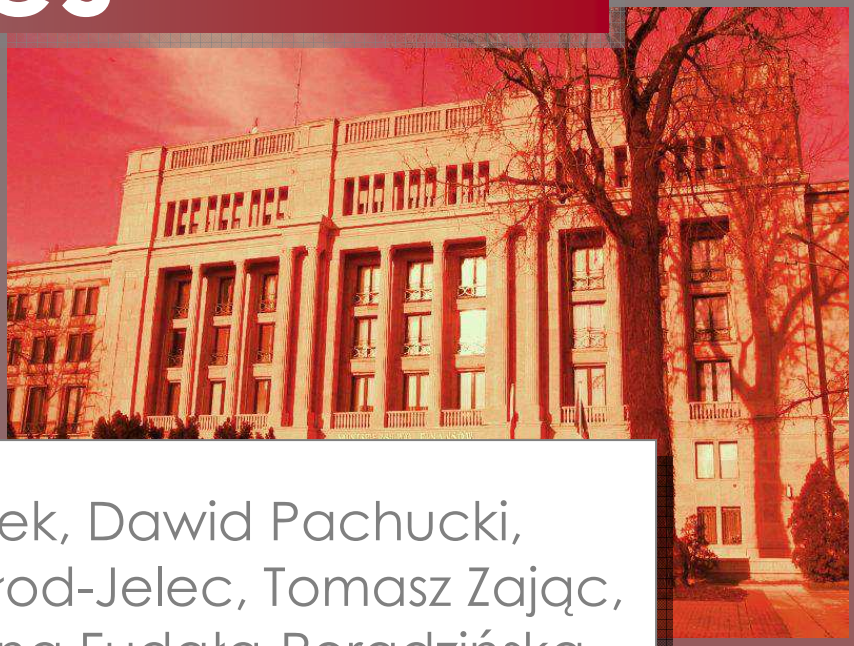
Ministry of Finance | Republic of Poland

No 14-2012
June 2012

MF Working Paper Series



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eMPF Econometric Model of Public Finance

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November 2011

Abstract

This paper presents the Econometric Model of Public Finance, eMPF. The model has been developed and maintained at the Polish Ministry of Finance to facilitate forecasting process, especially for the budget and convergence programme purposes, and to deliver scenario analyses. We present the particular blocks of the model and responses to some standard shocks.

The eMPF model is a medium size quarterly macroeconometric model of the Polish economy. It was estimated on the seasonally adjusted data on the 1995-2010 sample. The model consists of 352 variables, of which 279 are endogenous and about 40 are explained by stochastic ECM type equations. The long run of the model is theory based and is derived from optimization conditions of the market participants. Microeconomic foundations of the long-run equilibrium impose constraints for dynamics of the model to force it to converge to the steady state. In the short run the model is demand driven with elasticities estimated to reflect historical path of the variables and rigidities in the economy. Taking into account the mix of economic theory and the willingness to fit the equations to the data, the eMPF model belongs to the so-called hybrid models family.

There are two sectors identified in the model: the market sector and the general government sector, both summing up to the total economy according to the ESA95 methodology. Within the market sector two additional subsectors are recognised: households and companies, but only part of the institutional accounts is incorporated for these two subsectors. To fulfill the needs of the Ministry of Finance to prepare fiscal policy analyses, the model has quite detailed public finance block.

JEL Classification: E10, E17, E20, E50, E60

Keywords: structural macroeconometric model, macroeconomic model, polish economy

*The views expressed in this Working Paper are those of the authors and do not necessarily reflect those of the Ministry of Finance. All errors and omissions are ours.

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1 Introduction

1.1 Motivation for the macroeconometric model

The Polish Ministry of Finance has a several-year long history of building econometric models. The need for having a structural macroeconomic model is closely related to the goal of conducting optimal fiscal framework by the Minister of Finance and the government. As an institution responsible for designing appropriate fiscal policy, the Ministry needs tools to analyse different policy scenarios and to estimate possible consequences of selected shocks affecting the economy. Another area of responsibility of the Ministry in which a macroeconometric model is an indispensable tool is the provision of medium-term forecasts for budget purposes [1]. Fiscal policy decision making process requires knowledge of the current stance of the public finance and the economy, their future development in the budget bill horizon as well as knowledge of the reaction of several macroeconomic and fiscal variables to the fiscal impulses. The structural macroeconomic model serves all above-mentioned purposes. As it is estimated on the Polish economy data, it provides knowledge about relations between relevant macroeconomic categories in the country. The model works as a system, and thus allows feedbacks from one set of variables to another.

Whereas models used at central banks mainly focus on monetary policy, models used at the Ministry of Finance should concentrate on the fiscal policy. Accordingly, the econometric Model of Public Finance (the eMPF model) developed in the Polish Ministry of Finance and presented in this paper, has extended public finance block.

However, model users must be aware of model's limitations and weaknesses. Economic reality is usually more complex than reflected in the model's set of equations. Constructing the model thus lies in including only those equations which together give the realistic picture of the key relationships between the objectives and instruments of economic policy. Model quality also depends substantially on the quality of the data used. All these aspects have been taken into consideration on the model building process. Particular attention was drawn to choice of variables incorporated in the model as well as data preparation process.

[2]

[1] More detailed description of the MoF forecasting process using the eMPF model is presented in the Appendix A.

[2] More detailed description of the MoF forecasting process using the eMPF model is presented in the Appendix A.

1.2 Origins of the eMPF model

The first steps in building the quarterly econometric model for the Polish economy within the Ministry of Finance were taken in 2000. Before, lack of reliable quarterly time series limited the possibility of reliable econometric modelling. Some models built by the staff had been already in use, though based on annual data.

The first version of the quarterly model was constructed in co-operation with the French Ministry of Finance and INSEE (National Institute for Forecasting and Economic Studies). The French team consisting of Jean Louis Brillet, Stephane Capet and Julien Deroyon, encountered a number of problems, mainly with the availability of specific data. There were no volume series calculated for Poland, time series were not seasonally adjusted and sample covered was very short (1995-2000). Another encountered problem was the division of data into particular sectors of the economy (market and non-market division was decided). Nevertheless, a working version of the model was constructed. In retrospect, the most important result of the cooperation seems to be the know-how which the Polish staff engaged in the project benefited from.

The experience gained during the first stage of the project allowed the Polish team (consisting of Sławomir Dudek, Iwona Fudała-Poradzińska, Monika Kurtek and Dawid Pachucki) to start up a PHARE project for further development of the model. A new version of the model was being built within the twinning project with the Finnish Ministry of Finance. The twinning partner of the Polish Ministry was represented by prof. Matti Viren and dr Pekka Sulamaa. From the Polish side, the project was supervised by prof. Aleksander Welfe. The bulk of time was spent on data preparation as mentioned earlier. Using some statistical techniques, quarterly data consistent with ESA95 methodology for general government sector was estimated (at that time the official information from the Polish Statistical Office was limited for selected time frequency). The Project team also had to make a decision concerning the methodology for computation of volume series as well as regarding the seasonality of the data. The first problem was solved by application of annual overlapping technique, which is in line with Eurostat recommendations. For the second, it was decided to use seasonally adjusted series (Tramo-Seats procedure was chosen). It is worth mentioning that the same solutions were also selected by the Polish Statistical Office after some time, to enhance the quality of public statistics.

The final version of the model was consulted with external experts and was published as an internal document of the Polish Ministry of Finance in 2003. The constructed model was then maintained by the team and further developed with the support of Jean Louis Brillet and Thomas Le Barbanchon as a result of bilateral co-operation between Polish and French

ministries of finance. The updated version of the model was presented during seminars organized by the Polish Ministry of Finance and also on the MACROMODELS'2006 international conference organised by the University of Lodz.

Afterwards, due to the changes in model team and reallocation of new duties, the model development was practically discontinued. The decision to update the model and to assemble a new team was made at the end of 2008. The model update started at the beginning of 2009 and beside strict technical processes, significant part of it was connected with completing the team and building its human capital. The outcome of that work prepared by the team consisting of Dawid Pachucki, Magdalena Zachłod-Jelec, Tomasz Zając and Paweł Kolski with assistance and supervision of Sławomir Dudek is presented in this study. [3]

Reading this document, please bear in mind that the current version of the model and the whole system designed to maintain could only be achieved due to hard work of all the people listed in the cover page and considerable contributions of the staff working for the Department of Financial Policy, Analyses and Statistics in the Ministry of Finance in Poland.

[3]Starting with August 2009 for a one-year period Piotr Karp from the University of Lodz was also working on the model.

2 Model overview

The eMPF model is a medium size macroeconometric model of the Polish economy. It consists of 352 variables, of which 279 are endogenous including 40 stochastic ECM type equations. In the long run solution of the model is theory based and is derived from optimization conditions of market participants. Microeconomic foundations of the long-run equilibrium impose constraints on dynamics of the model and make it to converge to the steady state. The long term path depends on exogenous demography and labour augmented technological progress (TFP). The joint growth of these two variables determine the real growth rates for all other variables in the model. As Poland is an open economy, in the long-run the abovementioned exogenous variables are calibrated to reflect a real growth of the foreign demand. In the short run the model is demand driven with elasticities estimated to reflect historical path of the variables and rigidities in the economy. When disequilibrium in the model occurs, the price-wage loop, influencing the structure of the demand, will force the model to adjust to the long run solution. In order to put model variables onto the steady-state path, dynamic homogeneity restrictions are imposed in all stochastic equations. Taking into account the mix of economic theory and the willingness to fit the equations to the data, the eMPF model belongs to the so-called hybrid models family. The graph below presents the idea of the main flows in the model on a highly aggregate level. Particular blocks are described in more details in the next sections of this paper. The model has been estimated on the quarterly, seasonally adjusted data on the 1995-2010 sample. Due to some data limitations, additional transformations were necessary. The details are described in the Appendix B. In the model two sectors are distinguished: the market sector and the general government (henceforth referred to as GG) sector, both summing up to the total economy according to the ESA95 methodology. Within the market sector two additional subsectors are recognised: households and companies, however only part of the institutional accounts is incorporated for these two subsectors.

To make the model operational, substantial set of well-defined procedures was designed to update dataset, re-estimate the equations and solve the model. All the technical documentation will be available in the form of internal manuals at the Ministry of Finance.

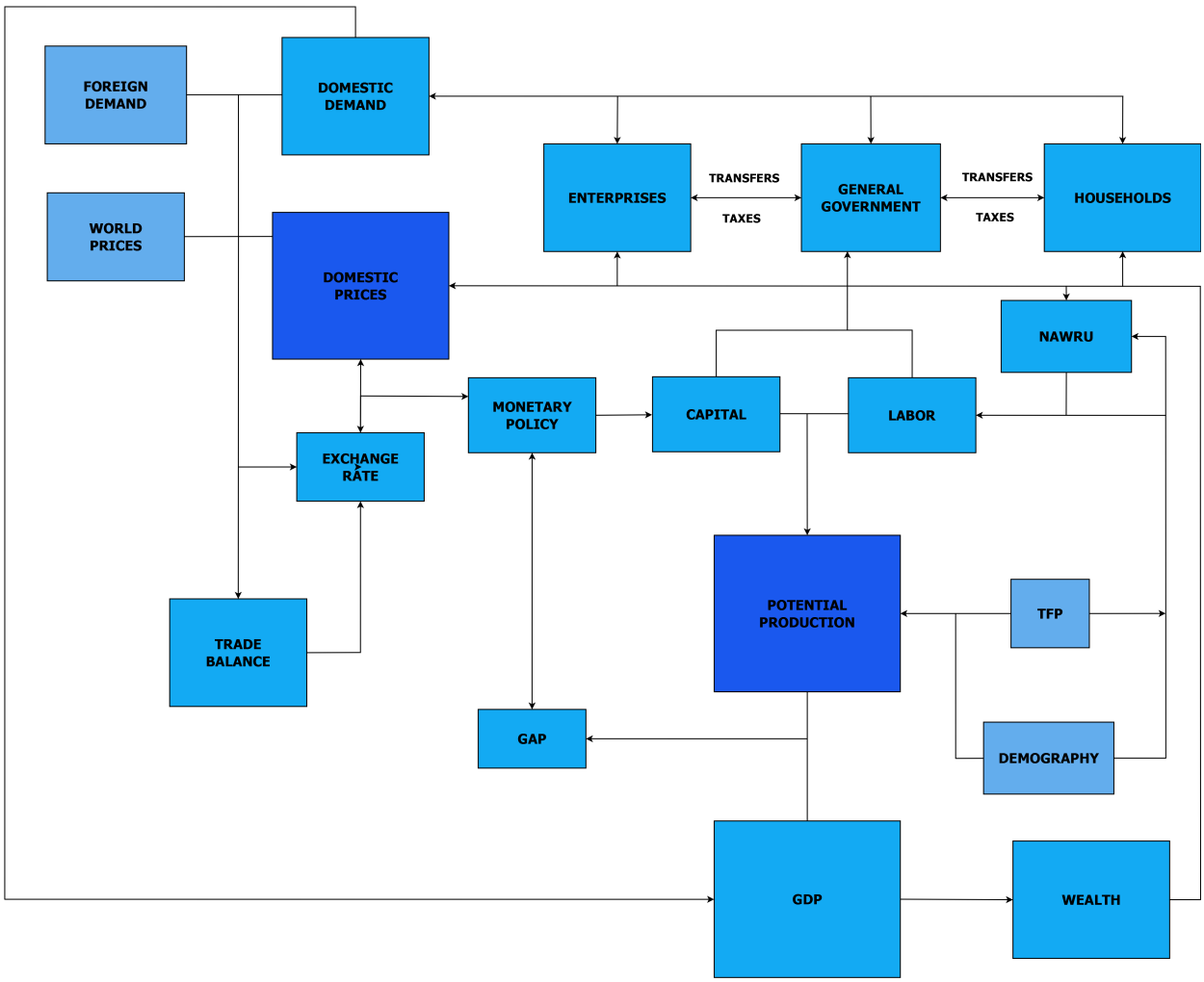

Figure 1: General structure of the eMPF model

3 Data

The eMPF model operates on quarterly data from various sources. The quarterly national accounts data are taken from the Central Statistical Office of Poland (GUS). Other sources of raw data include inter alia the National Bank of Poland, Eurostat, World Bank and OECD. Due to limited availability of reliable time series, the estimation sample usually starts from 1995 and ends with the latest available observation. The quarterly national accounts data in the eMPF model are classified in compliance with ESA95 approach.

Most of the collected series are subject to further transformations concerning their economic (chain-linking, benchmarking, reconciliation) and statistical properties (seasonal adjustment). Quarterly volume measures in national accounts in real terms are calculated using the chain-linking[4] approach. Across EU countries implementation of chain-linking was not fully harmonised and currently three competitive techniques are used. Following the methodology of GUS, annual-overlap method has been used. The only difference between our approach and that applied by GUS is a choice of a reference year. In our approach we update the reference year to the latest available. The results of our study prove that in the annual overlap technique a change of the reference year does not affect dynamic properties of the series (monthly and quarterly dynamics are the same). This change is motivated mainly by the reduction of the statistical discrepancy which is the lowest in the years close to the reference year.

Some variables used in the eMPF model exist only at annual frequency. This implies that some formal statistical techniques have to be used to generate quarterly data. For the purpose of disaggregation, the following methods are applied: Fernandez (1981), Cholette (1984), Boot et al. (1967).

The use of chain-linking and seasonal adjustment methods causes non-additivity in two dimensions: temporal and cross sectional, i.e. components do not add up to the aggregate and the sum of quarterly data is not equal to the corresponding annual data. To restore the consistency between agregates and components data, benchmarking (Cholette (1984)) and reconciliation (DiFonzo and Marini (2005b)) techniques have been used. A detailed description of data, its transformations, disaggregation and balancing methods is given in the Appendix C.

[4]Chain-linked volume series are created by referring to relative prices which represent the structure of the annual averages of prices of the respective previous year.

4 Main equations

4.1 Aggregate demand and value added

In the further part of this paper we describe main equations of the model from the supply side and the demand side point of view. As the eMPF is based on ESA95 framework, it was very important for us to first, build the model consistent with macroeconomic theory, and second, to reflect all the accounting structure the data should apply to.

The supply side of the model is based on output at basic prices (i.e. gross value added), not on GDP at market prices which represents demand side of economy according to the National Accounts concept. As the market sector was separated in the model, the supply side constrains are decided to be applied to the value added in that sector meaning that general government sector does not directly influence potential output. To implement such an approach we need to ensure consistency of production account (value added in the market sector plus value added in the public sector) with uses account (i.e. demand) adjusted for taxes less subsidies, both in nominal and real terms. Such an identity and foundation of production function is not so common in the other empirical works. Most macroeconometric models treat the production function as a tool for providing the model with long-term path of growth rates or for calculation of the output gap, using GDP at market prices for the whole economy, i.e. not limited to the the market sector only. The supply-demand equality consistent with the National Accounts concept is either omitted or, at most, not exposed in descriptions.

Likewise in production account, also demand on market goods and services (market GDP) has been separated from the non-market part. Accordingly, market GDP includes only part of general government consumption, public direct expenditures on market goods and services (i.e. general government intermediate consumption) and social transfers in-kind which in fact include expenditures also on market goods and services. According to the above, the identities in the model are constructed in line with concept presented in a Table 1, both in nominal and real terms.

<table>
<tr><td colspan="9">GDP</td></tr>
<tr><td rowspan="2">CONSHS</td><td rowspan="2">MGFCF</td><td rowspan="2">GGGFCF</td><td rowspan="2">INVT</td><td rowspan="2">X</td><td rowspan="2">-M</td><td colspan="3">CONSGG</td></tr>
<tr><td colspan="2" rowspan="2">CONSGG
market</td><td rowspan="3">CONSGG
non-market</td></tr>
<tr><td>GGIC</td><td>GGSTRK</td></tr>
<tr><td colspan="6">GDPM</td></tr>
<tr><td rowspan="4">TXSBP</td><td colspan="8">VA</td></tr>
<tr><td rowspan="3" colspan="5">MVA</td><td colspan="3">GGVA</td></tr>
<tr><td>GGSALES</td><td>GGVA_NM</td></tr>
<tr><td colspan="3">GGLC+GGOS+
GGTAX_SUB</td></tr>
<tr><td colspan="8">GDP at producer prices</td></tr>
</table>

Table 1: Uses of GDP at market prices

where:

GDP – gross domestic product (cb),

$GDPM$ – market gross domestic product (cb),

$CONSHS$ – individual consumption of households (cb),

$MGFCF$ – gross fixed capital formation, market sector (cb),

$GGGFCFE$ – gross fixed capital formation, GG sector (cb),

$INVT$ – changes in inventories (cb),

X – exports of goods and services(cb),

M – imports of goods and services (cb),

$CONSGG$ – public consumption (cb),

$CONSGGmarket$ – public consumption (cb) - market,

$GGIC$ – intermediate consumption, GG sector (cb),
$GGSTRK$ – GG social transfers in kind (cb),
$CONSGGnon-market$ – public consumption (cb) - non-market,
MVA – value added gross, market sector (cb),
$GGVA$ – value added gross, GG sector (cb),
$TXSB$ – taxes on products minus subsidies on products (cb),
$GGSALES$ – market sales of general government (cb),
$GGLC$ – compensation of employees, GG sector (cb),
$GGOS$ – gross operating surplus, GG sector (cb),
$GGTAX\_SUB$ – other taxes on production, payable minus other subsidies on production, receivable (cb),

The main equations of the aggregate demand identity in the eMPF are as follows:

$$\begin{aligned} GDPQ &= CONSHSQ + CONSGGQ + MGFCFQ \\ &\quad + GGGFCFEQ + INVTQ + XQ - MQ \end{aligned} \tag{1}$$

$$\begin{aligned} GDPMQ &= CONSHSQ + GGICQ + GGSTRKQ + MGFCFQ \\ &\quad + GGGFCFEQ + INVTQ + XQ - MQ \end{aligned} \tag{2}$$

where all acronyms have meaning like in diagram 1 and "Q" indicate volumes.
As mentioned above $GDPMQ$ includes only part of general government consumption, i.e. intermediate consumption ($GGICQ$) and transfers in kind ($GGSTRKQ$). Total public consumption is calculated using "bridge" equation (see details in the public finance section), and the non-market part is residual so as to hold identities from table 1.

Gross domestic product (GDP), as well as market GDP in nominal terms are a sum of the above-mentioned components adjusted to the current year prices with use of deflators described in the price section of the document.

To make the production-demand identity hold, value added in the market sector is equal to market GDP corrected for taxes and subsidies (adjustment from market prices to basic prices) and corrected for the part of market demand which is met by market production of the general government sector. As a consequence, the formula is as follows:

$$MVAQ = GDPMQ - TXSBPQ - GGSALESQ \tag{3}$$

where:

$MVAQ$ – value added gross, market sector (cs),

$GDPMQ$ – market gross domestic product (cs),

$TXSBPQ$ – taxes on products minus subsidies on products (cs),

$GGSALESQ$ – market sales of general government (cs).

Nominal value added in the market sector is calculated as a product of volume and deflator:

$$MVA = PMVA * MVAQ \tag{4}$$

Volume of the value added of the market sector, as defined above, is further compared with the potential output in the market sector ($MVAQPOT$) to asses whether the demand is excessive/insufficient compared to the potential level calculated from the production function.

One of the conditions for consistency of the system is to have all the taxes and their changes, not presented only on the demand side but also reflected in the difference between producer and market prices (i.e. difference between GDP and value added). In our system this difference is described by the deflator of taxes less subsidies category ($PTXSBP$). According to the economic theory and ESA95 methodology, tax rate changes relative to the base year should not directly influence real changes of modelled variables. Such changes should instead be reflected in the price index. The real path of taxes less subsidies depends on the tax weighted structure of demand side, where the weights are taken from the base year.

$$\begin{aligned} LOG(TXSBPQ) &= LOG(\frac{PFP\_EFRVAT\_CONSHS\_CSB + PFP\_RGGEXC\_CSB}{1 + PFP\_EFRVAT\_CONSHS\_CSB + PFP\_RGGEXC\_CSB} \cdot \\ &\cdot \quad CONSHSQ + \frac{PFP\_EFRVAT\_IG\_CSB}{(1 + PFP\_EFRVAT\_IG\_CSB)} \cdot GGGFCFEQ + \\ &+ \quad \frac{PFP\_EFRVAT\_ICGG\_CSB}{(1 + PFP\_EFRVAT\_ICGG\_CSB)} \cdot GGICQ + \frac{CGTAXRES}{PGDP} + \\ &+ \quad \frac{PFP\_GGTAXCD\_CSB}{(1 + PFP\_GGTAXCD\_CSB)} \cdot MQ + \frac{PFP\_EFRVAT\_IM\_CSB}{(1 + PFP\_EFRVAT\_IM\_CSB)} \cdot \\ &\cdot \quad MGFCFQ - GGSUBPQ) + 0.15 + 0.08 \cdot dum^{ls,q204} \end{aligned} \tag{5}$$

where:

$PFP\_EFRVAT\_CONSHS\_CSB$ – effective weighted VAT index on household consumption expenditures,

PFP_RGGEXC_CSB – index of effective excise tax rate (cb),

$CONSHSQ$ – individual consumption of households (cs),

$PFP\_EFRVAT\_IG\_CSB$ – effective weighted VAT index on government investment (cb),

$GGGFCFEQ$ – gross fixed capital formation, GG sector (cs),

$PFP\_EFRVAT\_ICGG\_CSB$ – effective weighted VAT index on government intermediate consumption (cb),
$GGICQ$ – intermediate consumption, GG sector (cs),
$PFP\_GGTAXCD\_CSB$ – index of scaling factor $GGTAXCD$ equation (cb),
MQ – imports of goods and services (cs),
$PFP\_EFRVAT\_IM\_CSB$ – effective weighted VAT index on non-government investment (cb),
$MGFCFQ$ – gross fixed capital formation, market sector (cs),
$CGTAXRES$ – taxes on lotteries, gambling and betting (cb),
$PGDP$ – deflator of gross domestic product,
$GGSUBPQ$ – subsidies on products (paid) GG sector (cs).

The above outlined long-term path for $TXSBPQ$ is allowed to deviate from the theoretical path in the short term, depending on changes in some other economic variables. This deviation can be explained with price stickiness, lags in adjustments and is estimated using historical behaviour of the data. In the long term, the direct effect of tax changes relative to the base year disappears. Due to the fact that the $PTXSBP$ is computed as the $TXSBP$ to $TXSBPQ$ ratio, all the direct effect of tax rate translate to prices. Next section describes the determination of the long-run value added in the eMPF model.

4.2 The supply side and costs

4.2.1 Production function

In the eMPF model, the neoclassical production function approach is used. Accordingly, in the long-run the supply curve is vertical, meaning that supply is perfectly inelastic with respect to prices. Real equilibrium in the long-run is determined by the available production factors and technical progress, implying that production growth in the long-run is independent of prices and inflation. Long-run equlibrium values of the three main variables: investments, employment and GDP deflator at basic prices are estimated jointly in the supply block.
Production function in the model relies on a "putty-putty" assumption, what implies that elasticity of substitution of capital for labour is the same *ex ante* (at the moment of investment decision taking) and *ex post* (after the production factors are employed). Within a "putty-putty" framework, it is never optimal for a cost minimizing firm to produce with idle capital because current variable costs could always be reduced by substituting idle capital into labour Abel (1981).

The eMPF model uses the Cobb-Douglas production function approach with constant re-

turns to scale. Production in the market sector ($MVAQ$) is set using the combination of the two production factors: capital (MK) and labour (LM), under the assumption of an exogenous technical progress (Harrod's neutral). Thus, the production function, linear with respect to the logarithms of the relevant variables, may be written as:

$$log(MVAQ) = log(A) + \beta \cdot \gamma \cdot TREND\_TFP + (1 - \beta) \cdot log(MK) + \beta \cdot log(LM) \quad (6)$$

where:

A – scaling parameter,

$MVAQ$ – gross value added, market sector (cs),

$\gamma \cdot TREND\_TFP$ – total factor productivity[5] (smoothed Solow residual) (cs),

β – production elasticity[6] with respect to effective labour, calculated as an average labour income to value added ratio,

MK – capital stock, market sector (cs),

LM – average employment, market sector.

Capital demand and price equations in the long-run are determined on the basis of the profit maximization first order conditions. Labour demand optimizing production costs in the market sector (LMD), is set using an inverted production function. Such an approach results in the long term in the same level of employment as alternative ones: derivation of the desired employment level form profit maximisation or cost minimisation constrains. However, taking into account better simulation properties of the model, the implemented approach seems to be more often accepted in the modelling exercises (Fagan et al. (2001)). The formula for the long-term labour demand is as follows:

$$log(LMD) = \frac{log(MVAQ) - \beta \cdot \gamma \cdot TREND\_TFP - (1 - \beta) \cdot log(MK) - log(A)}{\beta} \quad (7)$$

In the short-run, labour demand is a function of a deviation of actual labour demand from its optimal level, lagged change in the labour demand, current and lagged change in the equilibrium labour demand. Accordingly, the dynamic specification of the labour demand equation is as follows:

[5]The growth rate of total factor productivity γ has been set to 0.01.

[6]The parameter value of production elasticity with respect to effective labour β has been assumed to be equal 0.65 according to our estimation results.

$$\begin{aligned}\Delta log(LM_t) &= \underset{(-1.81)}{-0.017} \cdot (log(LM_{t-1}) - log(LMD_{t-1})) + \underset{(29.4)}{0.89} \cdot \Delta log(LM_{t-1}) + \\ &+ \underset{(2.4)}{0.06} \cdot \Delta log(LMD_t) + (1 - 0.06 - 0.89) \cdot \Delta log(LMD_{t-1}) \end{aligned} \tag{8}$$

where:

LM – average employment, market sector,

LMD – labour demand which optimize production costs, market sector.

$R^2 = 0.86$ $Adj.R^2 = 0.85$ $\sigma = 0.002$ $LMtest(p - value) = 0.03$

Capital demand ensuring optimization of production costs (MKD) is stated as follows:

$$\begin{aligned} log\left(\frac{MKD}{MVAQ}\right) &= \beta \cdot \left(log\left(\frac{WCOST/1000}{PCONSHS}\right) - log\left(\frac{UCC}{PMGFCF}\right) - \gamma \cdot TREND\_TFP\right) \\ &+ \beta \cdot (log(1-\beta) - log(\beta)) - log(A) \end{aligned} \tag{9}$$

where:

MKD – capital demand which optimize production costs, market sector (cs),

$MVAQ$ – value added gross, market sector (cs),

$WCOST$ – labour cost per employee (cb),

$PCONSHS$ – deflator of household individual consumption (cs),

UCC – user cost of capital (cb),

$PMGFCF$ – deflator of gross fixed capital formation, market sector (cs),

$\gamma \cdot TREND\_TFP$ – total factor productivity (smoothed Solow residual) (cs).

Due to data limitations in Poland, the physical capital stock in the market sector needs to be estimated. Estimates of capital stock at the end of each period (MK_t) have been obtained by applying the perpetual inventory method using the formula:

$$MK_t = I_t + (1 - \delta) \cdot MK_{t-1} \tag{10}$$

where:

I_t – gross value of new fixed assets obtained from investment activity,

δ – quarterly depreciation rate in the market sector.

The starting value of physical capital should be estimated. Applying the method of Mankiw et al. (1992) it is calculated as GDP of 1996 multiplied by the average investment-to-GDP ratio and divided by the sum of TFP growth, depreciation rate and average population growth, production factors constraints implied by the selected form of production function are thus

taken into account. We assume that time series of gross fixed capital formation, being calculated in compliance with National Accounts framework, is not immediately added up to the productive capital. Gross value of new fixed assets obtained from investment has been calculated using the following formula:

$$\begin{aligned} I_t &= 0.38 \cdot MGFCFQ_t + 0.22 \cdot MGFCFQ_{t-1} + \\ &\quad +0.12 \cdot MGFCFQ_{t-2} + 0.09 \cdot MGFCFQ_{t-3} + \\ &\quad +0.08 \cdot MGFCFQ_{t-4} + 0.06 \cdot MGFCFQ_{t-5} + \\ &\quad +0.05 \cdot MGFCFQ_{t-6} \end{aligned} \tag{11}$$

where:
$MGFCFQ$ – gross fixed capital formation, market sector (cs).

Modelling the capital in the market sector thus takes into account an investment cycle. Weights for the gross fixed capital formation in the consecutive quarters are a result of individual assumptions for various types of fixed assets (see Gradzewicz and Kolasa (2004)).

The short-run capital demand is targeted to its long-run theoretical level. Its deviation from the optimal level is a function of lagged change in the capital demand as well as lagged changes in the volume of gross domestic product. The dynamic homogeneity restriction was imposed in the equation. Additionally, a dummy variable has been included to improve the fit of the equation.

$$\begin{aligned} \Delta log(MK_t) &= \underset{(-3.55)}{-0.002} \cdot (log(MK_{t-1}) - log(ma(MKD_{t-1}, 4)) - 0.228 \cdot dum^{ls,q204}) + \\ &\quad + \underset{(8.2)}{0.07} \cdot \Delta log(ma(GDPQ_t, 4)) + (1 - 0.07) \cdot \Delta log(MK_{t-1}) - \\ &\quad \underset{(-3.34)}{-0.0006} \cdot dum_t^{ls,q101q301} \end{aligned} \tag{12}$$

where:
MK – capital stock, market sector (cs),
$GDPQ$ – gross domestic product (cs),
$dum^{ls,q101q301}$ – 0-1 variable, equal to one in q1:2001–q3:2001 and zero elsewhere,
$dum^{ls,q204}$ – 0-1 variable, equal to one from the second quarter of 2004 onwards and zero elsewhere,
$ma(variable\_name, n)$ – n–period centered moving average operator.

$R^2 = 0.99$ $Adj.R^2 = 0.99$ $\sigma = 0.000042$ $LMtest(p - value) = 0.00$

The error correction parameter in the above equation might seem very small, but we should bear in mind that this is an equation for the stock of capital. Higher parameter would result in huge fluctuations of gross fixed capital formation, which is a flow derived from the changes in the capital stock.In extreme situations it could lead to negative investments, which - taking into account log transformations - would result in the solution brake. As the equation above is a behavioral equation for the short-run demand for capital, the gross fixed capital formation in the market sector ($MGFCFQ$) is computed using capital accumulation identity (with weights summing up to unity):

$$\begin{aligned} MGFCFQ_t &= MK_t - (1-\delta)\cdot MK_{t-1} + 0.22\cdot MGFCFQ_{t-1} + 0.12\cdot MGFCFQ_{t-2} + \\ &+0.09\cdot MGFCFQ_{t-3} + 0.08\cdot MGFCFQ_{t-4} + 0.06\cdot MGFCFQ_{t-5} + \\ &+0.05\cdot MGFCFQ_{t-6} \end{aligned} \tag{13}$$

It is assumed that all capital in the market sector is employed in the long-run. In the spirit of Giorno et al. (1995), potential labour input is calculated on the basis of the labour supply corrected for the NAWRU. Due to the fact that we compute potential production in the market sector, we have to adjust the total labour supply for the labour supply of the general government sector. It is assumed in the model that there is no disequilibrium in the public sector labour market, hence the employment in the general government sector is a proxy for labour supply in this sector. Accordingly, potential output ($MVAQPOT$) in the market sector, calculated on the basis of the production function equation, is expressed by the following formula:

$$\begin{aligned} log(MVAQPOT) &= log(A) + \beta\cdot\gamma\cdot TREND\_TFP + (1-\beta)\cdot log(MK) + \\ &+\beta\cdot log((1-NAWRU)\cdot(LS-LG)) \end{aligned} \tag{14}$$

where:

A – scaling parameter,

$MVAQPOT$ – potential gross value added in the market sector (cs),

β – production elasticity with respect to labour, established as an average labour income to value added ratio,

MK – capital stock market sector (cs),

$NAWRU$ – non-accelerating wage inflation rate of unemployment (cb),

LS – average labour supply,

LG – average employment in general government sector.

The difference between actual and potential production in the market sector (expressed in

relation to the potential production) determines the output gap of this sector (GAP). In line with the above, the formula for the output gap is as follows:

$$GAP = \frac{MVAQ - MVAQPOT}{MVAQPOT} \tag{15}$$

4.2.2 Costs and deflators

The key price in the model, which determines all other prices, is deflator of the value added in the market sector ($PMVA$). The long-run value of $PMVA$ depends, as implied from theory, on the mark up over the nominal wage rate and marginal product of labour. Long run paths of other deflators (adjusted for respective taxes)- apart from consumer price index (CPI) - have been directly modelled as a weighted average of $PMVA$ and the imports deflator PM. This refers to the concept that in a small open economy prices of goods and services are determined not only by domestic factors but also by imported products valued by foreign prices and nominal exchange rate. The impact of $PMVA$ and PM on other deflators depends on the share accounted for by, respectively, domestic and foreign factors affecting the total price of the product or service. In the short term, we impose dynamic homogeneities to fulfil steady-state conditions stemming from the long run relations. Consumer price index whose dynamics is targeted by the central bank, is modelled in a similar way, but in the long run it is directly linked to the household consumption deflator $PCONSHS$.

Value added deflator in the market sector

Market sector value added deflator $PMVA$, a core variable in the eMPF model, influences all other price deflators. In the long-term, it is determined by the profit maximisation condition of a representative company. As an enterprise decides upon its production within the production function framework described in the previous section, from the first-order condition we can derive the long-term price equation (see e.g. Willman and Estrada (2002)). Depending on the chosen production function form in the eMPF model, the price of the market sector production in the long-run is determined by total labour costs corrected for long-term labour productivity. The increase of wages exceeding the productivity growth translate into additional prices growth, as stated below:

$$\begin{aligned} log(PMVA^*) = & \underset{(-954)}{-6.45} + log(WCOST) + log(LMD) - log(MVAQ) \\ & + \underset{(6.11)}{0.06} \cdot dum^{ls,q404q310} \end{aligned} \tag{16}$$

where:
$WCOST$ – labour cost per employee (cb),
$MVAQ$ – value added gross, market sector (cs),
LMD – labour demand which optimize production costs, market sector,
$dum^{ls,q404,q310}$ – dummy variable equal to one from the fourth quarter of 2004 up to the third quarter of 2010 and zero before.

In the short-run, the price of the market sector production adjusts to the equilibrium level determined by the long-term equation 16. In addition, dynamic specification involves changes in the labour costs, labour productivity and expected changes in prices. We assume that future price dynamics is consistent with the inflation target(2.5%). Such specification, taking into account forward looking inflationary expectations, is in line with the New Keynesian Phillips Curve (see Gali and Gertler (2000) and Budnik et al. (2009)).

$$\begin{aligned}\Delta log(PMVA_t) &= \underset{(-2.08)}{-0.11} \cdot (log(PMVA_{t-1}) - log(PMVA^*_{t-1})) \underset{(-2.41)}{-0.03} \cdot dum_t^{q205} \\ &+ (1-0.17) \cdot \left(\sqrt[4]{1+CPISTAR}-1\right) + \underset{(3.08)}{0.04} \cdot dum_t^{q109} \\ &+ \underset{(2.66)}{0.17} \cdot \Delta log\left(\frac{WCOST \cdot LMD}{MVAQ}\right) + \underset{(1.97)}{0.027} \cdot dum_t^{q204} \end{aligned} \quad (17)$$

where:
$CPISTAR$ – inflation target of CB (cb),
$MVAQ$ – value added gross, market sector (cs),
$WCOST$ – labour cost per employee (cb),
LMD – labour demand which optimize production costs, market sector,
dum_t^{q109} – dummy variable equal to one in the first quarter of 2009 and zero elsewhere,
dum_t^{q205} – dummy variable equal to one in the second quarter of 2005 and zero elsewhere,
dum_t^{q204} – dummy variable equal to one in the second quarter of 2004 and zero elsewhere.

$R^2 = 0.26$ $Adj.R^2 = 0.20$ $\sigma = 0.013$ $LMtest(p-value) = 0.08$

Wages in the market sector

The most important production factor is labour. Its price in the long-run depends positively on the labour productivity ($\gamma \cdot TREND\_TFP$) and negatively on the unemployment rate in the market sector (URM). In addition, we include a wedge (the difference between the wage value from an employee and employer's point of view) as a proxy of the bargaining process (the firm and labour suppliers). The fixed coefficient has been estimated on the historical data

and represents the market power of employers to adjust the gross wages in case of increase its contributions compared to the part of the tax wedge paid by employee. Thus, the wage curve formula may be expressed as:

$$\begin{aligned} log(3 \cdot MW^*) \quad = \quad & -log(1 + r\_ERCONT + r\_EROTH) + \underset{(129.7)}{8.59} + \gamma \cdot TREND\_TFP + \\ & + \underset{(4.8)}{0.48} \cdot log((1 + r\_ERCONT + r\_EROTH)/((1 - r\_EECONT) \cdot \\ & \cdot (1 - pfp\_WPIT - pfp\_TFI - pfp\_RESPIT - r\_HSHCD - \\ & - pfp\_DEDTAX))) + log(PCONSHS) - \underset{(-3.5)}{0.65} \cdot URM \\ & \underset{(-11.4)}{-0.12} \cdot dum^{ls,q404q310} \end{aligned} \tag{18}$$

where:

MW – average monthly wage and salary in the market sector (*cb*),

r_ERCONT, r_EROTH – social contribution rate of an employer (*cb*),

r_EECONT – employees' social contributions (retirement pays, pensions and illness) overall statutory rate (*cb*),

pfp_* – tax system parameters (see next section for more explanation),

$PCONSHS$ – deflator of household individual consumption (*cs*),

β – elasticity of production to the labour factor (production function parameter),

URM – average unemployment rate in the market sector,

$dum^{ls,q404q310}$ – dummy variable equal to one from the fourth quarter of 2004 to the third quarter of 2010 and zero before.

In the short-term, wages in the market sector adjust to their equilibrium level ($(3 \cdot MW)^*$). Dynamic specification involves also changes in the wedge and consumption prices. Accordingly:

$$\begin{aligned}\Delta log(3 \cdot MW_t) \quad = \quad & - \underset{(-3.67)}{0.33} \cdot (log(3 \cdot MW_{t-1}) - log(3 \cdot MW^*_{t-1})) - \underset{(-3.47)}{0.08} \cdot dum_t^{q299} + \\ & + (1 - 0.3) \cdot \Delta log(PCONSHS_t) + (1 - 0.3) \cdot \Delta log\left(\frac{MVAQ}{LM}\right) + \\ & + \underset{(2.90)}{0.3} \cdot \Delta \left(log(3 \cdot MW_{t-3}) \cdot (1 + r\_ERCONT_{t-3} + r\_EROTH_{t-3})\right) + \\ & + \underset{(2.64)}{0.38} \cdot \Delta log(((1 + r\_ERCONT + r\_EROTH)/((1 - r\_EECONT) \cdot \\ & \cdot (1 - pfp\_WPIT - pfp\_TFI - pfp\_RESPIT - r\_HSHCD - \\ & - pfp\_DEDTAX))) \end{aligned} \tag{19}$$

where:
dum_t^{q299} – dummy variable equal to one in the second quarter of 1999 and 0 elsewhere.

$R^2 = 0.41$ $Adj.R^2 = 0.378$ $\sigma = 0.025$ $LMtest(p - value) = 0.97$

Wages in the public sector are described in the public finance section 4.6.2.

NAWRU – Non-accelerating wage inflation rate of unemployment

It can be shown that within the bargaining framework the natural rate of unemployment in the NAWRU form, can be derived under the conditions that price and wage expectations are fulfilled (see e.g. Layard et al. (1991)). Substituting the wage curve, as expressed in 18, into the price curve (embodied in the formula for the market sector value added deflator – see (16), we obtain the following:

$$\begin{aligned} NAWRU \quad = \quad & (0.48 \cdot (log(1 + r\_ERCONT + r\_EROTH) - log((1 - r\_EECONT) \cdot \\ & \cdot (1 - pfp\_WPIT - pfp\_TFI - pfp\_RESPIT - r\_HSHCD \\ & - pfp\_DEDTAX))) + log(LMD) - log(MVAQ) + \gamma \cdot TREND\_TFP \\ & + log(PCONSHS) - log(PMVA) + (0.06{-}0.12) \cdot dum^{ls,q404q310} \\ & + 8.59 - 6.45)/0.65 \end{aligned} \tag{20}$$

where:
$NAWRU$ – non-accelerating wage inflation rate of unemployment (cb),
$MVAQ$ – value added gross, market sector (cs),
LMD – labour demand which optimize production costs, market sector,
$PMVA$ – deflator of value added market sector,
$PCONSHS$ – deflator of household individual consumption,

pfp_* – tax system parameters (see next section for more explanation).
(For explanation of other variables see sections on wages and deflators above).

The equilibrium rate of unemployment thus depends positively on the difference between the wage value from an employee and employer's point of view (first term on the right hand side of the above formula) as well as price wedge ($log(PCONSHS_t) - log(PMVA_t)$). $NAWRU$ goes up if an increase in productivity exceeds the marginal product of labour. Additionally, Poland's entry to the European Union contributed to the reduction in the equilibrium unemployment rate, what is captured by the respective dummy variable.

Tax wedge

The tax wedge is defined as a difference between the wage value from an employee and employer's point of view. Therefore:

$$\begin{aligned} WEDGE \;=\; & \left(\frac{1 + r\_ERCONT + r\_EROTH}{PMVA}\right) / ((1 - r\_EECONT) \cdot (1 - (1 - ee\_COST) \cdot \\ & \cdot (1 - pfp\_PITDEDINC) \cdot (pfp\_WPIT - pfp\_TFI - pfp\_RESPIT - \\ & - r\_HSHCD - pfp\_DEDTAX))/PCONSHS) \end{aligned} \tag{21}$$

where
$WEDGE$ – tax wedge (cb),
r_ERCONT – employers' social contributions (retirement pays, pensions and accidental) overall statutory rate (cb),
r_EROTH – employers' social contributions (other) overall statutory rate (cb),
$PMVA$ – deflator of value added, market sector,
r_EECONT – employees' social contributions (retirement pays, pensions and illness) overall statutory rate (cb),
ee_COST – relation of costs of obtained revenue from salaries to obtained revenue from salaries (PIT) (cb),
$pfp\_PITDEDINC$ – all deductions from income (PIT) (cb),
pfp_WPIT – weighted nominal tax rate (PIT) (cb),
pfp_TFI – tax-free income to taxable income (PIT) (cb),
pfp_RESPIT – residual unbalanced items (PIT) (cb),
r_HSHCD – health care contribution statutory rate deducted from PIT (cb),
pfp_DEDTAX – deductions from tax (PIT) other (cb),
$PCONSHS$ – deflator of household individual consumption (cs).

User cost of capital

The second production factor in the model is capital. User cost of capital (UCC) is derived from the Hall-Jorgenson formula (see Hall and Jorgenson (1967)), where it is determined by an interest rate (proxy for opportunity costs of lending the capital), prices of investment goods, depreciation rate of the capital in the market sector and effective corporate income tax (CIT) rate as a proxy for the value of taxes on potential profits from the capital. The formula for UCC is as follows:

$$UCC_t = \left(\frac{PMGFCF_t}{4} \cdot \left(\frac{MDEPR_t}{100} + \frac{1 + \frac{R\_5Y_t}{100}}{\frac{PMVA_t}{PMVA_{t-4}} - 1} \right) \right) \cdot \frac{1}{1 - pfp\_cit\_er} + res\_UCC \tag{22}$$

where

UCC – user cost of capital,

$PMGFCF$ – deflator of gross fixed capital formation, market sector (cs),

R_5Y – yield on 5-year treasury bond ($nominal$) (cb),

$PMVA$ – deflator of value added, market sector,

pfp_cit_er – effective CIT rate (cb),

res_UCC – difference between trend of the UCC and UCC unadjusted for short-run fluctuations.

In the model we actually use the trend of the UCC.

As stated at the beginning of this section, all other prices in the eMPF are determined mainly by the price of the value added in the market sector. Another factor affecting deflators level is the price of imports. The impact of both domestic and foreign prices on a particular deflator is either calibrated, using import intensities of particular demand components calculated from the input-output tables, or estimated.

Household consumption deflator

In the long run, price of the household consumption adjusted for VAT and excise tax is determined by the value added deflator and import prices. Taking into account the fact that in the long term the growth rate of $PMVA$ converges to the inflation target, which is consistent with the growth of world prices, this ensures that demand prices in the model converge to the world prices, as it should take place in case of a small open economy. The equation is as follows:

$$\begin{aligned}\log(PCONSHS^*) &= \log\left(VAT\_CONSHS\_I\_CSB \cdot RGGEXC\_I\_CSB\right) - \\ &- \underset{(-12.3)}{0.028} + \underset{(4.78)}{0.2} \cdot \log\left(PM\right) + (1-0.2) \cdot \log\left(PMVA\right) + \\ &+ \underset{(2.58)}{0.016} \cdot dum^{ls,q307q109} + \underset{(4.75)}{0.026} \cdot dum^{ls,q101q103} \end{aligned} \tag{23}$$

where:

$PCONSHS$ – deflator of household individual consumption (cs),

$VAT\_CONSHS\_I\_CSB$ – index of effective weighted VAT rate on household consumption expenditures (cb),

$RGGEXC\_I\_CSB$ – index of effective weighted excise rate (cs),

PM – deflator of imports of goods and services,

$PMVA$ –deflator of value added, market sector,

$dum^{ls,q307q109}$ – dummy variable equal to one from the third quarter of 2007 to the first quarter of 2009 and zero elsewhere,

$dum^{ls,q101q103}$ – dummy variable equal to one from the first quarter of 2001 to the first quarter of 2003 and zero elsewhere.

In the short run, household consumption deflator is determined by deviations from its estimated equilibrium level and changes in import prices and value added deflator:

$$\begin{aligned}\Delta log(PCONSHS_t) &= - \underset{(-4.8)}{0.43} \cdot (log(PCONSHS_{t-1}) - log(PCONSHS^*_{t-1})) \\ &+ \Delta \log\left(VAT\_CONSHS\_I\_CSB_t \cdot RGGEXC\_I\_CSB_t\right) \\ &+ \underset{(2.6)}{0.09} \cdot \Delta \log\left(PM_t\right) + (1-0.09) \cdot \Delta \log\left(PMVA_t\right) \\ &- \underset{(-3.5)}{0.018} \cdot dum_t^{o,q102q202} \end{aligned} \tag{24}$$

where:

$dum_t^{o,q102q202}$ – dummy variable equal to 1 in the first quarter of 2002, -1 in the second quarter of 2002 and 0 elsewhere.

$R^2 = 0.66 \qquad Adj.R^2 = 0.65 \qquad \sigma = 0.01 \qquad LMtest(p-value) = 0.55$

Market gross fixed capital formation deflator

In case of market investments deflator ($PMGFCF$), the long term impact of the value added deflator in the market sector ($PMVA$) and import prices (PM) has been estimated. As an additional factors, we have also included the effective market investments VAT rate

($VAT\_IM\_I\_CSB$) with assumed unitary elasticity as well as dummy variables. The first one has been equal to one before the first quarter of 2009 and zero afterwards and the second one has been equal to one before the first quarter of 2004.

$$\begin{aligned} log(PMGFCF^*) &= \underset{(20.2)}{0.97} \cdot log(PMVA) + (1 - 0.97) \cdot log(PM) + log(VAT\_IM\_I\_CSB) \\ &\quad - \underset{(-9.5)}{0.05} + \underset{(7.7)}{0.046} \cdot dum^{ls,q100q109} + \underset{(7.2)}{0.03} \cdot dum^{ls,q100q104} \end{aligned} \tag{25}$$

In the short run, changes in the price of market gross fixed capital formation are determined by error correction term(deviation from estimated equilibrium level) and fluctuations of the producer and import prices (with dynamic homogeneity restriction imposed).

$$\begin{aligned} \Delta log(PMGFCF_t) &= \underset{(-4.85)}{-0.72} \cdot (log(PMGFCF_{t-1}) - log(PMGFCF^*_{t-1})) \\ &\quad + \underset{(16.7)}{0.97} \cdot \ \Delta log(PMVA_t) + (1 - 0.97) \cdot \Delta \log(PM) \\ &\quad + \Delta log(VAT\_IM\_I\_CSB_t) \end{aligned} \tag{26}$$

$R^2 = 0.67$ $Adj.R^2 = 0.66$ $\sigma = 0.011$ $LMtest(p - value) = 0.63$

Prices of gross fixed capital formation in the general government sector

In the model, we have assumed that prices of the general government investments ($PGGGFCF$) net of corresponding VAT rate are equal to the adjusted investment prices in the market sector ($PMGFCF$). The only difference between both categories lies in the discrepancy of the effective VAT for both type of activities. It is captured by the following formula:

$$\frac{PGGGFCF}{VAT\_IG\_I\_CSB} = \frac{PMGFCF}{VAT\_IM\_I\_CSB} \tag{27}$$

where:

$VAT\_IG\_I\_CSB$ – index of an effective weighted VAT rate on government investment,

$VAT\_IM\_I\_CSB$ – index of an effective weighted VAT rate on market investment.

General government intermediate consumption deflator

The price of an intermediate consumption of the public sector ($PGGIC$) is modelled as a weighted average of the market sector value added and imports' deflators, adjusted for the effective VAT rate. In addition, the long-run equation includes two dummies: the first one

($dum^{ls,q206}$) equals to one from the second quarter of 2006 onwards and zero before that period, whereas the second one ($dum^{ls,q201}$) equals to one from the second quarter of 2001 onwards and zero before.

$$\begin{aligned} log(PGGIC^*) &= \underset{(-31.6)}{-0.23} + \underset{(10.4)}{0.99} \cdot logPMVA + (1 - 0.99) \cdot log(PM) + \underset{(12.6)}{0.11} \cdot dum^{ls,q206} \\ &\quad + \underset{(9.3)}{0.10} \cdot dum^{ls,q201} + log(VAT\_ICGG\_I\_CSB) \end{aligned} \tag{28}$$

Short term fluctuations around the above defined equilibrium level are a function of changes in prices of market value added, import prices, lagged intermediate consumption deflator and effective VAT rate.

$$\begin{aligned} \Delta log(PGGIC_t) &= \underset{(-2.6)}{-0.14} \cdot (log(PGGIC_{t-1}) - log(PGGIC^*_{t-1})) + \underset{(3.1)}{0.30} \cdot \Delta log(PMVA_t) \\ &\quad + \underset{(2.1)}{0.09} \cdot \Delta log(PM_t) \\ &\quad + \underset{(3.9)}{0.41} \cdot (\Delta log(PGGIC_{t-1}) - \Delta \log(VAT\_ICGG\_I\_CSB_{t-1})) \\ &\quad + (1 - 0.30 - 0.09 - 0.41) \cdot \Delta \log(PMVA_{t-1}) \\ &\quad + \Delta log(VAT\_ICGG\_I\_CSB_t) \end{aligned} \tag{29}$$

$R^2 = 0.21$ $Adj.R^2 = 0.16$ $\sigma = 0.005$ $LMtest(p - value) = 0.08$

GDP deflator

In the $eMPF$ model most of the deflators for aggregates is modelled indirectly as the ratio of the nominal series to the values of the corresponding series in real terms. One example of such an aggregate is gross domestic product. The deflator of it is simply a folowing formula:

$$PGDP = \frac{GDP}{GDPQ} \tag{30}$$

Other deflators of minor importance for the whole system are expressed in an analogous way to the $PGDP$. It refers to the following deflators:

- $PCONS$ (total consumption),
- $PGFCF$ (gross fixed capital formation),
- $PTXSBP$ (taxes on products minus subsidies on products).

Consumer price index

In the long-run we assumed that the level of consumer prices ($PCPI$) is determined by household consumption deflator ($PCONSHS$). The baskets of goods for both categories are different, however the difference is not so important from the model point of view. As can be seen from the equation below, it is close to 1%, with exception of dummies.

$$\begin{aligned} \log(PCPI^*) &= \underset{(2.84)}{0.01} + \log(PCONSHS) + \underset{(7.37)}{0.032} \cdot dum^{ls,q200} \\ &\quad - \underset{(-2.72)}{0.01} \cdot dum^{ls,q200q109} - \underset{(-2.76)}{0.026} \cdot dum^{q397} \end{aligned} \tag{31}$$

where:

$dum^{ls,q200}$ – a dummy variable equal to one from the second quarter of 2000 onwards an zero before that period,

$dum^{ls,q200q109}$ – a dummy variable equal to one from the second quarter of 2000 to the first quarter of 2009 and zero elsewhere,

dum^{q397} – a variable equal to one in the third quarter of 1997 and zero elsewhere.

In the short-run, CPI dynamics adjusts to the equilibrium level determined by the long-run equation. Additionally, dynamic specification involves changes in households consumption deflator:

$$\Delta \log(PCPI) = \underset{(-5.65)}{-0.69} \cdot (log(PCPI_{t-1}) - log(PCPI^*_{t-1})) + \Delta log(PCONSHS_t) \tag{32}$$

Annual dynamics of consumer price index (CPI) is given by the formula:

$$CPI_t = \left(\frac{PCPI_t}{PCPI_{t-4}} \right) \cdot 100 - 100 \tag{33}$$

4.3 Labour supply

Labour supply is a number of workers willing to work in a given market conditions. From the accounting point of view it is a simple sum of employed and registered unemployed. In order to better capture the specific factors influencing labour supply of young, prime-age and elderly workers, we decided to divide it into three age groups: 18-24 (young), 25-44 (prime-age) and 45-59/64 (old-age). Labour force in the eMPF model is defined in a way that is consistent with data on the "registered unemployment". However, as registered data do not provide the distinction between age groups, we used Labour Force Survey (LFS) data to divide labour supply into the abovementioned age groups. As the Ministry of Finance in Poland is the key

centre of the medium-term forecasts for the government, it has to provide forecasts of the specific macreoconomic categories for the budget bill. It is harder to lean forecasts of these categories on the LFS data than using "registered" data. Both advantages and drawbacks of the LFS vs. "registerd" data were analyzed from the Ministry's forecast obligations point of view and it was decided to use detailed information from the LFS and at the same time stay consistent with forecast requirements. It is described in more details in the internal study of the Ministry of Finance in Poland - see Ministry of Finance (2009).

Labour supply in the eMPF model is a product of *a priori* assumed participation rate and average number of working age population. Taking into consideration demographical structure, calculations of total labour supply have been made on the basis of three consecutive age groups (the young - Y, prime-age - M and elderly - O workers). The participation rates have been calibrated to be consistent with the respective Eurostat projections. In the future some additional research is going to be done to make the participation rates endogenous and explain by the behaviour of other variables being present in the model. In line with the above:

$$LS = \sum_{i \in \{M,O,Y\}} ACT\_RATE\_i \cdot POPWA\_i = LS\_M + LS\_O + LS\_Y \tag{34}$$

where:

LS – average labour supply,

LS_i – average labour supply of accordingly M (prime-age), O (old), Y (young) age group,

ACT_RATE_i – participation rate of accordingly M, O, Y age group,

$POPWA\_i$ – average number of working age population accordingly M, O, Y.

4.4 The demand side

4.4.1 Household sector

Household sector is of huge importance for the general government sector. Households are recipients of social benefits and at the same time this sector generates the largest part of general government revenues. In 2010 total value of taxes and social contributions levied on households amounted to around 50% of public sector revenues.

As households are the ultimate owners of the production factors and all assets in the economy, it is this sector by means of which nominal economy (wages, asset prices etc.) affects real economy (private consumption and then GDP).

Household sector in the eMPF model is a part of the market sector and is divided into

five subsectors: employees, self-employees in non-agricultural subsector, old-age pensioners, pensioners and agricultural subsector.

4.4.2 Consumption function

Private consumption[7] is the largest component of gross domestic product. In Poland it constitutes around 60% of GDP. The consumption function is a key behavioral equation in the household sector block and one of the most important equations in the model.

In the eMPF model long-run relationship for consumption ($CONSHSQ_t$) is derived from the approximated version (i.e. for the logarithms of the variables) of the permanent income model (see Campbell and Mankiw (1989)). According to this model, consumption in the long -run is proportional to wealth of a representative consumer. Theoretical wealth is a sum of net assets (non-human wealth) and (unobserved) discounted present value of future non-property income (human wealth). Regarding the stock-flow stability condition of the macroeconometric model, both wealth and income of households should be defined in a broader sense, i.e. taking into account the consolidation of the flows between institutional sectors and an assumption that households are ultimate owners of all assets and debt in the economy. Accordingly, in the eMPF model real wealth ($PRWQ$) is defined as the sum of the real capital stock (MK) and net financial assets with the latter being decomposed further into net foreign assets (NFA) and public debt ($GDEBT\_ESA$), deflated with private consumption deflator:

$$PRWQ = MK + NFA/PCONSHS + GDEBT\_ESA/PCONSHS \tag{35}$$

Gross disposable income of households ($HSGDI$) consists of compensation ($HSLC$), small enterprises' and farmers' incomes ($HSGOS$), general government transfers ($GGSSBE$) and other transfers to the household sector ($HSNTR$) as well as households' property income ($HSPIN$). In order to assure consistency within this approach, households' income is augmented with disposable income of enterprises, here proxied with the corporate gross operating surplus ($CORPGOS$). Similar concept of income and wealth in the consumption function is used in Willman and Estrada (2002). Social contributions and taxes paid by households are subtracted from the calculated income.

Long-run relation between consumption, disposable income and assets is captured by a cointegrating vector. It has been estimated using the VAR model with the above-mentioned three variables. Long-run homogeneity between consumption, income and wealth has been tested

[7] According to national accounts methodology, private consumption consists of individual consumption of households and consumption of the non-profit institutions serving households

and not rejected. In line with the cointegrating vector under the homogeneity restriction, consumption in the long-run depends positively on income and total wealth (as defined above):

$$\begin{aligned} log(CONSHSQ^*) &= \underset{(25.8)}{0.79} \cdot log((HSGDI + CORPGOS)/PCONSHS) + \\ &+ (1 - 0.79) \cdot log(PRWQ) + \underset{(3.0)}{0.05} \cdot dum^{q408} \underset{(-12.2)}{-0.76} \end{aligned} \tag{36}$$

where:

$CONSHSQ^*$ – individual consumption of households (cs),

$HSGDI$ – gross disposable income of households and non-profit institutions (cb),

$CORPGOS$ – gross operating surplus in corporation sectors (cb),

$PCONSHS$ – deflator of household individual consumption (cs),

$PRWQ$ – private sector real wealth (cs),

dum^{q408} – 0-1 variable, equal to 1 in the forth quarter of 2008 and 0 elsewhere.

In line with the rational expectations permanent income theory, interest rates do not affect long-run consumption directly, only indirectly via wealth.

In the eMPF model short-run fluctuations of private consumption are a result of an adjustment of this category to the estimated long-run relation, changes in households' non-property income (broadly defined) and wealth, lagged changes in potential output, consumption and real interest rate. The last two variables capture respectively: consumers' habits and uncertainty they face. Accordingly, short-run version of the consumption function is as follows:

$$\begin{aligned} \Delta log(CONSHSQ_t) &= \underset{(-2.28)}{-0.12} \cdot (log(CONSHSQ_{t-1}) - log(CONSHSQ^*_{t-1})) + \\ &+ \underset{(3.08)}{0.12} \cdot \Delta log\left(\frac{HSGDI_t + CORPGOS_t}{PCONSHS_t}\right) \underset{(-2.15)}{-0.0009} \cdot \Delta RR\_3M_{t-1} \\ &+ \underset{(2.54)}{0.21} \cdot \Delta log(PRWQ_{t-2}) + \underset{(2.58)}{0.27} \cdot \Delta log\left(CONSHSQ_{t-1}\right) + \\ &+ (1 - 0.15 - 0.21 - 0.27) \cdot \Delta log(MVAQPOT_{t-1}) + \\ &- \underset{-2.12}{0.013} \cdot dum^{q209} \end{aligned} \tag{37}$$

where:

$CONSHSQ^*$ – individual consumption of households (cs),

RR_3M – 3 month WIBOR ($real$),

$MVAQPOT$ – potential gross value added in the market sector (cs).

$R^2 = 0.18$ $Adj.R^2 = 0.09$ $\sigma = 0.006$ $LMtest(p - value) = 0.21$

4.4.3 Households' disposable income

Gross disposable income of households ($HSGDI$) is calculated according to the national accounts methodology as:

$$\begin{aligned} HSDGI &= HSGOS + HSWSOLC + HSPIN + HSSAB + \\ &\quad + HSNTR - SCSF - HSTAX - EECONTHC \end{aligned} \tag{38}$$

where:
$HSGOS$ – gross operating surplus and mixed income of households and non-profit institutions (*cb*),
$HSLC$ – compensation,
$HSPIN$ – property income (*balance*) of households and non-profit institutions (*cb*),
$HSSAB$ – social assistance benefits (*cb*),
$HSSAB$ – social security benefits,
$HSNTR$ – other current transfers (balance) in households and non-profit institutions sector (*cb*),
$HSCSF$ – social contributions (*cb*),
$HSTAX$ – current taxes on income, wealth, etc. paid by households (*cb*).

Disposable income components are modelled separately in the eMPF model. The largest part of households' gross disposable income ($HSGDI$) constitutes production factors income, mainly compensation ($HSLC$) including social contributions borne by employers, gross operating surplus including mixed income ($HSGOS$) and property income ($HSPIN$). Gross opertaing surplus in the households sector is a function of the gross value added in the market sector. Compensation is a sum of wages and salaries received by households ($HSWSOLC$) and social contributions paid by employers ($ERCONT$). Wages and salaries of households in the eMPF model are modelled separately for the general government sector, market sector and external sector. Accordingly:

$$HSWSOLC = GGWSOLC + MWSOLC + WS\_EX, \tag{39}$$

where:
$HSWSOLC$ – wages, salaries and other income connected with hired work received by households (*cb*),
$GGWSOLC$ – fund of general government wages, salaries and other income connected with hired work (*cb*),
$MWSOLC$ – fund of market sector wages, salaries and other income connected with hired work (*cb*),
WS_EX – external sector wages, salaries and other income connected with hired work (balance) (*cb*).

Wages, salaries and other income connected with hired work earned by households in the public sector are simply average quarterly wage in this sector multiplied by the number of employees. The analoguos formula applies for the market sector.Some scaling parameter (1000) is also applied to adjust the units other data are presented in. Accordingly:

$$GGWSOLC = \frac{3 \cdot GGW \cdot LEG}{1000} \tag{40}$$

$$MWSOLC = \frac{3 \cdot MW \cdot LEM}{1000} \tag{41}$$

where:

MW, GGW – average monthly wage and salary in market sector (cb) and average monthly wage and salary GG sector (cb),

LEM, LEG – average number of paid employment in market sector and average paid employment in general government sector.

Real wages and salaries from abroad (WS_EX) in the long-run depend positively on the world demand (with unity coefficient). Some dummies are incorporated to account for the EU pre-accession period as well as the beginning of the global financial crisis. Accordingly:

$$\begin{aligned} log\left(\frac{WS\_EX^*}{PLNEUR \cdot PP\_EU27}\right) &= \underset{(23.66)}{0.72} + log(WDINDIC) + \underset{(24.59)}{1.04} \cdot dum^{ls,q403} - \\ &\quad - \underset{(-6.34)}{0.77} \cdot dum^{q403} - \underset{(-10.1)}{0.47} \cdot dum^{ls,q108} \end{aligned} \tag{42}$$

where:

WS_EX^* – external sector wages, salaries and other income connected with hired work (balance) (cb),

$WDINDIC$ – world demand index (cs),

PP_EU27 – foreign prices (cb),

$PLNEUR$ – PLN/EUR exchange rate (cb),

$dum^{ls,q403}$, $dum^{ls,q108}$ – 0-1 variable, equal to 1 from the respective quarter onwards and 0 before,

dum^{q403} – a 0-1 variable equal to 1 in the forth quarter of 2003 and zero elsewhere.

In the short-run, wages and salaries from abroad are driven by deviations of this variable from its long-run level, changes in world demand volume (dynamic homogeneity restriction is imposed) and dummies.

Property income of households includes interest received and paid by households, distributed income of corporations, property income attributed to policy insurance holders (including profits on investing Open Pension Funds contributions) as well as rents paid by households. In

2000-2010 property income constituted 6.3% of households disposable income (4.9% in 2010). In the eMPF model property income of households and non-profit institutions ($HSPIN$) is modelled as income rendered on the private wealth. In the long-run, property income is homogeneous in relation to this theoretically defined (i.e. using consolidated wealth concept) property income:

$$log\left(\frac{HSPIN^*}{PCONSHS}\right) = \underset{(-408.7)}{-5.27} + log\left(\left(\left(1+\frac{rr\_3m}{100}\right)^{0.25}-1\right)\cdot PRWQ\right) - \underset{(-3.25)}{0.19}\cdot dum^{q408} + \underset{(23.4)}{+0.4}\cdot dum^{ls,q305} - \underset{(-5.0)}{0.2}\cdot dum^{o,q305} \underset{(-7.46)}{-0.15}\cdot dum^{q103,q205} \quad (43)$$

where:

$(HSPIN^*/PCONSHS)$ – property income (*balance*) of households and non-profit institutions (*cb*) deflated by deflator of household individual consumption,

RR_3M – 3 month WIBOR (*real*),

$PRWQ$ – private sector real wealth (*cs*),

$PCONSHS$ – deflator of household individual consumption (*cs*),

$dum^{ls,q305}$ – 0-1 variable, equal to 0 from the forth quarter of 2005 onwards and 1 before,

$dum^{o,q305}$ – 0-1 variable, equal to 1 in the third quarter of 2005 and -1 in the forth quarter,

dum^{q408} – 0-1 variable equal to 1 in the forth quarter of 2008 and zero elsewhere,

$dum^{ls,q103q205}$ – 0-1 variable, equal to 1 from the first quarter of 2003 to the second quarter of 2005 and zero elsewhere.

In the short-run, households' property income fluctuations are driven by deviations of this variable from its long-run level, lagged dependent variable and changes in real wealth corrected for general government debt.

Another part of the households disposable income are social assistance benefits. In 2000-2010 they constituted 3.6% of households disposable income (3.5% in 2010). That include Labour Fund benefits (mainly unemployment benefits, pre-retirement benefits and allowances), family and attendance allowances, scholarships and grants as well as one-off child-birth aid. Social assistance in the long-run is assumed to follow estimated relation to GDP. In the short-run some adjustment to the long-term relation is allowed according to the following equation:

$$\Delta log(HSSAB_t) = \underset{(-3.48)}{-0.33} \cdot (log(HSSAB_{t-1}) - log(HSSAB^*_{t-1}) + \Delta log(GDP_{t-1}) + \\ + \underset{(1.86)}{0.13} \cdot dum_t^{q406} + \underset{(2.8)}{0.14} \cdot dum_t^{o,q107q108} - \underset{(-2.9)}{0.21} \cdot dum_t^{q397} \quad (44)$$

where:
$HSSAB^*$ – social assistance benefits (cb) in equilibrium,
$HSSAB$ – social assistance benefits (cb),
GDP – gross domestic product (cb),
dum^{q406},dum^{q397} – 0-1 variable equal to 1 in the relevant quarter and zero elsewhere,
$dum^{o,q107q108}$ – 0-1 variable equal to 1 in the first quarter of 2007, -1 in the first quarter of 2008, and zero elsewhere.

$R^2 = 0.41$ $Adj.R^2 = 0.37$ $\sigma = 0.07$ $LMtest(p-value) = 0.58$

(t-statistic in brackets)

Other current transfers have been modelled in proportion to nominal GDP.

Around 20% of total disposable constitute social security benefits. At the same time they constitute roughly 30% of the general government sector total expenditures. Social security system is described in detail in the public finance block.

Taxes paid by households

Main taxes paid by households are:

- personal income tax,
- inheritance and donation tax,
- tax on civil law actions,
- agricultural tax,
- forest tax,
- real estate tax,
- value added tax and excise duty, both included in prices paid.

Personal income tax covers all kind of income with major exemption of income from agriculture and from social assistance. Tax is levied on income i.e. gross income (gross earnings) after deductions of tax costs. There are tax reliefs deductible either from income or from tax.

Main deductions from income are: social security contributions, losses from previous years (in case of business income) and expenses for the purpose of rehabilitation incurred by a taxpayer who is a disabled person, or a taxpayer who supports the disabled or for use of Internet. Generally tax is calculated according to tax scale with tax rates of 18% and 32%, tax bracket of 85,525 PLN and basic allowance of 556.02 PLN deductible from tax.
Deduction from taxes covers:

- contributions paid to National Health Fund (but no more than 7.75% of base of calculation of contribution),
- child allowances,
- 1% of due tax for public benefit organizations.

As for **business activity income** taxpayer can choose between taxation according to general terms (progressive tax scale), flat tax rate of 19% of income, lump-sum taxation or 'tax card'. Submission of written declaration on the choice to local tax office is obligatory.
The lump-sum taxation may be chosen by taxpayer who in previous year raised revenue from economic activity at the amount not exceeding 150,000 EUR, or when - in the case of partnership - the revenue raised by the all partners from such an activity did not exceed 150,000 EUR.
The lump-sum tax rates on registered revenue amount to:

- 20% for revenue raised by liberal professions and revenue from contracts of lease, sublease, tenancy or subtenancy or other contracts of similar nature on the surplus over the equivalent of 4,000 EUR,
- 17% for revenue raised, inter alia, from rendering the following services: car rent, hotels, agency in wholesale trade,
- 8.5% on revenue gained, inter alia, from service activities, including the sale of drinks with the volume of alcohol above 1.5%, from contracts of lease, sublease, tenancy or subtenancy or other contracts of similar nature on the equivalent of up to 4,000 EUR,
- 5.5% on income gained from production and construction activities,
- 3.0% on income gained from service activities in the scope of trade and catering, with the exception of income on the sale of drinks with the volume of alcohol above 1.5%.

Tax base is revenue without deduction of costs.
Rates of 'tax card' are specified in amount in tax office decision and depend on:

- the form and scope of the activity performed,
- the number of employees,
- the number of inhabitants of the place where the economic activity is performed.

Married couples may, at request, be taxed jointly (the tax is assessed on behalf of both spouses in the amount equal to double of the tax calculated for half of the joint taxable incomes of the spouses, provided that the sum of such incomes shall not include incomes (revenues) liable to flat tax rate of 19% or a lump sum taxation or to tonnage tax). The same rules apply to **person solely bringing up a child**.

In the eMPF model taxes paid by households are the sum of income taxes ($GGTAXIFHS$) and other taxes ($HSOTHTAX$):

$$HSTAX = GGTAXIFHS + HSOTHTAX \tag{45}$$

Main part of taxes paid by households sector are taxes on income($GGTAXIFHS$). Income taxes are calculated as gross earnings (i.e. including taxes and social contributions) diminished by the social contributions and corrected for the taxed income deductions (modelled by the $pfp\_PITDEDINC$ parameter) multiplied by the weighted average personal income tax (pfp_WPIT) and diminished by the amount deductible from tax (including part of the health contribution rate – modelled by the pfp_TFI and r_HSHCD) as well as other tax deductions (pfp_DEDTAX). Resulting tax value is then corrected for the differences between personal income tax forms data and national accounts data (pfp_RESPIT). Tax base for personal income tax is modelled in the eMPF model separately for contract employees ($HSWSOLC = GGWSOLC + MWSOLC$), pensioners ($HSB$), self-employed and own-account workers, including farmers ($HSGOS$) and property income earners ($HSPIN$). In addition, some households pay the lump-sum tax ($PITLUMP$) and those running businesses pay simple 19% tax rate. In line with the above, the formula for income taxes paid by households in the eMPF model is as follows:

$$\begin{aligned} log(GGTAXIFHS_t) \;=\; & log(((HSWSOLC_t \cdot (1 - EE\_COST_t) \cdot (1 - r\_EECONT_t) + HSB_t) \cdot \\ & \cdot (1 - pfp\_PITDEDINC_t) \cdot (pfp\_WPIT_t - pfp\_TFI_t \\ & - pfp\_RESPIT_t - r\_HSHCD_t - pfp\_DEDTAX_t)) + (HSGOS_t \cdot \\ & \cdot (1 - HSGOS\_COST_t) - (r\_ERCONT_t + r\_EECONT_t + r\_EROTH_t) \\ & \cdot (0.6 \cdot (\frac{1}{3}(3W_{t-2}) + \frac{2}{3}(3W_{t-3})) \cdot pfp\_LSELFT_t \cdot LSELFT_t/1000))) \cdot \\ & \cdot 0.19 + (HSPIN_t \cdot (1 - HSPIN\_COST_t)) \cdot 0.19 + PITLUMP_t) \\ & + 0.29 \cdot dum_t^{q207} + 0.28 \cdot dum_t^{q308q109} \end{aligned} \tag{46}$$

where:
EE_COST_t – relation of costs of obtained revenue from salaries to obtained revenue from salaries (PIT) (cb),
r_EECONT – employees' social contributions (retirement pays, pensions and illness) overall statutory rate (cb),
HSB – average quarterly retirement pay and pension bill (cb),
$(r\_ERCONT + r\_EROTH)$ – sum of social contribution rates paid by employers,
r_HSHCD – health care contribution statutory rate deducted from PIT (cb),
$HSGOS\_COST$ – relation of costs of obtained revenue from non-agricultural economic activity to obtained revenue from non-agricultural economic activity (cb),
W – average monthly wage and salary (cb),
$LSELFT$ – average number of employers and own-account workers and the rest employment,
pfp_LSELFT – share of taxpayers earning income from non-agricultural business and special branches of agricultural production in average number of employers and own-account workers and the rest employment (cb),
$HSPIN\_COST$ – relation of costs of obtained revenue from property rights, rent or lease to obtained revenue from property rights, rent or lease (cb),
$PITLUMP$ – lump-sum personal income tax (cb).

Due to the fact that in the history the calculated data do not exactly correspond the observed one, in the eMPF model we decided to include the dynamic equation for $GGTAXIFHS$ as an usual error correction type equation. It represents kind of bridge equation between theoretical taxes and those recorded in the GG balance-sheets.
Lump-sum of taxes paid by households are modelled in relation to the gross operating surplus. Other taxes paid by households (agriculture tax, forest tax, property tax and other taxes) that constitute around 10% of total taxes on income and wealth paid by households have been modelled altogether in relation to GDP.

Social contributions

Social insurance contributions cover:

- old-age pension insurance,
- disability and survivors' pension insurance,
- sickness insurance,
- work accident insurance,

- health insurance.

The first four contributions from the above list are provided by ZUS (Social Insurance Institution) and the last one is provided by NFZ (National Health Fund).
Contributions are obligatory in case of employment, self-employment, business activity. Additionally, retired or disabled persons receiving pensions are obliged to pay health insurance contributions.
ZUS contributions differ depending on group of insured persons, i.e.:

- for employees, freelancers, members of agricultural production cooperatives - revenue as described in Law on natural person income tax (PIT Act),
- for persons running business outside of agriculture - declared income but not less than 60% of average wage in previous quarter,
- for recipients of unemployment benefits - the amount of the benefits,
- for clergy and non-professional soldiers - minimum wage,
- for others - amount of remuneration.

The calculation base is similar to that used for calculation of the social insurance contribution. The base including almost all incomes of an insured person without limiting the total amount of these incomes. In consequence, the base for calculating the health insurance premiums became similar to incomes taxable by personal income tax (PIT).
The percentage rates of contributions in each insurance type are uniform for all insured persons. The rates are:

- 19.52% - for old-age pension insurance,
- 6% - for disability and survivors' pension insurance,
- 2.45% - for sickness insurance,
- 0.4% - 8.12% - for work accident insurance.

Since 1 January 2003 a percentage rate of a contribution to work accident insurance has been differentiated for individual contribution payers and depends on risk category and on a number of persons notified to work accident insurance.
Contributions to old-age pension insurance are financed by insured persons and contribution payers, in equal parts. Contributions to sickness insurance (2.45%) are fully financed by insured persons. Contributions to accident insurance are fully financed by contribution payers.

In the eMPF model social contributions ($HSCSF$) are calculated as a sum of contributions paid by employers ($ERCONT$), contributions paid by contract employees ($EECONTHC$), self-employed and own-account workers ($SCSF$).
Contributions paid by the employers have been modelled as a product of an appropriate contribution rate ($r\_ERCONT + r\_EROTH$) and aggregated contribution base (wages, salaries and other income connected with hired work received by households – $HSWSOLC$). Due to the change in the average value of this category (in logarithm) in the first quarter of 2000, it is modelled in a form of a switching equation:

$$\begin{aligned} log(ERCONT) &= dum^{ls,q100} \cdot \underset{(-10.4)}{(-0.24} + log((r\_ERCONT + r\_EROTH) \cdot HSWSOLC)) + \\ &+ (1 - dum^{ls,q100}) \cdot \underset{(-21.3)}{(-0.29} + log((r\_ERCONT + r\_EROTH) \cdot \\ &\cdot HSWSOLC) + \underset{(8.1)}{0.25} \cdot dum^{ls,q408} \end{aligned} \tag{47}$$

Social contributions paid by contract employees ($EECONTHC_t$) have been modelled as a product of appropriate contribution rate (r_EECONT), augmented by the health contribution rate (r_HSHC), and aggregated contribution base ($HSWSOLC$):

$$\begin{aligned} log(EECONTHC) &= \underset{(-66.4)}{-0.27} + log((r\_EECONT + (1 - r\_EECONT) \cdot r\_HSHC) \cdot \\ &\cdot HSWSOLC) - \underset{(-4.6)}{0.09} \cdot dum^{o,q199q299} + \underset{(3.9)}{0.05} \cdot dum^{ls,q399q103} - \\ &- \underset{(-2.3)}{0.03} \cdot dum^{o,q408q109} \end{aligned} \tag{48}$$

Social contributions of self-employed, own-account workers and farmers ($SCSF$) have been modelled on the basis of the aforementioned legal regulations (this category includes also the health-care contributions amount paid by the pensioners ($r\_HSHC_t \cdot HSB_t$)). Accordingly, the formula is as follows :

$$\begin{aligned} SCSF_t &= sc\_SCSF_t \cdot ((r\_ERCONT_t + r\_EECONT_t + r\_EROTH_t) \cdot \\ &\cdot (0.6 \cdot (\frac{1}{3}(3W_{t-2}) + \frac{2}{3}(3W_{t-3})) + r\_HSHC \cdot (0.75 \cdot (\frac{1}{3}(3MW_{t-2}) + \frac{2}{3}(3MW_{t-3})) \cdot \\ &\cdot pfp\_LSELFT_t \cdot LSELFT_t/1000) + r\_HSHC_t \cdot HSB_t + 0.3 \cdot 0.5 \cdot RETNA_t \cdot \\ &\cdot pfp\_KRUS_t \cdot LSELFT_t/1000) \end{aligned} \tag{49}$$

where:

sc_SCSF – scaling parameter $SCSF$ equation (cb),

$(r\_ERCONT + r\_EROTH)$ – sum of social contribution rates paid by employers,

r_EECONT – employees' social contributions (retirement pays, pensions and illness) overall statutory rate (cb),

r_HSHC – health care contribution statutory rate (cb),
$LSELFT$ – average number of employers and own-account workers and the rest employment,
pfp_LSELFT – share of taxpayers earning income from non-agricultural business and special branches of agricultural production in average number of employers and own-account workers and the rest employment (cb),
HSB – average quarterly retirement pay and pension bill (cb),
$RETNA$ – average monthly retirement pay from non-agricultural social security system (cb),
pfp_KRUS – share of persons insured in Agriculture Social Security Fund (KRUS) in average number of employers and own account workers and the rest employment.

4.4.4 External sector

In the preliminary version of the model exchange rate was specified according to the BEER approach. The problem with such specification is that it does not necessarily lead to the steady-state level of current account balance as well as it does not ensure internal convergence to the long run paths. To ensure sustainable current account balance, the medium-term fundamental equilibrium exchange rate approach is implemented. In the literature the real exchange rate consistent with simultaneous internal-external balance is known as fundamental equilibrium exchange rate (FEER). Under the FEER approach, internal balance refers to the potential production and low inflation. External balance definition is used for the sustainable current account balance. In order to ensure the model convergence to the long-run path, the level of the FEER is calculated on the basis of a complete system in the eMPF model. Due to this, the calculations have been made using whole sequence of economic accounts as well as its long-run paths. In line with this, FEER is the real exchange rate that ensures fulfilment the steady-state condition:

$$CA = TCA \tag{50}$$

where CA is current account balance in relation to GDP and TCA is a current account ratio which provides convergence of net foreign assets to the desired level in relation to gross domestic product (NFA_TARGET). The left-hand side of the identity $CA = TCA$ is a sum of net export balance, income balance CA_CAI and current transfers balance CA_CAT. Accordingly:

$$CA = NEXP + CA\_CAI + CA\_CAT \tag{51}$$

Exchange rate

In the eMPF model the real exchange rate is defined as a relative price of domestic goods to foreign goods:

$$RER = \frac{PMVA}{PP\_EU27 \cdot PLNEUR} \tag{52}$$

where:
RER – real exchange rate,
$PMVA$ – deflator of value added, market sector,
PP_EU27 – foreign prices,
$PLNEUR$ – PLN/EUR exchange rate.

To provide internal-external equilibrium the real exchange rate in the long term converges to the steady state level set by the FEER. Building the model we faced the problem of FEER determination. Referring to the literature, calculations can be made via full scale macroeconometric model or partial equilibrium approach based on the foreign trade model. To provide that the level of FEER is consistent with the steady state of the eMPF model we have chosen the full scale macroeconometric model approach. According to this approach, the level of FEER is determined in two steps. In the first step, using long-run equations for $PMVA$, MW, $PCONSHS$ and PM, we simply set the exchange rate level that provides internal equilibrium.

The external balance represented by the attainment of the current account balance its target level is incorporated by changing the constant term[8] in the long-run equation for PM. Thus, changing FEER enforces adjustment process in real exchange rate and in turn the changes of PLNEUR and prices. Finally, this causes changes in net trade and provides that the current account is heading to its target. The intuition behind this is that we let FEER to change its level that will correspond to the external equilibrium in the steady state in order to preserve consistent system.

Following partially the work of Rubaszek (2009), target current account TCA is calculated on the basis of the Milesi-Ferretti and Razin extended framework. Accordingly, the desired level of current account is defined using net foreign assets adjustment to steady state level and nominal GDP growth. The first element corresponds to the growth of CA to GDP in the steady state. The second element represents the convergence of NFA to GDP ratio to the sustainable long-term value of $\overline{NFA\_l}$, with ρ representing a convergence path.The deviation of net foreign assets from the steady state is set to the 65% of annual GDP with the speed of convergence equal to 2.5% per quarter. As for the nominal GDP growth we use the NBP yearly inflation target set to 2.5% as well as potential output growth.

[8]The constant term in equation for $PMVA$ represents the difference between RER's calculated on $PMVA$ and that on PM

$$TCA_t = \frac{NFA\_Y_{t-1} \cdot (exp((\sqrt[4]{1+CPISTAR}-1)+\Delta log(GDPQ\_POT))-1)}{GDP_{t-1} \cdot exp((\sqrt[4]{1+CPISTAR}-1)+\Delta log(GDPQ\_POT))} + \rho \cdot (NFA\_TARGET - NFA\_Y_{t-1}) \quad (53)$$

where:
TCA – target current account as a percent of GDP,
NFA_Y – net foreign assets as a percent of GDP,
NFA_TARGET – net foreign assets as a percent of GDP desired ratio,
$CPISTAR$ – inflation target of CB,
$GDPQ\_POT$ – potential gross domestic product (cs).

Current account convergence to the path set by TCA is provided by additional construction founded on changes in FEER. From the long-run equation for import prices, after some transformations, we obtain

$$log\left(\frac{PM}{PP\_EU27 \cdot PLNEUR}\right) = -0.65 + (1-0.41) \cdot log\left(\frac{PMVA}{PP\_EU27 \cdot PLNEUR}\right) + + 0.05 \cdot dum^{ls,q102} \quad (54)$$

We can see that the difference between RER on PMVA and on PM is constant in the steady state. In order to provide convergence of the NFA level to its equilibrium value via current account target, we let the constant (-0.65) to change in the equation for PM. This change is incorporated in the way that we allow this constant to change in a controlled manner up to the moment when the current account to GDP ratio reaches its target. This leads to the following expression:

$$diff\_PM_t = diff\_PM_{t-1} - \rho \cdot \left(TCA_t - \frac{CA_t}{GDP_t}\right) \quad (55)$$

where:
$diff\_PM$ – is in the estimation sample equal to the constant from equation on import prices,
ρ – is the speed parameter set to 2.5% quarterly.

In the steady state, when $TCA_t = \frac{CA_t}{GDP_t}$ parameter $diff\_PM_t$ is constant. After rearranging the long-run parts of equations for $PMVA$, MW, $PCONSHS$, PM and incorporating

external condition we obtain a solution for the level of $FEER$.

$$\begin{aligned} log(FEER^{*}) &= 2.11 + log(LMD) - log(MVAQPOT) - 0.65 \cdot NAWRU + \\ &+ \gamma \cdot TREND\_TFP + 0.48 \cdot log((1 + r\_ERCONT + r\_EROTH)/((1 - \\ &- r\_EECONT) \cdot (1 - pfp\_WPIT - pfp\_TFI - pfp\_RESPIT - \\ &- r\_HSHCD - pfp\_DEDTAX))) + log(VAT\_CONSHS\_I\_CSB) + \\ &+ log(RGGEXC\_I\_CSB) + 0.20 \cdot (diff\_PM + 0.053 \cdot dum^{ls,q102}) + \\ &+ 0.20 \cdot log(GGTAXCD\_I\_CSB) - 0.056 \cdot dum^{ls,q404q310} + \\ &+ 0.026 \cdot dum^{ls,q101q103} + 0.016 \cdot dum^{ls,q307q109})/(0.2 \cdot 0.41) \end{aligned} \tag{56}$$

Dynamic equation for the real exchange rate is written as a function of error correction term represented by deviation of lagged exchange rate from its equilibrium level set by $FEER^{*}$, change in the share of net foreign assets in annual GDP current account to GDP ratio.

$$\begin{aligned} \Delta log(PLNEUR_t) &= - 0.025 \cdot (log(PLNEUR_{t-1}) - log(PMVA_{t-1}) + log(PP\_EU27_{t-1}) \\ &+ log(FEER^{*}_{t-1})) - \underset{(-1.75)}{0.0018} \cdot (RR\_3M_t - ELRR3M_t) + \\ &+ \underset{(5.83)}{0.59} \cdot \Delta log\left(\frac{GDEBT\_ESA_t}{GDP_t}\right) - \underset{(-3.87)}{0.05} \cdot dum^{ls,q209q310} + \\ &+ \underset{(5.37)}{0.16} \cdot dum^{q109} \end{aligned} \tag{57}$$

where:
$PLNEUR$ – PLN/EUR exchange rate,
$FEER^{*}$ – fundamental equilibrium exchange rate,
$PMVA$ – deflator of value added, market sector,
PP_EU27 – foreign prices,
RR_3M – 3 month WIBOR (real),
$ELRR\_3M$ – short term interest rate in EMU (real),
$GDEBT\_ESA$ – stock of government debt (*cb*),
GDP – gross domestic product (*cb*),
$dum^{ls,q209q310}$ – 0-1 variable equal to 1 from the second quarter of 2009, up to the third quarter of 2010, and zero elsewhere,
dum^{q109} – 0-1 variable equal to 1 in the relevant quarter and zero elsewhere.

$R^2 = 0.7$ $Adj.R^2 = 0.67$ $\sigma = 0.029$ $LMtest(p - value) = 0.75$

The next version of the model will be extended by an additional constraint: a balance of the external sector will be connected with a balance of savings in the internal economy.

To incorporate it properly, balance of savings for the whole sequence of accounts should be developed in the model. This is a step ahead compared to the flows currently covered by the eMPF model and will be made in the next version of the model.

Foregin trade

Foreign trade equations are of the utmost importance for the calculation of $FEER$. The foreign trade system is consists of four equations: for exports volume, imports volume, export prices and import prices.

In the long-run the share of exports of goods and services in world demand index is determined by real exchange rate.

$$log(XQ^*) = \underset{(16.7)}{5.3} - \underset{(-4.1)}{0.82} \cdot log\left(\frac{PX}{PP\_EU27 \cdot PLNEUR}\right) + log(WDINDIC) - \\ - \underset{(-13.2)}{0.25} \cdot dum^{o,q201q106} \tag{58}$$

In the short-run, it adjusts to the above long-run relation. Additionally, dynamic specification for exports incorporates changes in world demand and real exchange rate:

$$\Delta log(XQ_t) = - \underset{(-1.85)}{0.12} \cdot (logXQ_{t-1} - log(XQ^*_{t-1})) + \Delta log(WDINDIC_t) - \\ - \underset{(-11.6)}{0.85} \cdot \Delta log\left(\frac{PX_t}{PP\_EU27_t \cdot PLNEUR_t}\right) \tag{59}$$

where:
XQ^* – exports of goods and services (cs) -equilibrium level,
XQ – exports of goods and services (cs),
$WDINDIC$ – world demand index (cs),
PX – deflator of exports of goods and services (cs),
PP_EU27 – foreign prices,
$PLNEUR$ – PLN/EUR exchange rate (cb).

$R^2 = 0.73$ $Adj.R^2 = 0.72$ $\sigma = 0.03$ $LMtest(p-value) = 0.1$

Long-run share of imports of goods and services in the volume of domestic GDP is constant when relative prices stabilize. The equation is of the following form:

$$log(MQ^*) = - \underset{(-62.2)}{0.97} - \underset{(-2.13)}{0.48} \cdot log\left(\frac{PM}{PMVA}\right) + log(GDPQ) - \\ - \underset{(-9.4)}{0.21} \cdot dum^{ls,q197q103} + \underset{(5.88)}{0.13} \cdot dum^{ls,q306q308} \tag{60}$$

In the short-run, the share of imports volume in domestic output adjusts to the equilibrium level and additionally it is affected by changes of import prices relative to domestic prices:

$$\begin{aligned}\Delta log(MQ_t) &= -\underset{(-3.8)}{0.33}\cdot(log(MQ_{t-1})-log(MQ^*_{t-1}))-\underset{(-5.46)}{0.77}\cdot\Delta log\left(\frac{PM_t}{PMVA_t}\right)+\\ &+\Delta log(GDPQ_t)+\underset{(1.82)}{0.04}\cdot dum^{o,q108q109}\end{aligned} \tag{61}$$

where:
MQ^* – imports of goods and services (cs) -equilibrium level,
MQ – imports of goods and services (cs),
PM – deflator of imports of goods and services,
$PMVA$ – deflator of value added, market sector,
$GDPQ$ – gross domestic product (cs),
$dum^{o,q108q109}$ – 0-1 variable equal to 1 in the second quarter of 2009,-1 in the third quarter of 2010, and zero elsewhere.

$R^2 = 0.56$ $Adj.R^2 = 0.55$ $\sigma = 0.03$ $LMtest(p-value) = 0.67$

The specification of export and import prices equations in the system is based on the price maker - price taker approach. In the long-run export prices are determined as a weighted average of domestic and foreign prices expressed in national currency:

$$log(PX^*) = -\underset{(-3.37)}{0.42}+\underset{(8.85)}{0.71}\cdot log(PMVA)+(1-0.71)\cdot log(PP\_EU27\cdot PLNEUR) \tag{62}$$

Dynamic equation for the export prices, estimated using the error correction approach, may be written as:

$$\begin{aligned}\Delta log(PX_t) &= -\underset{(-4.98)}{0.68}\cdot(log(PX_{t-1})-log(PX^*_{t-1}))+\underset{(5.89)}{0.69}\cdot\Delta log(PMVA_t)+\\ &+(1-0.69)\cdot\Delta log(PP\_EU27_t\cdot PLNEUR_t)+\underset{(2.64)}{0.02}\cdot dum^{ls,q104}\end{aligned}\quad(63)$$

where:
PX – deflator of exports of goods and services,
PP_EU27 – foreign prices,
$PLNEUR$ – PLN/EUR exchange rate,
$PMVA$ – deflator of value added, market sector,
$dum^{ls,q104}$ – 0-1 variable equal to 1 from the first quarter of 2004 up to the end of the estimation sample, and zero elsewhere.

$R^2 = 0.42$ $Adj.R^2 = 0.4$ $\sigma = 0.034$ $LMtest(p-value) = 0.75$

In the long-run import prices corrected for custom duties are also determined as a weighted average of domestic and foreign prices expressed in domestic currency:

$$\begin{aligned}log(PM^*) &= -\underset{(-8.6)}{0.65}+\underset{(-8.6)}{0.41}\cdot log(PP\_EU27\cdot PLNEUR)+(1-0.41)\cdot log(PMVA)+\\ &+\underset{(6.34)}{0.05}\cdot dum^{ls,q102}+log(GGTAXCD\_I\_CSB)\end{aligned}\quad(64)$$

The short term dynamics of import prices was estimated using the error correction approach. Accordingly:

$$\begin{aligned}\Delta log(PM_t) &= -\underset{(-2.17)}{0.09}\cdot(log(PM_{t-1})-log(PM^*_{t-1}))+(1-0.38)\cdot\Delta log(PMVA_t)+\\ &+\underset{(3.2)}{0.38}\cdot\Delta log(PP\_EU27_t\cdot PLNEUR_t)-\underset{(-2.19)}{0.08}\cdot dum^{q400}+\\ &+\underset{(-2.14)}{0.08}\cdot dum^{q401}+\Delta log(GGTAXCD\_I\_CSB)\end{aligned}\quad(65)$$

where:
PM – deflator of imports of goods and services,
$PMVA$ – deflator of value added market sector,
PP_EU27 – foreign prices,
$GGTAXCD\_I\_CSB$ – index of scaling factor $GGTAXCD$ equation (*cb*),
$PLNEUR$ – PLN/EUR exchange rate,
dum^{q401} dum^{q400} – dummy variable to 1 in the selected period.

$R^2 = 0.43$ $Adj.R^2 = 0.4$ $\sigma = 0.036$ $LMtest(p-value) = 0.1$

4.5 Monetary rule

Monetary policy in the eMPF model is described by a simple Taylor-type reaction function augmented with interest rate smoothing mechanism. Current short-term nominal interest rate is determined by the interest rate in the previous period, deviation of inflation from the inflation target as well as output gap and equilibrium interest rate. For the simulation purposes we assume that short term equilibrium interest rate equals to the foreign short term interest rate, which in turn is the equivalent to the long term rate (adjusted for the time to maturity) that equals to potential foreign GDP growth. It is captured by the following formula:

$$\begin{aligned} R\_3M_t &= \underset{(35.2)}{0.83} \cdot R\_3M_{t-1} + (1-0.83) \cdot (\underset{(3.85)}{0.93} \cdot (CPI_t - CPISTAR_t) + \underset{(5.06)}{0.36} \cdot GAP_t \cdot 100 \\ &\quad + R\_3M_t^*) + \underset{(4.04)}{0.57} \cdot dum^{ls,q104q409} - \underset{(-5.08)}{1.17} \cdot dum^{q109} \end{aligned} \tag{66}$$

where:

R_3M – 3 month WIBOR (nominal),

CPI – consumer price index YoY,

$CPISTAR$ – inflation target of central bank,

GAP – output gap (cs),

R_3M^* – 3 month WIBOR (nominal) - equilibrium level,

$dum^{ls,q104q409}$ – dummy variable equal to 1 from the first quarter of 2004 to the fourth quarter of 2009 and zero elsewhere,

dum^{q109} – dummy variable equal to 1 in the first quarter of 2009 and zero elsewhere.

Such specification ensures that in a steady state with zero inflation gap, closed output gap and GDP dynamics equal to world demand growth, annual effective interest rate equals to GDP growth and puts no pressure, neither upward nor downward, on borrowing and spending.

4.6 Public finance block

The eMPF model is characterized by quite complex fiscal sector block. In particular, revenues as well as expenditures of the general government sector are modelled in detail. Taking into account the most required from a policy maker point of view simulations, modeling of tax revenues (around 55% of the total consolidated revenue) as well as social security benefits and social aid transfers (constitute around 40% of the total consolidated expenditures) is much more elaborated than the rest of the fiscal sector. What is more, to have a possibility to simulate a broad range of possible changes in taxes, the effective tax rates presented in the model itself, are calculated in the satellite models, i.e. outside the eMPF. Hence, the core

model together with the satellites creates quite powerful system for simulation of tax policy scenarios.

General government sector covers the whole sequence of non-financial national accounts such as: production account, income account and part of the financial account i.e. capital transfers and non - financial assets. Income account sector contains generation of income account, allocation of primary income account, secondary distribution of income account and use of disposable income account (see Figure 2).

Public finance block is connected with other institutional sectors in the eMPF. Connection with household sector is determined by social transfers, social benefits, wages and salaries which are expenditure for general government or taxes and social contributions which are income for general government. The rest of private sector is connected with the eMPF's public finance block by means of taxes, subsidies and EU transfers.

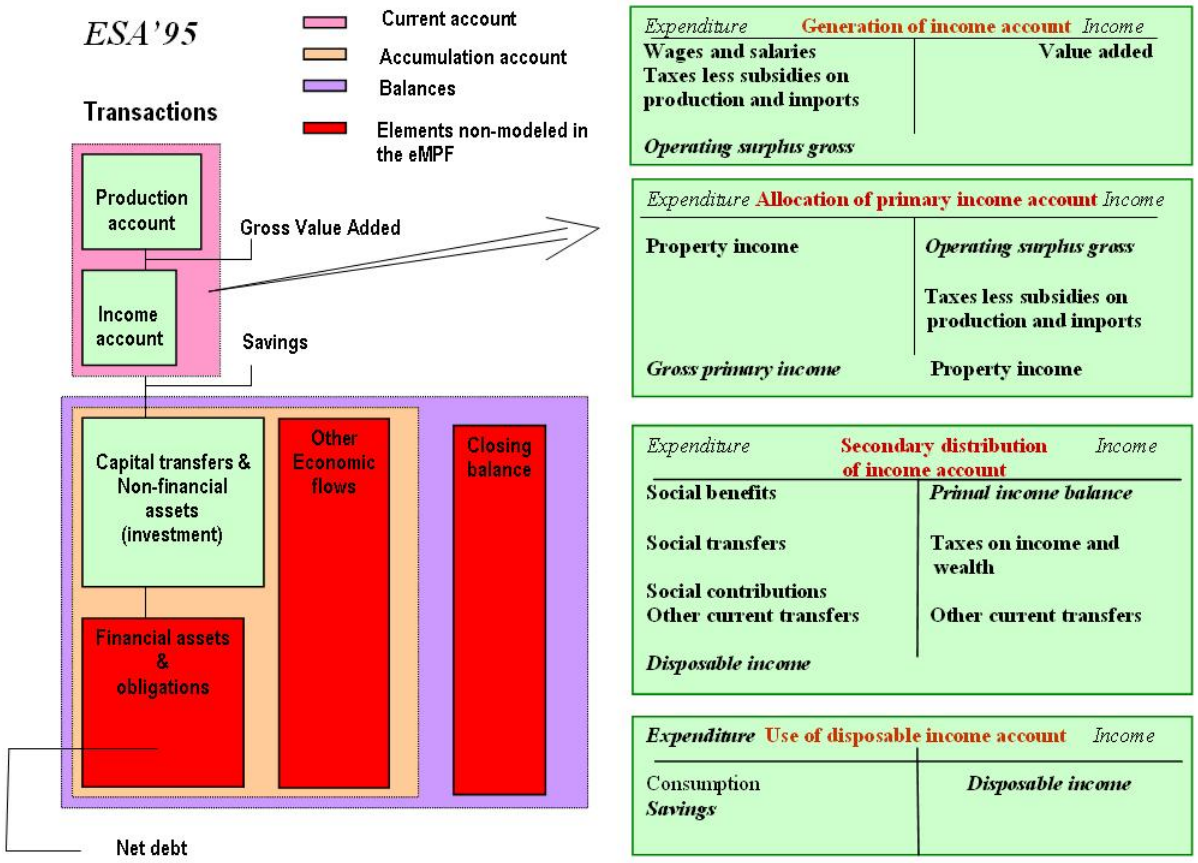

Figure 2: Sequence of general government accounts in the model

In the public sector section we consider the equations for (national) income accounting, public sector revenues and expenditures where the usual double entry principle applies. For instance, households' income taxes show up both in households disposable income and in general government revenues.

Transfers show up in both private and public sectors. Also public consumption shows up in both sectors: it is public expenditure item but also represent a part of households wage sum and thus disposable income.

The above-mentioned linkages are especially important regarding policy simulations. Not only direct demand effects but also indirect demand effects, which are caused by changes in sectoral incomes, should be considered. The eMPF model has not incorporated the whole sequence of financial accounts in the general government sector (only government debt, both domestic and external, is modelled). Although, it should be stressed that explicit modelling of the government deficit and debt is enough to evaluate the consequences of various fiscal policy actions.

The main guidelines on building the public finance block in the eMPF model were the following:

- to make the data consistent with ESA'95 framework
- to incorporate the possibly wide range of fiscal policy parameters
- to leave all detailed computation for accompanying satellite models (where relevant policy parameters are computed).

The first point refers to the fact that we have incorporated the public finance sector to the macro set-up which obviously has to be consistent with national accounts. Although, the Ministry itself is a source of detailed high-frequency data, not all of them can be used directly in the macroeconometric model. For example, cash-based and accrual data cannot be included in one equation.

The second point emphasizes the fact that the model is the econometric one. The main idea behind has been to build a model which is consistent with the institutional and legal features of the system. Thus, the equations and identities include - as far as possible - all relevant policy parameters (like statutory tax rates). On the other hand, taking into account operational aspect of the model, it was not possible to represent all the tax/expenditures

bases, i. e. households entitled to housing allowance. Some aggregation in this context was necessary. Hence, it was needed to include in the public finance block of the model some stochastic equations to complete the institutional ones within represented part of national accounts framework. The main requirement is that the reasonably extensive policy analysis can be carried out directly with the use of existing model.

Finally, last point reflects the fact that structural macroeconometric model uses quite aggregated data. Already now, most data manipulation operations are carried out outside the model (aggregation and disaggregation, chain-linking the quarterly values, seasonal adjustment and so forth). Thus, for instance, when computing average tax rates for different types of households or commodities, it is unnecessary to introduce all secondary data (often with different frequencies) to the model and its data base.

Modelling the EU transactions

On its accession to the European Union, Poland has become a beneficiary of and a payer to the EU budget. In the eMPF both EU tranfers as well as EU payments are modelled.

There are two sorts of EU-grants paid to government units. First, there are grants for which the government itself is the final recipient. Second, there are grants which the national government passes on and is strictly acting as an agent on behalf of the EU. In practice most of the grants paid by the EU pass through the accounts of general government.

As this is the case, some revenues and expenditures which may be recorded in government's bookkeeping data need to be removed from the sector account of general government in national accounts. In practice this adjustment may not be implemented successfully and there could be an influence on government deficit caused by the difference of amounts removed from government revenues and expenditures. This influence can occur at least if flows are recorded on a cash basis in the government accounts.

In national accounts there should be a correction transaction between the EU and the national government, which will have a deficit impact if the government is not able to reclaim the money from the original recipient.

General rule implemented in the equations of the model is that when the beneficiary of the EU grants is a government unit, the time of recording of government revenue from the EU is the same time as the national government expenditure. Therefore, as far as the government

deficit is concerned, revenue from the EU offsets the corresponding expenditure, and therefore there is no net impact expected on the government deficit.

In the model the nature of government expenditure financed by EU fund is reflected mainly in: intermediate consumption ($GGIC$) and gross fixed capital formation ($GGFCFC$). On the revenue side it is recorded in transfers, respectively current ($GGOTRC$) and capital ($GGKTRC$).

Tax modelling approach

There is one general modeling strategy for all taxes in the eMPF model. Effective tax rates are calculated in the satellite models (thus outside the eMPF) and are considered exogenous. For example, an effective CIT rate is calculated as a statutory CIT rate reduced by nontaxed and exempted income of enterprises ($pfp\_NON\_EXE\_i$), losses from the previous year, deductions and the amount increasing income/decresing loss of enterprises (pfp_LOSS_DED) and deductions, reductions and foregoing of CIT ($pfp\_DE\_RE\_CIT$):

$$\begin{aligned} pfp\_CIT\_ER &= (1 - pfp\_NON\_EXE\_i) \cdot (1 - pfp\_LOSS\_DED) \\ &\quad \cdot pfp\_CIT\_R \cdot (1 - pfp\_DE\_RE\_CIT) \end{aligned} \tag{67}$$

The resulting receipt (expenditure) varies with an endogenous tax base. In the long term equation takes the respective institutional form:

$$log(TAX_i) = \alpha_i + \beta_i \cdot log(TAXBASE_i) \tag{68}$$

where:
TAX_i – tax to be modelled,
$TAXBASE_i$ – tax base for the tax i,
β_i – effective tax rate.
In the short term, the ECM type of equation is used to model particular tax revenues. The above-mentioned institutional relation defines the long term equilibrium. The dynamic part is explained with use of some other variables depending on type of the tax.
The most important taxes in the eMPF model are those based on the following demand categories: government intermediate consumption, government investment, non-government intermediate consumption and household consumption expenditures.

4.6.1 General government revenues

Total revenue consolidated is a sum of gross operating surplus ($GGOS$), property income ($GGPIN$), current taxes on income and wealth ($GGTAXW$), taxes on production and imports ($GGTAXP$), social contributions ($GGSC$), other current transfers received consolidated ($GGOTRC$), and capital transfers (receivable) consolidated ($GGKTRC$):

$$GGTREVC = GGOS+GGPIN+GGTAXW+GGTAXP+GGSC+GGOTRC+GGKTRC \tag{69}$$

Figure 3 presents the direct linkages of the most important revenues of the general government sector to the macroeconomic categories. For example, decision on the PIT rate increase will immediately influence the revenues from this type of tax and will decrease households' disposable income. This type of policy will also affect relative prices in the model and through this channel will have impact on factor demand and foreign competitiveness.

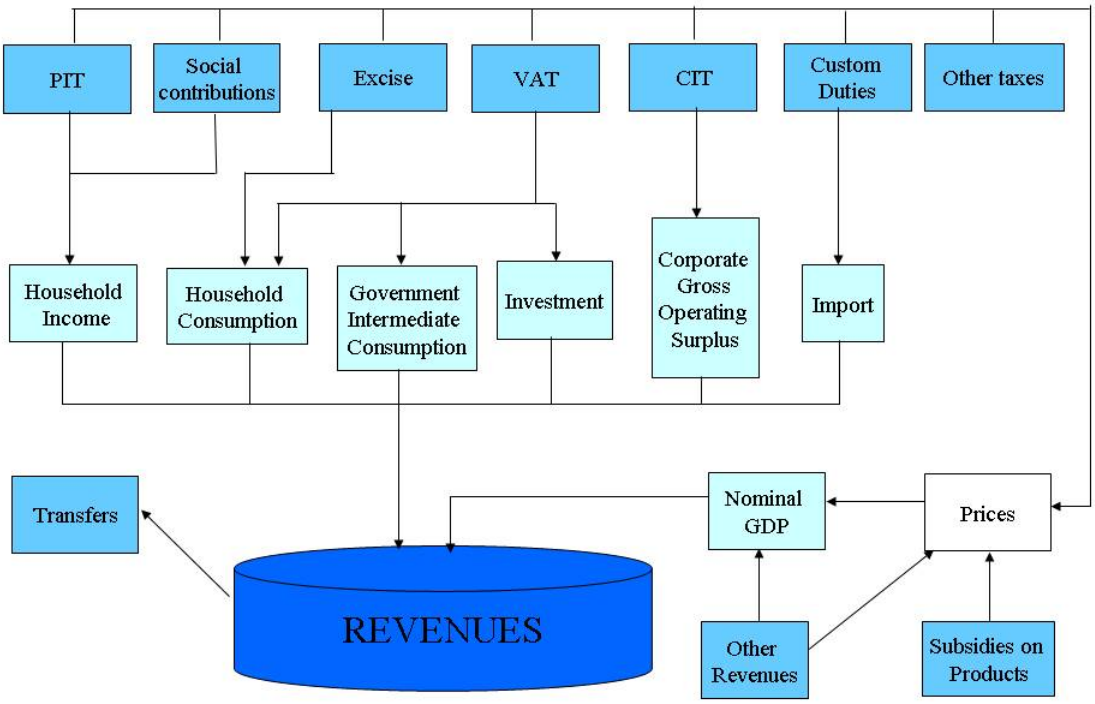

Figure 3: General government revenues and linkages

Gross operating surplus of the general government sector ($GGOS$) is a balancing item

and is calculated using the following equation:

$$GGOS = GGVA - GGWSOLC - GGERCONT - GGTAX\_SUB \tag{70}$$

where:
$GGVA$ – value added gross, GG sector (*cb*),
$GGWSOLC$ – fund of general government wages, salaries and other income connected with hired work (*cb*),
$GGERCONT$ – employers' social contributions, GG sector (*cb*),
$GGTAX\_SUB$ – other taxes on production, payable minus other subsidies on production, receivable (*cb*).

Nominal gross value added of the public sector, being registered in the supply accounts, is also part of public consumption which is registered on the demand side of national accounts. Hence, to assure the consistency of calculation, the following formula for the value added in the government sector is applied:

$$GGVA = GGFCE + GGSALES - GGIC - GGSTRK \tag{71}$$

where:
$GGVA$ – value added gross, GG sector (*cb*),
$GGFCE$ – final consumption expenditure, GG sector (*cb*),
$GGSALES$ – market sales of general government (*cb*),
$GGIC$ – intermediate consumption, GG sector (*cb*),
$GGSTRK$ – GG social transfers in kind (*cb*).

Taxes on income and wealth

Current taxes on income and wealth ($GGTAXW$) are the sum of current taxes on income and wealth paid by corporations ($GGTAXWCORP$) and its counterpart paid by households ($HSTAX$):

$$GGTAXW = GGTAXWCORP + HSTAX \tag{72}$$

Taxes paid by households are described in the respective section. Taxes paid by corporations are a function of gross operating surplus in the corporate sector ($CORPGOS$), effective CIT rate (pfp_CIT_ER) and scaling parameter ($pfp\_GGTAXWCORP$).

$$GGTAXWCORP = CORPGOS \cdot pfp\_CIT\_ER \cdot pfp\_GGTAXWCORP \tag{73}$$

Taxes on production and import

Taxes on production and import ($GGTAXP$) are the most important part of the general government sector revenues, that amounts to roughly 35% of total consolidated revenue. Taxes on production and import are described by the formula:

$$GGTAXP = GGATAXPCOM + LGTAXP \tag{74}$$

where:
$GGATAXPCOM$ –taxes on products, GG sector (*cb*),
$LGTAXP$ – other taxes on production (*cb*).

Main part of public revenues are taxes on products, which are a sum of VAT revenues ($GGVAT$), custom duties ($GGTAXCD$), excise tax revenues ($GGEXC$), tax on loteries, gambling and betting ($CGTAXRES$) reduced by the part of the EU contribution ($GGEUTORVAT$):

$$GGTAXPCOM = GGVAT + GGTAXCD + GGEXC + CGTAXRES - GGEUTORVAT \tag{75}$$

Among taxes on products, the most important are VAT revenues that are calculated as a function of the effective weighted tax rate and an estimated tax base. In the model we identified following tax bases: $CONSHS$, $GGIC$, $GGGFCFE$, $MGFCF$. For each of the tax base effective tax rate is calculated. In order to construct effective weighted average rate of VAT tax for all the components of final demand taken as the tax base, we use supply and use tables as well as other information from national accounts (for example COICOP data as regards private consumption). Supply and use table are available with an aggregation of 55 times 55 divisions, however for data compilation purpose, a working version of the tables includes about 465 groups of goods and services. So, to compute weighted VAT rate, almost 800 positions of household consumption, 120 positions of intermediate consumption and 40 positions of gross fixed capital formation are used. All of these calculations are operated with the use of the satellite models and as a result we receive linked effective weighted tax rates. So as the received theoretical values are slightly different from the empirical ones we correct the difference by scaling factors. Taking into account that the difference is insignificant in solution we assume that scaling parameters are unity.

VAT equation takes the following form:

$$\begin{aligned} GGVAT &= pfp\_GGVAT \cdot (CONSHS \cdot \frac{pfp\_efrVAT\_CONSHS}{1 + pfp\_efrVAT\_CONSHS} + \\ &+ GGIC \cdot \frac{pfp\_efrVAT\_ICGG}{1 + pfp\_efrVAT\_ICGG} + GGGFCFE \cdot \frac{pfp\_efrVAT\_IG}{1 + pfp\_efrVAT\_IG} + \\ &+ MGFCF \cdot \frac{pfp\_efrVAT\_IG}{1 + pfp\_efrVAT\_IM}) \end{aligned} \tag{76}$$

where:

$GGVAT$ – VAT revenue, GG sector (*cb*),

pfp_GGVAT – scaling parameter $GGVAT$ equation (*cb*),

$CONSHS$ – individual consumption of households (*cb*),

pfp_efrVAT_CONSHS – effective weighted VAT rate on household consumption expenditures,

$GGIC$ – intermediate consumption, GG sector (*cb*),

pfp_efrVAT_ICGG – effective weighted VAT rate on government intermediate consumption (*cb*),

$GGGFCFE$ – gross fixed capital formation, GG sector (*cb*),

pfp_efrVAT_IG – effective weighted VAT rate on government investment (*cb*),

$MGFCF$ – gross fixed capital formation market sector (*cb*),

pfp_efrVAT_IM – effective weighted VAT rate on non-government investment (*cb*).

Custom duties ($GGTAXCD$) are a function of import (M) and an exogenous scaling parameter ($pfp\_GGTAXCD$):

$$GGTAXCD = pfp\_GGTAXCD \cdot M \tag{77}$$

Excise tax revenues ($GGEXC$) are modelled in a similar fashion. Accordingly, excise is a function of scaling parameter (pfp_rGGEXC) and private consumption ($CONSHS$):

$$GGEXC = pfp\_rGGEXC \cdot CONSHS \tag{78}$$

Taxes on lotteries, gambling and betting ($CGTAXRES$) is linked with the households gross disposable income so as the long term share of $CGTAXRES$ in $HSDGI$ is equal to 0.3%. Part of the EU contribution ($GGEUTORVAT$) is a relation between scaling parameter ($sc\_VATRATE$) and gross national income (GNI):

$$GGEUTORVAT = sc\_VATrate \cdot GNI \tag{79}$$

Social contributions

The important part of the general government revenues are social contributions ($GGSC$), which makes up almost 30% of total revenues. As far as the eMPF model is concerned for

the long term values it is assumed that both mentioned categories grow proportionally. The short term adjustment process of this revenues is explained by following equation:

$$\begin{aligned}\Delta log(GGSC_t) &= \underset{(-9.00)}{-0.88} \cdot (log(GGSC_{t-1}) + 0.13 - 1 \cdot log(HSCSF_{t-1}) - \\ &\quad - 0.10 \cdot dum_t^{ls,q299} - 0.03 \cdot dum_t^{ls,q207})) + \underset{(16.97)}{0.97} \cdot \Delta log(HSCSF_t) + \\ &\quad + (1 - 0.97) \cdot \Delta log(HSCSF_{t-3}) - \underset{(-2.2)}{0.03} \cdot dum_t^{o,q408q108} - \\ &\quad - \underset{(-5.9)}{0.11} \cdot dum_t^{q409} \end{aligned} \tag{80}$$

where:
$GGSC$ – social contributions (received), GG sector (cb),
$HSCSF$ – social contributions (cb),
$dum_t^{ls,Q207}$ – 0-1 variable equal to 1 up to the second quarter of 2007, and 0 elsewhere,
$dum_t^{ls,Q299}$ – 0-1 variable equal to 1 up to the second quarter of 1999, and 0 elsewhere,
$dum_t^{o,q408q108}$ – 0-1 variable equal to 1 in the fourth quarter of 2008, -1 in the first quarter, and 0 elsewhere.

$$R^2 = 0.85 \qquad Adj.R^2 = 0.84 \qquad \sigma = 0.017 \qquad LMtest(p - value) = 0.8$$

Other revenues

For other revenues it has been assumed that their shape is modelled in proportion to nominal GDP. To incorporate institutional information (for example path of EU funds revenues) additional scaling parameters have been used.

4.6.2 General government expenditures

Total expenditure consolidated is a sum of property income ($GGPIE$), subsidies on products and production ($GGSUBE$), social benefits other than social benefits in kind ($GGSSBE$), other current ($GGCTREC$) and capital ($GGKTREC$) transfers consolidated, gross capital formation (GGGCF) and public consumption (GGFCE):

$$GGCEXPEC = GGPIE + GGSUBE + GGSSBE + GGCTREC \tag{81}$$

$$GGTEXPEC = GGCEXPEC + GGKTREC + GGGCF + GGFCE \tag{82}$$

This expenditures are then important part of further accounting framework of the model. The most substantial connections are presented on the following graph 4.

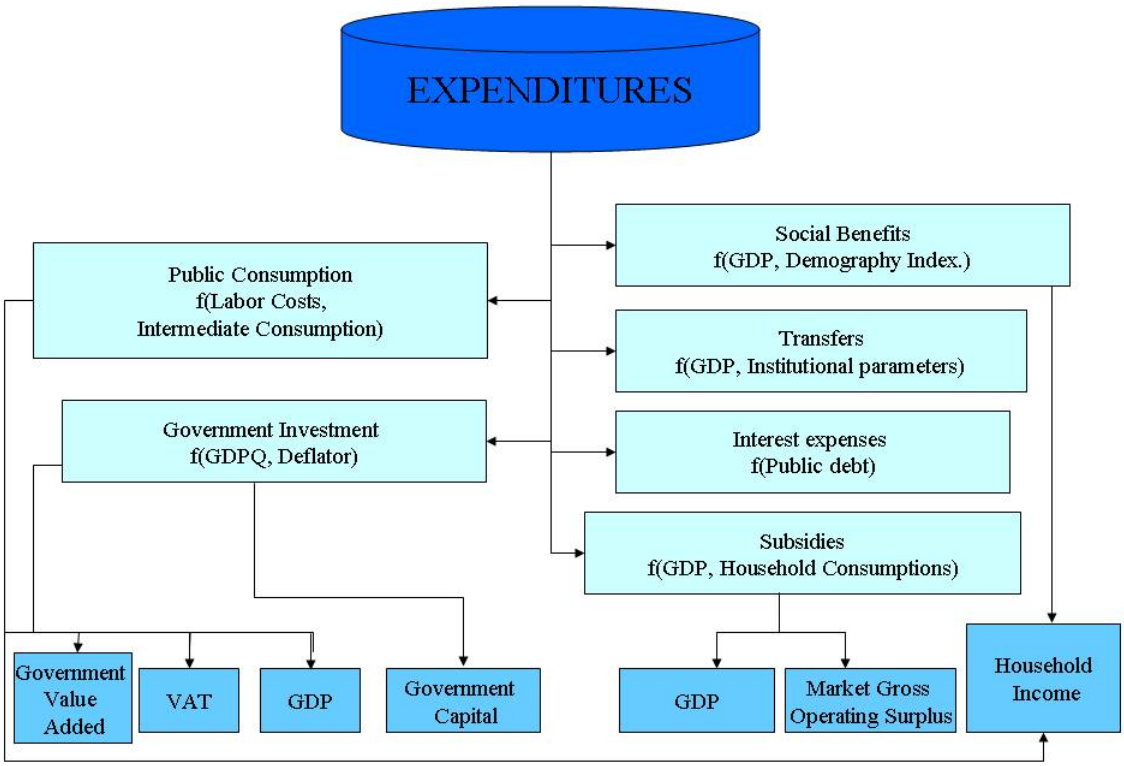

Figure 4: General government expenditures and linkages

Social security system

The biggest part that constitute almost 40% of total consolidated expenditures are social benefits and other social transfers ($GGSSBE$).
In the model it is a sum of social security benefits ($HSSSB$) and social assistance benefits ($HSSAB$):

$$GGSSBE = HSSSB + HSSAB \tag{83}$$

Social security system in the eMPF model is divided into two subsectors: agricultural and non-agricultural, what enables to capture the differences between these two subsectors in the social security system context. Within the two subsectors there are three main groups of social security benefits: retirement benefits (old-age pensions), disability pensions and family allowances. For each group it is possible to calculate the fund as a product of an average benefit and number of beneficiaries.

Old-age pension system

As a consequence of adverse tendencies in demography in recent years, general government expenditures for old-age pension benefits are increasing rapidly and the situation is deteriorating every year as it is not possible to reverse these tendencies from one year to another. Adequate and detailed modelling of the social security system in the eMPF model is thus crucial for proper analysis of the fiscal stance. In an econometric model that uses highly aggregated data, such as the eMPF model, it is hard to model social security system as this type of model is not designed to model demography. The most suitable tool seems to be an age-cohort model. Taking into account the above limitations, an effort was made in order to build quite detailed social security block in the eMPF model.

Old-age pension system is divided into agricultural and non-agricultural subsectors. Non-agricultural subsector is modelled separately for pensioners born before 1949 (here referred to as "old pension system") and for pensioners born from 1949 on (here referred to as "new pension system"). This distinction is a consequence of old-age pension system reform implemented in 1999 that introduced distinct rules for calculating benefits on the basis of a year of birth. In the old pension system benefits are calculated in dependence on a base sum and the base sum multiplier. In the new pension system, the benefit is calculated as an annuity, i.e. value of resources accumulated on a beneficiary's account divided by the average expected length of life (expressed in months). First old-age pension payments from the new pension system were made in the first quarter of 2009.

From the theory, the number of pensioners in the long-run should move together with total employment (see e.g. Palmer (2006)). Due to many exclusions from the new pension system [9] and other distortions to the actual functioning of the reformed pension system in Poland, it makes no sense to model number of old-age pensioners in dependence on total employment. Likewise in other macroeconometric models, population in the eMPF model is an exogenous variable. For simulation purposes we model the pensioners' number as a fraction of a respective population concept, what enables us to change parameter values (parameter values are time-varying). Making a forecast we use projections of the Central Statistical Office (GUS) and European Commission Ageing Working Group (AWG) and calibrate the parameters in order to match the experts' projections.

In line with the above, total number of old-age pensioners in both new and old pension

[9] From the new system i.a. farmers, miners, uniform workers and teachers are excluded; they account for ca. 50% of total employment.

system ($POPRNA$) is modelled as follows:

$$POPRNA \quad = \quad p\_poprna \cdot POPPP, \tag{84}$$

where:

p_poprna – average number of persons receiving retirement pay from non-agricultural social security system in relation to the average number of post-working age population,

$POPPP$ – average number of post-working age population.

Number of old-age pensioners in new pension system ($POPRNA\_NS$) is modelled in a similar way and the number of pensioners from the old pension system ($POPRNA\_OLD$) is calculated residually. Number of old-age pensioners in an agricultural system ($POPRA$) is modelled in relation to post-working age population in rural areas ($POPPPW$).

Average retirement pay ($RETNA\_old$) in the old pension system (i.e. one-pillar system) of non-agricultural subsector takes into account the changes in the composition of pensioners (i.e. current pensioners and new pensioners entering the benefit system). Benefits for new entries are shaped in dependence on a base sum ($PENBASE$) and the base sum multiplier ($retna\_m$) in a corresponding period. Retirement benefit for current pensioners depends on a quarterly indexation rate. According to the above, the following formula for the average retirement pay in the old pension system is used in the eMPF model:

$$\begin{aligned} log(RETNA\_OLD_t) \quad = \quad & log((1 + r\_indexationq_t) \cdot \left(\frac{1 - POPRNA\_OLD\_N_t}{1 + POPRNA\_OLD\_N_t}\right) \cdot \\ & \cdot RETNA\_OLD_{t-1} + \left(\frac{POPRNA\_OLD\_N_t}{1 + POPRNA\_OLD\_N_t}\right) \cdot \\ & \cdot retna\_m_t \cdot (PENBASE\_ADJ_t)) \end{aligned} \tag{85}$$

where:

$r\_indexationq_t$ – quarterly indexation rate of pensions,

$POPRNA\_OLD\_N_t$ – flow of new old-age pensioners in non-agricultural pension system in relation to the number of old-age pensioners in the previous quarter (old system),

$retna\_m_t$ – base sum multiplier,

$PENBASE\_ADJ_t$ – seasonally adjusted base sum (*cb*).

In the simulation version of the model, all average pension benefits are assumed to grow exactly at the quarterly growth rate of the nominal average wage, so that in the steady state pension funds grow in line with nominal GDP.

Quarterly change in one-pillar pensioners is a sum of a flow of the new one-pillar pensioners

into the pension system corrected for their loss due to death as well as other changes. Expressing this identity with the flow of the new one-pillar pensioners on the left-hand side and dividing by the number of old-age pensioners in the previous quarter results in the following formula:

$$\begin{aligned} POPRNA\_OLD\_N_t &= \frac{POPRNA\_OLD\_N_t}{POPRNA\_OLD\_N_{t-1}} - 1 + OLDDROP_t - \\ &\quad - POPRNA\_OLD\_OTHER_t, \end{aligned} \tag{86}$$

where:

$POPRNA\_OLD\_N_t$ –flow of new old-age pensioners in non-agricultural pension system in relation to the number of old-age pensioners in the previous quarter (old system),

$OLDDROP_t$ – outflow of old pensioners in non=agricultural pension system,

$POPRNA\_OLD\_OTHER_t$ – other changes in the number of old-age pensioners from the one-pillar pension system.

Flow of the new entries into the whole old-age pension system is modelled in an analogous way.

Equation for the base sum ($PENBASE$) as well as indexation formulas are based on legal regulations. The base sum is a function of wage growth corrected for the social contributions in the previous year. Accordingly:

$$\begin{aligned} PENBASE_t &= \underset{(-6.62)}{-61.9} + \underset{(5.48)}{0.44} \cdot WA\_LAG4_t + (1 - 0.44) \cdot WA\_LAG4_{t-1} - \\ &\quad - \underset{(-12.41)}{154.93} \cdot dum_t^{ls,q204} - \underset{(-2.7)}{126.0} \cdot dum_t^{q202} \end{aligned} \tag{87}$$

where:

WA_LAG4_t – wage growth corrected for the contributions in the previous year (cb),

$dum_t^{ls,q204}$ – 0-1 variable equal to 1 starting from the second quarter of 2004 onwards and zero elsewhere,

dum_t^{q202} – 0-1 variable equal to 1 in the second quarter of 2002 onwards and zero elsewhere.

Formula for the annual indexation rate ($r\_indexation_t$) in the eMPF model is of the form:

$$\begin{aligned} r\_indexation &= CPIA\_LAG4 + w\_wayoy \cdot \left(\frac{WAYOY + 1}{CPIA\_LAG4 + 1} - 1 \right) + \\ &\quad + extra\_indexation \end{aligned} \tag{88}$$

where:

$CPIA\_LAG4$ – average annual consumer price growth in the previous year,

w_wayoy – weight of the real wage growth in the indexation formula,

$WAYOY$ – nominal gross wage growth published by GUS in February for the purpose of indexation,
$extra\_indexation$ – extra indexation above statutory indexation.

Quarterly indexation rate ($r\_indexationq$) formula is an average of annual indexation rate for quarters in which according to law indexation takes place:

$$r\_indexationq = \frac{1}{3} \cdot q1 \cdot r\_indexation + \frac{2}{3} \cdot q2 \cdot r\_indexation \tag{89}$$

where
qi is a zero-one variable equal to 1 in a quarter i and 0 in other quarters.

Average retirement pay in the agricultural pension system ($RETA$) is modelled in an analogous way as its counterpart in the non-agricultural pension system.

Average retirement pay in the new pension system is modelled in a different way, being a result of different rules of calculation benefits in the new system. Average benefit of new entitled pensioners is calculated as a value of resources accumulated on a beneficiary's account ($K\_PENSION$) divided by the average expected length of life (LE, expressed in months). For current beneficiaries in the new pension system their retirement pay depends on a quarterly indexation rate. To model an average retirement pay in the new system as a whole ($RETNA\_NS$) we just take the weighted average of average benefits for these two groups of pensioners:[10]

$$\begin{aligned} RETNA\_NS_t &= d09q1 \cdot \frac{K\_PENSION\_ADJ_t}{LE_t} \cdot \frac{POPRNA\_NS\_N_t}{1 + POPRNA\_NS\_N_t} + \\ &+ (1 + r\_indexationq_t) \cdot \frac{1 - POPRNA\_NS\_N_t}{1 + POPRNA\_NS\_N_t} \cdot RETNA\_NS_{t-1} \end{aligned} \tag{90}$$

where:
$K\_PENSION\_ADJ_t$ – average value of account in the new pension system corrected for seasonality,
LE_t – average life expectancy for person aged 62,
$POPRNA\_NS\_N_t$ – flow of new pensioners in new pension system in relation to the number the pensioners in the new system in the previous quarter.

Taking into account the formulas for the new entries into the whole pension system as well as its old system part, the flow of the new entries into the new pension system is calculated residually.

[10] Currently this equation is not estimated in the model as it relates to the period starting only with the first quarter of 2009

Average value of account of all contributors in the new pension system is a sum of an average value of notional credit (initial account value) and cumulated value of pension contributions in the first and second pillar. In line with statutory regulations, a part of pension contribution going to first pillar is indexed in line with statutory rate of pension contributions indexation. The remaining part of pension contribution goes to the Open Pension Funds (OFE) and is invested by them, so it grows with quarterly rate of return on OFE (R_OFE). At the moment of a contributor's retirement the capital accumulated according to above mentioned rules is a base for calculation of the pension benefit.

In the model $K\_PENSION$ represents the average amount of capital registered on the account of retiring person. As we have no distinction for cohorts in the model, the formula for such a capital is quite complex. However taking into account the model steady state constraints , we can assume that the capital is a constant share in the wage fund. Such a constraint is used in the simulation version of the model. Making a forecast this capital is a subject for calibration on the basis of some additional information available from ZUS and KNF.

Quarterly indexation rate of contributions ($r\_indexationq\_ns_t$) accumulated on the new pension system members accounts is modelled in line with legal regulations.

As Open Pension Funds invest pension contributions of their members mainly in the treasury bonds and stocks, nominal quarterly rate of return of the Open Pension Funds is modelled in dependence of yields on the 5-year treasury bonds (R_5Y) and Warsaw Stock Exchange Index (WIG). In addition, to account for other asset allocations of minor importance, in the formula for the rate of return of the Open Pension Funds also short-term interest rate (R_3M) is included. Weights in this equation are calibrated and derived from the average share of the corresponding assets in the investment portfolio of Open Pension Funds.

Average retirement pay in the non-agricultural pension system ($RETNA$) is calculated as a weighted average of the average retirement pays for old and new pension system members. Equivalently, it may also be calculated as an aggregate pension fund divided by the number of pensioners:

$$RETNA = SSRETNA \cdot 1000/3 \cdot POPRNA, \tag{91}$$

where:

$SSRETNA$ – average quarterly retirement pay bill from non-agricultural social security system (cb),

$POPRNA$ – average number of persons receiving retirement pay from non-agricultural social security system.

Inability to work and family pensions

Pension system is modelled separately for agricultural and non-agricultural subsectors. It is divided further into inability and family pensions subsystems. Number of pensioners is exogenous to the model. While preparing out-of-sample assumptions referring to the number of pensioners, recent trends as well as expert's knowledge is taken into account.

Average pension benefit, similarly as in a case of an average retirement pay, is modelled in a way that the change in the composition of the beneficiary is taken into account. Average pension benefit for incoming beneficiary depends on the base sum and the base sum multiplier. In the eMPF model the same multiplier is used to model retirement and pension benefits. In fact they differ meaning that the difference is captured by the equation residual. Average pension benefit for pensioners already receiving pensions is indexed with the quarterly indexation rate. Average pension benefit is calculated as a weighted average of the average pension benefit of incoming and current pensioners. For example, formula for the average inability to work pension ($PENXNA$) in the non-agricultural system is modelled in a following way:

$$\begin{aligned} log(PENXNA_t) &= log((1 + r\_indexationq_t) \cdot \frac{1 - POPPENXNA\_N_t}{1 + POPPENXNA\_N_t} \cdot PENXNA_{t-1} + \\ &+ \frac{POPPENXNA\_N_t}{1 + POPPENXNA\_N_t} \cdot retna\_m_t \cdot PENBASE\_ADJ_t) \end{aligned} \tag{92}$$

where:

$POPPENXNA\_N_t$ – flow of new persons receiving pensions resulting from an inability to work in non-agricultural social security system in relation to the number of disability pensioners in the previous quarter,

$PENBASE\_ADJ_t$ – seasonally adjusted base sum (cb).

Average family pension in the non-agricultural pension system as well as average inability to work pension and average family pension in the agricultural pension system are modelled in an analogous way.

Interest expenses

Property income paid by the general government ($GGPIE$) is modelled as a function of interest expenses of the general government sector ($GGINTE$), adjusted by the proportionality parameter (sc_GGPIE):

$$GGPIE = sc\_GGPIE \cdot GGINTE \tag{93}$$

The debt service costs in the eMPF are interest expenses. They are calculated as a sum of domestic debt interest expenses ($GGINTE\_dom$) and foreign debt interest expenses

($GGINTE\_row$):

$$GGINTE = GGINTE\_dom + GGINTE\_row \tag{94}$$

Domestic debt interest expenses are a function of a stock of domestic debt ($GDEBT\_ESA\_dom$) and yield on the 5-year treasury bond, adjusted by the scaling parameter (sc_GGINTE_dom):

$$GGINTE\_dom = sc\_GGINTE\_dom \cdot GDEBT\_ESA\_dom(-1) \cdot \left(\left(\frac{1 + R\_5Y}{400} \right)^{0.25} - 1 \right) \tag{95}$$

To compute foreign debt interest expenses the relation between stock of foreign debt, exchange rates and long-term interest rate in the EMU has been taken into account:

$$\begin{aligned} GGINTE\_row \;=\; & sc\_GGINTE\_row \cdot GDEBT\_ESA\_row(-1) \cdot ((pfp\_GDEBT\_EUR \cdot \\ & \cdot PLNEUR + (1 - pfp\_GDEBT\_EUR) \cdot PLNUSD)/(pfp\_GDEBT\_EUR \cdot \\ & \cdot PLNEUR(-1) + (1 - pfp\_GDEBT\_EUR) \cdot PLNUSD(-1))) \cdot \\ & \cdot \left(\left(\frac{1 + ELLR}{400} \right)^{0.25} - 1 \right) \end{aligned} \tag{96}$$

where:

sc_GGINTE_row – scaling parameter $GGINTE\_ROW$ equation (*cb*),

$GDEBT\_ESA\_row$ – stock of foreign debt, GG sector (*cb*),

pfp_GDEBT_EUR – share of foreign public debt nominated in EUR (*cb*),

$PLNEUR$ – PLN/EUR exchange rate,

$PLNUSD$ – PLN/USD exchange rate,

$ELLR$ – long term interest rate in EMU (*cb*).

Public consumption

Public consumption ($GGFCE = CONSGG$) is modelled as the function of purchases of goods and services ($GGIC$) and compensations of employees ($GGLC$) in line with the following formula:

$$\begin{aligned}\Delta log(CONSGG_t) &= \underset{(-5.93)}{-0.63} \cdot (log(CONSGG_{t-1}) - log(GGIC_{t-1} + GGLC_{t-1}) + 0.14 + \\ &+ 0.035 \cdot dum_t^{ls,q105} + 0.037 \cdot dum_t^{ls,q104}) + \underset{(4.94)}{0.43} \cdot \Delta log(GGLC_t) + \\ &+ \underset{(4.75)}{0.19} \cdot \Delta log(GGIC_t) + (1 - 0.43 - 0.19) \cdot \Delta log(GDP_t) - \\ &- \underset{(4.55)}{0.04} \cdot dum_t^{o,q198q497} - \underset{(-5.42)}{0.06} \cdot dum_t^{q496q297} \end{aligned} \quad (97)$$

where:
$CONSGG$ – public consumption (*cb*),
$GGIC$ – intermediate consumption, GG sector (*cb*),
$GGLC$ – compensation of employees, GG sector (*cb*),
GDP – gross domestic product (*cb*),
$dum_t^{ls,q105}$ – 0-1 variable equal to 1 up to the first quarter of 2005 and 0 afterwards,
$dum_t^{ls,q104}$ – 0-1 variable equal to 1 up to the first quarter of 2004 and 0 afterwards,
$dum_t^{o,q198q497}$ – 0-1 variable equal to 1 in the first quarter of 1998, -1 in the fourth quarter of 1997 and 0 elsewhere,
$dum_t^{o,q496q297}$ – 0-1 variable equal to 1 in the fourth quarter of 1996, -1 in the second quarter of 1997 and 0 elsewhere.

$R^2 = 0.74$ $Adj.R^2 = 0.71$ $\sigma = 0.016$ $LMtest(p - value) = 0.54$

Other expenditures

For other expenditures it is assumed that they variation is modelled in proportion to nominal gross domestic product or gross national income. In addition, institutional information, like for example EU funds absorption, is taken into consideration.

4.6.3 General government deficit

The government balance ($GGNETB$), defined as the government net lending (+)/net borrowing (-), is the difference between total revenues ($GGTREVC$) and total expenditures ($GGTEXPEC$). It is exactly equal to the balancing item of the capital account in the main sequence of accounts. It represents the amount the government has available to lend or is forced to borrow for financing its non-financial operations.

$$GGNETB = GGTREVC - GGTEXPEC \quad (98)$$

Net lending (+)/net borrowing (-) is the balancing item of the financial account and is determined by all the transactions in financial assets and liabilities, so there is a close relationship

between the level of net lending (+)/net borrowing (-) and the change in debt as stated by the following identity:

$$GGFINN = -GGNETB \tag{99}$$

where:
$GGFINN$ – borrowing needs GG sector (cb),
$GGNETB$ – net lending (+), borrowing () GG sector (cb).

4.6.4 Stock of government debt

Public debt is defined as total gross debt at nominal value outstanding at the end of the year, consolidated between and within the subsectors of the general government sector. The stock of government debt is equal to the sum of liabilities of the general government sector in the following categories:

- currency and deposits,
- securities other than shares excluding financial derivatives,
- loans.

Although government debt is mainly a result of the financing required by accumulated government deficits, the relationship includes several other flows. The change in debt is by definition equal to the change in debt arising from transactions in debt liabilities plus the change arising from other changes in the volume of assets plus the change arising from revaluations. Also, the condition that change in debt liabilities from transactions be equal to change in financial assets from transactions minus net lending/ net borrowing minus the change in non-debt liabilities from transactions. Combining these equalities produces the following formula:

Increase in debt (at current market prices) =
- Net lending (+)/ net borrowing (-)
- transactions in financial assets
+ transactions in liabilities other than debt
- change in debt from revaluation
- change in debt from other changes in the volume of debt liabilities.

In the eMPF model the change in debt is generally expressed as the net borrowing plus

the sum of the other four elements of the equation, which is combined into a stock-flow adjustment.

Level of public debt ($GDEBT\_ESA$) is described as a sum of stock of domestic debt ($GDEBT\_ESA\_dom$) and stock of foreign debt ($GDEBT\_ESA\_row$):

$$GDEBT\_ESA = GDEBT\_ESA\_dom + GDEBT\_ESA\_row \tag{100}$$

Stock of domestic debt is a sum of lagged stock of domestic debt, net flow of general government sector debt excluding net domestic borrowing of general government ($CASHFLOWADJ\_dom$), and the relation between borrowing needs ($GGFINN$) and ratio of domestic financing of borrowing needs to total budget borrowing needs (pfp_GGFINN_dom):

$$\begin{aligned} GDEBT\_ESA\_dom_t &= GDEBT\_ESA\_dom_{t-1} + pfp\_GGFINN\_dom_t \cdot GGFINN_t + \\ &+ CASHFLOWADJ\_dom_t \end{aligned} \tag{101}$$

Stock of foreign debt equation takes the following form:

$$\begin{aligned} GDEBT\_ESA\_row_t &= GDEBT\_ESA\_row_{t-1} + (1 - pfp\_GGFINN\_dom_t) \cdot GGFINN_t + \\ &+ GDEBT\_ESA\_row_{t-1} \cdot ((pfp\_GDEBT\_EUR_t \cdot PLNEUR_t + \\ &+ (1 - pfp\_GDEBT\_EUR_t) \cdot PLNUSD_t)/(pfp\_GDEBT\_EUR_t \cdot \\ &\cdot PLNEUR_{t-1} + (1 - pfp\_GDEBT\_EUR_t) \cdot PLNUSD_{t-1}) - 1) + \\ &+ CASHFLOWADJ\_row_t \end{aligned} \tag{102}$$

where:
pfp_GDEBT_EUR – share of foreign public debt nominated in EUR (*cb*),
$CASHFLOWADJ\_row$ – net flow of GG sector debt without net foreign borrowing of general government (*cb*).

5 The long-run properties of the model

The steady-state of the model is determined by the long-run paths of key endogenous variables, stemmed from relevant equations. Other variables are set exogenously in a way that they are pinned down to their targets (e.g. to nominal GDP).

The long-run of the model is determined by the supply side. In line with the neo-classical paradigm, the supply curve is vertical in the long-run meaning that output is independent of prices (and demand factors). Output is on its potential level, determined by the two production factors as well as (exogenous in the model) total factor productivity. Assuming that factor markets are competitive, the marginal productivity conditions must hold in the long-run. Accordingly, marginal product of capital should be equal to the real user cost of capital and marginal product of labour should be equal to the real wage (defined from the perspective of an employer). For the Cobb-Douglas production function these conditions may be written as:

$$\frac{(1-\beta)\cdot MVAQPOT}{MK} = \frac{UCC}{PMVA} \tag{103}$$

$$\frac{\beta\cdot MVAQPOT}{LM} = \frac{WCOST}{PMVA} \tag{104}$$

where:

$MVAQPOT$ –potential gross value added in the market sector (cs),

MK – capital stock market sector (cs),

UCC – user cost of capital (cb),

LM – average employment in market sector,

$PMVA$ – deflator of value added, market sector,

$WCOST$ – labour cost per employee (cb).

It is assumed that all capital in the market sector is used for the production purpose. Harrod's neutral production function form implies that (market sector) capital stock grows in line with gross value added meaning that in the long-run capital stock to GDP ratio stabilizes. Marginal product of capital condition is incorporated in the error correction term of the equation of the demand for capital in the market sector. Potential labour input in the market sector is equal to the labour force corrected for the NAWRU and employment in the public sector. Marginal product of labour condition is incorporated in the equilibrium term of the wage equation.

Employment in the long-run is determined from the inverted production function. In line with

this:

$$LM = \frac{MVAQPOT^{\frac{1}{\beta}}}{A^{\frac{1}{\beta}} \cdot MK^{\frac{(1-\beta)}{\beta}} \cdot \gamma \cdot TREND\_TFP} \tag{105}$$

where:

A – scaling parameter in the production function equation,

$\gamma \cdot TREND\_TFP$ – total factor productivity (smoothed Solow residual) (cs).

The above condition for the long-run employment enters error correction term of an equation for the labour demand (employment) in the market sector.

Equilibrium unemployment rate is endogenous in the model and embodied by the NAWRU concept. In the long-run, short-run NAWRU (set consistently with the stable inflation condition) converges to the long-run NAWRU (set consistently with the stable inflation as well as zero unemployment gap condition). Long-run NAWRU depends on the demographic and institutional factors, namely fiscal and monetary policy parameters (see e.g. Budnik (2008) and formula 20 in this document).

In the eMPF model we assume that only market sector behaves according to the profit maximization rule. Public sector's behaviour is assumed to be different from that of the market sector. It is assumed that employment in the public sector equals to the labour supply of this sector. Employment in the public sector in the long-run moves in line with the population and employment in the market sector.

The supply-demand equality condition is fulfilled in the long-run by means of the stock-flow interaction that determines the equilibrium level of the real exchange rate (see Fagan et al. (2001)). In the long-run some components of aggregate demand are set constant in relation to GDP (inventories or general government expenditures) or are determined from the supply side (investments in the market sector – as discussed above). The only free in the long-run components of aggregate demand, private consumption and net exports, are linked via the real exchange rate. Private consumption in the long-run is proportional to wealth and linked to net exports through net foreign assets being cumulated trade balances. In the long-run they are the only free component of wealth. Consistency between private consumption and net exports renders the equilibrium exchange rate.

Real exchange rate in the long-run is converging to the equilibrium real exchange rate captured by the fundamental exchange rate (FEER). It is consistent with stable current-account-to-GDP ratio. Target current account level is set in the model so as to provide the convergence of net foreign assets to the sustainable ratio to annual GDP of 65%.

Domestic prices growth rates in the long-run converges to the world prices' growth rate. It is

due to the fact that we assumed consistency between world inflation and the inflation target set by the central bank.

The way the monetary and fiscal rules are defined is very important for stability of the model, its short term fluctuations and long term equilibrium. Monetary authorities in the model are responsible for interest rate settings depending on the behaviour of selected target. The target may consist of price stabilization, employment stabilization or some other user defined objectives. We assumed the monetary policy aims at stabilizing inflation at the inflation target and keeping output gap closed. Fluctuations of the interest rate directly influence the capital to labour ratio, household savings and debt servicing of the general government sector. Its level is also important for the long-run NAWRU. Indirectly, monetary policy influences all the endogenous variables in the model.
The impact of the fiscal rule is as wide as the monetary one. Fiscal policy, through the tax rates, restrains all the activities of decision makers being incorporated in the model. As the debt level of the general government sector is very important for the saving balance, the stability of the long-run solution of the model is in a straight line dependant on the fiscal sector indebtedness.

Other important variables, such as those connected with demography etc., are set exogenously in the long-run and converge to their targets.

6 Simulation properties of the model

6.1 Impulse response analysis

This section presents the results of the impulse response analysis to illustrate the model properties. We concentrate on the theoretical consistency of both short and long run responses of selected economic variables to typical shocks applied in the model. The list of shocks includes: world demand increase, world prices increase, depreciation of the domestic currency, a rise in domestic short term interest rate. For each shock we present a set of charts and tables with deviations of levels and/ or annual growth rates of selected variables from their baseline path in the first ten years after the shock (solid line on graphs) and in the steady state (dashed line on graphs). Before interpreting the results, it is worth pointing to some assumptions that are often made during impulse response analysis (compare e.q. Harrison et al. (2005)) and that we also made while generating the shocks. First, we assume the economy is at its long run equilibrium when the shock hits. As for fiscal balance, we assumed that general government debt stabilizes at the level of 50% of GDP in the steady state, which makes simulation results comparable with the present situation. Second, the shocks are generally unanticipated. Third, each shock represents an isolated change to a single variable (other exogenous variables remain unchanged), which helps clarity but is a simplification compared with most forecast issues or historical episodes, which often involve simultaneous shocks to a number of exogenous variables. Fourth, in order to shock endogenous variable (e.q. domestic interest rate or exchange rate) we make it exogenous in the period of shock.

6.1.1 World demand increase

The impulse of the expansion in global demand is defined as an acceleration in world demand (approximated by the EU imports) quarterly growth rate of 1 percentage point for one quarter (it translates into permanent 1% increase in the level of world demand). A direct effect of boom in the external environment for the national economy is an increase in foreign trade. At the moment the shock occurs the volume of exports goes up by 0.6% as compared to the baseline scenario while imports - due to high imports intensity of exports - rise by 0.4%. In response to higher demand from abroad domestic firms gradually increase investments (three quarters after the introduction of the shock gross fixed capital formation is higher by 0.8%), employment and salaries of employees. Household disposable income expands and stimulates private consumption that goes up in the short run by 0.3%. As a result, gross domestic product rises by 0.2% as compared to the baseline scenario. Increased domestic

activity triggers short term inflationary pressure and a rise in interest rates. Higher economic activity has also positive impact on the country's fiscal position. General government debt declines by 0.3% of GDP a year after the beginning of the shock. Positive impact of the increased external activity for the domestic economy persists in the long run. In the new steady state the volume of exports and imports remain persistently higher by 0.4%, private consumption is higher by 0.2%, while investments by 0.3%. The long term impact on the level of GDP does not significantly differ from the short term one, whereas the long run debt to GDP ratio remains 0.2 percentage point below the baseline path.

6.1.2 World prices increase

The impulse of higher external inflation is defined as a permanent increase of 1% in the level of world prices. Contrary to world demand shock, it is a nominal shock and affects domestic real variables only in the short term. A direct effect of higher world prices is an increase in price competitiveness of domestic producers and a growth in exports. The volume of exports rises by 0.2% at the moment the shock occurs. Higher demand for domestic goods stimulates investments and improves the situation on the labour market. Gross domestic product rises by 0.1% at the moment the shock occurs. Domestic inflation also speeds up and in the long run real economy moves back to the baseline path. In the fourth quarter of the shock scenario general government debt is 0.2% of GDP below the baseline path.

6.1.3 Interest rate increase

The interest rate impulse is defined as a transitory increase of 1 percentage point in the nominal short term interest rate for a period of one quarter. After the shock interest rates are determined by the Taylor rule and remain significantly above the baseline path for c.a. 12 quarters due to the smoothing mechanism. A rise in short term interest rates results in an increase in long term interest rates and consequently leads to a higher cost of obtaining capital and lower investments (in the sixth quarter after the shock private investments are lower by 2.3% against the baseline scenario) and higher debt financing costs. Due to a shift in consumption over time under the inter-temporal substitution and tighter credit conditions, private consumption also goes down gradually (three years after the shock it is lower by 0.3%). Higher domestic interest rates support the strengthening of the Polish zloty in the short term, which leads to a drop in price competitiveness of domestic producers. After a few quarters, as GDP decline deepens, domestic currency starts depreciating. In the short term general government debt increases by 0.4% of GDP. One-off nominal shock has only temporary effect on the real variables. After a transitory disturbances, in the long-run the economy moves back

to the baseline path.

6.1.4 Exchange rate depreciation

The exchange rate impulse is introduced as a temporary 10% depreciation of the domestic currency for a period of 1 quarter. After the shock the zloty exchange rate against the euro is again determined by exchange rate equation. The disturbance affects the real economy only in the short term. The weakening of the Polish zloty improves the price competitiveness of domestic producers, which results in an increase in exports of 5.2% at the moment the shock occurs. Due to high import intensity of exports, imports grows as well, but to a lesser extent: by 1.2% at the moment the shock occurs. The situation in the labour market improves gradually, which increases private consumption (two years after the shock it is higher by 1% as compared to the baseline scenario) and investments (in the fourth quarter of the shock scenario gross fixed capital formation in the market sector is higher by 8.2%). In the short term GDP increases by 3.7%. Higher economic growth supports the growth of general government revenue that outperforms an increase in expenditures due to higher debt financing costs and improves fiscal stance. Three quarters after the shock general government debt is 1.7% of GDP lower than in the baseline.

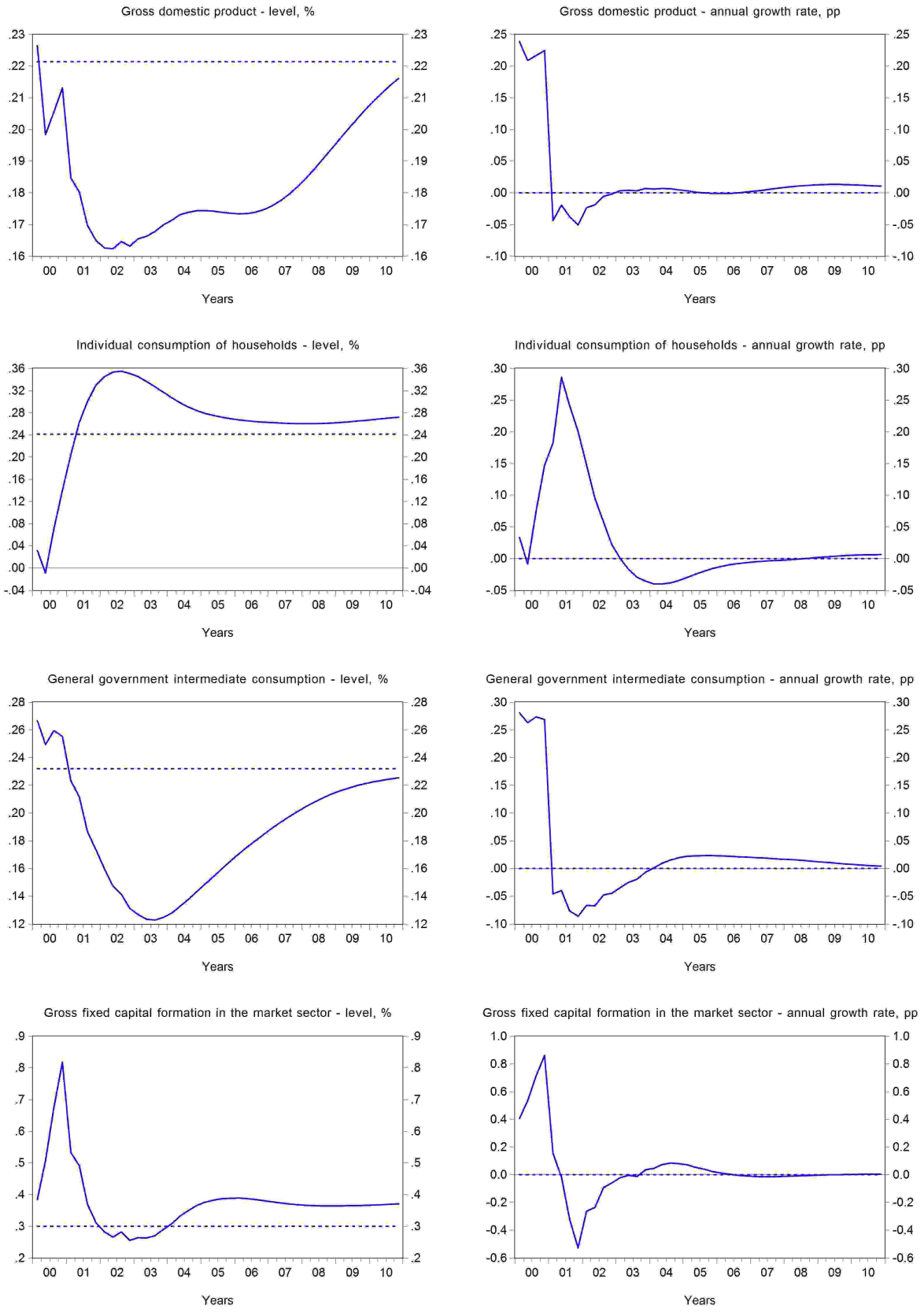

Figure 5: Response to world demand impulse (1)

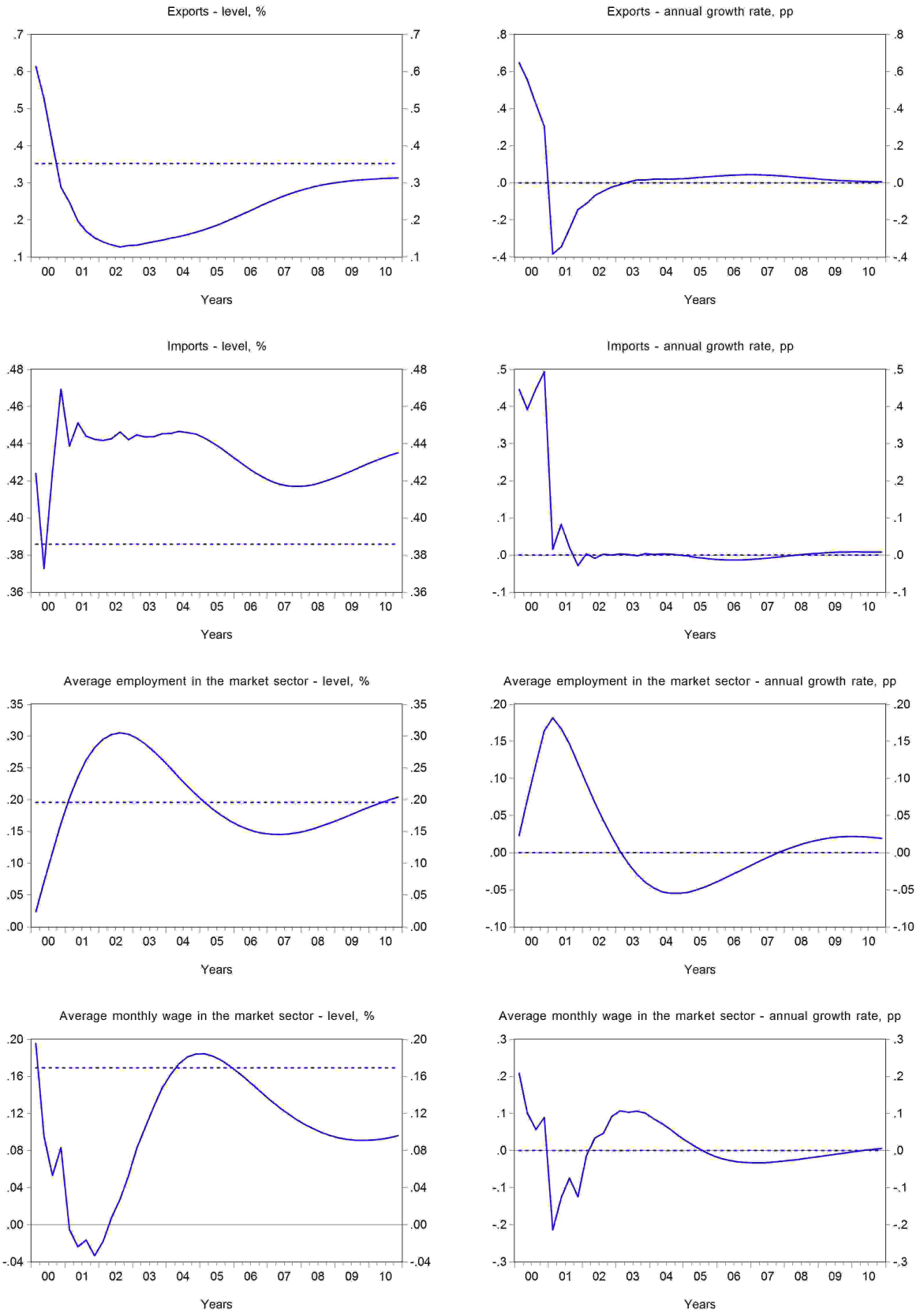

Figure 6: Response to world demand impulse (2)

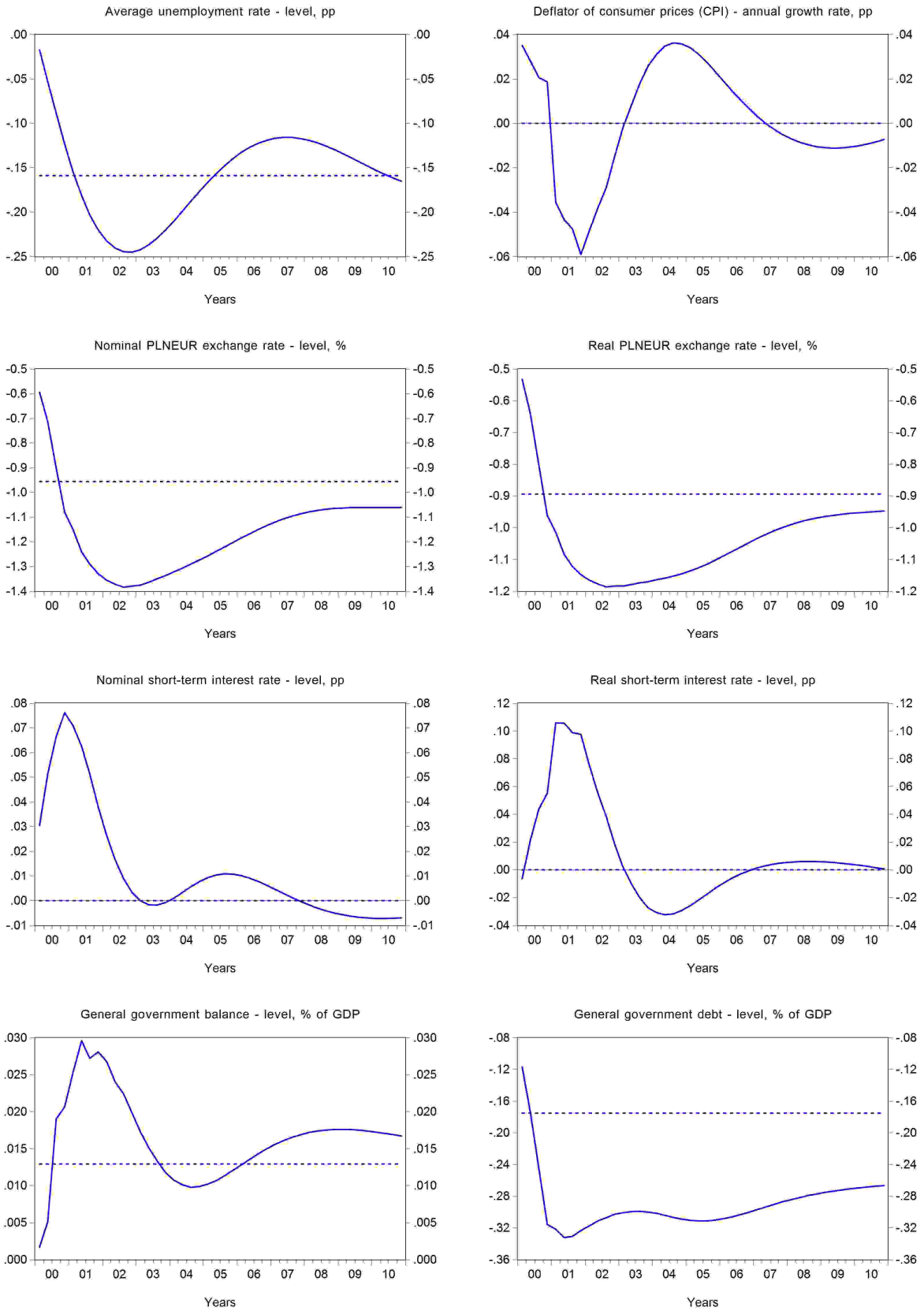

Figure 7: Response to world demand impulse (3)

Response to world demand impulse	**Quarters**						
	1	**3**	**6**	**12**	**20**	**200**	**800**
Deviation of level in %							
GDP	0.23	0.21	0.18	0.16	0.17	0.23	0.22
Export	0.61	0.41	0.20	0.13	0.17	0.36	0.35
Import	0.42	0.42	0.45	0.44	0.45	0.40	0.39
Final domestic demand	0.16	0.22	0.28	0.28	0.28	0.25	0.24
Final consumption expenditure	0.07	0.07	0.20	0.31	0.27	0.24	0.22
Individual consumption of households	0.03	0.07	0.26	0.35	0.28	0.26	0.24
Non-household consumption	0.18	0.08	0.03	0.17	0.22	0.18	0.17
Gross capital formation	0.53	0.79	0.57	0.17	0.32	0.28	0.29
Gross fixed capital formation	0.36	0.59	0.43	0.23	0.32	0.28	0.29
general government sector	0.27	0.26	0.21	0.13	0.14	0.24	0.23
market sector	0.38	0.68	0.49	0.26	0.37	0.29	0.30
General government wages and salaries	0.17	0.06	-0.02	0.05	0.19	0.16	0.17
Market sector wages and salaries	0.20	0.05	-0.02	0.05	0.18	0.16	0.17
Average paid employment in market sector	0.02	0.12	0.24	0.30	0.21	0.21	0.20
Average paid employment in national economy	0.02	0.09	0.19	0.27	0.20	0.18	0.17
Exchange rate (PLN/EUR)	-0.59	-0.90	-1.24	-1.38	-1.27	-0.95	-0.96
Value added deflator in the market sector	0.06	0.08	0.08	0.06	0.12	0.12	0.13
Deviation of annual growth rate in percentage points							
GDP	0.24	0.22	-0.02	0.00	0.00	0.00	0.00
Export	0.65	0.43	-0.35	-0.02	0.02	0.00	0.00
Import	0.45	0.45	0.08	0.00	0.00	0.00	0.00
Final domestic demand	0.17	0.23	0.14	0.01	0.00	0.00	0.00
Final consumption expenditure	0.07	0.08	0.19	0.05	-0.03	0.00	0.00
Individual consumption of households	0.03	0.07	0.29	0.02	-0.03	0.00	0.00
Non-household consumption	0.19	0.09	-0.10	0.13	-0.03	0.00	0.00
Gross capital formation	0.56	0.83	-0.07	-0.17	0.11	0.00	0.00
Gross fixed capital formation	0.38	0.62	-0.02	-0.06	0.07	0.00	0.00
general government sector	0.28	0.27	-0.04	-0.04	0.02	0.00	0.00
market sector	0.41	0.71	-0.02	-0.06	0.08	0.00	0.00
General government wages and salaries	0.18	0.07	-0.14	0.09	0.04	0.00	0.00
Market sector wages and salaries	0.21	0.06	-0.13	0.09	0.04	0.00	0.00
Average paid employment in market sector	0.02	0.12	0.17	0.02	-0.06	0.00	0.00
Average paid employment in national economy	0.02	0.09	0.13	0.04	-0.05	0.00	0.00
Value added deflator in the market sector	0.06	0.08	0.01	-0.01	0.03	0.00	0.00
Consumer price index	0.04	0.02	-0.04	-0.01	0.04	0.00	0.00

Response to world demand impulse	**Quarters**						
	1	**3**	**6**	**12**	**20**	**200**	**800**
Deviation of level in percentage points							
Average unemployment rate	-0.02	-0.09	-0.18	-0.25	-0.18	-0.17	-0.16
3 month WIBOR	0.03	0.07	0.06	0.00	0.01	0.00	0.00
General government balance to GDP ratio	0.00	0.02	0.03	0.02	0.01	0.01	0.01
General government debt to GDP ratio	-0.12	-0.24	-0.33	-0.30	-0.31	-0.20	-0.18

Table 2: Response to world demand impulse

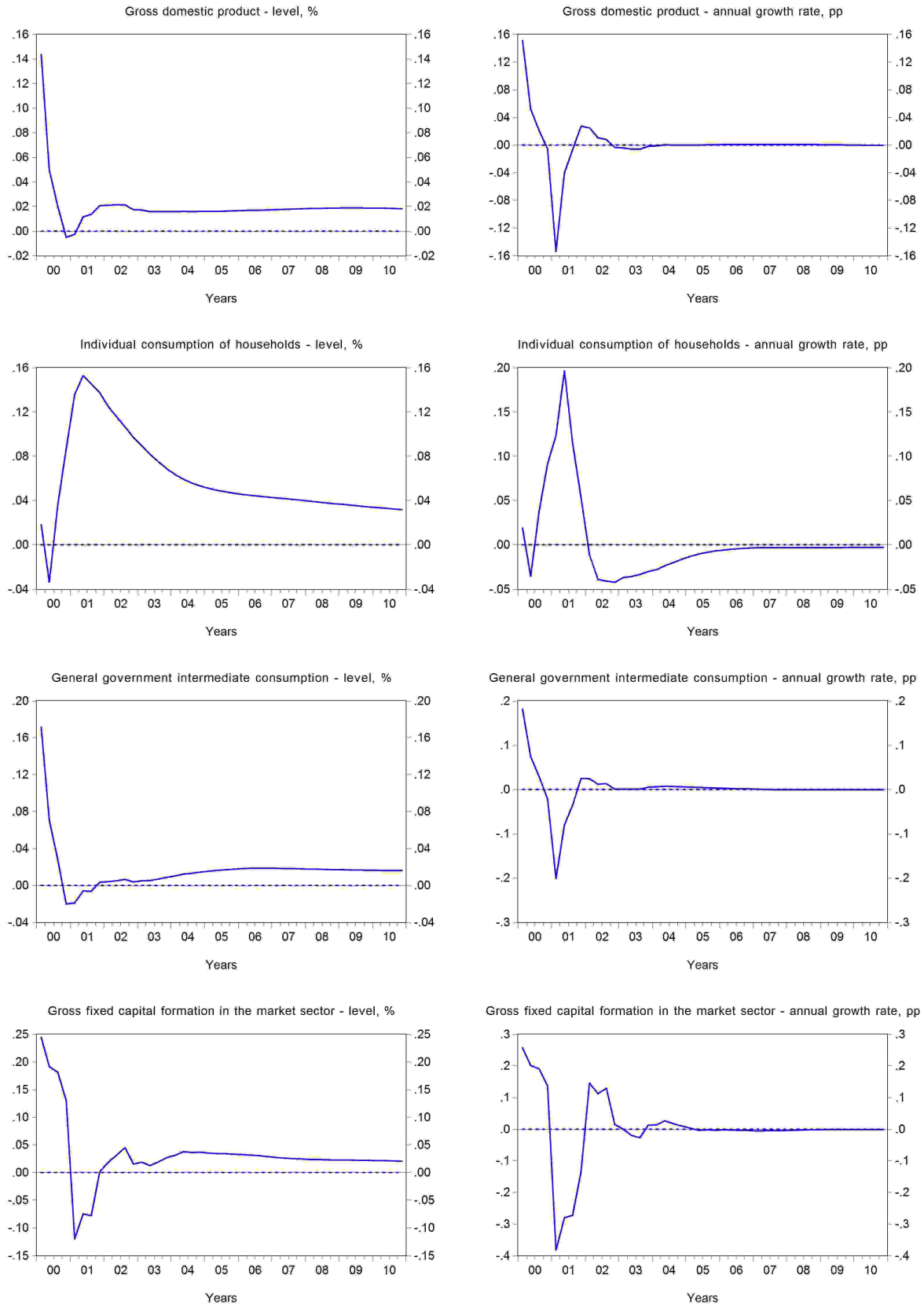

Figure 8: Response to world prices impulse (1)

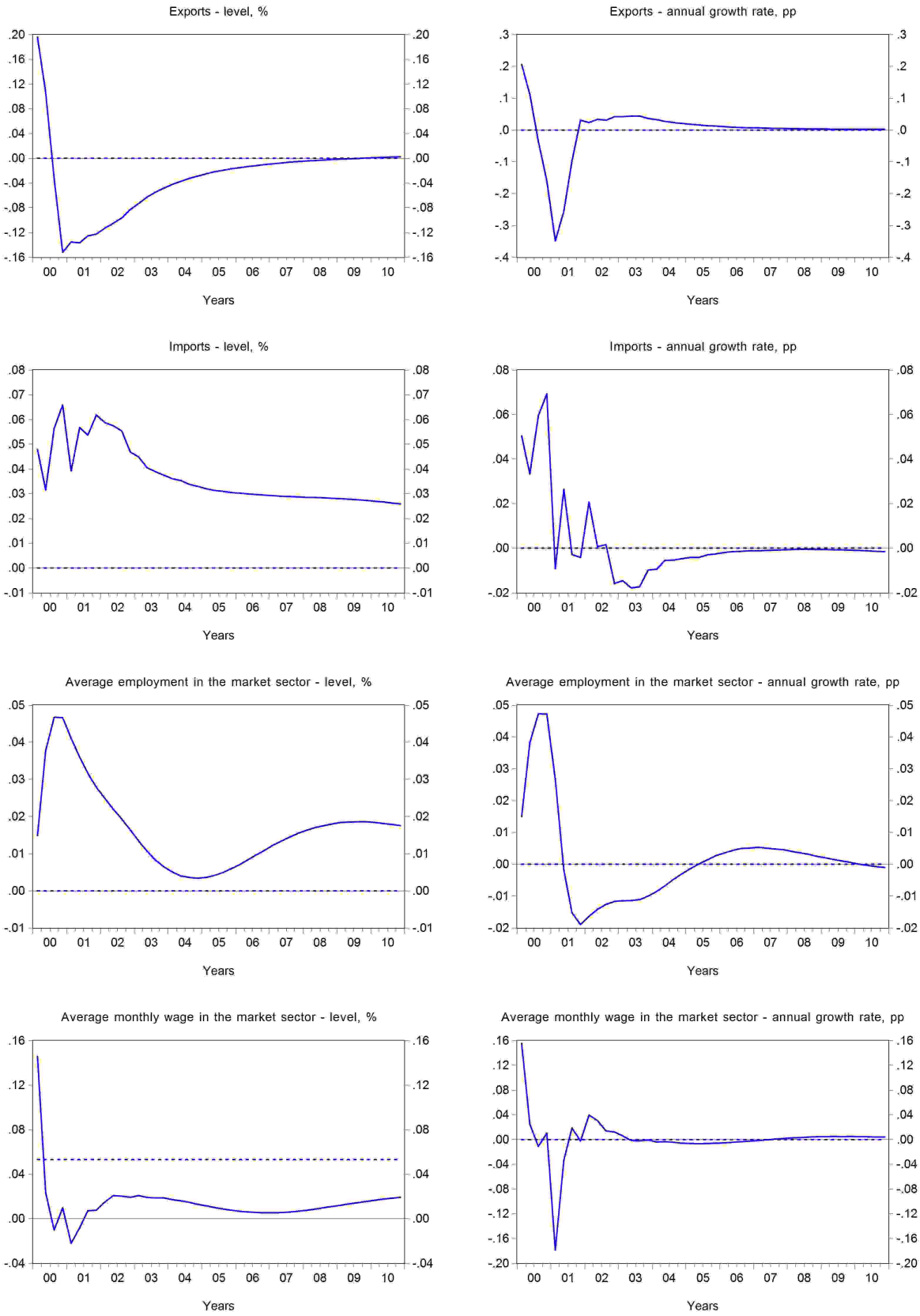

Figure 9: Response to world prices impulse (2)

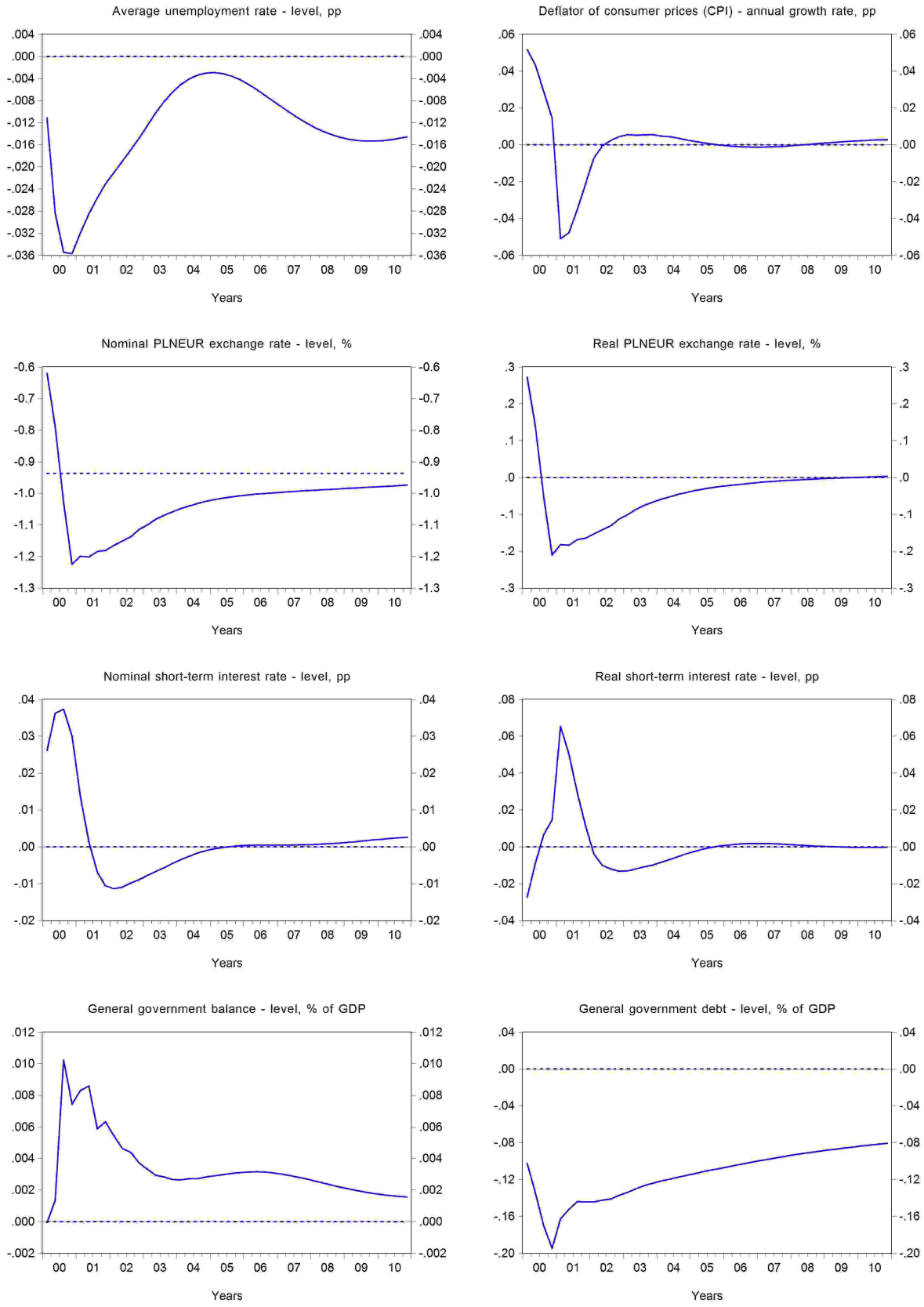

Figure 10: Response to world prices impulse (3)

Response to world prices impulse	**Quarters**						
	1	**3**	**6**	**12**	**20**	**200**	**800**
Deviation of level in %							
GDP	0.14	0.02	0.01	0.02	0.02	-0.01	0.00
Export	0.20	-0.03	-0.14	-0.08	-0.03	-0.01	0.00
Import	0.05	0.06	0.06	0.05	0.03	-0.01	0.00
Final domestic demand	0.09	0.05	0.08	0.06	0.04	-0.01	0.00
Final consumption expenditure	0.04	0.02	0.12	0.08	0.04	-0.01	0.00
Individual consumption of households	0.02	0.04	0.15	0.10	0.05	-0.01	0.00
Non-household consumption	0.11	-0.02	0.00	0.02	0.00	-0.01	0.00
Gross capital formation	0.28	0.17	-0.05	0.01	0.03	-0.01	0.00
Gross fixed capital formation	0.23	0.15	-0.06	0.01	0.03	-0.01	0.00
general government sector	0.17	0.03	-0.01	0.00	0.01	-0.01	0.00
market sector	0.24	0.18	-0.07	0.02	0.04	-0.01	0.00
General government wages and salaries	0.13	0.00	-0.01	0.02	0.01	0.05	0.05
Market sector wages and salaries	0.15	-0.01	-0.01	0.02	0.01	0.05	0.05
Average paid employment in market sector	0.01	0.05	0.04	0.02	0.00	0.00	0.00
Average paid employment in national economy	0.01	0.04	0.03	0.02	0.00	0.00	0.00
Exchange rate (PLN/EUR)	-0.62	-1.03	-1.20	-1.11	-1.03	-0.95	-0.94
Value added deflator in the market sector	0.04	0.02	0.01	0.01	0.01	0.05	0.05
Deviation of annual growth rate in percentage points							
GDP	0.15	0.02	-0.04	0.00	0.00	0.00	0.00
Export	0.21	-0.03	-0.26	0.04	0.02	0.00	0.00
Import	0.05	0.06	0.03	-0.02	0.00	0.00	0.00
Final domestic demand	0.09	0.06	0.06	-0.02	-0.01	0.00	0.00
Final consumption expenditure	0.04	0.02	0.14	-0.03	-0.02	0.00	0.00
Individual consumption of households	0.02	0.04	0.20	-0.04	-0.02	0.00	0.00
Non-household consumption	0.12	-0.02	-0.02	0.00	-0.01	0.00	0.00
Gross capital formation	0.30	0.18	-0.26	0.00	0.02	0.00	0.00
Gross fixed capital formation	0.24	0.16	-0.24	0.01	0.01	0.00	0.00
general government sector	0.18	0.03	-0.08	0.00	0.01	0.00	0.00
market sector	0.26	0.19	-0.28	0.01	0.01	0.00	0.00
General government wages and salaries	0.13	0.00	-0.06	0.01	-0.01	0.00	0.00
Market sector wages and salaries	0.16	-0.01	-0.03	0.01	-0.01	0.00	0.00
Average paid employment in market sector	0.01	0.05	0.00	-0.01	0.00	0.00	0.00
Average paid employment in national economy	0.01	0.04	0.00	-0.01	0.00	0.00	0.00
Value added deflator in the market sector	0.04	0.02	-0.02	0.00	0.00	0.00	0.00
Consumer price index	0.05	0.03	-0.05	0.00	0.00	0.00	0.00

Response to world prices impulse	**Quarters**						
	1	**3**	**6**	**12**	**20**	**200**	**800**
Deviation of level in percentage points							
Average unemployment rate	-0.01	-0.04	-0.03	-0.01	0.00	0.00	0.00
3 month WIBOR	0.03	0.04	0.00	-0.01	0.00	0.00	0.00
General government balance to GDP ratio	0.00	0.01	0.01	0.00	0.00	0.00	0.00
General government debt to GDP ratio	-0.10	-0.17	-0.15	-0.14	-0.12	0.00	0.00

Table 3: Response to world prices impulse

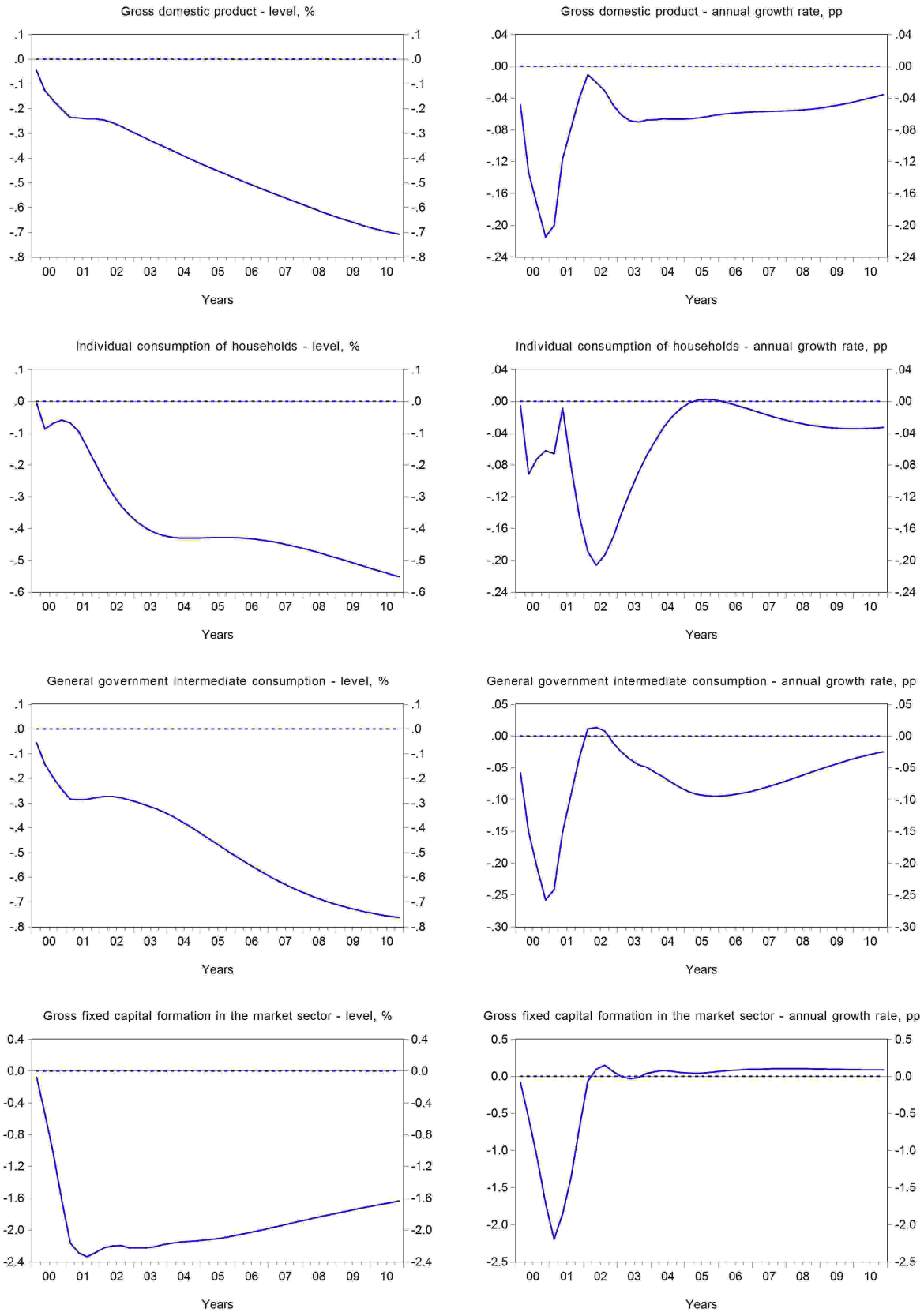

Figure 11: Response to interest rate impulse (1)

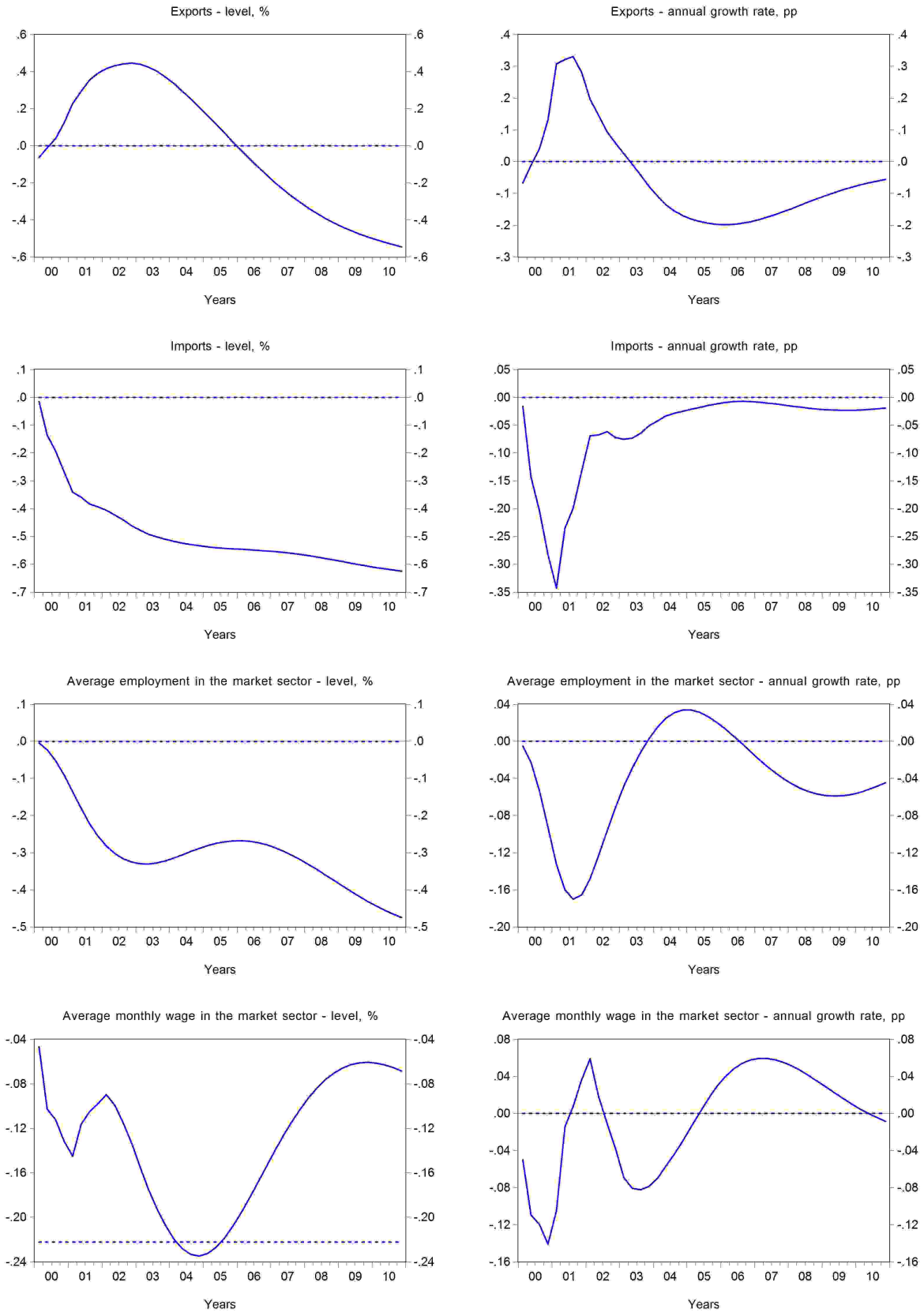

Figure 12: Response to interest rate impulse (2)

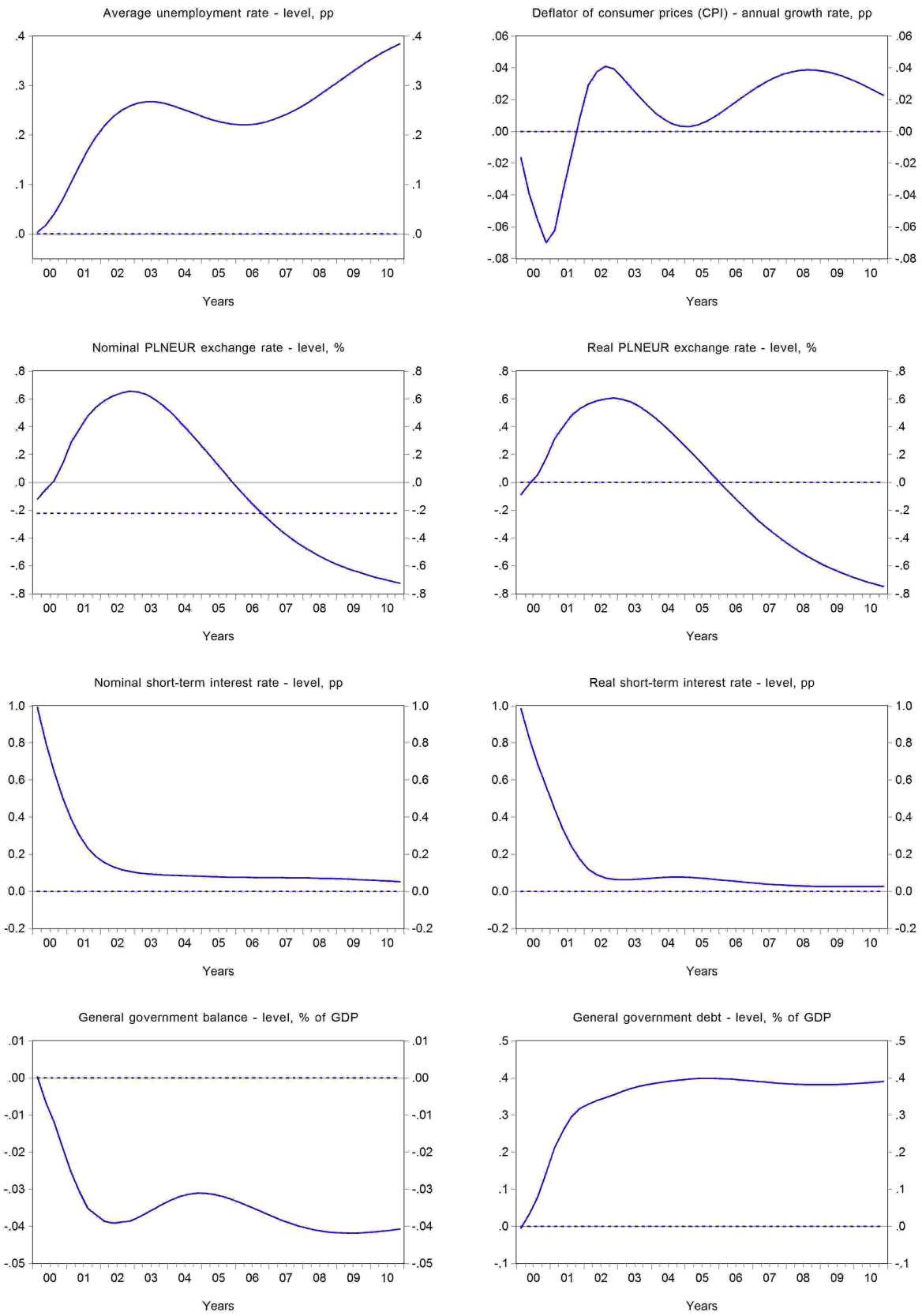

Figure 13: Response to interest rate impulse (3)

Response to interest rate impulse	**Quarters**						
	1	**3**	**6**	**12**	**20**	**200**	**800**
Deviation of level in %							
GDP	-0.05	-0.17	-0.24	-0.29	-0.41	0.08	0.00
Export	-0.06	0.04	0.29	0.45	0.21	0.06	0.00
Import	-0.01	-0.19	-0.36	-0.46	-0.53	0.07	0.00
Final domestic demand	-0.03	-0.25	-0.47	-0.62	-0.68	0.09	0.00
Final consumption expenditure	-0.01	-0.08	-0.10	-0.32	-0.42	0.05	0.00
Individual consumption of households	-0.01	-0.07	-0.10	-0.36	-0.43	0.04	0.00
Non-household consumption	-0.04	-0.10	-0.11	-0.22	-0.39	0.07	0.00
Gross capital formation	-0.09	-0.95	-1.98	-1.80	-1.74	0.25	0.00
Gross fixed capital formation	-0.07	-0.86	-1.87	-1.82	-1.77	0.25	0.00
general government sector	-0.06	-0.20	-0.29	-0.29	-0.41	0.09	0.00
market sector	-0.08	-1.04	-2.29	-2.22	-2.14	0.30	0.00
General government wages and salaries	-0.04	-0.11	-0.12	-0.13	-0.24	-0.19	-0.22
Market sector wages and salaries	-0.05	-0.11	-0.12	-0.13	-0.23	-0.19	-0.22
Average paid employment in market sector	0.00	-0.05	-0.18	-0.33	-0.29	0.05	0.00
Average paid employment in national economy	0.00	-0.04	-0.14	-0.28	-0.27	0.04	0.00
Exchange rate (PLN/EUR)	-0.12	0.01	0.38	0.66	0.30	-0.12	-0.22
Value added deflator in the market sector	-0.01	-0.06	-0.10	-0.09	-0.06	-0.22	-0.22
Deviation of annual growth rate in percentage points							
GDP	-0.05	-0.18	-0.12	-0.05	-0.07	0.01	0.00
Export	-0.07	0.04	0.32	0.06	-0.17	0.01	0.00
Import	-0.02	-0.20	-0.24	-0.07	-0.03	0.01	0.00
Final domestic demand	-0.03	-0.26	-0.32	-0.10	-0.01	0.01	0.00
Final consumption expenditure	-0.01	-0.08	-0.01	-0.16	-0.02	0.01	0.00
Individual consumption of households	-0.01	-0.07	-0.01	-0.17	-0.01	0.01	0.00
Non-household consumption	-0.04	-0.10	-0.03	-0.12	-0.05	0.01	0.00
Gross capital formation	-0.09	-1.00	-1.55	0.15	0.01	0.00	0.00
Gross fixed capital formation	-0.08	-0.91	-1.50	0.05	0.03	0.00	0.00
general government sector	-0.06	-0.21	-0.15	-0.01	-0.08	0.01	0.00
market sector	-0.08	-1.10	-1.86	0.06	0.05	-0.01	0.00
General government wages and salaries	-0.04	-0.12	-0.03	-0.03	-0.03	0.00	0.00
Market sector wages and salaries	-0.05	-0.12	-0.01	-0.04	-0.03	0.00	0.00
Average paid employment in market sector	0.00	-0.05	-0.16	-0.07	0.03	0.01	0.00
Average paid employment in national economy	0.00	-0.04	-0.13	-0.07	0.02	0.01	0.00
Value added deflator in the market sector	-0.01	-0.06	-0.07	0.02	0.01	-0.01	0.00
Consumer price index	-0.02	-0.06	-0.04	0.04	0.00	-0.01	0.00

Response to interest rate impulse	**Quarters**						
	1	**3**	**6**	**12**	**20**	**200**	**800**
Deviation of level in percentage points							
Average unemployment rate	0.00	0.04	0.14	0.26	0.24	-0.04	0.00
3 month WIBOR	0.99	0.65	0.30	0.11	0.08	-0.02	0.00
General government balance to GDP ratio	0.00	-0.01	-0.03	-0.04	-0.03	0.00	0.00
General government debt to GDP ratio	0.00	0.08	0.26	0.35	0.39	0.06	0.00

Table 4: Response to interest rate impulse

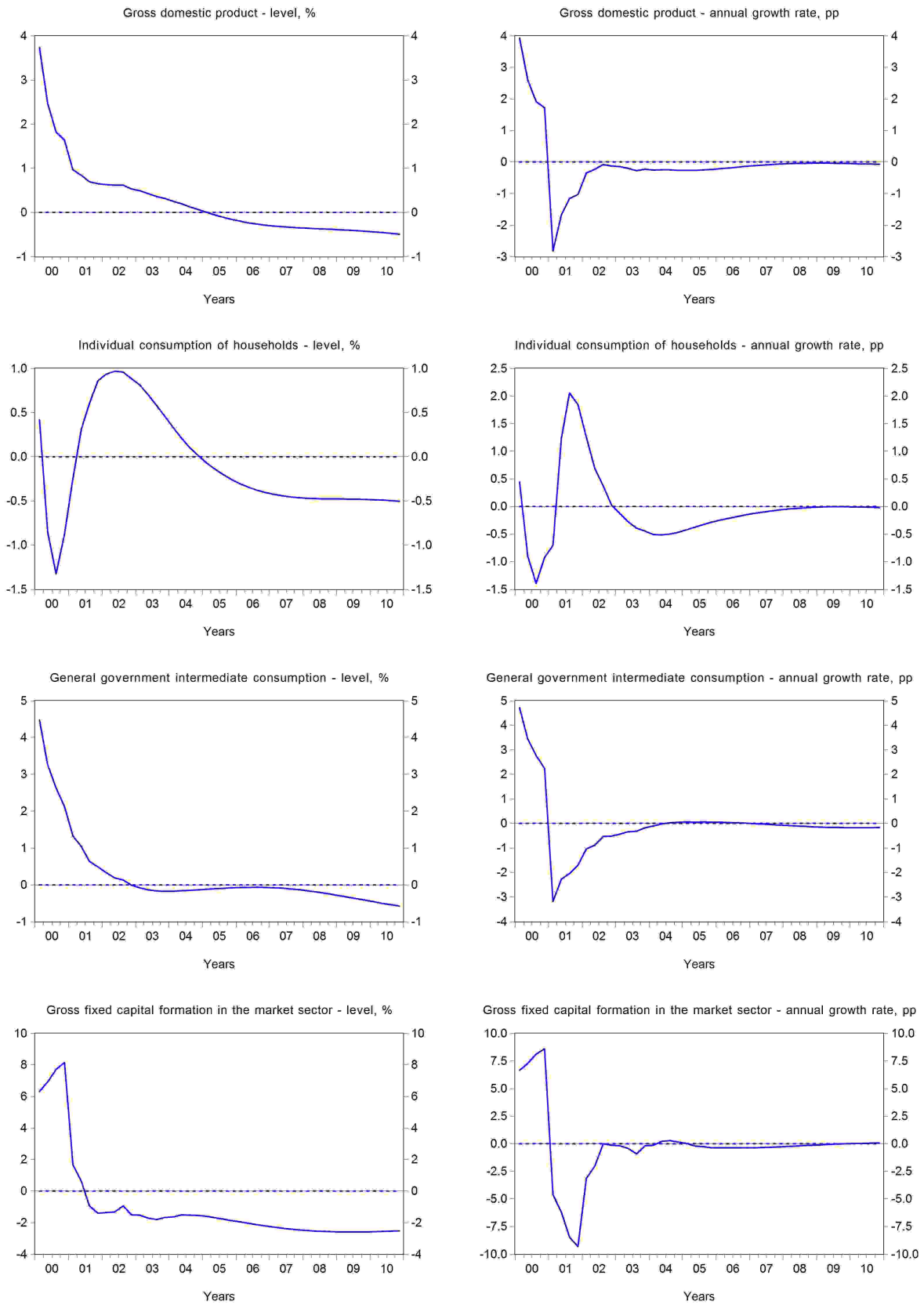

Figure 14: Response to exchange rate impulse (1)

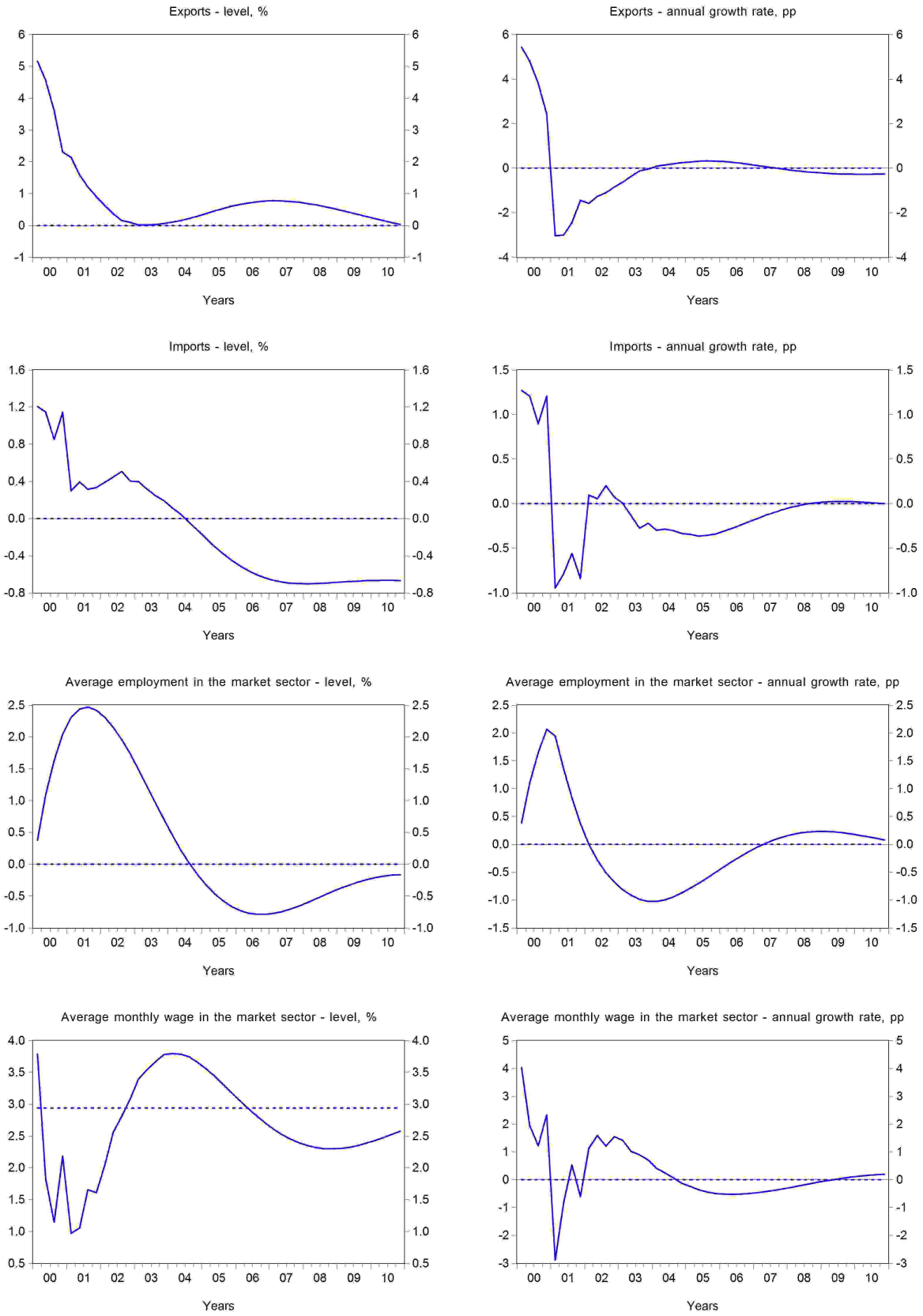

Figure 15: Response to exchange rate impulse (2)

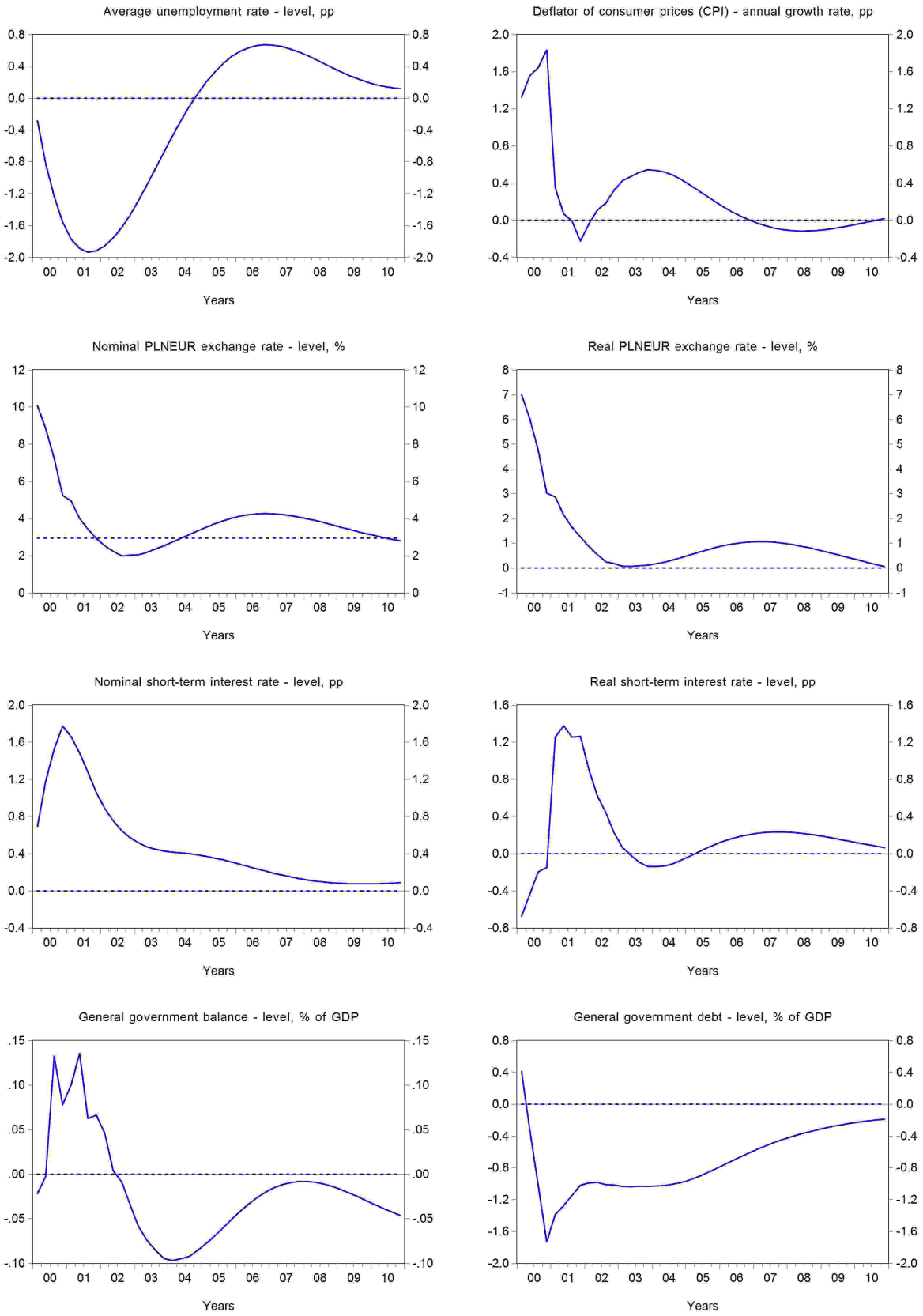

Figure 16: Response to exchange rate impulse (3)

Response to exchange rate impulse	**Quarters**						
	1	**3**	**6**	**12**	**20**	**200**	**800**
Deviation of level in %							
GDP	3.73	1.82	0.84	0.53	0.07	-0.09	0.00
Export	5.17	3.62	1.59	0.10	0.29	-0.12	0.00
Import	1.21	0.85	0.39	0.40	-0.13	-0.10	0.00
Final domestic demand	2.26	0.81	0.40	0.64	-0.09	-0.08	0.00
Final consumption expenditure	1.02	-0.87	0.34	1.22	0.21	-0.15	0.00
Individual consumption of households	0.42	-1.32	0.31	0.88	0.01	-0.17	0.00
Non-household consumption	2.87	0.53	0.43	2.25	0.81	-0.08	0.00
Gross capital formation	7.24	7.53	0.65	-1.69	-1.28	0.19	0.00
Gross fixed capital formation	5.93	6.64	0.71	-1.19	-1.24	0.19	0.00
general government sector	4.47	2.63	1.04	-0.01	-0.13	-0.08	0.00
market sector	6.32	7.70	0.62	-1.51	-1.54	0.26	0.00
General government wages and salaries	3.25	1.33	1.06	3.08	3.69	3.02	2.94
Market sector wages and salaries	3.79	1.15	1.05	3.09	3.66	3.02	2.94
Average paid employment in market sector	0.38	1.63	2.44	1.73	-0.17	-0.07	0.00
Average paid employment in national economy	0.29	1.25	1.96	1.64	0.02	-0.06	0.00
Exchange rate (PLN/EUR)	10.07	7.25	3.99	2.03	3.33	2.84	2.94
Value added deflator in the market sector	1.02	1.18	1.30	1.80	2.80	3.06	2.94
Deviation of annual growth rate in percentage points							
GDP	3.93	1.92	-1.67	-0.12	-0.26	0.03	0.00
Export	5.44	3.81	-2.99	-0.84	0.25	0.03	0.00
Import	1.27	0.90	-0.78	0.07	-0.34	0.02	0.00
Final domestic demand	2.38	0.85	-0.85	0.21	-0.47	0.02	0.00
Final consumption expenditure	1.08	-0.91	0.68	0.30	-0.64	0.02	0.00
Individual consumption of households	0.44	-1.39	1.23	0.02	-0.47	0.03	0.00
Non-household consumption	3.02	0.56	-0.97	1.17	-1.18	0.02	0.00
Gross capital formation	7.63	7.93	-6.57	-0.18	0.24	0.02	0.00
Gross fixed capital formation	6.25	6.99	-5.40	-0.21	0.13	0.02	0.00
general government sector	4.71	2.77	-2.27	-0.52	0.05	0.03	0.00
market sector	6.65	8.12	-6.20	-0.12	0.15	0.01	0.00
General government wages and salaries	3.46	1.41	-1.11	1.54	-0.11	0.00	0.00
Market sector wages and salaries	4.04	1.22	-0.81	1.55	-0.13	0.00	0.00
Average paid employment in market sector	0.38	1.65	1.35	-0.68	-0.87	0.02	0.00
Average paid employment in national economy	0.29	1.26	1.13	-0.38	-0.82	0.01	0.00
Value added deflator in the market sector	1.04	1.21	0.19	0.45	0.42	-0.01	0.00
Consumer price index	1.33	1.65	0.07	0.33	0.43	-0.01	0.00

Response to exchange rate impulse	Quarters						
	1	**3**	**6**	**12**	**20**	**200**	**800**
Deviation of level in percentage points							
Average unemployment rate	-0.29	-1.23	-1.89	-1.47	0.06	0.06	0.00
3 month WIBOR	0.69	1.53	1.48	0.57	0.39	-0.03	0.00
General government balance to GDP ratio	-0.02	0.13	0.14	-0.03	-0.09	-0.01	0.00
General government debt to GDP ratio	0.41	-1.02	-1.27	-1.01	-0.98	0.18	0.00

Table 5: Response to exchange rate impulse

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A Forecasting process

The eMPF was build to provide the Ministry with a tool for simulations of different policy scenarios and for forecasts. The simulation work is kind of an ad hoc analysis that can be done anytime in the model lifecycle. Forecasting process is a bit more constrained. It should be designed in a way to take into account the timetable of the data publications, on the one hand, and on the other hand - to be consistent with the schedule of official forecasting business in the Ministry.

The official forecasts of the Ministry are in fact published twice a year: in April, when update of the Convergence Program and Multiannual Financial Plan is prepared, and in September, when Budgetary Act is provided to the Parliament. Hence, these two periods are kind of first order restrictions for the forecasting process. To publish the official document some time for passing it through all the required administration levels is necessary. For this reason, the true deadlines for the forecast to be ready are mid of August and mid of March. Till these dates the forecast can incorporate: in the March round first release of the information on previous year macroeconomic outcome (without institutional breakdown of National Account data for the fourth quarter of the year $T-1$) and in the August round an update of the first release and additional data concerning the first quarter of the year T. The forecasting process is a multi-stage course of action which can be summarized on the diagram below.

The process consists of few important steps and, taking into account the upper limit defined by the abovementioned deadlines, should take no longer than two months. The bottom limit is connected with the dates, when Statistical Office publish an information on macroeconomic outcome. The more recent data are included in the forecast, the chance for better assessment of future economic development is higher. Extension of the forecasting process would result in the loss of information mentioned in the paragraph above. So, despite the fact that the process itself is multilevel, two months seems to be long enough to go through the whole process successfully.

The first stage of the process concentrates on updating of the data (see appendix B) and checking the equations. In general, the estimated relations are quite stable, however issuance of the new data is sometimes connected with the revision of historical figures. Data transformation process also includes seasonal adjustment which often results in changes of some previously computed numbers, especially the latest ones. Hence, after updating the model to the most recent data, some inspection of the estimated equations is necessary.

When the model is filled in, the stage of exogenous assumptions starts. It seems to be the most important part of the process. The accepted path for exogenous variables is of crucial

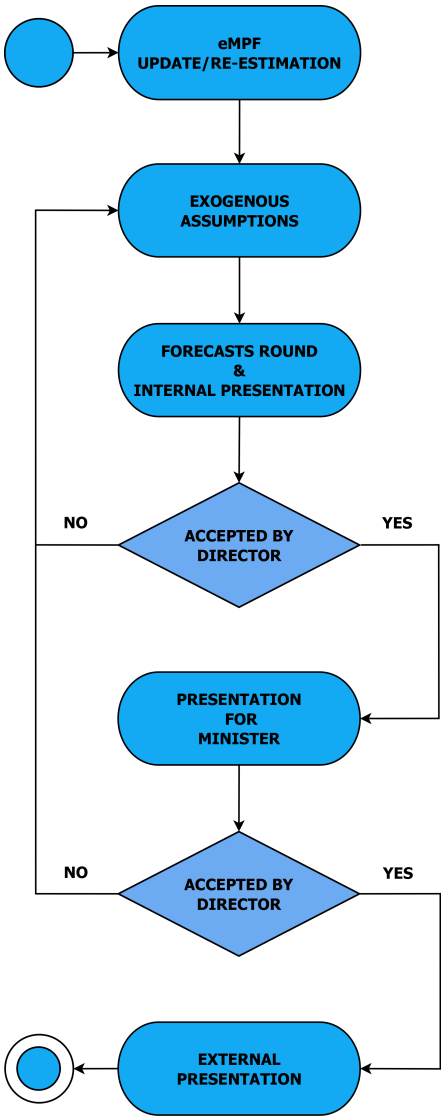

Figure 17: The forecasting process in the Financial Policy, Analysis and Statistics Department

importance for the outcome of the model. Within this activity different sets of possible exogenous assumption is discussed with the experts of particular areas of the economy/public finances. The most probable are then verified in the model in terms of their consistency and impact on endogenous variables. Finally, one set of exogenous assumptions is decided and used to prepare an internal presentation for the group of experts and the management of the Department. At this stage, some additional corrections of the assumptions are still possible. If the final scenario gets the acceptance of the Director, the next stage, presentation for the Minister, starts. This part of the process consists of discussion on the main exogenous assumptions and the forecast outcome from the model generated on the basis of them. The

Minister may decide to change some assumptions or to apply some additional policy measures to influence the macroeconomic forecasts or projected path for public finances. Details of the proposals are then discussed with the experts and used in the new set of exogenous assumptions. Then, next forecasts set is generated and discussed with the Minister. Finally, when all the iterations are finished, the official new forecast can be publicished and used by the interested entities.

B Data transformation process

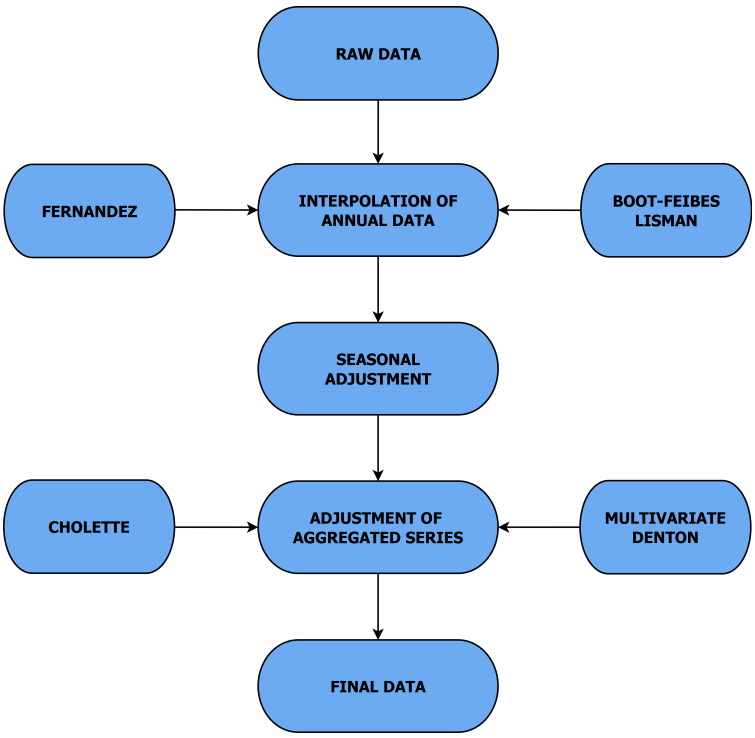

Figure 18: Data transformation process for the purpose of the eMPF model

The data is quarterly and is based mainly on the national accounts of GUS (Central Statistical Office). Other data sources include the National Bank of Poland, Eurostat, World Bank, OECD. The data set used for estimation of the model range from 1995Q1 to 2010Q1. The data set is divided into two sectors: general government sector and non-general government sector, using the ESA-95 approach.

The series used in eMPF model are at constant prices (volumes) with base year. Base year is the previous year $(t-1)$ of last available data.

When series were not originally available at the required frequency, an interpolation methods (Fernandez (1981); Cholette (1984); Boot et al. (1967)) was employed to transform data into a quarterly frequency.[11] This is the first step in data transformation process (see Figure 18).

[11] The criteria for reasonableness are (Boot et al. (1967)):

- sum of quarterly figures should, for each year, equal the given yearly total,
- symmetry considerations, in particular the requirement that if the yearly totals in there successive year are t_1,t_2 and t_3 the quarterly figures for year 2 are the same but in reverse order from what they would have been had the yearly totals been t_3, t_2, t_1,

The difference between Fernandez and Boot - Feibes - Lisman (BFL) methods is availability of indicator of the data. Fernandez method use indicator to interpolate annual data. BFL method does not need to have such a time series.
The second step in data transformation process is seasonally adjustment of the data. All series used in eMPF model, are seasonally adjusted with Tramo/Seats method, implemented in Demetra package.
As the result of seasonally adjusting of the data and use of chain - linked data, statistical discrepancy between sum of quarterly data and correspond yearly aggregate (time-varying) occur. Another problem with the data is statistical discrepancy between aggregate and sum of components of this aggregate (space-varying). In third step we solve this problems using Chollete method for time-varying, and Multivariate Denton method for space-varying. In Appendix B we discuss the problem of benchmarking and reconciliation.

- trend considerations, in particular the desire that if the yearly totals in three successive years rise by equal steps ($t_2 - t_1 = t_3 - t_2$) the quarterly figures during year 2 should also rise by equal steps,
- cycle considerations, in particular the requirement that $t_2 - t_1 = t_2 - t_3$, the quarterly figures during year 2 should lie on a sinusoid.

C Benchmarking and Reconciliation

C.1 Introduction

The Quarterly National Accounts data simultaneously comply with both relevant annual figures and accounting constraints. Data transformations described in the previous section generally violate both cross sectional additive constraint and temporal constraint. Cross sectional condition occurs in systems of series and requires the sum of components values in each time add up to the value of aggregate. Typically time series must also temporally add up to its annual benchmarks what is known as temporal aggregation constraint. To restore the consistency between economic data we incorporate benchmarking and reconciliation methods. In line with the definitions provided by Dagum and Cholette (2006) the problem can be separated into benchmarking and reconciliation procedures. The classical benchmarking problem arises when the annual sums of the high-frequency series are not equal to the corresponding annual values. In our case the need for benchmarking occurs only in the context of seasonal adjustment. The need for reconciliation emerge when the system of series for example GDP and its main components must apart from temporal constraint satisfy also cross-sectional additive constraint.

In the data preparation process we identified two sources of statistical discrepancy:

- seasonal adjustment process
- chain-linking of volumes

The occurrence of the specified statistical discrepancies is dependent on the type of the data used. We operate on the two types of data - nominal and chain-linked volumes. The statistical discrepancy that occur in the case of nominal data is caused only by seasonal adjustment procedure and in this case reconciliation is possible - the presence of reference data. To measure economic reality more accurately since 2005 almost all statistical institutes in the European Union (EU) have been using annual chain-linking for the calculation of quarterly volume measures in Quarterly National Accounts. However the implementation of chain linking among countries was not harmonised and three different techniques of chain-linking quarterly volume measures are used in practice. According to the type of computation different techniques preserve a certain type of growth rate not affected by the changes in the price structure.Accordingly:

1. Annual Overlap - the quarter-on-quarter rates of change within the same calendar year remains not affected

2. One Quarter Overlap - the quarter on quarter rates of change for all quarters of the year are undistorted

3. Over The Year - year-on-year growth rates for all quarters remains not affected.

The preservation of a specific rates of change determine various advantages and disadvantages of the QNA volumes. Independently from technique chain-linking of volumes violate contemporaneous constraint and the lost of additivity is irrevertible due to the lack of the reference data. The applied by the Central Statistical Office in Poland technique is annual overlap. In line with this we compute the chain-linked volumes using the same technique. The only difference is the choice of reference period which is updated year by year according to data availability This change is justified by the specific feature of the annual overlap technique that preserve accounting constraint in one year ahead the reference period. Furthermore the statistical discrepancies near the reference period are negligible and increase slightly in time. As mentioned earlier for chain-linked volumes we restore only temporal constraint due to the lack of reference data for reconciliation.

C.2 Denton's Multivariate Benchmarking Method

In the literature the benchmarking techniques are classified into two groups:

- Numerical methods - where the data set is balanced by minimizing an objective function what in turn determine a covariance matrix

- Model-based methods - where the covariance matrix originate from a statistical model (for more see Dagum and Cholette (2006))

To preserve the dynamics of the data untouched as much as possible we decided on numerical methods based on the movement preservation principle (see Denton (1971)).

For the classical benchmarking problem we choose a modified Denton's benchmarking procedure proposed by Cholette (1984) which is suitable when no contemporaneous constraint is in order. The approach we applied in the case of systems of time series that have to simultaneously comply with contemporaneous and temporal constraints is known in the literature as the multivariate Denton's benchmarking (see DiFonzo and Marini (2005b)). This method is a generalization of the movement preservation principle presented by Denton (1971).
In this paragraph we present an adjustment process we applied to the seasonally adjusted data from National Accounts to restore the accounting constraints originally linking the series. The use of univariate seasonal adjustment introduce annual statistical discrepancies. The seasonal adjustment method TRAMO/SEATS almost in all cases causes that the annual sums of the

high frequency(quarterly) series aren't equal to the corresponding annual values. Apart from that the sum of the system components isn't equal to the value of the system marginal total for each period of time.

Before the data transformation the following accounting constraints must hold:

- Contemporaneous aggregation criterion

$$\sum_{i=1}^{M} X_{it} = X_{M+1,t}, \quad t = 1, ..., n; \tag{106}$$

where:

X_i – quarterly raw series,

X_{M+1} – seasonally adjusted benchmarked to the yearly sums of the raw series aggregate.

- Temporal aggregation criterion

$$\sum_{s=1}^{4} X_{i,(T-1)12+s} = Y_N, \quad i = 1, ..., M+1, T = 1, ..., N \tag{107}$$

where:

X_i, – quarterly raw series,

X_N – annual value of the raw series.

The Multivariate Denton's Benchmarking Method underpinning model assume that the unknown series $\mathbf{Y_i^*}$ are unbiasedly distributed around the preliminary data

$$\mathbf{Y_i^*} = \mathbf{Y_i} + \mathbf{e_i}, \quad i = 1, ..., M \tag{108}$$

where:

$\mathbf{Y_i^*}$ – quarterly benchmarked series complying with the constraints,

$\mathbf{Y_i}$ – preliminary value of the raw series,

$\mathbf{e_i}$ – zero mean disturbances with $E(\mathbf{e_i}, \mathbf{e_j^{'}}) = \mathbf{\Omega_{ij}}, i, j = 1, ..., M$.

For the whole system made up of M components we obtain the model

$$\mathbf{Y^*} = \mathbf{Y} + \mathbf{e} \tag{109}$$

where $E(\mathbf{e}) = \mathbf{0}$ and $E(\mathbf{ee^{'}}) = \mathbf{\Omega}$

Using that model we obtain the simultaneously benchmarked series by solving the least squares problem with constraints:

$$min(\mathbf{Y^*} - \mathbf{Y})^{'}\mathbf{\Omega}^{-1}(\mathbf{Y^*} - \mathbf{Y}) \text{ subject to } \mathbf{HY^*} = \mathbf{X_a} \tag{110}$$

The $\mathbf{H}$ is the aggregation matrix and the vector $\mathbf{X_a}$ contains both contemporaneous and temporal aggregates. The occurence of the redundant constraints impose a problem of singular

matrices inversion. To overcome this problem the Moore-Penrose generalized inverse is used. The solution of the system is given by:

$$\hat{\mathbf{Y}}^{*} = \mathbf{Y} + \mathbf{\Omega H}^{'}(\mathbf{H\Omega H}^{'})^{-}(\mathbf{X_a} - \mathbf{HY}) \tag{111}$$

where $(\mathbf{H\Omega H}^{'})^{-}$ is the Moore-Penrose generalized inverse of $\mathbf{H\Omega H}^{'}$. The solution equivalent (DiFonzo and Marini (2005b)) to presented can be expressed in terms of r 'free' constraints.

The choice of matrix $\mathbf{\Omega}$ determine the type of Denton's movement preservation principle. For our purposes we use the additive first differences variant of the multivariate extension of Denton's benchmarking procedure. Thus using the matrix notation $\mathbf{\Omega}$ is given by $\mathbf{\Omega} = I_M \otimes (\mathbf{D}^{'}\mathbf{D})^{-1}$ where $\mathbf{D}$ performs first differences:

$$\mathbf{D} = \begin{bmatrix} 1 & 0 & 0 & \dots & 0 & 0 \\ -1 & 1 & 0 & \dots & 0 & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots & \vdots \\ 0 & 0 & 0 & \dots & -1 & 1 \end{bmatrix} \tag{112}$$

D List of variables

Symbols in the brackets following the variable name stand for: EX exogenous, EN endogenous. Symbols in the brackets following the variable description stand for: cs constant price, cb current price.

Table 6

Code	Variable description	Type
ACT_RATE	participation rate	EN
ACT_RATE_M	participation rate of 25-44 age group	EN
ACT_RATE_O	participation rate of 45-59/64 age group	EN
ACT_RATE_O_TREND	smoothed participation rate of 45-59/64 age group	EN
ACT_RATE_Y	participation rate of 18-24 age group	EN
ADJ	subsidies on products UE (*cb*)	EX
CA	balance of payments: current account balance (*cb*)	EN
CA_CAI	balance of payments: smoothed income balance to GDP ratio	EN
CA_CAT	balance of payments: smoothed income to GDP ratio	EN
CAI	balance of payments: income balance (*cb*)	EN
CAIC	balance of payments: income credit (*cb*)	EN
CAID	balance of payments: income debit (*cb*)	EN
CASHFLOWADJ_DOM	net flow of GG sector debt without net domestic borrowing of general government (*cb*)	EN
CASHFLOWADJ_ROW	net flow of GG sector debt without net foreign borrowing of general government (*cb*)	EN
CAT	balance of payments: current transfers balance (*cb*)	EN
CATC	balance of payments: current transfers credit (*cb*)	EN
CATD	balance of payments: current transfers debit (*cb*)	EN
CGTAXRES	taxes on lotteries, gambling and betting (*cb*)	EN
CONSHS	individual consumption of households (*cb*)	EN
CONSHSQ	individual consumption of households (*cs*)	EN
CONS	final consumption expenditure (*cb*)	EN
CONSGG	public consumption (*cb*)	EN
CONSGGQ	public consumption (*cs*)	EN
CONSQ	final consumption expenditure (*cs*)	EN
CORPGOS	gross operating surplus in corporation sectors (*cb*)	EN
CPI	consumer price index YoY	EN
CPIA	yearly average CPI	EN
CPI_LAG_4	yearly consumer prices growth in the previous year	EN
CPISTAR	inflation target of CB (*cb*)	EX
DNB	gross national income (*cb*)	EN

Table 6

Code	Variable description	Type
EE_COST	relation of costs of obtained revenue from salaries to obtained revenue from salaries (PIT) (*cb*)	EX
EECONTHC	employees' social contributions (with payments on activity of the health unities) (*cb*)	EN
ELLR	long term interest rate in EMU (*cb*)	EX
ELRR_3M	real short term interest rate in EMU	
ELR3M	short term interest rate in EMU	EN
ERCONT	employers' social contributions (*cb*)	EN
EURUSD	EUR/USD exchange rate	EX
EXTRA_INDEXATION	extra indexation above statutory indexation	EN
FD	domestic demand without non-market services of GG sector (*cb*)	EN
FDDEM	final domestic demand (*cb*)	EN
FDDEMQ	final domestic demand (*cs*)	EN
FDQ	domestic demand without non-market services of GG sector (*cs*)	EN
FDQ_IND	indicator of domestic demand without non-market services of GG sector	EN
FEER	fundamental equilibrium exchange rate	EN
GAMMA_TFP	productivity growth	EX
GAP	output gap (*cs*)	EN
GCF	gross capital formation (*cb*)	EN
GCFQ	gross capital formation (*cs*)	EN
GDEBT_ESA	stock of government debt (*cb*)	EN
GDEBT_ESA_DOM	stock of domestic debt, GG sector (*cb*)	EN
GDEBT_ESA_ROW	stock of foreign debt, GG sector (*cb*)	EN
GDP	gross domestic product (*cb*)	EN
GDP_an	annual nominal gross domestic product (*cb*)	EN
GDPM	market gross domestic product (*cb*)	EN
GDPMQ	market gross domestic product (*cs*)	EN
GDPPOT_EU15	potential GDP in euro zone (*cs*)	EN
GDPQ	gross domestic product (*cs*)	EN
GDPQ_POT	potential gross domestic product (*cs*)	EN
GFCF	gross fixed capital formation (*cb*)	EN
GFCFQ	gross fixed capital formation (*cs*)	EN
GGCEXPEC	current expenditure consolidated, GG sector (*cb*)	EN
GGCREVC	current revenue consolidated, GG sector (*cb*)	EN
GGCTREC	other current transfers disbursed consolidated + current taxes on income, wealth payable (*cb*)	EN
GGCTRED	other current transfers disbursed consolidated + current taxes on income, wealth payable minus GNI contribution (*cb*)	EN
GGDEPR	depreciation rate, GG sector (*cs*)	EX
GGDIE	gross disposable income, GG sector (*cb*)	EN
GGDIV	property income other than interest (*received*), GG sector (*cb*)	EN

Table 6

Code	Variable description	Type
GGERCONT	employers' social contributions, GG sector (*cb*)	EN
GGEUCONTR	EU contribution (*cb*)	EN
GGEUDNB	EU contribution *GNI* part (*cb*)	EN
GGEUTORVAT	EU contribution VAT, TOR (*cb*)	EN
GGEXC	excise tax revenues, GG sector (*cb*)	EN
GGFCE	final consumption expenditure, GG sector (*cb*)	EN
GGFINN	borrowing needs, GG sector (*cb*)	EN
GGGCF	gross capital formation, GG sector (*cb*)	EN
GGGFCFE	gross fixed capital formation, GG sector (*cb*)	EN
GGGFCFEQ	gross fixed capital formation, GG sector (*cs*)	EN
GGGSAVE	gross saving, GG sector (*cb*)	EN
GGIC	intermediate consumption, GG sector (*cb*)	EN
GGICQ	intermediate consumption, GG sector (*cs*)	EN
GGINT	interest received, GG sector (*cb*)	EN
GGINTE	interest expenses, GG sector (*cb*)	EN
GGINTE_DOM	interest expenses (*domesticdebt*), GG sector (*cb*)	EN
GGINTE_ROW	interest expenses (foreign debt), GG sector (*cb*)	EN
GGK	capital stock, GG sector (*cs*)	EN
GGKTRC	capital transfers, receivable consolidated, GG sector (*cb*)	EN
GGKTREC	capital transfers, payable consolidated, GG sector (*cb*)	EN
GGLC	compensation of employees, GG sector (*cb*)	EN
GGNETB	net lending (+), borrowing (−), GG sector (*cb*)	EN
GGNETB_AN	annual general government deficit (*cb*)	EN
GGOS	gross operating surplus, GG sector (*cb*)	EN
GGOTRC	other current transfers received consolidated, GG sector (*cb*)	EN
GGPB	primary balance, GG sector (*cb*)	EN
GGPIE	property income (*paid*), GG sector (*cb*)	EN
GGPIN	property income, GG sector (*cb*)	EN
GGSALES	market sales of general government (*cb*)	EN
GGSALESQ	market sales of general government (*cs*)	EN
GGSC	social contributions (received), GG sector (*cb*)	EN
GGSSBE	social benefits other than social benefits in kind (*cb*)	EN
GGSTRK	GG social transfers in kind (*cb*)	EN
GGSTRKQ	GG social transfers in kind (*cs*)	EN
GGSUBE	subsidies total (*paid*), GG sector (*cb*)	EN
GGSUBP	subsidies on products (*paid*), GG sector (*cb*)	EN
GGSUBPQ	subsidies on products (paid), GG sector (*cs*)	EN
GGSUBPR	subsidies on production (paid), GG sector (*cb*)	EN
GGTAX_SUB	other taxes on production, payable minus other subsidies on production, receivable (*cb*)	EN
GGTAXCD	custom duties, GG sector (*cb*)	EN

Table 6

Code	Variable description	Type
GGTAXCD_I_CSB	index of custom duties, GG sector	EN
GGTAXIFHS	taxes on income paid by households sector (*cb*)	EN
GGTAXP	taxes on production and imports (received), GG sector (*cb*)	EN
GGTAXPCOM	taxes on products, GG sector (*cb*)	EN
GGTAXPCOM_SUBP	taxes on products minus subsidies on products (*cb*)	EN
GGTAXW	current taxes on income, wealth, etc. (*cb*)	EN
GGTAXWCORP	current taxes on income, wealth, etc. paid by corporations (*cb*)	EN
GGTEXPEC	total expenditure consolidated, GG sector (*cb*)	EN
GGTREVC	total revenue consolidated, GG sector (*cb*)	EN
GGVA	value added gross, GG sector (*cb*)	EN
GGVAQ	value added gross, GG sector (*cs*)	EN
GGVAT	VAT revenue, GG sector (*cb*)	EN
GGW	average monthly wage and salary in GG sector (*cb*)	EN
GGWSOLC	fund of general government wages, salaries and other income connected with hired work (*cb*)	EN
HSB	average quarterly retirement pay and pension bill (*cb*)	EN
HSBA	average quarterly retirement pay and pension bill from agricultural social security system (*cb*)	EN
HSBNA	average quarterly retirement pay and pension bill from non-agricultural social security system (*cb*)	EN
HSCSF	social contributions (*cb*)	EN
HSGDI	gross disposable income of households and non-profit institutions (*cb*)	EN
HSGOS	gross operating surplus and mixed income of households and non-profit institutions (*cb*)	EN
HSGOS_COST	relation of costs of obtained revenue from non-agricultural economic activity to obtained revenue from non-agricultural economic activity (*cb*)	EX
HSNTR	other current transfers (balance) in households and non-profit institutions sector (*cb*)	EN
HSOTHTAX	other income taxes paid by households sector (*cb*)	EN
HSPIN	property income (*balance*) of households and non-profit institutions (*cb*)	EN
HSPIN_COST	relation of costs of obtained revenue from property rights, rent or lease to obtained revenue from property rights, rent or lease (*cb*)	EX
HSSAB	social assistance benefits (*cb*)	EN
HSSSB	social security benefits (*cb*)	EN
HSSUBPR	subsidies on production (*received*) in the households and non-profit institutions sector (*cb*)	EN
HSTAX	current taxes on income, wealth, etc. paid by households (*cb*)	EN
HSWSOLC	wages, salaries and other income connected with hired work received by households (*cb*)	EN

Table 6

Code	**Variable description**	**Type**
INVT	changes in inventories (*cb*)	EN
INVTQ	changes in inventories (*cs*)	EN
INVTS	stock of inventories (*cs*)	EN
K_PENSION	average value of account of a new pension system member (*cb*)	EN
K_PENSION_ADJ	average value of account in the new pension system corrected for seasonality	EN
LE	average life expectancy for person aged 62	EX
LEG	average paid employment in general government sector	EN
LEM	average number of paid employment, market sector	EN
LET	average paid employment in national economy	EN
LG	average employment in general government sector	EN
LGTAXP	other taxes on production (*cb*)	EN
LM	average employment in market sector	EN
LMD	labour demand which optimize production costs, market sector	EN
LS	average labour supply	EN
LS_M	average labour supply of 25-44 age group	EN
LS_O	average labour supply of 45-59/64 age group	EN
LS_Y	average labour supply of 18-24 age group	EN
LSELFM	average number of employers and own-account workers and the rest employment in market sector	EN
LSELFT	average number of employers and own-account workers and the rest employment	EN
LT	average employment according to ESA95	EN
M	imports of goods and services (*cb*)	EN
MDEPR	depreciation rate, market sector (*cs*)	EX
MGFCF	gross fixed capital formation, market sector (*cb*)	EN
MGFCFQ	gross fixed capital formation, market sector (*cs*)	EN
MGOS	gross operating surplus, market sector (*cb*)	EN
MK	capital stock, market sector (*cs*)	EN
MKD	capital demand which optimize production costs, market sector (*cs*)	EN
MQ	imports of goods and services (*cs*)	EN
MVA	value added gross, market sector (*cb*)	EN
MVAQ	value added gross, market sector (*cs*)	EN
MVAQPOT	potential gross value added in the market sector (*cs*)	EN
MW	average monthly wage and salary in market sector (*cb*)	EN
MWSOLC	fund of market sector wages, salaries and other income connected with hired work (*cb*)	EN
NAWRU	non-accelerating wage inflation rate of unemployment (*cb*)	EN
NEXP	net exports (*cb*)	EN
NEXPQ	net exports (*cs*)	EN
NFA	net foreign assets (*cb*)	EN

Table 6

Code	Variable description	Type
NFA_Y	net foreign assets as a percent of GDP	EN
NPI	non-property income of households (cb)	EN
OLDDROP	outflow of old pensioners in non=agricultural pension system	EN
OPEN	degree of an openess of the economy	EN
P_POPRA	average number of persons receiving retirement pay from agricultural social security system in relation to the average number of post-working age population in rural areas	EN
P_POPRNA	average number of persons receiving retirement pay from non-agricultural social security system in relation to the average number of post-working age population	EN
P_POPRNANS	average number of persons receiving retirement pay from new pension system in relation to the average number of post-working age population	EN
PCONS	deflator of total consumption (cs)	EN
PCONSGG	deflator of public consumption (cs)	EN
PCONSHS	deflator of household individual consumption (cs)	EN
PCPI	consumer price index (cs)	EN
PENBASE	base sum (cb)	EN
PENBASE_ADJ	seasonally adjusted base sum (cb)	EN
PENXA	average monthly pension resulting from an inability to work from agricultural social security system (cb)	EN
PENXNA	average monthly pension resulting from an inability to work from non-agricultural social security system (cb)	EN
PENXNA_NEW	average monthly disability pension pay for new pensioners (cb)	EN
PENYA	average monthly family pension from agricultural social security system (cb)	EN
PENYNA	average monthly family pension from non-agricultural social security system (cb)	EN
PENYNA_NEW	average monthly family pension pay for new pensioners	EN
PFD	deflator of domestic demand without non-market services of GG sector (cs)	EN
PFP_CIT_ER	effective CIT rate (cb)	EN
PFP_CIT_R	statutory CIT rate (cb)	EX
PFP_DE_RE_CIT	deductions, reductions and foregoing of CIT (cb)	
PFP_DEDTAX	deductions from tax (PIT) other (cb)	EX
PFP_DNBRATE	ratio of GNI contribution paid by GG sector to GNI (cb)	EX
VAT_CONSHS_I_CSB	index of effective weighted VAT rate on household consumption expenditures (cb)	EX
PFP_ EFRVAT_ CONSHS	effective weighted VAT rate on household consumption expenditures	EX
PFP_ EFRVAT_ CONSHS_ CSB	index of effective weighted VAT rate on household consumption expenditures	EX

Table 6

Code	Variable description	Type
PFP_EFRVAT_ICGG	index of effective weighted VAT rate on government intermediate consumption (*cb*)	EX
PFP_EFRVAT_ICGG_CSB	index of effective weighted VAT rate on government intermediate consumption (*cb*)	EX
PFP_EFRVAT_IG	effective weighted VAT rate on government investment (*cb*)	EX
PFP_EFRVAT_IG_CSB	index of effective weighted VAT rate on government investment (*cb*)	EX
PFP_EFRVAT_IM	effective weighted VAT rate on non-government investment (*cb*)	EX
PFP_EFRVAT_IM_CSB	index of effective weighted VAT rate on non-government investment (*cb*)	EX
PFP_EFRVAT_MIC	effective weighted VAT rate on non-government intermediate consumption (*cb*)	EX
PFP_GDEBT_EUR	share of foreign public debt nominated in EUR (*cb*)	EX
PFP_GGFCE	ratio of public consumption to sum of intermediate consumption GG and compensation of employees GG (*cb*)	EN
PFP_GGFINN_DOM	ratio of domestic financing of borrowing needs to total budget borrowing needs (*cb*)	EX
PFP_GGTAXCD	scaling factor $GGTAXCD$ equation (*cb*)	EX
PFP_GGTAXCD_I_CSB	index of scaling factor $GGTAXCD$ equation (*cb*)	EN
PFP_GGTAXWCORP	scaling factor $GGTAXWCORP$ equation (*cb*)	EX
PFP_GGVAT	scaling parameter $GGVAT$ equation (*cb*)	EX
PFP_KRUS	share of persons insured in Agriculture Social Security Fund (KRUS) in average number of employers and own account workers and the rest employment	EX
PFP_LOSS_DED	the previous year loss, deductions and the amount increasing income/decreasing loss of enterprises (CIT) (*cb*)	EX
PFP_LSELFT	share of taxpayers earning income from non-agricultural business and special branches of agricultural production in average number of employers and own-account workers and the rest employment (*cb*)	EX
PFP_NON_EXE_I	non-taxed and exempted income of enterprises (*cb*)	EX
PFP_PITDEDINC	all deductions from income (PIT) (*cb*)	EX
PFP_RESPIT	residual unbalanced items (PIT) (*cb*)	EX
PFP_RGGEXC	effective excise tax rate (*cb*)	EX
PFP_RGGEXC_I_CSB	index of effective excise tax rate (*cb*)	EX
PFP_TFI	tax-free income to taxable income (PIT) (*cb*)	EX
PFP_WAYOY	nominal gross wage growth published by GUS in February for the purpose of indexation divided by the wage growth corrected for the contributions in the previous year	EX
PFP_WPIT	weighted nominal tax rate (PIT) (*cb*)	EX
PGDP	deflator of gross domestic product	EN
PGFCF	deflator of gross fixed capital formation (*cs*)	EN
PGGGFCF	deflator of gross fixed capital formation, GG sector (*cs*)	EN

Table 6

Code	Variable description	Type
PGGIC	deflator of intermediate consumption, GG sector (*cs*)	EN
PGGVA	deflator of gross value added, GG sector (*cs*)	EN
PINVT	deflator of changes in inventories (*cs*)	EN
PITLUMP	lump-sum personal income tax (*cb*)	EN
PLNEUR	PLN/EUR exchange rate (*cb*)	EN
PLNEUR_FEER	PLN/EUR exchange rate $FEER$ (*cb*)	EN
PLNEUR_I_CSB	index of exchange rate PLN/EUR for the purpose of expressing foreign prices in Polish currency (*cb*)	EN
PLNUSD	PLN/USD exchange rate (*cb*)	EN
PLNUSD_I_CSB	index of exchange rate PLN/USD for the purpose of expressing foreign prices in Polish currency (*cb*)	EN
PM	deflator of imports of goods and services (*cs*)	EN
PMGFCF	deflator of gross fixed capital formation, market sector (*cs*)	EN
PMVA	deflator of value added, market sector	EN
POPBWA	average number of pre-working age population (0-17)	EN
POPBWAM	average number of pre-working age population (0-17) in urban areas	EN
POPBWAW	average number of pre-working age population (0-17) in rural areas	EN
POPPENXA	average number of persons receiving pensions resulting from an inability to work from agricultural social security system	EN
POPPENXA_N	flow of new persons receiving pensions resulting from an inability to work in agricultural social security system in relation to the number of disability pensioners in the previous quarter	EX
POPPENXNA	average number of persons receiving pensions resulting from an inability to work from non-agricultural social security system	EN
POPPENXNA_N	flow of new persons receiving pensions resulting from an inability to work in non-agricultural social security system in relation to the number of disability pensioners in the previous quarter	EX
POPPENXNA_NEW	flow of new beneficiaries of the pensions resulting from an inability to work in non-agricultural social security system	EN
POPPENYA	average number of persons receiving family pensions from agricultural social security system	EN
POPPENYA_N	flow of new persons receiving family pensions in agricultural social security system in relation to the number of pensioners receiving family pensions in the previous quarter	EX
POPPENYNA	average number of persons receiving family pensions from non-agricultural social security system	EN
POPPENYNA_N	flow of new persons receiving family pensions in non-agricultural social security system in relation to the number of pensioners receiving family pensions in the previous quarter	EN
POPPENYNA_NEW	flow of new beneficiaries of the family pensions in non-agricultural social security system	EN

Table 6

Code	Variable description	Type
POPPP	average number of post-working age population	EN
POPPM	average number of post-working age population in urban areas	EN
POPPW	average number of post-working age population in rural areas	EN
POPRA	average number of persons receiving retirement pay from agricultural social security system	EN
POPRA_N	flow of new old-age pensioners in agricultural pension system in relation to the number of old-age pensioners in the previous quarter	EX
POPRETA	average number of persons receiving retirement pay from agricultural social security system	EN
POPRNA	average number of persons receiving retirement pay from non-agricultural social security system	EN
POPRNA_N	flow of new old-age pensioners in non-agricultural pension system in relation to the number of old-age pensioners in the previous quarter	EN
POPRNA_NEW	flow of new pensioners in non-agricultural pension system	EN
POPRNA_NEWNS	flow of new pensioners in non-agricultural new pension system	EN
POPRNA_NS	average number of persons receiving retirement pay from new pension system	EN
POPRNA_NS_N	flow of new pensioners in new pension system in relation to the number the pensioners in the new system in the previous quarter	EX
POPRNA_OLD	average number of persons receiving retirement pay from nonagricultural social security system (old pension system)	EN
POPRNA_OLD_N	flow of new old-age pensioners in non-agricultural pension system in relation to the number of old-age pensioners in the previous quarter (old system)	EN
POPRNA_OLD_NEW	flow of new one-pillar pensioners in non-agricultural pension system	EN
POPRNA_OLD_OTHER	other changes in the number of old-age pensioners from the one-pillar pension system	EX
POPRNA_OTHER	flow of other pensioners	EX
POPTOT_EU27	average number of population in the EU27	EX
POPTOT	average number of population	EN
POPTOTM	average number of population in urban areas	EN
POPTOTW	average number of population in rural areas	EN
POPWA	average number of working age population $(18-59/64)$	EN
POPWA_M	average number of working age population $(25-44)$	EN
POPWA_O	average number of working age population $(45-59/64)$	EN
POPWA_Y	average number of working age population $(18-24)$	EN
POPWAM	average number of working age population (18-59/64) in urban areas	EN
POPWAW	average number of working age population (18-59/64) in rural areas	EN
PP	proxy of production prices (*cs*)	EN
PP_EU27	foreign prices	EX
PPI	producer price index YOY (*cb*)	EN

Table 6

Code	Variable description	Type
PRWQ	private sector real wealth (*cs*)	EN
PTXSBP	deflator of taxes on products minus subsidies on products (*cs*)	EN
PX	deflator of exports of goods and services (*cs*)	EN
R_5Y	yield on 5-year treasury bond (*nominal*) (*cb*)	EN
R_3M	3 month WIBOR (*nominal*) (*cb*)	EN
R_CAIC	balance of payments ratio of income received to *GDP* (*cb*)	EN
R_CAID	balance of payments ratio of income payable to *GDP* (*cb*)	EN
R_CATC	balance of payments ratio of transfers received to *GDP* (*cb*)	EX
R_CATD	balance of payments ratio of transfers payable to *GDP* (*cb*)	EX
R_EECONT	employees' social contributions (retirement pays, pensions and illness) overall statutory rate (*cb*)	EX
R_ERCONT	employers' social contributions (retirement pays, pensions and accidental) overall statutory rate (*cb*)	EX
R_EROTH	employers' social contributions (other) overall statutory rate (*cb*)	EX
RGGEXC_I_CSB	index of effective weighted excise rate (*cs*)	EN
R_HSHC	health care contribution statutory rate (*cb*)	EX
R_HSHCD	health care contribution statutory rate deducted from PIT (*cb*)	EX
R_INDEXATION	annual indexation rate of pensions	EN
R_INDEXATIONQ	quarterly indexation rate of pensions	EN
R_INDEXATION_NS	quarterly indexation rate of contributions accumulated on the new pension system member's account	EN
R_OFE	average weighted return on Open Pension Funds (OFE) assets (*cb*)	EN
REER	real exchange rate (*cb*)	EN
res_UCC	difference between trend of the *UCC* and *UCC* unadjusted for short-run fluctuations.	
RETA	average monthly retirement pay from agricultural social security system (*cb*)	EN
RETNA	average monthly retirement pay from non-agricultural social security system (*cb*)	EN
RETNA_M	base sum multiplier	EX
RETNA_NS	average monthly retirement pay for new pension system members (*cb*)	EN
RETNA_OLD	average monthly retirement pay from non-agricultural social security system (old pension system) (*cb*)	EN
RETNA_OLD_NEW	average monthly retirement pay of new beneficiaries in non-agricultural social security system (old system)	EN
RR_3M	3 month WIBOR (*real*)	EN
SC_GGCTRED	ratio of current transfers, payable by GG sector to *GDP* (*cb*)	EX
SC_GGERCONT	scaling parameter *GGERCONT* equation (*cb*)	EX
SC_GGGFCFEQ	ratio of gross fixed capital formation GG to *GDP* (*cs*)	EX
SC_GGICQ	ratio of intermediate consumption GG to value added GG (*cs*)	EX
SC_GGINT	ratio of interest received to *GDP* (*cb*)	EX

Table 6

Code	Variable description	Type
SC_GGINTE_DOM	scaling parameter $GGINTE\_DOM$ equation (*cb*)	EX
SC_GGINTE_ROW	scaling parameter $GGINTE\_ROW$ equation (*cb*)	EX
SC_GGKTRC	ratio of capital transfers received to GDP (*cb*)	EX
SC_GGKTREC	ratio of capital transfers, payable to GDP (*cb*)	EX
SC_GGOTRC	ratio of current transfers received to GDP (*cb*)	EX
SC_GGPIE	ratio of property income, payable to interest expenses, GG sector (*cb*)	EX
SC_GGPIN	ratio of property income, received to interest received, GG sector (*cb*)	EX
SC_GGSUBPQ	ratio of subsidies on products to value added of market sector (*cs*)	EX
SC_GGSUBPR	ratio of subsidies on production to GDP (*cb*)	EX
SC_GGTAX_SUB	ratio of other taxes on production, payable minus other subsidies on production, receivable to GDP (*cb*)	EX
SC_GGVA	ratio of the value added of the general government sector to compensation of employees of this sector (*cb*)	EX
SC_HSGCF	gross capital formation of households in relation to gross capital formation in the economy (*cb*)	EX
SC_HSOTHTAX	relation of other taxes in households sector to gross disposable income (*cb*)	EX
SC_LGTAXP	ratio of other taxes on production to GDP (*cb*)	EX
SC_PITLUMP	share of personal income lump sum tax in households and non-profit institutions sector gross operating surplus and mixed income (*cb*)	EX
SC_SCSF	scaling parameter $SCSF$ equation (*cb*)	EX
SC_VATRATE	ratio of VAT and TOR contribution to GNI	EX
SCSFEN	social contributions paid by self and non-employed persons (*cb*)	EN
SF_K_PENSION	seasonality factor for the average value of account in the new pension system	EN
SF_PENBASE	seasonal factor for the base sum series	EX
SSPENXA	average quarterly pension resulting from an inability to work bill from agricultural social security system (*cb*)	EN
SSPENXNA	average quarterly pension resulting from an inability to work bill from non-agricultural social security system (*cb*)	EN
SSPENYA	average quarterly family pension bill from agricultural social security system (*cb*)	EN
SSPENYNA	average quarterly family pension bill from non-agricultural social security system (*cb*)	EN
SSRETA	average quarterly retirement pay bill from agricultural social security system (*cb*)	EN
SSRETNA	average quarterly retirement pay bill from non-agricultural social security system (*cb*)	EN
SSRETNA_NS	average quarterly retirement pay bill for new pension system members (*cb*)	EN

Table 6

Code	Variable description	Type
SSRETNA_OLD	average quarterly retirement pay bill from non-agricultural social security system (old pension system) (*cb*)	EN
TBBP	balance of payments: trade balance (*cb*)	EN
TCA	target current account as a percent of *GDP*	EN
TFDDEM	total final domestic demand (*cb*)	EN
TFDDEMQ	total final domestic demand (*cs*)	EN
TFDDEMQW	total final domestic demand weighted by import intensities (*cb*)	EN
TREND_TFP	total factor productivity (smoothed Solow residual) (*cs*)	EN
TXN	steady-state quarterly growth of population (*cb*)	EX
TXSBP	taxes on products minus subsidies on products (*cb*)	EN
TXSBPQ	taxes on products minus subsidies on products (*cs*)	EN
TXQ	steady-state quarterly real *GDP* growth (*cs*)	EX
U	number of registered unemployed persons	EN
UCC	user cost of capital (*cb*)	EN
UCC_I	index of user cost of capital (*cb*)	EN
UCC_VARIATION	short term UCC variation (*cb*)	EX
ULC	unit cost of labour (*cb*)	EN
UR	average unemployment rate	EN
URGAP	unemployment gap (*cb*)	EN
URGAP_TREND	unemployment gap trend (*cb*)	EN
URM	average unemployment rate in the market sector	EN
URMGAP	market sector unemployment gap (*cb*)	EN
URGAP_TREND	market sector unemployment gap trend (*cb*)	EN
UTC	unit cost of production	EN
VA	value added, gross(*cb*)	EN
VAQ	value added, gross(*cs*)	EN
VAT_CIHS_I_CSB	index of effective weighted VAT rate on household consumption expenditures	EN
VAT_ICGG_I_CSB	index of effective weighted VAT rate on government intermediate consumption	EN
VAT_IG_I_CSB	index of an effective weighted VAT rate on government investment	EN
VAT_IQ_I_CSB	index of effective weighted VAT rate on government investment	EN
VAT_IM_I_CSB	index of effective weighted VAT rate on market investment	EN
VAT_MIC_I_CSB	index of effective weighted VAT rate on market intermediate consumption	EN
W	average monthly wage and salary (*cb*)	EN
W_CPIA	CPI weight in the indexation formula	EN
W_WAYOY	weight of the real wage growth in the indexation formula	EX
WA_LAG4	wage growth corrected for the contributions in the previous year (*cb*)	EN
WAYOY	nominal gross wage growth published by GUS in February for the purpose of indexation	EN

Table 6

Code	**Variable description**	**Type**
WCOST	labour cost per employee (*cb*)	EN
WCOST_I	index of labour cost per employee (*cb*)	EN
WDINDIC	world demand index (*cs*)	EX
WDINDIC_POT	potential world demand index (*cs*)	EN
WEDGE	tax wedge (*cb*)	EN
WIG	Warsaw Stock Exchange Index	EN
WS_EX	external sector wages, salaries and other income connected with hired work (balance) (*cb*)	EN
X	exports of goods and services(*cb*)	EN
XQ	exports of goods and services (*cs*)	EN

Table 6: Model variables