MACROECONOMIC PROJECTIONS DIVISION
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DEPARTMENT

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ECMOD MODEL OF THE POLISH ECONOMY APRIL 2007 VERSION

1 SUMMARY OF CHANGES IN THE ECMOD MODEL INTRODUCED BETWEEN MAY 2005 AND APRIL 2007

The ECMOD model became the official prognostic model of the NBP in May 2005. A detailed specification of the model was published at that time.[1] Since then, a number of changes have been introduced updating and extending the model in order to improve its forecasting properties. What follows is a synthetic and chronological presentation of the most important changes introduced to the model in subsequent forecasting rounds.

1.1 AUGUST 2005 PROJECTION

Due to the adjustment of National Accounts data for 2003-2004, the model was re-estimated in July 2005 also taking into account the data for 2005 Q1. Equations' specifications were not changed during the re-estimation, except for the equations of imports and exports (accounting for relative prices changes in short-term dynamics) and the equation of wages (abandoning the concept of dynamic homogeneity).

1.2 JANUARY 2006 PROJECTION

In December 2005 the ECMOD model was extended in relation to the August version of the model by including the equation of long-term interest rates. This modification was connected with the need for the investment equation to account not only for the short- but also long-term interest rate, as some investment decisions taken by entrepreneurs are based on the level of the long-term interest rate.

The long-term interest rate equation accounted for relation of general government balance to GDP, which opened an additional channel through which the fiscal sector affects the real economy. In addition, the element of the Polish economy's convergence with euro-

[1] T. Fic, M. Kolasa, A. Kot, K. Murawski, M. Rubaszek, M. Tarnicka, "ECMOC Model of the Polish Economy", *Materials and Studies* 194, NBP.

area economies was introduced through the impact of the foreign long-term interest rate on the domestic rate.

What is more, the introduction of the long-term interest rate equation to the model made it possible to endogenise the costs of domestic public debt service. Including this additional channel, i.e., the impact of the interest rate on the costs of domestic public debt service improved the simulation properties of the model.

1.3 APRIL 2006 PROJECTION

In March 2006 another re-estimation of the ECMOD model was performed accounting for the adjustment of National Accounts for 1995-2004 and adding new observations for the period up to 2005 Q4. Apart from the re-estimation, the following changes were introduced in the model:

- A distinction was made between agricultural and non-agricultural employment (according to BAEL data). In the modified version of the model the equation of the demand for labour is still based on the total employment. The non-agricultural employment is arrived at by subtracting the exogenously given agricultural employment from the endogenously calculated total employment. In contrast to the previous version of the model, in the modified version labour productivity and unit labour costs are obtained on the basis of the non-agricultural employment rather than the total employment.
- The definition of the external environment was changed to consist of the euro area, United Kingdom and the USA with weights of 87.8%, 7.2% and 5.0%, respectively (previously, it comprised of nine main trading partners of Poland).

1.4 JULY 2006 PROJECTION

No modifications in relation to the previous version were introduced to the model before the July 2006 forecasting round.

1.5 OCTOBER 2006 PROJECTION

In September 2006 the expenditure on active labour market policy was added to the equations of employed persons (and likewise to the fiscal block).

1.6 JANUARY 2007 PROJECTION

The inflow of new data released after the last re-estimation of the model (March 2006) necessitated the introduction of a few adjustments to the model, which can be summarised as follows:

- The equilibrium exchange rate was strengthened by shifting the medium-term path of the external real exchange rate and two internal exchange rates: in the equations of import and export prices.
- The medium-term paths of export and import volumes were shifted in accordance with the increases in the growth rates of exports and imports observed since 2006 Q1.
- By accounting for the latest data, historical estimates of the level of total factor productivity were lowered. This adjustment had an effect on the labour market in the model.
- The constant in long-term relation in the equations of wages and GDP deflator was shifted to adjust it to historical data and the short-term equation of GDP deflator was re-estimated.

1.7 APRIL 2007 PROJECTION

Before the April projection, in March 2007, a routine yearly re-estimation of the ECMOD model was performed. It accounted for data up to 2006 Q4.

The March re-estimation was used to endogenise the NAWRU. This modification implied a change in the form of a number of equations of the model – in particular the equation describing wages. The concept of an endogenous NAWRU was discussed in detail in the publication of K. Budnik: "Non-accelerating wage inflation rate of unemployment in Poland" (soon to be released as NBP Working Paper).

The endogenisation of the NAWRU was connected with the modifications in the specification of the fiscal module, which allowed to extend the feedback between fiscal variables and the other segments of the model.

Other important changes included replacing net capital with gross capital and replacing the mechanical formula generating inventories with an estimated equation.

Apart from changes in the model's specification, the re-estimation was also preceded by minor changes in the process of data preparation. Since March 2007 the national accounts

data have been seasonally adjusted jointly, i.e. in such a way as to preserve balance relationships among time series after seasonal adjustment. Previously it was difficult to forecast the error caused by seasonal adjustment.

2 MODEL EQUATIONS – AS AT THE END OF APRIL 2007

The specification of model equations after March 2007 re-estimation is presented below. This version was used in preparing the projection in April 2007. Only those equations that underwent significant modifications in relation to the version of the model published in May 2005 are included here, i.e. all the behavioural equations, new equations and significantly changed identity equations. The general government sector is presented in a shortened version.

The notation used follows the convention from the May 2005 publication, i.e. lower case letters mark the logarithms of the variables; t-Student statistics are reported below the values of estimated parameters.

2.1 REAL ECONOMY

❖ *TOTAL EMPLOYMENT*

$$\begin{aligned}\Delta emp_t = & \underset{-1.8}{0.11}(gdp_{t-1} - 0.68\, emp_{t-1} - 0.32\, k_{t-1} - tfp_{t-1}) / 0.68 \\ & + (1 - \underset{3.5}{0.50})\Delta lf_t + \underset{3.5}{0.50}\,\Delta emp_{t-1} + \underset{2.2}{0.31}(\Delta gdp_t - \Delta tfp_t / 0.68) \\ & - 0.15\,(\Delta(wage\_n_{t-1} + \ln(1 + GLT\_CORP\_TR_{t-1}) - pgdp_{t-1}) + \\ & - \Delta tfp_{t-1} / 0.68) + \\ & + \underset{0.44}{0.0011}\,((almp\_n_{t-1} - pgdp_{t-1}) - (unemp_{t-1} + lf_{t-1}) + 1.45) + \\ & + DUMMIES\end{aligned} \qquad \textbf{E. 1}$$

where:

EMP – total employment according to BAEL,

GDP – real Gross Domestic Product,

K – gross capital (rescaled to net capital level),

TFP– total factor productivity,

LF – number of economically active persons, in thousands, according to BAEL,

WAGE_N – gross nominal wages,

GLT_CORP_TR – effective rate of revenues from social security contributions paid by employers,

PGDP – GDP deflator,

ALMP_N – general government expenditure on active labour market policy,

UNEMP — unemployment rate according to BAEL,

DUMMIES – dummy variables.

Adjusted R^2: 49%

Autocorrelation of the random component: χ^2 (2)=0 (p=1.00)

Normality of distribution of the random component: $\chi^2(2)=0.77$ (p=0.68)

Sample: 1995Q4 – 2006Q4

❖ *PRIVATE CONSUMPTION (BY HOUSEHOLDS)*

$$\Delta conp_t = \underset{7.9}{0.0074} - \underset{-2.5}{0.13}(conp_{t-1} - 0.9\,yd_{t-1} - (1-0.9)\,wealth_{t-1} + 0.0062\ \ I\_W3MR\_CPI_{t-1} + \\ + 0.28) + \underset{5.3}{0.14}\,\Delta yd_t - \underset{-3.2}{0.0028}\ \ I\_W3MR\_CPI_t + DUMMIES \qquad \textbf{E. 2}$$

where:

CONP – private consumption,

YD – disposable income of households,

WEALTH – wealth,

I_W3MR_CPI – real interest rate (3M WIBOR deflated by CPI inflation),

DUMMIES – dummy variables.

Adjusted R^2: 53%

Autocorrelation of the random component: $\chi^2(2)=2.5$ (p=0.28)

Normality of distribution of the random component: $\chi^2(2)=3.2$ (p=0.20)

Sample: 1999Q1 – 2006Q4

❖ *DISPOSABLE INCOME*

$$YD\_N_t = WAGEFUND\_N_t \cdot (1 - GLT\_EMP\_TR_t) + GTR\_RETIRED\_N_t + \\ GTR\_UNEMP\_N_t + GTR\_RELIEF\_N_t - GPIT\_N_t - GLT\_HC\_N_t + YD\_REST\_N_t + 0.7\ TRANSFERY\_WPR_t + YD\_NO\_N_t + YD\_WL\_N_t - GOTAX\_HH\_N_t \qquad \textbf{E. 3}$$

where:

YD_N – disposable income,

WAGEFUND_N – wage fund,

GLT_EMP_TR – effective rate of revenues from social security contributions paid by employees,

GTR_RETIRED_N – retirement and disability pension transfers,

GTR_UNEMP_N – unemployment benefits,

GTR_RELIEF_N – transfers from social welfare,

GPIT_N – personal income tax,

GLT_HC_N – health insurance contributions,

YD_REST_N – other disposable income,
TRANSFERY_WPR – transfers from the EU allocated for the Common Agricultural Policy,
YD_NO_N – operating surplus of the household sector,
YD_WL_N – nominal income from property in the household sector,
GOTAX_HH_N – other taxes paid by households.

❖ *INCOME FROM OPERATING SURPLUS*

$$\Delta yd\_no\_n_t = \underset{1.2}{0.61}\Delta gdp\_n_t - \underset{-4.7}{0.86}(yd\_no\_n_{t-1} - gdp\_n_{t-1} + 1.35) \qquad \textbf{E. 4}$$

where:
YD_NO_N – operating surplus of the household sector,
GDP_N – nominal Gross Domestic Product.

Adjusted R^2: 43%
Autocorrelation of the random component: χ^2 (2)=1.3 (p=0.51)
Normality of distribution of the random component: $\chi^2(2)$=0.20 (p=0.91)
Sample: 1999Q4 – 2006Q4

❖ *INCOME FROM PROPERTY*

$$\Delta yd\_wl\_n_t = \underset{2.5}{0.034} + \underset{2.0}{1.4 \cdot 10^{-8}}\,\Delta(I\_W3M_{t-1} \cdot WEALTH_{t-1}) - \underset{-1.5}{0.16}(yd\_wl\_n_{t-1} + 2.98 - gdp\_n_{t-1}) + DUMMIES \qquad \textbf{E. 5}$$

where:
YD_WL_N – income from property in the household sector,
I_W3M – average quarterly value of 3M WIBOR,
WEALTH – wealth,
GDP_N – nominal Gross Domestic Product,
DUMMIES – dummy variables.

Adjusted R^2: 20%
Autocorrelation of the random component: $\chi^2(2)$=0.79 (p=0.67)
Normality of distribution of the random component: $\chi^2(2)$=0.26 (p=0.88)
Sample: 1996Q2 – 2006Q4

❖ *FIXED CAPITAL FORMATION*

$$\Delta finv_t = \underset{1.0}{-0.33}((1-0.68)\frac{GDP_{t-1}}{K_{t-1}} - RUCC_{t-1} - 0.022) + \underset{1.7}{0.28}\Delta finv_{t-1} + \underset{2.9}{0.47}\Delta finv_{t-2} + \underset{0.44}{0.093}(FINACC_t - FINACC_{t-4}) - \underset{-0.43}{0.012}\Delta(oil_t + s\_usd\_pln_t - pgdp_t - 4.7) \quad \textbf{E. 6}$$

where:

FINV – investment outlays,

GDP – real Gross Domestic Product,

K – gross capital (rescaled to net capital level),

RUCC – real cost of capital, i.e. medium-term real interest rate (arithmetic mean of 3M WIBOR deflated by GDP deflator and yields on 5-year bonds deflated by the inflation target) adjusted for capital depreciation and total tax burden of enterprises,

FINACC – share of disposable income of enterprises[2] in national disposable income,

OIL – oil prices,

S_USD_PLN – USD/PLN exchange rate,

PGDP – GDP deflator.

Adjusted R^2: 30%

Autocorrelation of the random component: $\chi^2(2)=0$ (p=1.0)

Normality of distribution of the random component: $\chi^2(2)=39$ (p=0.0)

Sample: 1998Q2 – 2006Q4

❖ *INVENTORIES*

$$\Delta stock_t = \underset{4.5}{0.48}\Delta stock_{t-1} + (1 - \underset{4.5}{0.48})\Delta gdp_t - \underset{-2.6}{0.16}(stock_{t-1} - gdp_{t-1} + 0.24) \quad \textbf{E. 7}$$

where:

STOCK – level of inventories,

GDP – real GDP.

Adjusted R^2: 30%

Autocorrelation of the random component: $\chi^2(2)=2.0$ (p=0.36)

Normality of distribution of the random component: $\chi^2(2)=3,0$ (p=0.23)

Sample: 1995Q3 – 2006Q4

[2] The term "enterprises" shall be understood to include two institutional sectors, distinguished in the national accounts: the enterprise sector and the sector of financial institutions.

2.2 PRICES AND COSTS

❖ *NET INFLATION*

$$\begin{aligned}\Delta netcpi_t &= \underset{2.9}{0.74}\Delta dl_{t-4} - \underset{(-1.7)}{0.055}(netcpi_{t-1} - (1.89 + 0.64 ulcna_{t-1} + \\ &+ (1-0.64)(p\_imp_{t-1} + \ln(1+GTAR\_TR_{t-1})) + 0.35 dl_{t-1} + GVAT\_TR_{t-1} + \\ &GGAM\_TR_{t-1} + 0{,}6\ GEXT\_TR_{t-1} - GTR\_GOODS\_TR_{t-1})) + \underset{1.9}{0.27}\Delta netcpi_{t-1} + \\ &+ \underset{2.7}{0.29}\Delta cpi_{t-2} + \underset{1.6}{0.087}\cdot 0.64\Delta ulcna_t + \\ &+ \underset{1.6}{0.087}(1-0.64)\Delta(p\_imp_t + \ln(1+GTAR\_TR_t)) + DUMMIES\end{aligned} \qquad \textbf{E. 8}$$

where:

NETCPI – net core inflation price index – excluding food and fuel prices

dl – dummy variable used to quantify the growth of net core inflation above its cost determinants in the sample (set at a fixed level since 2002 Q3),

ULCNA – unit labour costs in non-agricultural sectors, $ulcna_t = \ln(1 + GLT\_CORP\_TR_t) + empna_t + wage\_n_t - gdp_t$,

GLT_CORP_TR – effective rate of social insurance contributions paid by employer,

EMPNA – non-agricultural employment,

WAGE_N – nominal average wages,

GDP – real GDP level,

P_IMP – import prices adjusted for import taxes (applicable in the mid-90s),

GTAR_TR – effective rate of customs duties,

GVAT_TR – effective VAT rate,

GGAM_TR – effective gaming tax rate,

GEXT_TR – effective excise tax rate,

GTR_GOODS_TR – share of subsidies on products in the tax base for indirect taxes,

CPI – consumer price index,

DUMMIES – dummy variables.

Adjusted R^2: 93%

Autocorrelation of the random component: $\chi^2(2)=1.5$ (p=0.48)

Normality of distribution of the random component: $\chi^2(2)=22$ (p=0.0)

Sample: 1996Q2 – 2006Q4

❖ *GDP DEFLATOR*

$$\begin{aligned}\Delta pgdp_t = {} & (1.025^{\frac{1}{4}} - 1)(1 - \underset{2.3}{0.29} - \underset{3.4}{0.48} - 0.05) - \underset{-2.6}{0.14}(pgdp_{t-1} - 0.64\, ulcna_{t-1} + \\ & - (1 - 0.64)(p\_imp_{t-1} + \ln(1 + GTAR\_TR_{t-1})) - (0.84\ GVAT\_TR_{t-1} + \\ & + 0.62\ GGAM\_TR_{t-1} + 0.84\ GEXT\_TR_{t-1} - 0.84\ GTR\_GOODS\_TR_{t-1}) + \\ & + 3.31) + \underset{2.3}{0.29}\,\Delta pgdp_{t-1} + \underset{3.4}{0.48}\,\Delta ulcna_t + 0.05\,\Delta(p\_imp_{t-1} + \ln(1 + GTAR\_TR_t))\end{aligned} \qquad \textbf{E. 9}$$

where:

PGDP – GDP deflator,

ULCNA – unit labour costs in non-agricultural sectors $ulcna_t = \ln(1 + GLT\_CORP\_TR_t) + empna_t + wage\_n_t - gdp_t$,

GLT_CORP_TR – effective rate of social insurance contributions paid by employer,

EMPNA – non-agricultural employment,

WAGE_N – nominal average wages,

GDP – real GDP level,

GTAR_TR – effective rate of customs duties,

GVAT_TR – effective VAT rate,

GGAM_TR – effective gaming tax rate,

GEXT_TR – effective excise tax rate,

GTR_GOODS_TR – share of subsidies on products in the tax base for indirect taxes,

P_IMP – import prices adjusted for import taxes (applicable in the mid-90s).

Adjusted R^2: 45%

Autocorrelation of the random component: $\chi^2(2)=1.6$ (p=0.44)

Normality of distribution of the random component: $\chi^2(2)=602$ (p=0.0)

Sample: 1995Q4 – 2006Q4

❖ *WAGES*

$$\begin{aligned}\Delta wage\_n_t &= \underset{2.0}{0.24}\Delta wage\_n_{t-1} + \underset{1.5}{0.19}\Delta wage\_n_{t-2} + (1 - \underset{2.0}{0.24} - \underset{1.5}{0.19})\Delta cpi_t + \\ &+ (1 - \underset{2.0}{0.24} - \underset{1.5}{0.19})(\Delta gdp_t - \Delta emp_t) + \\ &- \underset{-3.5}{0.092}(wage\_n_{t-1} + \ln(1 - GLT\_EMP\_TR_{t-1}) - cpi2005_{t-1} - 1.48\ tfp_{t-1} + \\ &+ \ln(1 - GPIT\_TR_{t-1} - GLT\_HC\_TR_{t-1}) + 1.3\ UNEMP_{t-1} + \\ &- 0.41(RR\_BENEFIT_{t-1} + 0.2\ RR\_RELIEF_{t-1}) + 0.14\ LR_{t-1} - 6.40) + \\ &- \underset{-2.3}{0.13}(-3.31 + 0.64\ ulcna_{t-1} - pgdp_{t-1} + \\ &+ (1 - 0.64)(p\_imp_{t-1} + \ln(1 + GTAR\_TR_{t-1})) + 0.84\ GVAT\_TR_{t-1} + \\ &+ 0.62\ GGAM\_TR_{t-1} + 0.84\ GEXT\_TR_{t-1} - 0.84\ GTR\_GOODS\_TR_{t-1}) + \\ &+ DUMMIES\end{aligned} \qquad \textbf{E. 10}$$

where:

WAGE_N – nominal wages,

CPI – consumer price index,

GDP – real GDP,

EMP – total employment according to BAEL,

GLT_EMP_TR – effective rate of social security contributions paid by employee,

CPI2005 – consumer price index; year 2005 = 100,

TFP – total factor productivity,

GPIT_TR – effective personal income tax rate,

GLT_HC_TR – effective rate of health insurance contributions,

UNEMP –unemployment rate according to BAEL,

RR_BENEFIT – unemployment benefit replacement rate,

RR_RELIEF – social assistance benefits replacement rate,

LR – a control variable; number of fixed-term contracts in the total number of contracts (based on BAEL data),

DUMMIES – dummy variables,

ULCNA – unit labour costs in the non-agricultural sectors,
$ulcna_t = \ln(1 + GLT\_CORP\_TR_t) + empna_t + wage\_n_t - gdp_t$,

GLT_CORP_TR – effective rate of social insurance contributions paid by employer,

EMPNA – non-agricultural employment,

WAGE_N – nominal average wages,

GDP – real GDP level,

PGDP – GDP deflator,

P_IMP – import prices adjusted for import taxes (applicable in the mid-90s),

GTAR_TR – effective rate of customs duties,

GVAT_TR – effective VAT rate,

GGAM_TR – effective gaming tax rate,

GEXT_TR – effective excise tax rate,

GTR_GOODS_TR – share of subsidies on products in the tax base for indirect taxes.

Adjusted R^2: 77%

Autocorrelation of the random component :$\chi^2(2)=14$ (p=0.00)

Normality of distribution of the random component: $\chi^2(2)=0.11$ (p=0.94)

Sample: 1997Q1-2006Q4

❖ *EXCHANGE RATE*

$$\begin{aligned}\Delta s\_neer_t &= \underset{-3.1}{-0.30}(s\_neer_{t-1} - pgdp_{t-1} + pgdp\_ext_{t-1} \\ &+ 0.56(gdp\_pot_{t-1} - gdp\_ext\_pot_{t-1}) + 0.25\ NFA\_GDP_{t-1} + \\ &+ 1.23(I\_W3MR\_PGDP_{t-1} - I3MR\_EXT_{t-1}) - 9.03) + \\ &+ \Delta(pgdp_t - pgdp\_ext_t) - \underset{-0.38}{0.26}\Delta(gdp\_pot_t - gdp\_ext\_pot_t) + \\ &- \underset{-0.26}{0.09}\Delta(I\_W3MR\_PGDP_t - I3MR\_EXT_t) + DUMMIES\end{aligned}$$ **E. 11**

where:

S_NEER – nominal effective zloty exchange rate,

PGDP – GDP deflator,

PGDP_EXT – weighted GDP deflator abroad,

GDP_POT – potential GDP,

GDP_EXT_POT – weighted potential GDP abroad,

NFA_GDP – net foreign assets to GDP ratio,

I_W3MR_PGDP – real 3M WIBOR deflated by GDP deflator,

I3MR_EXT – real foreign 3M rate deflated by GDP deflator abroad,

DUMMIES – dummy variables.

Adjusted R^2: 12%

Autocorrelation of the random component: $\chi^2(2)=3.2$ (p=0.20)

Normality of distribution of the random component: $\chi^2(2)=0.82$ (p=0.66)

Sample: 1996Q2-2006Q4

2.3 INTEREST RATES

❖ *LONG-TERM INTEREST RATE EQUATION*

$$GGR5Y_t = \underset{2.1}{0.26}\,GGR5Y_{t-1} + (1-0.26)(\underset{3.2}{0.76} + \underset{14}{0.43}\,GGR5Y\_EUR_t + (1-\underset{14}{0.43})I\_W3M_t - 0.2\cdot 100\cdot GSALDO\_GDP_t + \underset{2.6}{25.5}\,GAP_t) + DUMMIES \qquad \textbf{E. 12}$$

where:

GGR5Y- yield on Polish 5-year bonds,

GGR5Y_EUR- yield on 5-year benchmark bonds for the euro-area

I_W3M - WIBOR 3M,

GSALDO_GDP- general government balance to GDP (four quarters moving average)

GAP- output gap,

DUMMIES – dummy variables.

Adjusted R^2: 97%

Autocorrelation of the random component: $\chi^2(2)=2$, (p=0.23)

Normality of distribution of the random component: $\chi^2(2)=0.85$ (p=0,.65)

Sample: 1999Q2-2005Q4

❖ *SHORT-TERM INTEREST RATE EQUATION*

$$\Delta GGR1Y_t = \underset{-3.7}{-0.72}(GGR1Y_{t-1} - 0.96\ I\_W3M_{t-1}) + \underset{9.0}{0.97}\,\Delta I\_W3M + DUMMIES \qquad \textbf{E. 13}$$

where:

GGR1Y- yield on Polish 52-week Treasury bills,

I_W3M - WIBOR 3M,

DUMMIES – dummy variables.

Adjusted R^2: 70%

Autocorrelation of the random component: $\chi^2(2)=1.2$ (p=0.55)

Normality of distribution of the random component: $\chi^2(2)=0.58$ (p=0.75)

Sample: 1999Q1-2006Q4

2.4 EXTERNAL SECTOR

❖ *EXPORTS OF GOODS AND SERVICES*

$$\Delta(gdp\_exp_t - gdp\_pot_t) = \underset{4.0}{0.0023} - \underset{-2.0}{0.19}(gdp\_exp_{t-1} - gdp\_pot_{t-1} + \\ + 1.53 - 0.011\ TREND_{t-1} - 0.50(p\_exp_{t-1} - pgdp_{t-1})) + \\ - \underset{1.8}{1.5}(gdp\_ext_{t-1} - gdp\_pot_{t-1}) + DUMMIES \qquad \textbf{E. 14}$$

where:

GDP_EXP – exports of goods and services in constant prices according to the national accounts,

GDP_POT – level of potential GDP,

GDP_EXT –weighted GDP abroad,

P_EXP – export deflator according to the national accounts,

PGDP – GDP deflator,

DUMMIES – dummy variables.

Adjusted R^2: 17%

Autocorrelation of the random component: $\chi^2(2)=15$ (p=0.00)

Normality of distribution of the random component: $\chi^2(2)=4.9$ (p=0.085)

Sample: 1996Q2-2006Q4

❖ *IMPORTS OF GOODS AND SERVICES*

$$\Delta(gdp\_imp_t - gdp\_pot_t) = -\underset{2.7}{0.014} - \underset{-2.4}{0.13}(gdp\_imp_{t-1} - gdp_{t-1} + 1.63 + \\ - 0{,}011\ TREND_{t-1} + 0.58(p\_imp\_noil_{t-1} + \ln(1 + GTAR\_TR_{t-1}) - pgdp_{t-1}))) + \\ + \underset{7.0}{1.6}\Delta\ln(0{,}4\ FINV1_t + 0.2\ CONP_t + 0.4\ GDP\_EXP_t) + \\ - \underset{-1.4}{0.18}\Delta(p\_imp\_noil_t + \ln(1 + GTAR\_TR_t) - pgdp_t) \qquad \textbf{E. 15}$$

where:

GDP_IMP – imports of goods and services in constant prices according to the national accounts,

GDP_POT –potential GDP,

GDP – real GDP,

P_IMP_NOIL – import deflator according to the national accounts, adjusted for oil price fluctuations and import taxes (applicable in the mid-90s),

PGDP –GDP deflator,

GTAR_TR – effective rate of customs duties,

FINV1 – investment outlays,

CONP – private consumption,

GDP_EXP –volume of exports.

Adjusted R^2: 58%

Autocorrelation of the random component: $\chi^2(2)=2.1$ (p=0.35)

Normality of distribution of the random component: $\chi^2(2)=0.39$ (p=0.82)

Sample: 1997Q1-2006Q4

❖ *EXPORT DEFLATOR*

$$\begin{aligned}\Delta(p\_exp_t - pgdp_t) &= \underset{-2.2}{-0.21}(p\_exp_{t-1} - pgdp_{t-1} + 2.8 + \\ &- 0.32(pgdp\_ext_{t-1} + s\_reer_{t-1} - pgdp_{t-1}) + 0.56(gdp\_pot_{t-1} - gdp\_pot\_ext_{t-1})) + \\ &+ \underset{3.8}{0.32}\Delta(pgdp\_ext_t + s\_reer_t - pgdp_t) + 0.60\Delta(gdp\_pot_t - gdp\_ext\_pot_t)\end{aligned} \quad \textbf{E. 16}$$

where:

P_EXP – export deflator according to the national accounts,

PGDP –GDP deflator,

PGDP_EXT – weighted GDP deflator abroad,

S_REER – real effective zloty exchange rate,

GDP_POT – potential GDP,

GDP_EXT_POT – weighted potential GDP abroad.

Adjusted R^2: 32%

Autocorrelation of the random component: $\chi^2(2)=0$ (p=1)

Normality of distribution of the random component: $\chi^2(2)=7.6$ (p=0.22)

Sample: 1996Q3-2006Q4

❖ *IMPORT DEFLATOR*

$$\begin{aligned}\Delta(p\_imp\_noil_t - pgdp_t) &= \underset{-2.8}{-0.21}(p\_imp\_noil_{t-1} - pgdp_{t-1} + 6.8 + \\ &- 0.71(pgdp\_ext_{t-1} + s\_reer - pgdp_{t-1}) + 0.56(gdp\_pot_{t-1} - gdp\_ext\_pot_{t-1})) + \\ &+ \underset{3.5}{0.38}(\Delta(pgdp\_ext_t + s\_reer_t - pgdp_t) + 0.56\Delta(gdp\_pot_t - gdp\_ext\_pot_t)\end{aligned} \quad \textbf{E. 17}$$

where:

P_IMP_NOIL – import deflator according to the national accounts, adjusted for oil price fluctuations, customs duties and import taxes,

PGDP – GDP deflator,

PGDP_EXT – weighted GDP deflator abroad,

S_REER – real effective zloty exchange rate,

GDP_POT – potential GDP,

GDP_EXT_POT – weighted potential GDP abroad.

Adjusted R^2: 25%

Autocorrelation of the random component: $\chi^2(2)=0$ (p=1)

Normality of distribution of the random component: $\chi^2(2)=16$ (p=0.0)

Sample: 1995Q2-2006Q4

2.5 GENERAL GOVERNMENT

❖ *GENERAL GOVERNMENT REVENUES*

$$GINC\_N_t = GPIT\_N_t + GLT\_HC\_N_t + G\_GLT_t \cdot (1 - G\_FUS_t \cdot G\_OFE_t) \cdot (GLT\_CORP\_N_t + GLT\_EMP\_N_t) + GTR\_OFE\_N_t + GLT\_FARM\_N_t + GCIT\_N_t + GVAT\_N_t + GEXT\_N_t + GGAM\_N_t + GENV\_N_t + GOTAX\_CORP\_N_t + GOTAX\_HH\_N_t + GTAR\_N_t + CGNBP\_N_t + GINC\_UE\_N_t + GPRIV\_N_t + GRT\_N_t \quad \textbf{E. 18}$$

where:

G_INC_N – revenues of the general government,

GPIT_N – personal income tax revenues,

GLT_HC_N – revenues from health insurance contributions,

G_GLT – share of own revenues of state-owned funds in the contribution fund adjusted for contributions paid to Open Pension Funds (parameter that allows for the calculation of the funds' own revenues on the basis of contribution fund),

G_FUS – share of contributions paid to the Social Insurance Fund in the total social insurance contributions (parameter that allows for the calculation of the share of contributions to the Social Insurance Fund in contributions paid by employees and employers),

G_OFE – share of revenues from contributions to Open Pension Funds in the total contributions to the Social Insurance Fund (parameter allowing the calculation of the share of contributions to Open Pension Funds in the total contributions paid to the Social Insurance Fund),

GLT_CORP_N – revenues from social contributions paid by employers,

GLT_EMP_N – revenues from social contributions paid by employees,

GTR_OFE_N – pension insurance contributions paid to Open Pension Funds,

GLT_FARM_N – revenues from farmers' retirement and disability pension contributions– FER/KRUS,

GCIT_N – revenues from corporate income tax and revenues from local governments simplified income tax ,

GVAT_N – value-added tax revenues,

GEXT_N – excise tax revenues,

GGAM_N – gaming tax revenues,

GENV_N – revenues of the National Fund for Environmental Protection and revenues of the Agricultural Land Protection Funds,

GOTAX_CORP_N – other taxes paid by enterprises,

GOTAX_HH_N – other taxes paid by households,

GTAR_N – customs revenues,

CGNBP_N – NBP profit transfer,

GINC_UE_N – special cash-flow facility from the EU budget (in the years 2004-2006),

G_PRIV_N – revenues from privatisation (in the years 2002-2004: the part constituting the revenues of the general government),

GRT_N – other revenues.

❖ *GENERAL GOVERNMENT EXPENDITURES*

$$GEXP\_N_t = GCE\_N_t + GTR\_CORP\_N_t + GTR\_GOODS\_N_t + GINV\_N_t + GTR\_UNEMP\_N_t + GTR\_RETIRED\_N_t + GTR\_RELIEF\_N_t + GDS\_FOR\_N_t + GDS\_DOM\_N_t + GEXP\_UE\_N_t + ALMP\_N_t + GRE\_N_t \quad \textbf{E. 19}$$

where:

GEXP_N – expenditures of the general government,

GCE_N – current expenditure,

GTR_CORP_N – subsidies to enterprises,

GTR_GOODS_N – subsidies on products,

GINV_N – investment expenditure,

GTR_UNEMP_N – unemployment benefits,

GTR_RETIRED_N – pension transfers,

GTR_RELIEF_N – transfers from social welfare,

GDS_FOR_N – costs of foreign debt service,

GDS_DOM_N – costs of domestic debt service,

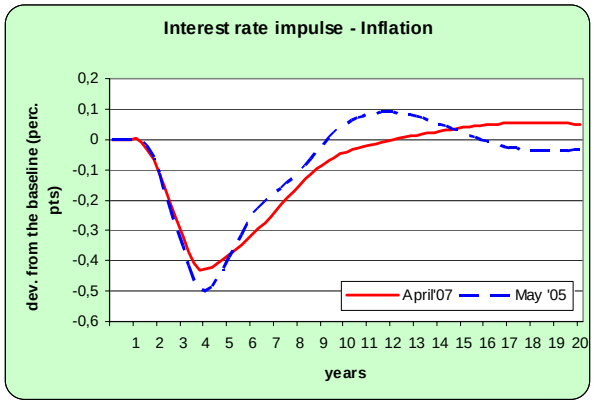
GEXP_UE_N – contribution to the EU budget,

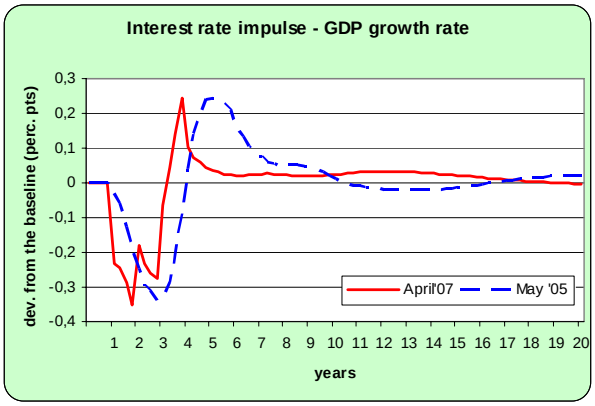
ALMP_N – expenditure on the active labour market policy,

GRE_N – other expenditure.

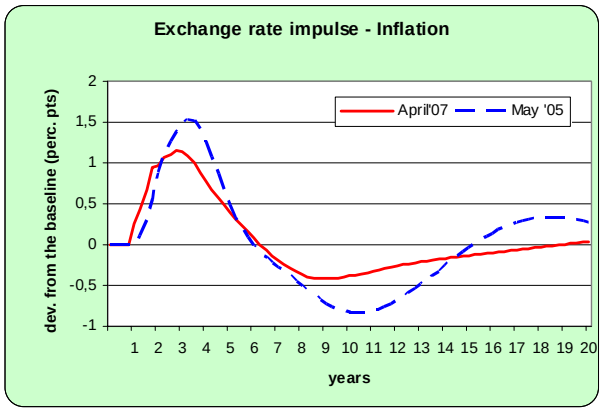
3 MODEL REACTION TO STANDARD IMPULSES

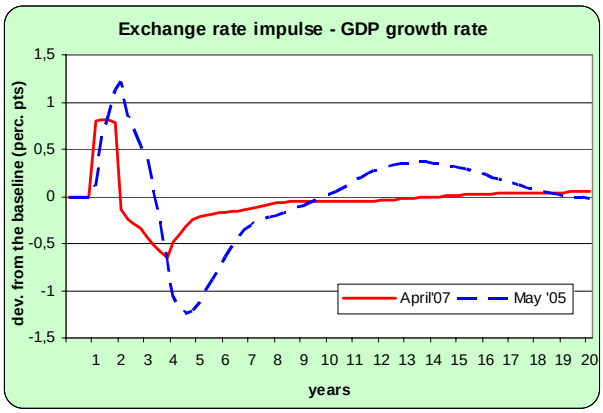
A comparison of the simulation properties of two versions of the ECMOD model: the May 2005 version and the April 2007 version is presented below. As both versions have different specifications, it was necessary to modify the definitions of impulses to make the results obtained from both versions of the model comparable. Due to different definitions of the given impulses, the lines presented below differ from the lines presented in the May 2005 publication.





The monetary impulse has been defined as a rise in interest rate by 1 percentage point for the period of eight quarters. After this period (i.e. starting from the ninth quarter) interest rate follows monetary policy rule (i.e. Taylor's rule). Fiscal policy rule is included in the ninth year of the simulation.





The exchange rate impulse has been defined as 10% currency depreciation for the period of eight quarters. After this period (i.e. starting from the ninth quarter) the exchange rate equation is included. The simulation has been run with the monetary policy rule (i.e. Taylor's rule) included. The fiscal policy rule is included from (beginning with) the ninth year of the simulation.