Financial Policy Institute
Ministry of Finance of the Slovak Republic

An Econometric Model of the Slovak Republic

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FINAL DRAFT

May 2004

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Abstract

This report presents of theoretically consistent quarterly econometric model of the Slovak Republic. The model was developed under the scope of the World Bank's Public Finance Management Reform project and is designed to assist analysts at the Ministry of Finance to produce forecasts for both the short- and long-term outlook for the Slovak economy in a consistent framework, analyse risks to the economic outlook and implications for the budget, and conduct policy simulation analysis. The structure of the econometric model of Slovakia is based on the income-expenditure accounting framework with an explicit treatment of the supply-side and a number of simulation results are presented to illustrate the properties, as well as some of the capabilities, of the model. The model report also contains a description of the supply side and the main equations in the demand, the wages and prices, the monetary and financial, and the fiscal blocs of the model. The developed model is now employed in the Financial Policy Institute of the Ministry of Finance of the Slovak Republic as a crucial component of the unit's suite of tools for economic analysis.

Table of contents

1. Introduction

Under the umbrella of the a World Bank financed Public Finance Management Reform (PFMR) project[1], a consultant was hired to help develop the macroeconomic capabilities of the Ministry of Finance of the Slovak Republic. A key element of this project was the development of a macroeconomic database and econometric model to facilitate the application of improved forecasting techniques and an improved capability to undertake policy analysis, specifically linking fiscal policy instruments to the economy as a whole. This paper describes the economic model of the Slovak Republic that has been developed.

Developing a model for many of the new EU countries includes many major challenges such as the availability and quality of data, almost continuous structural changes and uncertainty concerning the theoretical structure. However, these challenges should not lead to economic models being dismissed as not being a useful tool for economic analysis in a country such as the Slovak Republic. An econometric model is a very useful tool that will further the analytical capabilities of the Ministry of Finance. It will assist analysts at the Ministry of Finance to:

- Produce forecasts for both the short- and medium-term outlook for the Slovak economy in a consistent framework.
- Analyse risks to the economic outlook and implications for the budget
- Conduct policy analysis.

This framework for macroeconomic forecasting will facilitate the assessing of the current economic conditions in the Slovak economy and the quantifying the impact of 'economic shocks' and of various policy changes on the economy, as well as adding a layer of rigour and consistency to the presented macroeconomic forecasts. Forecasts and simulations based on the suggested system will greatly improve the policy-making process within the Ministry of Finance of the Slovak Republic. An integral feature of this model development has been to increase the forecast horizon from three years to incorporate a longer-term outlook.

The challenges posed by the new EU countries (which are similar, but greater, to those faced in more developed and stable economies) in constructing an economic model are met in the development process of the model and, crucially, the application of the system. Firstly, data is used a 'guide' rather than a 'bind', with the model structure being determined primarily by economic intuition. The implication is that, in deciding the structure of the econometric model, the forecasting and simulation properties complemented the role of test statistics. Secondly, the economic model should undergo continuous evaluation and assessment of performance and structure to ensure that the system keeps up-to-date with developments in the economy and does not become a 'false friend', i.e. producing misleading forecasts and scenario results because the system does not reflect the latest structural developments. Finally, the model

[1] For further details on the PFMR project refer to the website of the Ministry of Finance of the Slovak Republic (www.finance.gov.sk).

should, as much as possible, be one tool from a suite of models or approaches to economic analysis that can all complement each other.

A guiding principle during the development phase, in light of some of the challenges faced, was that model should have as simple a core structure as possible. This would facilitate manageability and transparency of both the model and analysis. However, this does not necessarily imply limitations of its applicability; appropriate satellite systems can be easily developed and effective training of staff will ensure effective use of the system.

The developed model is a quarterly model with a current forecast period extending up to ten years[2]. Its form is that of an error correction model, which distinguishes between long-run economic relations and short-run dynamics. This is still the mainstream approach to macroeconomic model building and combines the statistical rigour of vector autoregressive models (VARs) and the theoretical foundations of computable general equilibrium models (CGEMs). The adopted approach allows the application of statistically significant short-run dynamics that are underpinned by sound theoretical foundations that drive, in particular, longer run developments. This gives this approach to macroeconomic modelling the advantage of providing both an effective tool for forecasting and policy analysis.

The structure of the econometric model of Slovakia is based on the income-expenditure accounting framework with an explicit treatment of the supply-side. In the long run, the Slovak economy will behave like a one-sector economy under Cobb-Douglas technology in equilibrium. The Slovak economy has an underlying growth rate that is primarily determined by population developments and productivity growth, although investment can boost potential output and there are positive endogenous growth effects of FDI inflows and government investment. Output cycles around this underlying trend. Firms are assumed to set prices given output and the capital stock, but the labour market is imperfectively competitive – employers and employees bargain over wages but firms choose the level of employment. In the long run, inflation is a monetary phenomenon and the econometric model of the Slovak economy has a vertical Phillips curve. Consumption is a function of real incomes and interest rates. Investment is determined in the long run by the profit maximisation condition but takes into account the role of profits and corporation tax, as well as government investment. Exports and imports are determined by demand and competitiveness and, since Slovakia is a 'small' country, it has only a very limited ability to determine its own terms of trade. The fiscal sector is model at a fairly aggregated level but it fully linked – in both directions – to the rest of the economy. Monetary policy is set in accordance with a Taylor Rule, although it is possible to impose other monetary rules, and interest rate differentials is the main driver for short-term changes in the real exchange rate.

The paper is organised as follow. Section 1 introduces the economic model of the Slovak Republic and briefly outlines the main features of the econometric model. A schematic overview of the model is presented in section 2. Section 3 discusses some data issues encountered during model development. The core equations of the model are outlined in

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[2] The ten year forecast horizon is perceived to be manageable, but for relevant policy analysis the forecast period can be relatively easily extended. For example, the scenario results presented in section 6 cover a forecast period of 30 years.

section 4. Section 5 illustrates the long-run properties of the model. Section 6 presents the results of simulations undertaken with the developed model. Some potential future developments are outlined in section 7 and section 8 concludes. Finally, the annex contains a detailed listing of variables and equations of the econometric model of the Slovak Republic.

2. Model outline

2.1. Brief description of the model structure

The developed model of the Slovak Republic conforms to the current mainstream in economic modelling: it is a quarterly model of an error-correction form, which is specified to ensure a set of structural economic relationships, which are derived in the main from theory, determine economic behaviour in the long run. More specifically, the model of the Slovak economy is neoclassical in the long run, with output being determined by supply-side factors. This means that inflation in the long run is a monetary phenomenon or that money is neutral with respect to output in the long run. However, due to sluggish responsiveness of prices and volume the model is Keynesian in the short run. This means that increased demand will initially lead to higher output and employment, but will eventually also feed through into higher wages and prices and 'crowd out' demand via tighter monetary policy and reduced competitiveness. The model is run on adaptive (backward-looking) expectations and this is captured by lag dependent variables in many equations.

An Econometric Model of the Slovak Republic: a stylised model outline

The equations are all specified in a functional form (except for identities and exogenous variables) and are, in general, log-linear and in error-correction format.

<u>Supply side</u>

Potential output: YHAT = f(ESTAR, KIPNR, TFP) – Cobb-Douglas Production function
Equilibrium employment: HPTRENDET = (1-UPSTAR/100)*LS
Equilibrium unemployment rate: UPSTAR
Capital stock in the business sector: KIPNR = delbus* KIPNR(-1) + 0.75*IF
Depreciation rate in the private sector: delbus
Capital stock in the government sector: KGOV = delgov*KGOV(-1) + 100*GI
Depreciation rate in the government sector: delgov
Stock of FDI investment: FDIS = FDIS(-1) + 100*FDI/PGDP
Investment: IF = f(RELEND, FDI, PROF, GDP, KIPNR, PGDP, delbus)
Government investment: GI
Total factor productivity: TFP = f(TREND, FDIS, GI)
Employment: ET = f(GDP, ER/PGDP)
Unemployment: U = LS – ET
Unemployment rate: UP = 100*(LS-ET)/LS
Labour supply: LS = PART*POPW
Population: POP
Population of working age: POPW
Participation rate: PART

Time trend: TREND

Demand side

GDP: GDP = C + GC + IF + IS + X – M
Private consumption: C = f(PEDYP/CPI, RDEP)
Government consumption: GC
Stockbuilding: IS
Exports: X = f(WT, COMP)
Imports: M = f(TFE, COMP, TREND)
Total final expenditure: TFE = C + GC + IF + IS + X

Personal disposable income: PEDYP = ER*ET/1000000 + GCGPE + PEOY – TY – TSS
Other personal income: PEOY = f(GDP, PGDP)
World trade: WT

Prices & costs

GDP deflator: PGDP = f(OG, GDP/ET,ER)
CORE CPI: CPIU = f(PGDP, PPI, PM, TXR)
CPI: CPI = ((1-α)*CPIU/CPIU(-4) + α*CPIRINF))*CPI(-4)
Regulated price inflation: CPIRINF – in the longer term it is assumed to equal underlying inflation.
Share of regulated price inflation in overall inflation: α
PPI: PPI = f(M, TFE, PGDP, PM, WPEN, FDIS)
Import prices: PM = f(PGDP, PXEU, WPEN, RXD, RXEUR)
Export prices: PX = f(PGDP, PPI, PM, PXEU, RXEUR)

Wages: ER = f(GDP/ET, PGDP, CPI, UP, UPSTAR)
Competitiveness: COMP= (ER*ET)/WWC
Worldwide wage costs: WWC

Private consumption deflator: PC = f(CPI)
Government consumption deflator: PGC = f(PGDP)
Investment deflator: PIF = f(PGDP, PPI)

Export prices of the Eurozone: PXEU
World energy prices: WPEN

External sector

Share of goods in exports: XGSH = f(COMP)
Share of goods in exports: MGSH = f(XGSH, COMP)
Current account: BCU = BVI + BSER + BCUOTH
Balance of trade: BVI = XGSH.PX.X/100 – MGSH.PM.M/100
Balance of services: BSER = (1-XGSH)PX.X/100 – (1-MGSH)PM.M/100
Net transfers and IPD: BCUOTH

Balance of FDI in Slovakia: FDI

Monetary sector

Euro exchange rate: RXEUR = f(RDISC, RSHEUR, PGDP, PGDPEUR) ie modified UIP
Dollar exchange rate: RXD = RXEUR/RXDEUR
Short-term interest rate: RDISC = f(PGDP, GDP, YHAT) – Taylor Rule

Average interest rate on loans: RELEND = f(RDISC)
Average interest rate on deposits: RDEP = f(RDISC)

Short-term interest rate in the Eurozone: RSHEUR
GDP deflator in the Eurozone: PGDPEUR
US$/€ exchange rate: RXDEUR

Fiscal sector – consolidated general government

Government budget balance: GB = GREV – GEXP
Government debt: GGDBT = GGDBT(-1) + GB
Government revenues: GREV = TY + TSS + TCORP + TX + TOTH
Personal income tax: TPY = PY*TYR
Corporation tax: TC = PROF*TCORPR
Contributions for social insurance: TSS = TSSR*ER*ET/1000000
Expenditure tax: TX = TXR*C*PC/100
Tax rates: TxxR are all average effective tax rates
Other revenues (nec): TOTH = f(GDP, PGDP)

Government expenditures: GEXP = GC*PGC/100 + GI*PIF/100 + GCGPE + GDIP + GEOTH
Personal sector transfers from central government: GCGPE = f(U, CPI)
Government debt interest payments: GDIP = f(GGDBT, GB, RDISC)
Other expenditures (nec): GEOTH = f(GDP, PGDP)

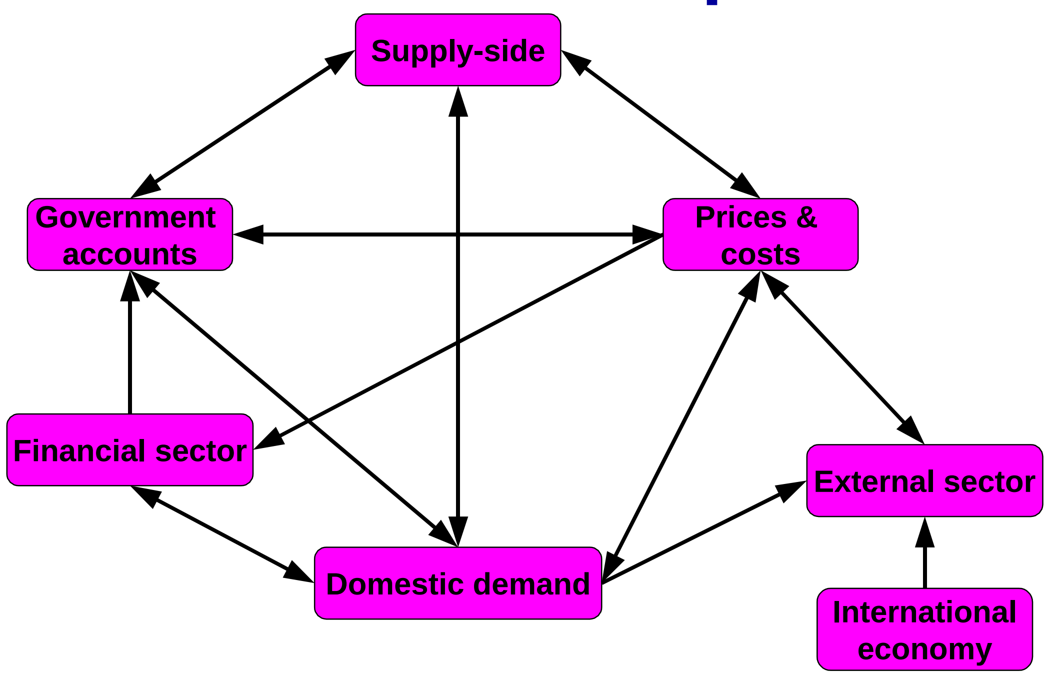
Corporate sector

Economy-wide profits: PROF = GDP*PGDP/100- ER*ET/1000000 - TX

It can be seen that the there is an economy wide production function, where output is determined by productivity growth, the capital stock and equilibrium employment. More specifically, a Cobb-Douglas production function is used and provides the anchor for model, i.e. the long run components of the wages, GDP deflator, employment and investment are derived from this equation via the first-order profit maximization condition. The equilibrium rate of unemployment (the structural unemployment rate) is exogenous and is used, together with the labour supply, to derive equilibrium employment. The wage equation is set in a wage-bargaining framework and prices are a flexible mark-up on cost, with the margin dependent on the economy's cyclical position. In the short-run, output is determined by aggregate demand

and the model contains standard demand equations for household consumption and trade volumes, and the dynamics of the investment equation contains a demand multiplier. Government consumption and stockbuilding are exogenous. The fiscal sector is as a simplified representation of the general government sector, with both expenditures and revenues included at a fairly aggregated level. The core interest rate variable is a simple Taylor Rule and the (SKK/EUR) exchange rate is driven by real interest rate differentials and a risk premium. The financial sector can be switched on and off depending on the type of scenario being employed.

A Birdseye View of the Model of the Slovak Republic



2.2. Dynamics of the Key Estimated Equations

The table below summarises the main drivers of the key behavioural equations. The general approach to modelling has been for the long-run to be derived from theory with, where possible, data-driven short-run dynamics. This permits that short-run relationships differ from those in the long-run and the economy can move away from its equilibrium path. However, the short-run dynamics are constrained by the need for variables to converge on to their long-run paths and the relevant homogeneity properties. In the main, the rate of adjustment to deviations from the long path, i.e. the coefficient on the ECM term, is also estimated. A more detailed description of the specification of key equations can be found in section 4 and a full equation listing can be found in annex A.2.

It should be noted that in the first instance the main requirement of equation was for it to make economic sense. While this is ensured for the long run through reliance on theoretical building blocks, it did mean that the short-term dynamics, including the adjustment term on the ECM, were data driven, if and only if the results were consistent with economic intuition. For a number of reasons, including the continuous structural change and the length and quality of the data set, this was not always the case. Therefore the elasticities illustrated below have been derived from a combination of economic theory, estimation and calibration, based on the forecasting and simulation properties of the model.

Key elasticties: Single-equation responses to 1% shocks to key explanatory variables
(% changes from baseline)

	Q1	Year 1	Year 2	Year 5	Year 10
Consumption					
Personal disposable income	0.4	0.8	1.0	1.0	1.0
Interest rates*	0.0	-0.4	-0.6	-0.6	-0.6
Investment					
GDP	1.0	2.2	2.5	2.6	2.6
Real Interest rates*	0.0	-0.1	-0.3	-1.1	-2.2
Exports					
World trade	1.0	1.0	1.0	1.0	1.0
Competitiveness	0.0	-0.1	-0.2	-0.2	-0.2
Imports					
Total final expenditure	1.8	1.5	1.1	1.0	1.0
Competitiveness	0.0	0.1	0.2	0.2	0.2
Employment					
GDP	0.0	0.4	0.9	1.0	1.0
Average real wages	0.0	-0.1	-0.5	-1.0	-1.0
Average wages					
GDP deflator	0.0	0.7	1.0	1.0	1.0
CPI	0.2	0.3	0.0	0.0	0.0
Productivity	0.0	0.7	1.0	1.0	1.0
Unemployment rate*	0.0	-0.1	-0.1	-0.2	-0.4
GDP deflator					
Unit labour costs	0.2	0.7	1.2	1.0	1.0
Output gap	0.1	0.1	0.1	0.1	0.1
CPI (excluding regulated prices)					
GDP deflator	0.5	0.5	0.5	0.5	0.5
PPI	0.2	0.2	0.2	0.2	0.2
Import prices	0.3	0.3	0.3	0.3	0.3
Effective indirect tax rate*	1.0	1.0	1.0	1.0	1.0

* 1% point change

3. Data issues

In building an econometric model data is one of the most crucial elements: future trends are extracted on the basis of historical precedents. Therefore data should be processed in such a way as to maximise its information content. The earliest possible data point for the Slovak Republic would have been the beginning of 1993, which limits the number of data points available, and at the beginning of this period the data coverage was not very broad and data quality questionable. This means that in order create a suitable data set some manipulation of the data has been necessary in order to improve its usefulness.

For the purpose of developing the econometric model a quarterly database stretching back to 1994Q1 was created. However, not all data-series in their raw form extend quarterly that far back, therefore it has sometimes been necessary to interpolate annual data in order to obtain a suitable time series. The annual data series were interpolated using the statistical method suggested by Lisman and Sandee (1964).

The second manipulation applied to the data was seasonal adjustment; the Statistic Office of the Slovak Republic releases some key data series in a seasonal adjusted format but the list of such series is not entirely comprehensive[3]. The raw data can be very seasonal and when plotted it is difficult to identify the underlying trend amongst the seasonality. Therefore the seasonal pattern would tend to dominate any estimation output. There are two apparent solutions, in addition to seasonally adjustment: constructing a model based on annual differences and using seasonal dummies. The former has the major disadvantage of only highlighting changes with some delay i.e. the current economic developments are mixed together with those in the previous three quarters. The use quarterly seasonal dummies implies a fixed seasonal pattern as opposed to moving seasonal pattern incorporated in the main seasonal adjustment procedures. Moreover, while seasonal dummies will account for the statistical aspect of a seasonal pattern they leave the data and forecast in its raw seasonal form and reduce the visual interpretability of the data. Seasonal adjusted data offers the major advantage of making the data more interpretable.

The data building blocks of the econometric model of the Slovak Republic are therefore constructed from seasonally adjusted data. The data is seasonally adjusted by the Statistical Office of the Slovak Republic using one the most commonly applied techniques of Tramo-Seats[4,5] and for the purposes of the model this data is adopted. Not every series needs to be seasonally adjusted; at this stage only the series that are crucial to the cycle element of the model, i.e. national accounts and the labour market. For those data series that are not already

[3] The seasonally adjusted data tends not to be available as a main output and can be found in the annex of publications such as 'Macro-economic Indicators of Quarterly National Accounts and Value Added' and 'Labour Force Sample Survey Results in the Slovak Republic'.

[4] The Tramo-Seats method was recommended by Eurostat and can be applied via the Eurostat distributed software 'DEMETRA'.

[5] The Statistics Office of the Slovak Republic adjusts for trading days (based on Slovak specific holidays) and leap-year effects when seasonally adjusting (Easter is only adjusted for when it is statistically significant). They also accept the default options of DEMETRA except for imposing a log transformation and selecting 'annual mean' when correcting for level bias in seasonally adjusted series. Contact the Statistics Office of the Slovak Republic for greater detail (www.statistics.sk).

seasonally adjusted a methodology compatible with that used by the Statistical Office of the Slovak Republic was employed[6].

[6] Capital expenditure by general government exists on a quarterly basis from 2001Q1 which is far too short a time series to be seasonally adjusted, and this non-seasonally adjusted data was spliced onto annual interpolated data. The same process was applied to all general government data included in the model, as well as FDI data. This inclusion of some non-seasonally adjusted data introduces the need for seasonal dummies in certain equations, most notably the equation for gross fixed capital formation.

4. Core equations

This section presents the key behavioural equations, outlining the structure of the equations and the concepts behind them. Most behavioural equations, and certainly the key ones, are specified in 'error correction model' (ECM) form, which ensures that the variables converge to long run path that is typically specified by theory but permits different short-run dynamics. The estimation method employed was Ordinary Least Squares (OLS), using White Heteroskedasticity-Consistent Standard Errors and Covariance when necessary. The data set used for estimation covers the period 1994Q1 to 2002Q4, though some data within this period needed to be constructed. The typical approach to each behavioural equation was to specify the long-run parameters in accordance with economic theory and calibration and then to estimate the short-run dynamics, including the adjustment to deviations from long-run behaviour, i.e. the coefficient on the ECM term. That said, the short-run dynamics are not purely data driven since consistency with economic intuition was given utmost importance. Dummies and occasional seasonal parameters[7] were included but they will not be discussed in any detail below.

4.1. Supply side

The concept of potential output is the best indicator of the aggregate supply-side capacity of an economy and the rate of growth that can be achieved without producing inflationary pressures or high external deficit. Potential output can be derived from purely statistical techniques such as the Hodrick-Prescott (HP) or from econometric analysis, i.e. the production function. Either approach necessitates an arbitrary choice of parameters, either the degree of smoothness of the filtered series or the specification of the theoretical model.

For econometric model of the Slovak Republic a production function has been adopted. This has the advantage of allowing the possibility of assessing the economic factors that are driving the changes in potential output. Moreover, the production function has the added advantage over the filtering techniques in the possibility of producing forecasts and building scenarios and it, therefore, facilitates the link between policy measures and outcomes. Finally, the production function approach is the approach adopted by the EC and the OECD, which in itself encourages the adoption this technique for the Ministry of Finance of the Slovak Republic.

The basic production function adopted in most models is the Constant Elasticity of Substitution (CES) function, which takes the form of:

$$GDP_t = f(K_t, ET_t) = A_t[\alpha K_t^{-\rho} + (1-\alpha)ET_t^{-\rho}]^{-1/\rho}$$

where constant returns to scale are assumed and GDP_t is GDP, K_t is the capital stock in the business sector, ET_t is employment, and A_t is trend factor productivity (TFP) and

$$\sigma = 1/(1+ \rho)$$

[7] These components were used when data outliers could 'distort' the estimation results.

where σ is the elasticity of substitution between capital and labour, so that

$$GDP_t = f(K_t, ET_t) = A_t[\alpha K_t^{(\sigma-1)/\sigma} + (1-\alpha)ET_t^{(\sigma-1)/\sigma}]^{\sigma/(\sigma-1)}$$

While the general form of CES function is accepted as the base for the supply side of the economy, there is not a consensus on the value of σ. The most common assumption is the $\sigma = 1$ and then the CES function reduces to the standard Cobb-Douglas function. If $\sigma < 1$ then labour and capital are complements of each other and changing factor shares has a less than proportional impact on output. Whereas if $\sigma > 1$, then labour and capital are substitutes and increasing the factor share of capital increases output more than proportionally[8]. In most industrial countries factor shares have been broadly constant over time, with maybe a slight reduction in the wage share of production costs, but nevertheless this suggests of value of σ close to 1 in most countries. Moreover, as pointed out in a recent EC paper (Denis *et al* (2002)), if $\sigma = 0.8$ or 1.2 then this would not make the results significantly different to that of the Cobb-Douglas function.

Therefore, due to the simplicity and clarity of the Cobb-Douglas production function and the preference of the EC for this specification (Denis *et al* (2002)), as well as the lack of data reducing the reliability of any estimates of σ for the Slovak Republic, the supply side of economic model is modelled using the Cobb-Douglas function. It is worth noting that such a detailed treatment of the supply-side is a new feature to economic models of the Slovak Republic.

The components that needed to be estimated were: factor shares; equilibrium employment; capital stock and total factor productivity. As much as possible, the techniques of the EC have been replicated.

Factor shares: these were calibrated using the share of wage costs in total value added. The value of α is estimated to be 0.53.

Equilibrium employment: this is normally calculated using labour supply and the NAIRU, the latter in turn is calculated by a various methods but an increasingly common method is the Kalman Filter. However, the NAIRU in the new EU countries is probably a theoretical and empirical research project in itself, which could be undertaken at a later date, i.e. wage bargaining systems and the role of indexation most likely differ to traditional OECD countries. At this initial model development stage a simple HP filter on employment is used to calculate equilibrium employment directly. An implicit equilibrium unemployment rate is then calculated using the labour supply and the calculated equilibrium employment series. Of

[8] To illustrate the impact of different values of σ the CES function can be linearised (see Duffy and Papageorgiou (2000)) using a simple first order Taylor series and assuming that ρ is close to zero (ie σ is close to 1):

$$gdp_t = a_t + \alpha k_t + (1-\alpha)et_t - 0.5\alpha\rho(1-\alpha)[k_t - et_t]^2 = a_t + \alpha k_t + (1-\alpha)et_t - 0.5\alpha((1-\sigma)/\sigma))(1-\alpha)[k_t - et_t]^2,$$

where lower case letters represent a logarithmic function. Values of σ that differ from one imply changing factor shares over time: a value of σ over 1 implies that capital stock will increase as a share of factor inputs and vice versa for $\sigma < 1$.

course, the model is not static and a more sophisticated estimation of the NAIRU can be incorporated at a later date.

Capital stock: a capital stock series as such does not exist for the Slovak Republic, nor does a detailed break down of gross fixed capital investment into sectors in constant prices. However, a point estimate for the value of the capital stock for end-1998 was obtained from the Statistics Office of the Slovak Republic and a time series can be constructed using suitable assumptions on the depreciation rate and business investment's share of total investment, i.e. using to fixed capital formation by sectors in current prices data (only available from 2000Q1 as part of quarterly national accounts but a available back to 1993 as part of Annual National Accounts). The method employed was a simplified perpetual inventory method (PIM) using the value of the capital stock supplied by the Statistics Office of the Slovak Republic as the initialisation reference.

The point estimate for the capital stock at end-1998 indicated that the value of the capital stock (excluding residential buildings) amounted to SKK4535.02 billion, which equates to a capital-output ratio of 5.8. Within the total, the value of the capital stock in the corporate sector was SKK2395.22 billion (or a capital-output ratio of 3.1) and that in the government sector amounted to SKK1047.62 billion (which is equal to a capital-output ratio of 1.3). In terms of international comparisons, the calculated figure is a little a high: according to capital stock data published in the World Bank Dataset[9] the capital-output ratio is typically in the range 2.6-3.9 in European countries and a figure of 2.7 has been calculated by Pula (2003) for Hungary. Although the capital stocks used in these datasets are probably not directly comparable with the figure calculated by the Statistics Office of the Slovak Republic, the comparison does suggest that the initialisation point for the calculation of a capital stock time series for the Slovak Republic may have been a little high. The consumption of capital time series, when combined with the calculate capital stock series, suggests the rate of depreciation of the total capital stock climbed from around 3% per annum in the mid-1990s to 4% per annum by the end of the decade. The depreciation rate in the business sector climbed from just under 4% to 5.7% per annum and that in the government sector from just over 2% to just below 3% per annum.

Note on the construction of a Capital Stock time series:

1) Annual data on investment, investment by sector and the investment deflator were collected from national accounts data.

2) Data on gross fixed capital formation and consumption of capital (i.e. depreciation) by sector was collected from Annual National Accounts.

3) Estimate of capital stock by sector for end-1998 and end-1999 from the Statistics Office was used as a benchmark.

4) All data were converted to 1995 prices using the investment deflator.

[9] The dataset was constructed by Nehru and Dhareswar (1993).

5) A time series for the capital stock was calculated from the end-1998 benchmark using investment and depreciation.

K=K(-1) - depreciation + investment (or K(-1)=K + depreciation - investment for pre 1998)

6) Individual sector capital stock series were calculated as above but using the share of investment (in current prices) in a particular sector out of the total.

$K_i = K_i(-1)$ - depreciation + (investment!$_i$/investment!)*investment, where investment! is investment in current prices and i = Financial corporations, non-financial corporations and general government.

7) Using capital stock at end-1993 as a starting point, a quarterly time-series for capital stock was calculated as above, using seasonally adjusted investment and assuming that the depreciation rate was constant during a given year.

8) Quarterly capital stock series for individual sectors were calculated as above, using interpolated investment shares.

9) The equations to project capital stock forward are:

Total: K = (1-DEL)*K(-1)+IF
Business: KIPNR = (1-DELBUS)*KIPNR(-1)+0.75*IF
Government: KG = (1-DELGOV)*KG(-1)+100*GI, where GI is gross capital formation by the government at constant prices (the nominal series deflated with the investment deflator).

In reality, the depreciation rate will be time varying but set flat from the last data point.

Total factor productivity: this is another unobserved variable, which was estimated, in line with EC methodology, as the Solow Residual on the production function. The series was then smoothed using the HP filter.

Results[10]

	Potential output (% year)	Capital stock	Employment	TFP	GDP (% year)	Output gap
		Contributions to potential output growth				
1995	4.7	1.3	0.4	2.9	5.8	0.1
1996	5.0	2.0	0.3	2.7	6.2	1.2
1997	4.9	2.4	0.1	2.4	4.6	0.9
1998	4.4	2.5	-0.2	2.1	4.2	0.8
1999	3.1	1.5	-0.3	1.9	1.5	-0.9
2000	2.4	0.7	-0.3	2.1	2.0	-1.3
2001	3.0	0.8	-0.2	2.3	3.8	-0.5
2002	3.5	1.0	0.0	2.6	4.4	0.4

The profit maximisation condition, using the value of GDP less the cost of employing the factors of production, generates the main equilibrium concepts that anchor the long run behaviour of the econometric model of the Slovak Republic. The profit function is defined as,

$$\pi(ET_t, K_t, TFP_t) = p_t GDP_t - w_t ET_t - p^k_t(r_t + \delta_t)K_t,$$

$$\text{where } GDP = e^{TFPt} K_t^{\alpha} ET_t^{(1-\alpha)}$$

and where r is the real interest rate, p is the general price level, p^k is the price of capital and the other mnemonics are as above. Maximising the profit function with respect to labour and capital produces two equilibrium conditions:

$$(1-\alpha)GDP_t/ET_t = w_t/p_t \qquad (1)$$

$$\alpha GDP_t/K_t = (r_t + \delta_t).p^k_t/p_t \qquad (2)$$

Both conditions state that the factor of production, i.e. capital or labour, is employed up to a point where its marginal productivity is equal to its marginal cost. Equation (1) is used in the employment, GDP deflator and wages equation and states that in equilibrium that the marginal productivity of labour is equal to the real wage. Equation (2) is used in the investment equation and imposes that the marginal productivity of capital is equal the sum of the real interest rate and the real rate of depreciation, i.e. the marginal cost of using capital.

Investment

D(LOG(IF/GDP)) = - 0.02 + 0.15*D(LOG(GI)) + 0.092*D(LOG(GI(-1))) + 0.682*D(LOG(((1-TCORPR(-1))*PROF(-1)/PGDP(-1)))) + 0.032*D(LOG((FDI(-2)/PIF(-2))))

[10] These are the results from a purely statistical derivation of potential output, i.e. no productivity adjustment is made for the fact that a new Volkswagen factory became active at end-2002.

+ 0.25*((0.53*GDP(-1)/KIPNR(-1))-(RELEND(-1)/400-D(LOG(PGDP(-1))))-DELBUS(-1)) + dummies and seasonal factors

IF: Gross fixed capital formation (constant prices)
GDP: GDP (constant prices)
GI: Government investment (constant prices)
TCORPR: Average effective rate of taxation on profits
FDI: Foreign direct investment
PIF: Investment deflator
PGDP: GDP deflator
KIPNR: Capital stock in the business sector
DELBUS: rate of depreciation of capital in the business sector
RELEND: Average lending interest rate

While the profit maximisation conditions define the equilibrium path for investment and employment, this is only in the long run[11]. The short run dynamics are driven by the other variables such as demand. In the investment equation, demand plays an important role directly and through estimated profit developments. In addition, investment flows from the government and abroad boost investment demand.

Employment

D(LOG(ET)) = 0.55 + 0.57*D(LOG(ET (-1))) + 0.237*D(LOG(GDP (-1))) - 0.07*(LOG(ET (-1))-LOG(PGDP(-1)*GDP (-1)/ER (-1))) + dummies

ET: Total employment (based on Labour Force Survey data)
GDP: GDP (constant prices)
PGDP: GDP deflator
ER: Economy-wide average earnings

In the long-run employment converges to a path where labour productivity equals the real wage as defined by the profit maximising condition, but the short-run dynamics are determined by output growth and a lagged dependent variable.

4.2. Demand

Expenditure GDP in constant prices, i.e. the demand-side of the model, is split into six categories, all of which are modelled separately:

- Private consumption, which includes final consumption of households and final consumption of non-profit institutions serving households.
- Government consumption (an exogenous variable).
- Gross fixed capital formation (see previous section).
- Stockbuilding (an exogenous variable)
- Exports of goods and services.

[11] For simplicity it is assumed that the general level of prices is equal to the price of capital, i.e. $p = p^k$.

- Imports of goods and services.

Private consumption

D(LOG(PRICONS)) = 3.5 + 0.40*D(LOG(PEDY/PCONS)) - 0.76*(LOG(PRICONS(-1))-LOG(PEDY(-1)/PCONS(-1)) + 0.006*RELEND(-1))

PRICONS: Private consumption (constant prices)
PEDY: Personal disposable income
PCONS: Private consumption deflator
RELEND: Average lending interest rate

The equation for private consumption is fairly standard and relates consumption to real income and the cost of borrowing (and/or the opportunity cost of not saving). The income variable used is personal disposable income, which is the sum of labour income, transfers and other income less the income tax and social security contributions. In the long-run, the coefficient on real personal disposable income is imposed to be unity and ensures that if income increases by 1% then so does private consumption. The interest rate enters the equation in nominal terms, rather than real as would have been expected, because the coefficient on the real interest rate was found to be insignificant. In the short-term, the consumer does not immediately respond in full to a change in its income.

Exports of goods and services

D(LOG(X)) = 0.44 + 1*D(LOG(0.85*MEUR+0.15*MCZ)) - 0.53*(LOG(XSA(-1))-LOG(0.85*MEUR(-1)+0.15*MCZ(-1))+0.2*LOG(WCR(-1)))

X: Exports of goods and services (constant prices)
MEUR: Imports of goods and services into the Eurozone (constant prices, indexed)
MCZ: Imports of goods and services into the Czech Republic (constant prices, indexed)
WCR: Relative unit labour costs

The trade equations both depend on demand and competitiveness. The demand variable in the exports of goods and services is world trade, which is the trade-weighted sum of import demands of Slovakia's main export markets. At this stage world trade is proxied by the weighted sum of import growth in the Eurozone and the Czech Republic[12]. These two economic areas account for over 70% of total exports. In both the short- and long-term, a unit coefficient is imposed upon world trade. This ensures that the Slovak Republic does not gain/loss share in the world market in response to world demand changes.

Imports of Goods and Services

D(LOG(M)) = - 0.54 + 1.75*D(LOG(TFE)) -0.29*(LOG(MSA(-1))-LOG(TFE(-1))-0.15*LOG(WCR(-1))) + 0.003*STTREND + dummies

[12] All international variables included in the econometric model of the Slovak Republic are assumed to be exogenous.

M: Imports of goods and services (constant prices)
TFE: Total final expenditure (constant prices)
WCR: Relative unit labour costs
STTREND: Split time trend

The demand component used in the equation for imports of goods and services is total final expenditure, which corresponds to the sum of private consumption, government consumption, investment, stockbuilding and exports. In the long-run, the coefficient on this term has been imposed as a unit coefficient. The coefficient in the short-run has also been imposed via calibration. When freely estimated the results suggested that in the first instance a shock to total final expenditure is completely absorbed by imports, a property that was clearly undesirable.

The competitiveness variable used in both trade equations is relative unit labour costs in a common currency (using the trade-weighted average of unit wage costs in the Eurozone and the Czech Republic as the denominator). The response of trade to changes in competitiveness was calibrated based on simulation output because the estimated coefficients in both equations were insignificant.

4.3. Wages and Prices

Within the model there are a number of price and cost variables, but the price system is tightly linked together through the assumption of static homogeneity. This states that following a 'shock' that there are no changes is relative prices in the wage-price bloc in the long-run, i.e. a 10% devaluation will, in the long run, lead to a 10% rise in domestic wages and prices and as such a depreciation has no long-run effect on competitiveness and real wages (see section 6.3.). This is achieved by all of the coefficients on the long-run components in the wage/price bloc of the model having unit coefficients. Dynamic homogeneity is also imposed for the core price and cost equations, namely wages and the GDP deflator. This ensures that the NAIRU is independent of inflation rate and that the model has a vertical long-run Phillips Curve. The foundation price variable, upon which the others are constructed, is the GDP deflator. The key domestic wage and price variables are:

- Economy-wide average earnings.
- GDP deflator.
- Consumer prices, excluding regulated prices.
- Consumption deflator.
- Producer prices.
- Import and export deflators.

The government consumption deflator and the investment deflator are also identified separately in the model.

Economy-wide average earnings

D(LOG(ER/(1+TESSR))) = 5.58 + 0.25*D(LOG(ER (-1)/(1+TESSR(-1)))) + 0.15*D(LOG(CPI)) + 0.25*D(LOG(CPI(-1))) + 0.2*D(LOG(CPI(-2))) + 0.15*D(LOG(CPI(-3))) – 0.68 *(LOG((ER (-1)/(1+TESSR(-1)))/PGDP(-1)) – LOG(GDP (-1)/ET (-1)) + 0.025*LOG(UP (-1)/UPSTAR(-1)))

ER: Economy-wide average earnings
ET: Total employment (based on Labour Force Survey data)
GDP: GDP (constant prices)
PGDP: GDP deflator
CPI: Consumer price index
TESSR: Average effective rate of employer social security contributions
UP: Rate of unemployment rate
UPSTAR: Unemployment rate consistent with equilibrium employment

The long-term behaviour of earnings is determined by the profit maximisation condition outline above where real wages equals marginal productivity. However, the wage equation is generally set in a bargaining framework. Employees and employers bargain over the real wage – the wages bargained over is the gross wages received by employees and therefore employer social security contributions are netted off gross wages paid by the employer – and the relative strength of the two parties determines the final outcome (the relative strength is usually captured through a measure of the unemployment gap, in this case the difference between the unemployment rate and the rate of unemployment consistent with equilibrium employment). However, employees are interested in the real consumption wage whereas employers are interested in the product wage. For this reason CPI terms are included in the dynamics but ultimately the price system rests on the GDP deflator. The coefficients on the dynamics were calibrated but restricted to ensure dynamic homogeneity.

GDP deflator

D(LOG(PGDP)) = -0.84 + 0.25*D(LOG(PGDP(-1))) + 0.15*D(LOG(PGDP(-2))) + 0.2*D(LOG(ER)) + 0.25*D(LOG(ER(-1))) + 0.15*D(LOG(ER (-2))) + 0.05*D(LOG(GDP/YHAT)) – 0.1*(LOG(PGDP(-1))-LOG(ER(-1)*ET (-1)/GDP (-1))-0.1*LOG(GDP (-1)/YHAT(-1)))

ER: Economy-wide average earnings
ET: Total employment (based on Labour Force Survey data)
GDP: GDP (constant prices)
PGDP: GDP deflator
YHAT: Potential GDP (constant prices)

The long run equilibrium for the GDP deflator is also determined by the profit maximisation condition. The short-run is driven by a lag dependent variable and wage inflation, with coefficients restricted to ensure dynamic homogeneity. Added price pressures also arise through excess demand and this is captured by the inclusion of an output gap term.

In Slovakia regulated prices account for almost a quarter of the CPI basket and this share has been on a gradual upward trend. Though not uncommon in European countries the share of regulated prices tends to be much lower, accounting for on average under 10% of the CPI basket of prices. These regulated prices are administered and as such do not necessarily respond to market conditions and distorts the evolution of prices, i.e. regulated prices will not behaviour in accordance with the basic profit maximisation assumptions. Therefore regulated prices are treated separately in the econometric model of the Slovak Republic, with post tax core inflation being modelled endogenously. That is, the CPI is a weighted average of core non-regulated prices and regulated prices,

$$CPI_t = \lambda_t CPIREG_t + (1-\lambda_t)CPIU_t,$$

where λ_t is the time varying share of regulated prices in the CPI basket. Regulated price are treated as exogenous in the short-run and are set in accordance with information released by the relative regulatory offices. In the longer run, it is assumed regulated prices will develop in line with underlying inflation.

The CPIU series was constructed using the contribution of regulatory prices to the monthly rise in the total CPI and basing the CPIU index in December 2000. One issue is that the Statistics Office of the Slovak Republic only produces times series for regulated prices from 1997 onwards. For data earlier than 1997 it was assumed the regulated prices remained unchanged, except when they had a significant impact on the overall CPI, as identified by Hajnovič (2001). For the pre-1997 period, it was also assumed that regulated prices accounted for a fixed 20% share of the CPI.

Consumer price index (excluding regulated prices)

D(LOG(CPIU/(1+TXR))) = -0.04 + 0.1*D(LOG(CPIU(-1)/(1+TXR(-1)))) + 0.2*D(LOG(PPI)) + 0.25*D(LOG(PM)) + 0.45*D(LOG(PGDP)) – 0.1*(LOG(CPIU(-1)/(1+TXR(-1))) – 0.5*LOG(PGDP(-1)) – 0.2*LOG(PPI(-1)) – 0.3*LOG(PM(-1)))

CPIU: Consumer price index, excluding regulated prices
PGDP: GDP deflator
PPI: Producer price index
PM: Import deflator
TXR: Average effective tax rate on consumption

Post-tax core inflation is modelled as a weighted average of domestic prices and import prices in the long-run. The PGDP term captures the impact of service prices (the approximate weight of services in the consumer basket, after removing regulated prices is 0.5) and the PPI and PM captures the impact of the price of goods (it is assumed that around a quarter of imported goods are for final consumption and this implies imports account for around 0.3 of consumption and the coefficient on PPI is one minus the other two). The short-term dynamics have been imposed in a similar way. The impact of a tax change is immediate and is passed through in its entirety to end prices.

Consumption deflator

D(LOG(PCONS)) = 0.34 + 1.12*D(LOG(CPI)) – 0.78*(LOG(PCONS(-1)) – LOG(CPI(-1))) – 0.002*TTREND

PCONS: Private consumption deflator
CPI: Consumer price index
TTREND: Time trend

The consumption deflator is simply a function of the CPI and in the long run it is assumed that there is an unit elasticity on the CPI. However, the data for the two price indices do not move together and this is captured by the greater than unit coefficient on CPI inflation in the dynamics (although a Wald Test suggests that the coefficient is not significantly different to one) and the trend term. The government consumption deflator and the investment deflator are both specified as a function of the GDP deflator.

Producer price index

D(LOG(PPI)) = 12.56 + 0.31*D(LOG(PPI(-1))) + 0.24*D(LOG(PGDP)) + 0.11*D(LOG(PM(-3))) - 0.52*(LOG(PPI(-1))-(1-M(-1)/TFE(-1))*LOG(PGDP(-1))-(M(-1)/TFE(-1))*LOG(PM(-1))) – 1.29*LOG(FDIS(-1)) + dummies

PPI: Producer price index
PGDP: GDP deflator
PM: Import deflator
TFE: Total final expenditure (constant prices)
FDIS: Stock of FDI

Producer prices in the long run are again a weighted average but this time of domestic prices and imported input costs. The stock of FDI is included to generate productivity gains resulting from greater foreign participation in production. The short-run dynamics were freely estimated to ensure goodness of fit.

Export and import deflators

D(LOG(PX)) = -0.42 +0.2*D(LOG(PX(-1)))+0.2*D(LOG(PXEU*RXEUR)) + 0.19*D(LOG(PGDP)) + 0.25*D(LOG(PM)) - 0.31*(LOG(PX(-1))-0.3*LOG(PPI(-1))-0.4*LOG(PXEU(-1)*RXEUR(-1))-0.3*LOG(PM(-1))) + dummies

D(LOG(PM)) = - 0.32 +0.25*D(LOG(PM(-1))) + 0.16*D(LOG(PXEU*RXEUR)) + 0.04*D(LOG(WPEN*RXD)) - 0.11*(LOG(PM(-1))-0.65*LOG(PXEU(-1)*RXEUR(-1))-0.15*LOG(WPEN(-1)*RXD(-1))-0.2*LOG(PGDP(-1))) + dummies
PX: Export deflator
PM: Import deflator
PGDP: GDP deflator
PPI: Producer price index

PXEU: Export price deflator of the Eurozone
WPEN: World price of energy products (US$)
RXEUR: SKK/euro exchange rate
RXD: SKK/US$ exchange rate

The trade price equations essentially have two components: international prices and domestic prices. International prices of manufactured goods and services are proxied by the export deflator of the Eurozone. In addition, there is a world energy price term in the import price deflator. Domestic prices are based on the GDP deflator and the PPI. However, in 'small' open economies like the Slovak Republic, the price of tradable goods (measured in a common currency) cannot deviate significantly from some world value. This means that while trade prices are a weighted average of domestic production prices and world prices, the latter has a much heavier weighted. In both equations static homogeneity was imposed in the long run and the dynamics were derived from a mixture of estimation and calibration.

4.4. External sector

The external balance on goods and services traded is given by the equations for volumes and their price deflators that were discussed in sections 4.2. and 4.3. above. Simple share equations, which split the total value of exports and imports into goods and services, are used to derive the balance of trade. Net transfers and net profit, interest and dividends payment are aggregate into one variable, which is assumed to be exogenous. Net foreign direct investment is also separately identified but, apart this variable, capital flows and the financial account are not modelled.

4.5. Monetary and financial sector

Interest and exchange rates

RDISC = (1 - EMU)*(RDISC(-1) + 0.5*400*(PGDP/PGDP(-1) – PGDP(-1)/PGDP(-2)) + 0.5*100*D(GDPSA/YHAT – 1) – 0.5*(RDISC(-1) – 1.0*400*(PGDP(-1)/PGDP(-2) – 1) – 0.25*100*(GDP(-1)/YHAT(-1) – 1))) + EMU*RSHEUR

LOG(RXEUR) = (1 – EMU)*(LOG(RXEUR(-1)) + (LOG(1 + RSHEUR/400) – LOG(1 + RDISC/400)) + (D(LOG(PGDP)) – D(LOG(PGDPEU))) – 0.1*FDI(-1)/(GDP(-1)*PGDP(-1)/100)) + EMU*LOG(RXEUR(-1))

RDISC: Interest rate, basic interest rate of the NBS
RXEUR: Exchange rate, Euro rate (SKK/Euro)
PGDP: GDP deflator
GDP: GDP (constant prices)
YHAT: Potential GDP (constant prices)
RSHEUR: Euribor 3-month rate
RXDEUR: US$/€ exchange rate
PGDPEU: GDP deflator in the Eurozone
BCU: Current account balance

FDI: Foreign direct investment
EMU: Switch variable (=1 if the Slovak Republic country joins EMU)

There are two main equations in the monetary section of the model: the key interest rate (currently the two-week REPO Tender Limit Rate of the National Bank of Slovakia) and the SKK/€ exchange rate (the SKK/US$ exchange rate is calculated as an identity from the SKK/€ and US$/€ exchange rates). The interest rate function follows the Taylor Rule and relates the interest rate to the inflation rate and the output gap. The coefficients in the equation have been calibrated to ensure sensible simulation properties.

The SKK/€ exchange is a modified uncovered interest rate parity (UIP) equation, where the equilibrium exchange rate is driven by weak PPP. This relates the expected changes to the SKK/€ exchange rate over and above those suggested by weak PPP to differences between the interest rates in the Eurozone and the Slovak Republic and a risk premium[13].

Also included in both of the main equations in the monetary section of the model is a switch variable named 'EMU'. This allows for the possibility of the Slovak Republic entering ERM II and EMU. This variable permits the monetary policy options to be amended. When this variable is set to 1 the monetary sector behaves as if the Slovak Republic had entered EMU and the exchange is irrevocable fixed and monetary policy is determined by the European Central Bank[14].

4.6. Government sector

The fiscal sector included in the econometric model of the Slovak Republic is a simplified representation of the general government sector and is modelled using cash based numbers with no adjustment for privatisations or state guarantees[15]. More detailed analysis of the public sector is carried out elsewhere in the Ministry of Finance and the aim of incorporating this sector into the model is to get an initial quantification of the budgetary impact of macroeconomic developments.

Government revenues and grants

GREV = TY +TESS + TOSS + TCORP + TX +TOTH

Government expenditure and lending minus repayments

[13] In a single sector model of the economy, i.e. not distinguishing between the tradable and non-tradable sectors, it is not possible to explicitly model the Balassa-Samuelson effect. The predicted real appreciation of the currency and its competitiveness impact, i.e. its impact on relative unit labour costs, need therefore to be implemented by the model user and the phenomenon explicitly accounted for when undertaking relevant policy or scenario analysis.
[14] Although the Slovak economy will enter the decision function of the European Central Bank, it can be reasonably assumed, given the size of the Slovak economy, that the impact will be negligible and, therefore, the ECB's key interest rates are assumed to be exogenous at all times.
[15] More detailed analysis of the fiscal sector is carried out elsewhere in the Ministry of Finance and the aim of incorporating this sector into the model is to facilitate links between the fiscal policy and the economy as a whole and to get an initial quantification of the budgetary impact of macroeconomic developments.

GEXP = GCP + GIP + GCGPE + GDIP + GEOTH

GREV: Government revenues
GEXP: Government expenditures
TY: Personal income tax
TESS: Employer's social security contribution
TOSS: Other social security contributions
TCORP: Corporation tax
TX: Expenditure tax (i.e. VAT and Excise duties)
TOTH: Other residual government income (including grants and non-tax revenues).
GCP: Government procurement and wages
GIP: Government investment (in fixed capital assets)
GCGPE: Social transfer payments
GDIP: Government interest payments
GEOTH: Other government expenditure (which includes lending minus repayments and capital transfers).

The revenue side is driven using average effective tax rates (ETRs) applied to the relevant proxy for a tax base in a number key sectors and the rest of government revenues is grouped into a residual component that is assumed to move in line with nominal GDP. On the expenditure side, a significant proportion of the drivers are exogenous; real government consumption and investment are assumed to be determined by policy, so that government expenditure on these elements will only vary with their price deflators. Social transfers are determined by inflation and unemployment developments, while government interest payments are dependent on the level of government debt and interest rates. Other government expenditure acts as a residual catch-all category and moves in line with nominal GDP[16].

[16] The fiscal accounts link variables that are calculated on ESA95 methodology with those calculated on IMF GFS86 methodology and inconsistencies may arise. In the case of revenues this is absorbed by the effective tax rates and, in part, the residual category, whereas on the expenditure side everything is absorbed by other government expenditures.

5. Long-run properties

As has been already noted, the econometric model of the Slovak Republic is a standard aggregate demand and aggregate supply model. In the short-run, GDP is determined by the demand-side of the economy, as specified by the equations for the components of expenditure GDP in sections 4.1. and 4.2. However, in the long-run the aggregate supply curve is vertical and is largely determined by exogenous factors, namely trend factor productivity (which is determined by trend technological progress, the stock of FDI and the capital stock in the government sector, all of which are exogenous) and equilibrium employment (which is dependent on population developments and structural labour market features). In response to a supply and/or demand shocks the economy may move off its long run supply curve and this triggers price, wage and interest rate adjustments that eventually brings the economy back to its long-run equilibrium level of output.

5.1. The long-run steady state

A theoretical consistent supply side is essentially the core of the econometric model and it consists of six equations:

Supply side

$$YHAT_t = e^{TFP_t} ESTAR_t^{(1-\alpha)} K_t^{\alpha} \quad (5.1.1)$$

$$(1-\alpha)GDP_t/ET_t = w_t/p_t \quad (5.1.2)$$

$$\alpha GDP_t/K_t = r_t + \delta_t \quad (5.1.3)$$

$$ESTAR_t = (1-UPSTAR_t/100)*LS_t \quad (5.1.4)$$

$$GDP_t = YHAT_t \quad (5.1.5)$$

$$ET_t = ESTAR_t \quad (5.1.6)$$

YHAT: Potential output (constant prices)
GDP: GDP (constant prices)
ESTAR: Equilibrium employment
ET: Employment
UPSTAR: Equilibrium rate of unemployment
LS: Labour supply
TFP: Total factor productivity
K: Capital stock in the business sector
w: Nominal wages
p: Price level
r: Real interest rate
δ: Depreciation rate

Equation (5.1.1) is simply the standard Cobb-Douglas production function and equations (5.1.2) and (5.1.3) are the first-order profit maximisation conditions discussed in section 4.1. above (i.e. the marginal productivity of labour is equal to the real wage and the marginal productivity of capital is equal to the cost of capital). Equation (5.1.4) determines the equilibrium level of employment and is a function of equilibrium rate of unemployment and the labour supply. The former of these determining variables is assumed to be exogenous and determined by structural factors. The labour supply determined by the participation rate, also assumed to be exogenous and determined by structural factors, and the population of working age. Equation (5.1.5) states that in equilibrium actual output equals potential output and equation that employment will equal equilibrium employment.

Solving the system above gives the steady-state (long-run) level of output:

$$YHAT^* = e^{TFP/(1-\alpha)}.(1-UPSTAR/100).LS.(\alpha/(r^*+\delta))^{\alpha/(1-\alpha)} \qquad (5.1.7)$$

for a given steady-state real interest rate. The above supply-side equations are captured in the model, as already noted, via the employment, wages, GDP deflator and investment equations and, therefore, the long-run solution of the model ensures that output is driven by the supply-side of the model. It should be noted that the above steady-state output is a very long-term concept because capital stock converges only very slowly to the level specified by the profit maximisation condition. Therefore it is only in the longer time frame that YHAT converges upon YHAT*.

Also from the above steady-state output condition, the steady-state real wage can be derived by substituting equation (5.1.7) into equation (5.1.2) above, i.e.

$$w/p = (1-\alpha)e^{TFP/(1-\alpha)}(\alpha/(r^*+\delta))^{\alpha/(1-\alpha)} \qquad (5.1.8)$$

However, the supply-side system only determines relative prices and not the level of wages or prices. For example, the profit maximisation condition specified in equation (5.1.2) above only defines real wages, which is the price of labour relative to the general price level. Similarly, all prices in the long run are defined as relative prices, e.g. the CPI (excluding regulatory prices) is defined as being relative to the GDP deflator, the PPI and import prices. The prevailing price level or inflation rate, therefore, needs to be determined by some external factor – a factor that is external to the supply-side of the econometric model of the Slovak Republic. In the standard set up of the model this external factor is the National Bank of Slovakia, which targets inflation through the appropriate setting of interest rates. If inflation rises above target (due to, say, an aggregate demand shock) then the National Bank of Slovakia will raise interest rates, squeezing out demand directly and via the exchange rate. In the longer-run the all nominal variables will adjust to ensure that the economy converges back on its long-run equilibrium. In a situation where the Slovak Republic has entered EMU[17] then the price level will be anchored to foreign prices and wages and the adjustment mechanism would be initiated through competitiveness and trade.

[17] In this situation, the EMU is then set equal to 1 and interest rates in the Slovak Republic are set by the European Central Bank and the exchange rate is irrevocably fixed.

The functioning of the econometric in the wake of a varying economic ‘shocks’ is illustrated in section 5, where the results from a variety of standard simulations are presented. Though the core focus of the results presented is the short- to medium-term, results are presented for a time horizon of up to 30 years. This output also gives a feel towards the long-term properties of the econometric model of the Slovak Republic.

6. Simulation properties

6.1. Government consumption +1% of GDP *(ex ante)*

- Government consumption is increased permanently by 1% of GDP *(ex ante)* compared to baseline.
- In the first instance, a significant proportion of the demand shock is absorbed directly by imports but then domestic production begins to respond.
- There is a multiplier effect as employment and profitability increases, which benefits both private consumption and investment in the first few years of the scenario.
- Excess demand results in inflationary pressure.
- Interest rate respond to the increased inflationary pressure and crowds out investment. The koruna also appreciates in response to the rise in interest rates and reduces competitiveness.
- In the longer-term GDP returns to baseline.
- The increased domestic demand and deterioration in competitiveness – unit labour costs have permanently increased – results in a sustained deterioration of the external balance.
- The government balance deteriorates permanently, as a consequence of the increased government expenditure.

Difference table

(% changes from baseline, unless otherwise specified)

Year	Consumer expenditure	Gross fixed investment	GDP	Employment	Unemployment rate (% points)	Average earnings	Consumer prices	Short-term interest rates (% points)	Koruna per €	Public sector balance (% of GDP)	Current account (% of GDP)
1	0.0	0.6	0.3	0.1	-0.1	0.2	0.0	0.2	-0.1	-1.0	-0.7
2	0.1	1.0	0.5	0.3	-0.2	0.6	0.2	0.5	-0.2	-1.0	-0.5
3	0.2	0.9	0.5	0.3	-0.3	0.9	0.4	0.5	-0.3	-0.9	-0.5
4	0.3	0.7	0.4	0.3	-0.3	1.3	0.6	0.4	-0.3	-0.9	-0.6
5	0.4	0.5	0.3	0.2	-0.2	1.5	0.8	0.4	-0.3	-0.9	-0.6
6	0.5	0.3	0.2	0.2	-0.1	1.8	1.0	0.3	-0.3	-0.9	-0.7
7	0.5	0.1	0.1	0.1	-0.1	2.0	1.2	0.2	-0.3	-0.9	-0.7
8	0.6	-0.1	0.0	0.0	0.0	2.2	1.3	0.1	-0.2	-0.9	-0.7
9	0.6	-0.2	-0.1	0.0	0.0	2.3	1.5	0.1	-0.2	-0.9	-0.7
10	0.6	-0.3	-0.1	0.0	0.0	2.4	1.5	0.0	-0.1	-0.9	-0.7
15	0.6	-0.2	-0.1	0.0	0.0	2.4	1.6	0.0	0.1	-0.9	-0.7
20	0.5	-0.2	0.0	0.0	0.0	2.4	1.7	0.0	0.1	-0.9	-0.6
25	0.5	-0.2	-0.1	0.0	0.0	2.5	1.8	0.0	0.2	-1.0	-0.6
30	0.5	-0.3	-0.1	0.0	0.0	2.5	1.8	0.0	0.2	-1.0	-0.6

6.2. Government consumption +1% of GDP *(ex ante)*

- It is assumed this time that the Slovak Republic has already entered European Monetary Union and, therefore, interest rates are determined by the European Central Bank and the exchange rate is irrevocably fixed against the euro.

- As in scenario1, government consumption is increased permanently by 1% of GDP *(ex ante)* compared to baseline.

- The impact of the 'shock' unfolds as in the section 6.1., but, because the interest and exchange rates are not dependent on developments in the Slovak economy, two of the transmission mechanisms have been removed.

- Although the actual 'shock' is quite small, the burden of nominal adjustment now falls entirely upon wages and prices.

- In the short-run the multiplier effect is slightly greater than when the Slovak Republic has independent monetary policy – GDP is 0.6% above baseline after three years compared to 0.5% with independent monetary policy.

- However, without independent interest rates to smooth in a softer landing as the nominal sector adjusts, the economy tends to exhibit more cyclicality in the wake of the fiscal shock.

Difference table

(% changes from baseline, unless otherwise specified)

Year	Consumer expenditure	Gross fixed investment	GDP	Employment	Unemployment rate (% points)	Average earnings	Consumer prices	Short-term interest rates (% points)	Koruna per €	Public sector balance (% of GDP)	Current account (% of GDP)
1	0.1	0.6	0.3	0.1	-0.1	0.2	0.0	0.0	0.0	-1.0	-0.7
2	0.3	1.2	0.6	0.3	-0.3	0.7	0.2	0.0	0.0	-1.0	-0.5
3	0.6	1.4	0.6	0.4	-0.3	1.1	0.5	0.0	0.0	-0.9	-0.5
4	0.7	1.4	0.6	0.4	-0.3	1.6	0.8	0.0	0.0	-0.9	-0.6
5	0.8	1.3	0.4	0.3	-0.3	2.1	1.2	0.0	0.0	-0.9	-0.6
6	0.8	1.2	0.3	0.3	-0.2	2.6	1.5	0.0	0.0	-0.9	-0.7
7	0.9	1.1	0.2	0.2	-0.2	2.9	1.8	0.0	0.0	-0.9	-0.7
8	0.9	0.9	0.0	0.1	-0.1	3.2	2.1	0.0	0.0	-0.9	-0.7
9	0.9	0.7	-0.1	0.0	0.0	3.4	2.2	0.0	0.0	-0.9	-0.7
10	0.8	0.5	-0.2	-0.1	0.0	3.4	2.3	0.0	0.0	-0.9	-0.7
15	0.6	0.1	-0.1	-0.1	0.1	2.4	1.7	0.0	0.0	-0.9	-0.7
20	0.5	0.3	0.2	0.1	-0.1	1.7	1.1	0.0	0.0	-0.9	-0.6
25	0.6	0.3	0.2	0.1	-0.1	2.1	1.3	0.0	0.0	-1.0	-0.6
30	0.6	0.1	0.0	0.0	0.0	2.3	1.6	0.0	0.0	-1.0	-0.6

6.3. The koruna depreciates by 10%

- The koruna, in nominal terms, depreciates permanently by 10% against both the euro and the US$.

- The competitiveness gain boosts GDP by 1.9% after two years and the current accounts by 1.7% of GDP in 2005.

- The currency depreciation has an immediate inflationary effect via imported prices, which is magnified by the excess demand generated. After around 6 years, the competitiveness gain of the depreciation has been eroded and the external balances return towards baseline levels, although the impact takes a couple of years to feed through.

- Interest rates respond to keep the increased inflation in check, resulting initially in a deterioration in private consumption, despite lower unemployment. Investment gains, despite higher interest rates, from the increased output resulting from the competitiveness gain, which boosts profitability and returns to capital.

- In order to control inflation, GDP needs to fall below baseline in the medium-term.

- In the long run, the real side economy will converge to baseline and the nominal side will fully reflect the 10% fall in the value of the koruna, i.e. static homogeneity is followed.

Difference table

(% changes from baseline, unless otherwise specified)

Year	Consumer expenditure	Gross fixed investment	GDP	Employment	Unemployment rate (% points)	Average earnings	Consumer prices	Short-term interest rates (% points)	Koruna per €	Public sector balance (% of GDP)	Current account (% of GDP)
1	-0.5	1.3	0.8	0.1	-0.1	0.6	1.0	0.7	10.0	-0.1	1.1
2	-1.4	3.8	1.9	0.9	-0.7	3.1	3.0	2.5	10.0	-0.3	1.7
3	-1.5	3.9	1.8	1.1	-0.9	5.5	5.1	2.9	10.0	-0.3	1.6
4	-1.2	2.9	1.3	0.9	-0.8	7.7	7.1	2.5	10.0	-0.1	1.3
5	-0.8	1.7	0.7	0.6	-0.5	9.6	8.8	2.0	10.0	-0.1	0.9
6	-0.4	0.5	0.2	0.2	-0.2	11.1	10.1	1.4	10.0	0.0	0.6
7	-0.1	-0.4	-0.3	-0.1	0.1	12.1	11.1	0.8	10.0	0.1	0.3
8	0.1	-1.1	-0.6	-0.3	0.3	12.7	11.7	0.3	10.0	0.2	0.1
9	0.3	-1.5	-0.8	-0.5	0.4	12.8	12.0	-0.1	10.0	0.2	-0.1
10	0.4	-1.7	-0.9	-0.6	0.5	12.6	12.0	-0.5	10.0	0.3	-0.2
15	0.2	-0.6	-0.2	-0.1	0.1	9.9	10.1	-0.5	10.0	0.3	-0.2
20	-0.1	0.3	0.2	0.1	-0.1	9.3	9.4	0.2	10.0	0.2	0.1
25	0.0	-0.1	0.0	0.0	0.0	10.1	10.0	0.1	10.0	0.2	0.1
30	0.1	-0.2	-0.1	0.0	0.0	10.1	10.1	0.0	10.0	0.1	0.0

6.4. The NBS raises the 2 week REPO rate by 100bps

- The National Bank of Slovakia raises the discount rate by 100bps in the first quarter of the scenario time horizon. After this initial shock, interest rates respond to inflationary and demand developments.

- In response to tighter monetary the Slovak koruna appreciates against the euro and US$.

- The combination of higher interest rates and a stronger koruna triggers a decline in activity and inflation.

- At the end of the first year output has fallen by 0.1% and at the maximum impact inflation is just over 0.1% below baseline.

- Lower inflation and GDP cause interest rates to be lowered very rapidly and they fall below baseline in order to stimulate activity.

- In the long run GDP, inflation and interest rates return to baseline but the price level is permanently below baseline levels.

Difference table

(% changes from baseline, unless otherwise specified)

Year	Consumer expenditure	Gross fixed investment	GDP	Employment	Unemployment rate (% points)	Average earnings	Consumer prices	Short-term interest rates (% points)	Koruna per €	Public sector balance (% of GDP)	Current account (% of GDP)
1	-0.2	-0.1	-0.1	0.0	0.0	0.0	0.0	0.4	-0.4	-0.1	0.1
2	0.0	-0.4	-0.1	-0.1	0.1	-0.2	-0.1	-0.1	-0.4	0.0	-0.1
3	0.0	-0.3	-0.1	-0.1	0.1	-0.3	-0.3	-0.2	-0.4	0.0	-0.1
4	0.0	-0.3	-0.1	-0.1	0.0	-0.4	-0.3	-0.1	-0.4	0.0	0.0
5	0.0	-0.2	0.0	0.0	0.0	-0.5	-0.4	-0.1	-0.4	0.0	0.0
6	0.0	-0.1	0.0	0.0	0.0	-0.6	-0.5	-0.1	-0.4	0.0	0.0
7	0.0	-0.1	0.0	0.0	0.0	-0.6	-0.5	0.0	-0.4	0.0	0.0
8	0.0	-0.1	0.0	0.0	0.0	-0.6	-0.6	0.0	-0.5	0.0	0.0
9	0.0	-0.1	0.0	0.0	0.0	-0.6	-0.6	0.0	-0.5	0.0	0.0
10	0.0	-0.1	0.0	0.0	0.0	-0.6	-0.6	0.0	-0.5	0.0	0.0
Quarter											
Q1	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	1.00	-0.25	-0.24	-0.01
Q2	-0.42	-0.11	-0.05	0.00	0.00	-0.01	-0.03	0.47	-0.36	-0.18	0.15
Q3	-0.30	-0.17	-0.09	-0.01	0.01	-0.05	-0.04	0.20	-0.41	-0.11	0.07
Q4	-0.16	-0.27	-0.12	-0.03	0.03	-0.10	-0.06	0.03	-0.43	-0.06	0.00
Q5	-0.07	-0.33	-0.13	-0.05	0.04	-0.14	-0.09	-0.07	-0.43	-0.01	-0.03
Q6	-0.01	-0.36	-0.13	-0.07	0.05	-0.17	-0.12	-0.12	-0.43	0.01	-0.04
Q7	0.03	-0.37	-0.13	-0.07	0.06	-0.20	-0.15	-0.15	-0.43	0.02	-0.06
Q8	0.04	-0.37	-0.13	-0.08	0.06	-0.23	-0.18	-0.16	-0.42	0.03	-0.09
Q9	0.05	-0.36	-0.12	-0.08	0.07	-0.26	-0.21	-0.16	-0.42	0.04	-0.06
Q10	0.05	-0.35	-0.11	-0.08	0.06	-0.29	-0.24	-0.15	-0.42	0.03	-0.05
Q11	0.04	-0.33	-0.10	-0.07	0.06	-0.32	-0.26	-0.15	-0.41	0.02	-0.06
Q12	0.04	-0.31	-0.09	-0.07	0.06	-0.34	-0.29	-0.14	-0.41	0.01	-0.08

6.5. Eurozone imports +2%

- Eurozone imports increase permanently by 2% compared to baseline.
- There is a direct positive demand impact, which, despite being partially offset by rising imports, boosts GDP and the external balance.
- There is a multiplier effect as employment and profitability increases, which benefits both private consumption and investment in the first couple of years.
- Excess demand results in inflationary pressure.
- Interest rates respond to the increased inflationary pressure and crowds out investment. In the longer term GDP returns towards baseline.
- The increased demand and deterioration in competitiveness – unit labour costs have permanently increased – results in the erosion of the improvement in the external balance.

Difference table

(% changes from baseline, unless otherwise specified)

Year	Consumer expenditure	Gross fixed investment	GDP	Employment	Unemployment rate (% points)	Average earnings	Consumer prices	Short-term interest rates (% points)	Koruna per €	Public sector balance (% of GDP)	Current account (% of GDP)
1	0.0	0.9	0.5	0.1	-0.1	0.3	0.0	0.3	-0.1	0.0	0.2
2	0.2	1.6	0.8	0.5	-0.4	0.9	0.2	0.8	-0.3	0.0	0.3
3	0.4	1.5	0.8	0.6	-0.5	1.5	0.6	0.8	-0.5	0.1	0.3
4	0.6	1.3	0.7	0.5	-0.4	2.1	1.0	0.7	-0.6	0.2	0.2
5	0.7	0.9	0.5	0.4	-0.4	2.6	1.4	0.7	-0.6	0.2	0.1
6	0.8	0.6	0.3	0.3	-0.3	3.1	1.7	0.5	-0.6	0.2	0.0
7	0.9	0.2	0.2	0.2	-0.2	3.5	2.1	0.4	-0.5	0.2	0.0
8	1.0	0.0	0.0	0.1	-0.1	3.9	2.3	0.3	-0.5	0.2	-0.1
9	1.0	-0.2	-0.1	0.0	0.0	4.1	2.6	0.2	-0.4	0.2	-0.1
10	1.1	-0.4	-0.1	0.0	0.0	4.3	2.7	0.1	-0.3	0.3	0.0
15	1.1	-0.4	-0.1	0.0	0.0	4.4	3.0	0.0	0.1	0.3	0.0
20	1.0	-0.3	-0.1	0.0	0.0	4.4	3.1	0.0	0.3	0.3	0.0
25	1.0	-0.4	-0.1	0.0	0.0	4.5	3.2	0.1	0.3	0.3	0.1
30	1.0	-0.6	-0.2	0.0	0.0	4.7	3.4	0.1	0.3	0.3	0.1

6.6. FDI +SKK50bn for one year

- Direct foreign investment in the Slovak Republic increases by SKK50 bn compared to baseline in the first year of the scenario before returning to baseline levels. The FDI inflow is not assumed to be specifically 'greenfield' investment.

- The extra FDI inflow initially encourages greater investment, which results in increased imports, and is broadly neutral with regards to GDP.

- The extra imports cause the current account to deteriorate.

- The FDI inflow improves the 'broad' external balance, allowing the koruna to appreciate.

- The appreciation in the koruna reduces competitiveness, inducing a temporary short-term GDP loss.

- Monetary policy is relaxed to accommodate lower GDP and reduced inflationary pressure.

- The FDI inflow improves total factor productivity and results in a permanent rise in potential output.

- In the long run GDP converges on the higher potential output and inflation returns to baseline.

Difference table

(% changes from baseline, unless otherwise specified)

Year	Consumer expenditure	Gross fixed investment	GDP	Employment	Unemployment rate (% points)	Average earnings	Consumer prices	Short-term interest rates (% points)	Koruna per €	Public sector balance (% of GDP)	Current account (% of GDP)
1	0.1	1.5	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.6	0.0	-0.3
2	0.3	1.4	0.1	0.1	-0.1	-0.1	-0.4	-0.2	-1.7	0.1	-0.5
3	0.5	-0.4	-0.2	0.0	0.0	-0.5	-0.7	-0.5	-1.5	0.2	-0.4
4	0.5	-0.4	-0.2	-0.1	0.1	-0.9	-1.0	-0.6	-1.4	0.1	-0.4
5	0.4	-0.2	-0.1	-0.1	0.1	-1.2	-1.3	-0.5	-1.4	0.1	-0.3
6	0.3	0.1	0.0	0.0	0.0	-1.5	-1.5	-0.3	-1.3	0.1	-0.3
7	0.2	0.3	0.1	0.0	0.0	-1.7	-1.6	-0.2	-1.3	0.1	-0.2
8	0.2	0.4	0.2	0.1	-0.1	-1.8	-1.8	-0.1	-1.3	0.0	-0.2
9	0.1	0.5	0.3	0.1	-0.1	-1.9	-1.8	-0.1	-1.3	0.0	-0.2
10	0.1	0.6	0.3	0.1	-0.1	-1.9	-1.9	0.0	-1.4	0.0	-0.1
15	0.1	0.6	0.2	0.1	-0.1	-1.6	-1.7	0.0	-1.3	0.0	-0.1
20	0.2	0.5	0.2	0.0	0.0	-1.3	-1.5	0.0	-1.1	0.0	-0.2
25	0.2	0.6	0.3	0.0	0.0	-1.3	-1.4	0.0	-1.0	0.0	-0.2
30	0.2	0.7	0.3	0.0	0.0	-1.2	-1.4	0.0	-0.8	0.0	-0.2

6.7. FDI +SKK50bn for one year

- It is assumed this time that the Slovak Republic has already entered European Monetary Union and, therefore, interest rates are determined by the European Central Bank and the exchange rate is irrevocably fixed against the euro.

- As in scenario 6.6., direct foreign investment in the Slovak Republic increases by SKK50 bn compared to baseline in the first year of the scenario before returning to baseline levels. The FDI inflow is not assumed to be specifically 'greenfield' investment.

- The impact of the 'shock' unfolds as in the scenario 6.6., but, because the interest and exchange rates are not dependent on developments in the Slovak economy, two of the transmission mechanisms have been removed.

- In the first instance, the increased capital inflow to the Slovak Republic can not exert upward pressure on the exchange rate. This means that a deterioration in competitiveness does not squeeze out any of the positive impact of increase in investment demand. This results in the demand impact being greater than in the scenario where independent monetary policy is assumed.

- However, the improvement to trend productivity means that the increased demand does not lead to any noticeable rise in inflationary pressure.

Difference table

(% changes from baseline, unless otherwise specified)

Year	Consumer expenditure	Gross fixed investment	GDP	Employment	Unemployment rate (% points)	Average earnings	Consumer prices	Short-term interest rates (% points)	Koruna per €	Public sector balance (% of GDP)	Current account (% of GDP)
1	0.0	1.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.3
2	0.2	1.7	0.3	0.1	-0.1	0.2	-0.1	0.0	0.0	0.1	-0.5
3	0.2	0.3	0.1	0.1	-0.1	0.2	0.0	0.0	0.0	0.2	-0.4
4	0.2	0.1	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.1	-0.4
5	0.1	0.0	0.0	0.0	0.0	0.1	-0.1	0.0	0.0	0.1	-0.3
6	0.1	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.1	-0.3
7	0.1	0.0	0.0	0.0	0.0	-0.1	-0.2	0.0	0.0	0.1	-0.2
8	0.1	0.0	0.1	0.0	0.0	-0.2	-0.2	0.0	0.0	0.0	-0.2
9	0.1	0.0	0.1	0.0	0.0	-0.3	-0.3	0.0	0.0	0.0	-0.2
10	0.0	0.0	0.1	0.0	0.0	-0.3	-0.3	0.0	0.0	0.0	-0.1
15	0.1	0.2	0.2	0.1	0.0	-0.4	-0.4	0.0	0.0	0.0	-0.1
20	0.1	0.2	0.2	0.0	0.0	-0.2	-0.4	0.0	0.0	0.0	-0.2
25	0.1	0.1	0.2	0.0	0.0	-0.3	-0.4	0.0	0.0	0.0	-0.2
30	0.1	0.2	0.2	0.0	0.0	-0.4	-0.4	0.0	0.0	0.0	-0.2

7. Future Developments

No econometric model can ever considered as finalised and this applies with greater truth to econometric models of countries that have relatively short data sets and have been undergoing major structural changes. Both of these facets apply to the Slovak Republic and, with accession to the European Union and, at a later date, to European Monetary Union, the Slovak economy is likely to undergo further significant structural changes. This means that the econometric model of the Slovak Republic will undergo continuation assessment and evaluation that could potentially alter some of the model structure and properties. The modelling system permits for such continuous improvements in the econometric model. The modelling system includes crucially the model-users and a key future development is to improve the capabilities of the main operators to realise the maximum potential of the developed tool.

In addition to this continuous development of the model outlined above, there are several aspects that could benefit from improved research in the other areas. The crucial supply-side anchor could benefit from two main research avenues: firstly, better estimates of the capital stock would add rigour to potential output calculations, as would more research into the labour market. More specifically, this research would look to the functioning of the labour market in the Slovak Republic and develop more sophisticated estimates of structural unemployment. In addition, more research into FDI flows and there economic impact would be of benefit to the economic model.

The developed model of the Slovak Republic will be used at the heart of economic analysis in the Ministry of Finance of the Slovak Republic and, therefore, steps will be taken to integrate further the modelling of the macro-economy and the fiscal sector. One of the initial aims of the project was to assist in integrating the impact of fiscal policy into macroeconomic forecasts and analysis, but the next logical step will be to closer integrate macroeconomic developments into government revenues (and expenditure) forecasts and permitting feedback effects in both directions. This top-down approach to fiscal forecasting will be guided and complement by micro-analysis – and, indeed act as check upon the more detailed sectoral analysis – and will require an expansion into more detail of the current aggregated fiscal sector.

It is necessary to acknowledge the important role the international economy, and the Eurozone in particular, plays in economic developments within the Slovak economy, given the economy's extremely open nature. Therefore it is necessary to expand the analytical capabilities in the realm of the international economy and to develop analysis of the relevant transmission mechanisms from external shock to domestic impact. Therefore links between the Slovak macro-economic model and data, forecasts and models of international economies will be developed[18]. Through integrating the econometric model of the Slovak Republic used at the Ministry of Finance into an international system and implementing the 'real world' financial and trade linkages between Slovakia and the rest of the world, the impact of international shocks or the impact of shocks in 'major' economies upon the Slovak economy could be traced.

[18] The models of international economies will be pre-existing models developed by a relevant organisation. Moreover, the direction of this links will be one-way and flow from the international economy to the Slovak economy.

8. Conclusion

The development of the econometric model of the Slovak Republic has been a successful exercise that has improved the capability of the Ministry of Finance to undertake economic analysis, including simulating policy impacts and making and monitoring economic forecasts. The model has been built on sound theoretical foundations and has been designed to reflect as much as possible Slovak data. It has also been seen that the effects of various economic 'shocks', under different monetary policy assumptions, can be traced through the macro-economy, up to and including giving an initial indication of the likely fiscal consequences. This means that the policy implication of, say, a tax change can now be assessed in a dynamic environment with feed through and feedback effects, instead of using the customary static approach.

The economic model of the Slovak Republic is also not presented as a finished tool and there are future avenues to be explored, which could improve the structure, properties and usefulness of the econometric model of the Slovak Republic and the model system facilitates such continuous improvement. Nor is it presented as the complete forecasting tool. The model is now a vital element of the suite of tools employed at the Ministry of Finance of the Slovak Republic to undertake economic forecasts and is flexible enough to reflect inputs from economist analysis and other models[19]. There are several forecasts that can be generated by the designed system: model generated, model updated (i.e. the impact on the forecast from new data) and imposed forecasts (plus any combination of the threes alternatives). All options can be used to generate a baseline (comparison base) forecast for any subsequent scenario analysis. This means that it is possible to stop a behavioural equation functioning (i.e. exogenise a variable) and impose a specific forecast. For each variable there is a band of forecasts that can be considered consistent given the values for it explanatory variables and it may be desirable to impose of specific path for a variable and assess whether it is realistic. This may be the case when from a suite of models and the forecast of another model is preferred, e.g. the path for consumption, at least in the short-term, may derived from the short-run consumption models and imposed on the macroeconomic model to assess whether it is consistent with the economic fundamentals and historical precedents. Thus having this single 'core' model into which outputs from other models and economist judgements are fed provides an invaluable focal point for the forecasting and policy analysis process.

The power of the econometric model of the Slovak Republic is derived from it being a tool of analysis where economic risks and policy can be assessed in a consistent framework. It is a system for generating alternative scenarios to assess risks and design policy to react to perceived risks and it provides a structure for longer-term projections to help determine appropriate policy settings. The developed econometric model provides a framework for understanding and quantifying how the Slovak economy works, for understanding how economy responds to changes to policy and other 'shocks', i.e. the transmission mechanisms in the Slovak economy, and for analysing the latest economic data and developments in a

[19] The econometric model has not been designed with the intention of adopting it to generate short-term forecasts. Producing an economic forecast is not a black box exercise and the forecasts produced will be the output of a team of analysts using a variety of tools. Indeed, a short-term forecast usually relies very heavily on economist judgments.

systematic way. This framework also provides a system in which the current economic situation can be assessed and short-term forecasts prepared, as well as a benchmark against which to judge whether economic behaviour is changing.

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ANNEX

A.1. List of variables

This file gives details of database variables. The variables have been grouped by the following categories and these may be located through the Search facility:

Demand	Prices and Costs
Current Price	Government Accounts
Financial	Personal Sector
Supply	Corporate Sector

Mnemonic	Description	Data Source

Demand Variables

Constant price data are based in Koruna bn 1995 prices or 1995 = 100, unless otherwise stated.

GDPSA	GDP	Statistics Office
PRICONSSA	Consumption, private	Statistics Office
IFSA	Gross fixed capital formation, total	Statistics Office
GI	Government expenditure fixed capital assets	MoF General government capital expenditure deflated by investment deflator Data before 2001 was interpolated
GCSA	Consumption government	Statistics Office
ISSA	Stockbuilding and statistical discrepancy	Calculated GDPSA-PRICONSSA-IFSA-GCSA-XSA+MSA
XSA	Exports of goods & services	Statistics Office
MSA	Imports of goods & services	Statistics Office
TFESA	Total final expenditure	Calculated See SVKEQNS.doc

Current Price Variables

Current price data are in Koruna bn, unless otherwise stated

XGSH	Share of goods in total exports	NBS calculated
MGSH	Share of goods in total imports	NBS calculated
BCU	Current account of the balance of payments	NBS Data before 1997 was interpolated
BVI	Visible trade balance	NBS Data before 1997 was interpolated
BSER	Service balance of the balance of payments	NBS Data before 1997 was interpolated
BCUOTH	Services flow, net transfers and net IPD	Calculated BCU-BVI-BSER
G_R	Export of goods	NBS
S_R	Export of services	NBS
G_E	Import of goods	NBS
S_E	Import of services	NBS
FDI	Balance of direct investment in the Slovak Republic	NBS Data before 1997 was interpolated

Financial Variables

RDISC	Interest rate, basic interest rate of the NBS	NBS

RDEP	Interest rate, average deposit rate	NBS
RELEND	Interest rate, average lending rate	NBS
RXD	Exchange rate, dollar rate (SKK/US$)	NBS
RXEUR	Exchange rate, Euro rate (SKK/Euro)	NBS
EMU	=1 if a country joins EMU	Calculated

Supply Variables

POP	Population (000s)	Statistics Office interpolated
POPW	Population (000s), 15-64	World Bank Interpolated
LSLFSSA	Labour supply (000s), labour force survey	calculated ETLFSSA+ ULFSSA
PART	Participation rate	calculated LSLFSSA/POPW
ETLFSA	Employment, total (000s), labour force survey	Statistics Office
ULFSA	Unemployment (000s),labour force survey	Statistics Office
UPLFSA	Unemployment rate (%),labour force survey	Statistics Office
YHAT	Potential output, constant prices; Bn 1995 SKK	Calculated see SVKEQNS.doc
HPTRENDET	Trend employment (000s)	Calculated HP Filtered ETLFSSA
UPSTAR	Equilibrium unemployment (%)	Calculated 100*(LSLFSSA-HPTRENDET)/ LSLFSSA

HPTRENDTFP	Productivity, total factor	Calculated HP Filtered Solow Residual
KIPNR	Capital stock, business, constant 1995 prices; SKK bn	Statistics Office A point estimate for 1998 was rebased & a time-series calculated using national accounts
KGOV	Capital stock, government, constant 1995 prices; SKK bn	Statistics Office A point estimate for 1998 was rebased & a time-series calculated using national accounts data.
FDIS	Stock of FDI, constant 1995 prices; SKK bn	Calculated FDIS=FDIS(-1) +100*FDI/PGDP 1993Q4=18838.5
DELBUS	Depreciation rate for the business sector capital stock (%)	Calculated
DELGOV	Depreciation rate for the government sector capital stock (%)	Calculated
TTREND	Time trend (1993Q1=1)	Calculated

Prices and Costs

ERSA	Average earnings, SKK/person	Calculated 1000000*(gross wages & salaries) /ETLFSSA
WCR	Costs, relative unit labour (1995=100)	Calculated see SVKEQNS.doc
CPI	Prices, consumer index - total (Dec 2000=100)	Statistics Office

CPIU	Prices, excluding regulated prices (Dec 2000=100)	Calculated
CPIRINF	Inflation, regulated prices	Statistics Office Data pre-1997 is estimated
CPIRINF_SH	Share of regulated price inflation of total	Statistics Office
PCONS	Deflator, private consumption (1995=100)	Statistics Office
PIF	Deflator, gross fixed investment (1995=100)	Statistics Office
PGC	Deflator, government consumption (1995=100)	Statistics Office
PGDP	Deflator, GDP (1995=100)	Statistics Office
PM	Deflator, imports - total (1995=100)	Statistics Office
PX	Deflator, exports - total (1995=100)	Statistics Office
PPI	Prices, producer price index - total (Dec 2000=100)	Statistics Office

<u>Government Accounts</u>

Current price data are in SKK BN, unless otherwise stated

TYR	Tax, rate on income (%)	Calculated
TXR	Tax, rate on expenditure (%)	Calculated
TESSR	Tax, rate employers pay for social security contributions	Calculated
TOSSR	Tax, rate employees pay for social security contributions	Calculated
TCORPR	Tax, rate on profits	Calculated
TXR	Tax, rate on expenditure (%)	Calculated
TY	Tax, personal income	MoF Data before 2001 was interpolated
TSS	Social security contributions	MoF Data before 2001 was

		interpolated
TCORP	Tax, corporation	MoF Data before 2001 was interpolated
TX	Tax, expenditure	MoF Data before 2001 was interpolated
TOTH	Other government revenues	Calculated GREV-TY-TSS -TCORP-TX
GREV	Revenue, total government	MoF Data before 2001 was interpolated
GDIP	Interest, government gross payments	MoF Date before 2001 was interpolated
GEOTH	Other government expenditure and lending minus repayments, miscellaneous government	Calculated GEXP- PGC.GCSA/100- GI*PIF/100-SBSA- GDIP
GEXP	Expenditure, total government	MoF
GB	Government financial balance	MoF GREV-GEXP
GGDBT	Gross government debt – gross	MoF interpolated

Personal Sector

Current price data are in SKK BN, unless otherwise stated

PEDYPSA	Income, personal disposable, current prices	Statistics Office

		Data before 1995 was interpolated
SBSA	Income, social benefits other than social transfers in kind	Statistics Office Data before 1995 was interpolated
PEOYSA	Other income	Calculated PEDYPSA-ETLFSSA*ERSA/1000000-SBSA+TAXY
TAXY	Social contributions & taxes on income, wealth, etc.	Statistics Office Data before 1995 was interpolated

Corporate Sector

PROF	Company profits, SKK bn	Calculated GDPSA*PGDP/100-ETLFSSA*ERSA/1000000-TX

International variables

WWC	Costs, world wage (1995=100)	Calculated
WPEN	World price of fuel (oil, gas & coal), 1995=100, US$	IMF
PGDPEU	GDP deflator in the Eurozone, 1995=100, Euros	Eurostat
PXEU	Export prices in the Eurozone, 1995=100, Euros	Eurostat
MEU	Imports in the Eurozone, 1995=100, Euros	Eurostat Indexed
MCZ	Imports in the Eurozone, 1995=100, Euros	Czech Stats Office

		Seasonally adjusted Indexed
RSHEUR	Euribor 3-month rate	ECB
RXDEUR	US$/€ exchange rate	ECB

Additional information on data

Seasonal adjusted: all seasonal adjusted is carried out using Tramo-seats

Interpolation: data is interpolated using the method suggested by Lisman and Sandee (1964).

Interpolation takes place post seasonal adjustment, when necessary.

A.2. List of equations

This file gives details of the equations used in econometric model of the Slovak Republic. The variables have been grouped by the following categories and these may be located through the Search facility:

Demand	Prices and Costs
Current Price	Government Accounts
Financial	Personal Sector
Supply	Corporate Sector

<u>Demand Variables</u>

GDPSA = PRICONSSA + GCSA + IFSA + ISSA + XSA – MSA

D(LOG(PRICONSSA)) = 3.496825001 + 0.4025695756*D(LOG(PEDYPSA/PCONS)) - 0.7592714491*(LOG(PRICONSSA(-1))-LOG(PEDYPSA(-1)/PCONS(-1))) - 0.004363569905*RELEND(-1)

D(LOG(IFSA/GDPSA)) = - 0.01602632024 + 0.1543702715*D(LOG(GI)) + 0.09188185176*D(LOG(GI(-1))) + 0.6818715452*D(LOG(((1-TCORPR(-1))*PROF(-1)/PGDP(-1)))) + 0.03040880017*D(LOG((FDI(-2)/PIF(-2)))) + 0.25*((0.53*GDPSA(-1)/KIPNR(-1))-(RELEND(-1)/400-D(LOG(PGDP(-1))))-DELBUS(-1)) - 0.2389089683*Q42001 + 0.1848811058*Q12001

D(LOG(XSA)) = 0.4360040005 + 1*D(LOG(0.85*MEUR/3.667+0.15*MCZ/2.02345)) - 0.5343814126*(LOG(XSA(-1))-LOG(0.85*MEUR(-1)/3.667+0.15*MCZ(-1)/2.02345)+0.2*LOG(WCR(-1)))

D(LOG(MSA)) = - 0.5373740953 + 1.75*D(LOG(TFESA)) -0.2909716171*(LOG(MSA(-1))-LOG(TFESA(-1))-0.15*LOG(WCR(-1))) + 0.02826146744*DUM96Q4 + 0.03378014682*DUM97Q1 + 0.03470421677*DUM98Q4 + 0.003129371114*STTREND

TFESA = PRICONSSA + GCSA + IFSA + ISSA + XSA

<u>Current Price Variables</u>

D(XGSH) = -0.002045411531 + 0.2639773527*D(LOG(0.85*MEUR/3.7238+0.15*MCZ/2.0149)) - 0.0949931025*D(LOG(WCR)) + 0.01539770585*Q1 - 0.01166613371*Q3

D(MGSH) = 0.002359202422 + 0.3127244571*D(XGSH) - 0.02154023774*DUM99Q2 - 0.0157040608*DUM00Q4

BCU = BVI + BSER + BCUOTH

BVI = G_R - G_E

BSER = S_R - S_E

G_R = XGSH*PX*XSA/100

S_R = (1 - XGSH)*PX*XSA/100

G_E = MGSH*PM*MSA/100

S_E = (1 - MGSH)*PM*MSA/100

D(LOG(FDI),0,4)=D(LOG(RXEUR),0,4)

<u>Financial Variables</u>

RDISC = (1 - EMU)*(RDISC(-1) + 0.0* 400* (PGDP/PGDP(-1) - 1) + 0.5*400*(PGDP/PGDP(-1) - PGDP(-1)/PGDP(-2)) + 0.0*100*(GDPSA/YHAT - 1) + 0.5*100*d(GDPSA/YHAT - 1) - 0.5*(RDISC(-1) - 1.0*400*(PGDP(-1)/PGDP(-2) - 1) - 0.25*100*(GDPSA(-1)/YHAT(-1) - 1))) + EMU*RSHEUR

D(RDEP) = D(RDISC)

D(RELEND) = D(RDISC)

RXD = RXEUR / RXDEUR

LOG(RXEUR) = (1 - EMU) * (LOG(RXEUR(-1)) + (LOG(1 + RSHEUR / 400) - LOG(1 + RDISC / 400)) + (D(LOG(PGDP)) - D(LOG(PGDPEU))) - 0.1 * FDI(-1) / (GDPSA(-1) * PGDP(-1) / 100)) + EMU * LOG(RXEUR(-1))

<u>Supply Variables</u>

LSLFSSA = PART * POPW

D(LOG(ETLFSSA)) = 0.547331308 + 0.5668161546*D(LOG(ETLFSSA(-1))) - 0.06560207135*(LOG(ETLFSSA(-1))-LOG(PGDP(-1)*GDPSA(-1)/ERSA(-1))) + 0.2300724108*D(LOG(GDPSA(-1))) + 0.01020370655*DUM96Q1 - 0.008470854616*DUM97Q1

ULFSSA = LSLFSSA - ETLFSSA

UPLFSSA = 100 * ULFSSA / LSLFSSA

LOG(YHAT) = 0.47 * LOG(HPTRENDET) + 0.53 * LOG(KIPNR) + HPTRENDTFP

HPTRENDET = (1 - UPSTAR / 100) * LSLFSSA

HPTRENDTFP= 0.005021249999*TTREND + 0.1*LOG(KGOV) +
0.9299833058*LOG(FDIS) - 12.46427631 - 0.001858602319*LOG(WPEN*RXD/PGDP)

KIPNR = (1 - DELBUS) * KIPNR(-1) + 0.75 * IFSA

KGOV = (1 - DELGOV) * KGOV(-1) + GI

FDIS = FDIS(-1) + 100*FDI/PGDP

Prices and Costs

D(LOG(ERSA/(1+TESSR))) = 5.579884746 + 0.15*D(LOG(CPI))+0.25*D(LOG(CPI(-
1)))+0.2*D(LOG(CPI(-2)))+0.15*D(LOG(CPI(-3)))+0.25*D(LOG(ERSA(-1)/(1+TESSR(-
1)))) - 0.6785076996 *(LOG((ERSA(-1)/(1+TESSR(-1)))/PGDP(-1))-LOG(GDPSA(-
1)/ETLFSSA(-1))+0.025*LOG(UPLFSSA(-1)/UPSTAR(-1)))

WCR = ((1 / 1.095) * (((ETLFSSA * ERSA) / GDPSA) / RXEUR) / WWC)

CPI = (CPIRINF_SH * CPIRINF / 100 + (1 - CPIRINF_SH) * (CPIU / CPIU(-4))) *
CPI(-4)

D(LOG(CPIU/(1+TXR))) = -0.04292357626 +0.1*D(LOG(CPIU(-1)/(1+TXR(-
1))))+0.2*D(LOG(PPI))+0.25*D(LOG(PM))+0.45*D(LOG(PGDP)) - 0.1*(LOG(CPIU(-
1)/(1+TXR(-1)))-0.5*LOG(PGDP(-1))-0.2*LOG(PPI(-1))-0.3*LOG(PM(-1)))

CPIRINF = 100 * (((CPIU + CPIU(-1) + CPIU(-2) + CPIU(-3)) / (CPIU(-8) + CPIU(-9) +
CPIU(-10) + CPIU(-11)))^0.5)

D(LOG(PCONS)) = 0.3406908424 + 1.120109381*D(LOG(CPI)) -
0.7758320435*(LOG(PCONS(-1))-LOG(CPI(-1))) - 0.001936463266*TTREND

D(LOG(PIF)) = 0.02118738211 +0.2*D(LOG(PIF(-
1)))+0.25*D(LOG(PGDP))+0.65*D(LOG(PM)) - 0.9741695366*(LOG(PIF(-1))-
LOG(PGDP(-1)))

D(LOG(PGC)) = - 0.00645883955 +0.3*D(LOG(PCONS))+0.7*D(LOG(PGDP)) -
0.3739741347*(LOG(PGC(-1))-LOG(PGDP(-1))) + 0.07686362004*DUM97Q1 +
0.07372606432*DUM95Q2

D(LOG(PGDP)) = -0.843584326+ 0.25*D(LOG(PGDP(-1)))+0.15*D(LOG(PGDP(-2)))+0.2*D(LOG(ERSA))+0.25*D(LOG(ERSA(-1)))+0.15*D(LOG(ERSA(-2)))+0.05*D(LOG(GDPSA/YHAT))-0.1*(LOG(PGDP(-1))-LOG(ERSA(-1)*ETLFSSA(-1)/GDPSA(-1))-0.1*LOG(GDPSA(-1)/YHAT(-1)))

D(LOG(PX)) = -0.4222125793 +0.2*D(LOG(PX(-1)))+0.2*D(LOG(PXEU*RXEUR)) + 0.1936759323*D(LOG(PGDP)) + 0.254861384*D(LOG(PM)) - 0.3063508354*(LOG(PX(-1))-0.3*LOG(PPI(-1))-0.4*LOG(PXEU(-1)*RXEUR(-1))-0.3*LOG(PM(-1))) - 0.03031678544*DUM97Q1

D(LOG(PM)) = - 0.3227782426 +0.25*D(LOG(PM(-1))) + 0.1552989091*D(LOG(PXEU*RXEUR)) + 0.04299438357*D(LOG(WPEN*RXD)) - 0.1139242773*(LOG(PM(-1))-0.65*LOG(PXEU(-1)*RXEUR(-1))-0.15*LOG(WPEN(-1)*RXD(-1))-0.2*LOG(PGDP(-1))) + 0.05602485468*DUM00Q3 + 0.04647499007*DUM94Q1

D(LOG(PPI)) = 12.55914955 + 0.309063864*D(LOG(PPI(-1))) + 0.2378491785*D(LOG(PGDP)) + 0.1128538993*D(LOG(PM(-3))) - 0.5239064407*(LOG(PPI(-1))-(1-MSA(-1)/TFESA(-1))*LOG(PGDP(-1))-(MSA(-1)/TFESA(-1))*LOG(PM(-1))) - 1.289300663*LOG(FDIS(-1)) - 0.01430474492*DUM94Q2

Government Accounts

TY = TYR * (ERSA * ETLFSSA / 1000000)

TSS = (TOSSR + TESSR) * (ERSA * ETLFSSA / 1000000)

TCORP = TCORPR * PROF

TOTH = TOTH(-4) * (PGDP * GDPSA) / (GDPSA(-4) * PGDP(-4))

GREV = TY + TSS + TCORP + TX + TOTH

D(GDIP , 0 , 4) = - ((1 + RDISC / 100)^0.25 - 1) * GB + 0.15*D(((1 + RDISC / 100)^0.25 - 1) , 0 , 4) * GGDBT(-1)

GEOTH = GEOTH(-4) * (PGDP * GDPSA) / (GDPSA(-4) * PGDP(-4))

GEXP = GC*PGC/100 + 100*GI/PIF/100 + SBSA + GDIP + GEOTH

GB = GREV - GEXP

D(GGDBT) = - GB

Personal Sector

PEDYPSA = ETLFSSA * ERSA / 1000000 + SBSA + PEOYSA - TAXY

D(LOG(SBSA),0,4) = 0.005847079541+D(LOG(CPI),0,4)+0.15*D(LOG(ULFSSA),0,4)

D(LOG(PEOYSA)) = -1.977127666 - 0.3316007929*(LOG(PEOYSA(-1))-1*LOG(GDPSA(-1)*PGDP(-1))) - 0.327278533*DUM95Q1 + 0.1699485867*DUM95Q4(1)

TAXY = TAXY(-1) * ((TY + TSS) / (TY(-1) + TSS(-1)))

Corporate Sector

PROF = GDPSA * PGDP / 100 - ERSA * ETLFSSA / 1000000 - TX