector
<i>CORR^G</i>	correcton due to layoffs in the government sector
<i>CRC</i>	stock of consumer and other credits
<i>CRCDEV</i>	stock of foreign exchange consumer and other credits
<i>CRCDR</i>	ratio of new foreign exchange consumer and other credits to household consumption expenditure
<i>CRCHUF</i>	stock of HUF consumer and other credits
<i>CRCHR</i>	ratio of new HUF consumer and other credits to household consumption expenditure
<i>CRCTR</i>	transactions in consumer and other credits
<i>D</i>	effect of changes in regulated prices on the price level
<i>DEV</i>	changes in inventories and statistical discrepancies (as part of the GDP)
<i>ERROR</i>	error term in income account of households
<i>EUR^M</i>	import price in euro
<i>EUR^X</i>	export price in euro
<i>EXOG</i>	exogenous transactions in wealth of households
<i>G</i>	government consumption at 2005 prices
<i>GDP</i>	GDP at 2005 prices
<i>GDP^G</i>	government sector GDP at 2005 prices
<i>GDP^{PR}</i>	private sector GDP at 2005 prices
<i>GDPCR^{PR}</i>	private sector GDP at current prices
<i>GW</i>	average gross nominal earnings of employees in the whole economy
<i>GW^{EDU1}</i>	average gross nominal earnings of employees with at most primary education
<i>GW^G</i>	average gross nominal earnings of employees in the government sector
<i>GW^{PR}</i>	average gross nominal earnings of employees in the private sector
<i>HUFEUR</i>	HUF/EUR exchange rate
<i>I</i>	gross capital formation at 2005 prices
<i>I^{PR}</i>	gross capital formation of private enterprises at 2005 prices
<i>IDTRATE</i>	implicit indirect tax rate
<i>IDT</i>	indirect tax income of general government
<i>INVCR^H</i>	gross capital formation of households at current prices
<i>K^{PR}</i>	private capital stock
<i>L</i>	employed population (based on the labour force survey of the Hungarian Central Statistical Office)

L_0^{EDU1}	employed population with at most primary education, without layoffs in the government sector
L_0^{EDU2}	employed population with secondary education, without layoffs in the government sector
L_0^{EDU3}	employed population with tertiary education, without layoffs in the government sector
L^{PR}	employed population in the private sector
L_{INST}^{PR}	number of employees in the private sector (based on the institutional survey of the Hungarian Central Statistical Office)
$LIQI$	"liquid" income of households
$LIQW$	"liquid" wealth of households
$LIQWTR$	transactions in liquid wealth of households
LS^{EDU1}	equilibrium employment of people with at most primary education
m	direct import ratio of private production
M	import at 2005 prices
MUP	mark-up ratio (in the equation of core inflation)
$MINW$	minimum wage
$MORTTR$	transactions in housing loans
$NOMP$	nominal productivity in the private sector
NW	average net nominal earnings of employees in the whole economy
NW^G	average net nominal earnings of employees in the government sector
NW^{PR}	average net nominal earnings of employees in the private sector
$OINC$	other income of households
p^{CE}	consumption expenditure deflator
p^{COREV}	price level corresponding to the core inflation
p^{GTRK}	government consumption expenditure deflator
p^I	investment deflator
p^{IPR}	private investment deflator
p^M	import deflator
p^X	export deflator
PDI	personal disposable income of households at current prices
$PDICON$	personal disposable income of households at 2005 prices
$PENS$	pension benefits (from general government)
PIT	income of general government from personal income tax
$PITRATE$	implicit personal income tax rate
$PROPINC$	property income of households
$RWCOST$	real wage cost (wage cost/export price)
SCE	social security contribution of employers
$SCECORR^G$	correction factor for employers' social security contribution in the government sector
$SCECORR^{PR}$	correction factor for employers' social security contribution in the private sector
$SCERATE$	employers' social security contribution rate
SCW	social security contribution of employees (without contribution to private pension funds)
$SCWCORR$	correction factor for employees' social security contribution
$SCWCORRH$	correction factor for employees' "total" social security contribution (private pension funds included)

$SCWH$	social security contribution of employees (private pension funds included)
$SCWRATE$	employees' social security contribution rate
TFP	total factor productivity
$TIME$	time trend
$TRCASH$	social transfers in cash other than pension benefits
TRK	social transfers in kind at 2005 prices
U	unemployed population
ULC	unit labour cost
$URATE$	unemployment rate
UTI	capacity utilization
$WCOST^{PR}$	average wage cost in the private sector
$WCOST^{EDU1}$	average wage cost of employees with at most primary education
$WDEM$	demand in export markets
$WINC$	wages and salaries in the whole economy
$WINC^G$	wages and salaries in the government sector
$WINC^{PR}$	wages and salaries in the private sector
$WRATIO$	share of labour income in the private GDP (wage ratio)
X	export at 2005 prices
$XSTAR$	long-run equilibrium level of export
Y^G	output of the government sector at 2005 prices
Y^{PR}	output of the private sector at 2005 prices
YCR^{PR}	output of the private sector at current prices

Contents

1 Introduction	4
2 Modelling principles	5
2.1 Methodological considerations	5
2.2 Economic considerations	9
3 The model	10
3.1 Private and government output, GDP and imports	11
3.2 Production side	15
3.3 Export	17
3.4 Investment	18
3.5 Prices	19
3.6 Labour market	21
3.7 Households	29
3.8 Monetary policy	35
3.9 General government	35
3.10 Global equations	43
4 Simulations and sensitivity analyses	43
4.1 Parameter uncertainty	44
4.2 Uncertainty of exogenous factors	46
4.3 Simulation of policy decisions	49
5 Directions for future research	50
References	60
Appendix: list of variables	62

Available Working Papers in Public Finance

18. Réka Firlé és Péter András Szabó: Targeting and labour supply effect of the regular social assistance. April 2007.

Available Finance Ministry Working Papers from 2004

17. Dóra Benedek, Réka Firlé and Ágota Scharle: Degree and efficiency of redistribution. July 2006.
16. Dóra Benedek, Mariann Rigó, Ágota Scharle and Péter Szabó: Increases in the minimum wage in Hungary, 2001-06. January 2006.
15. Anna Vidor: The effect of saving incentives: empirical evidence from Hungary. October 2005.
14. Róbert Iván Gál, Árpád Törzsök, Márton Medgyesi and Tamás Révész: Generational accounts in Hungary, 1992-2001. July 2005.
13. Zsombor Cseres-Gergely: Inactive middle-aged people and households: incentives and constraints. June 2005.
12. Mária Lesi and Gabriella Pál: The expected impact of the introduction of the carbon-dioxide trading on the domestic power market. April 2005.
11. Mária Lesi and Gabriella Pál: Theoretical foundations and EU regulation of carbon-dioxide emission trading. March 2005.
10. Dóra Benedek and Orsolya Lelkes: Assessment of income distribution in Hungary using a microsimulation model. January 2005.
9. Dóra Benedek, Orsolya Lelkes, Ágota Scharle and Miklós Szabó: The structure of general government expenditure and revenues in Hungary, 1991-2002. August 2004.
8. John Hills: Privatisation and public welfare: Principles and economic analysis. May 2004. (Available only in Hungarian)
7. Orsolya Lelkes: Social cohesion in Hungary: Theoretical foundations and facts. March 2004.
6. Balázs Borsi: Technological modernisation, innovation and research and development as factors of competitiveness in the economy of Hungary. February 2004.