„Development of econometric model for impact assessment of the Structural and Cohesion Funds of the EU” under project № 0018-ЦИО-3.2. „Development of a model for impact assessment of SCF”, financed by Operational Programme Technical Assistance

MODEL FOR IMPACT ASSESSMENT OF THE STRUCTURAL FUNDS AND THE COHESION FUND OF THE EUROPEAN UNION IN BULGARIA

SIBILA: Simulation model of Bulgaria's Investment in Long-term Advance

Technical Documentation

(data used, theoretical framework and model specification, data used, estimation and validation, technical appendices)

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TABLE OF CONTENTS

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Abbreviations

GDP	Gross Domestic Product
BNB	Bulgarian National Bank
VAT	Value Added Tax
GS	Government Securities
Eurostat	Statistical Office to the European Commission
EU	European Union
ESF	European Social Fund
EFRD	European Fund for Regional Development
ICT	Information and Communication Technologies
UMIS	Unified Management Information System
LOTHAR	System for preparing financial forecasts for the absorption of the EU Structural and Cohesion Funds and their implementation monitoring
CoM	Council of Ministers
IMF	International Monetary Fund
IFI	International Financial Institutions
NATO	North Atlantic Treaty Organization
R&D	Research and Development
NSI	National Statistical Institute
NSRF	National Strategic Reference Framework
OECD	Organisation for Economic Co-operation and Development
OP	Operational Programmes
OPAC	Operational Programme Administrative Capacity

OPE	Operational Programme Environment
OPC	Operational Programme Competitiveness
OPRD	Operational Programme Regional Development
OPHRD	Operational Programme Human Resource Development
OPT	Operational Programme Transport
OPTA	Operational Programme Technical Assistance
CMEA	Council for Mutual Economic Assistance
SCF	Structural and Cohesion Funds
MA	Managing Authority
EURIBOR	Euro Interbank Offered Rate

Introduction

This technical documentaion is prepared within the project "Development of econometric model for impact assessment of the EU Structural and Cohesion Funds". The documentation is an indivisible part from the developed macroeconomic model for impact assessment of the Structural and Cohesion Funds in Bulgaria.

The aim of the constructed model is to allow the assessment of the SCF resources impact on the main macroeconomic indicators. The principles, methods, techniques and the instruments, described in this documentation, correspond to the impact assessment practices in the EU and the modern approaches to macroeconomic modeling.

The model consists of 170 equations, including econometric estimates, macroeconomic identities and calibrated dependencies (on the basis of stable historical links and applying existing knowledge). The model is developed in a specialised software environment (EViews 7.0) but the very use of the model requires work only with electronic tables (Excel). This is achieved through a function, incorporated in the model, for automatic extraction of input data from electronic tables prepared in advance and a possibility is also programmed in the model to export the results in electronic tables. In this way, work with the model is practically narrowed down to changing the model input data in Excel (at the user discretion), launching the model with the help of the specialised EViews software and opening the exported results in an output Excel document.

The model allows tracing the net effects from the structural funds at various levels of aggregation – from the full effect from all resources to impact assessment of each operational programme, priority and sub-priority. In this way, the effect of a target combination of structural instruments can be estimated, including the impact, observed at various levels of absorption of the funds.

The documentation is structured in two main parts.

Part 1 includes the main issues in the development and use of the model. Its content follows the logical progression of the model development and is divided in four main steps (separate chapters), which should support the practical understanding of the model and its use. Chapter 1 describes the data used, its processing and preparation for work with the model as well as presents the adopted assumptions regarding the exogenous variables. The structure of the model is outlined in chapter *2*. It includes the technical description of the used linkages in the four model sectors – real, fiscal, financial and external. The approaches for modeling the aggregate demand and supply are shown in detail. In addition, the section on the applied production function has a detailed description of the used production factors, including the constructed blocks for human resources, infrastructure and technological capital. Chapter *3* describes the procedures for estimating and validating the model.

All technical details about the model and its development are included in *Part 2* and are organised in technical appendices.

PART 1: MAIN ISSUES IN THE DEVELOPMENT AND USE OF THE MODEL

1 Input data

1.1 The Structural and Cohesion Funds of the EU

1.1.1 Data processing

The need for data on the absorption of the EU's SCF is borne from the main objective of the model to evaluate their effects. This makes necessary the compilation of data on the EU funds and the data to be processed according to the model requirements.

The main source of data, which was studied in detail and used to a maximum degree for the project purposes, was the Unified Management and Information System (UMIS). UMIS has a public part and a part, which is used solely by the specialised administration. The public part provides data in several main areas. The data on the operational programmes are presented in the following several breakdowns, described in the figure below.

The information on priority axes, sub-priority axes and procedures does not include data on the actually paid resources by years, which is of key significance for the project execution since the model requires the use of data on an annual basis.

Table 1: Main parameters of the data on the operational programmes in UMIS

Financial execution	The information is in an aggregate form on a programme level – it presents the distribution of the budget by years, contracted amounts and made payments.
Priority axes/ sub-priorities/ procedures/ projects	
Priority axes	The information by priority axes includes: budget of the priority axis (total, EU financing, national co-financing); contracted amounts (total, percentage of execution, EU share in the contracted amount); actually paid amounts (total, percentage of execution, actually paid out – the EU share). The data on priority areas is not sufficient to allow additional processing for the purposes of the model and it is therefore necessary to go to a lower level.
Sub-priorities	The sub-priorities include information for: the contracted amounts (total, percentage of execution, EU share in the contracted amount); actually paid amounts (total, percentage of execution, actually paid out – the EU share), and the name of the sub-priority very often coincides with the name of some of the procedures, included in it. There are several procedures with one and the same names.
Procedures	The procedures include information for: the contracted amounts (total, percentage of execution, EU share in the contracted amount); actually paid amounts (total, percentage of execution, actually paid out – the EU share).

Projects	The **projects** include information on: beneficiary, residence, location of execution, name of the contract, total value, financial grant, financing from the beneficiary, actually paid amounts, duration (months), status.
Beneficiaries, regions, projects	
List of the beneficiaries	Includes information on beneficiaries in a table form for the number of projects, total amount, actually paid amounts. The menu "beneficiaries list" contains a registry of the beneficiaries, which allows the use of the financial resources to be determined. The information here could be of use in the further classification of the flows through the main economic blocks, included in the model.
Regions	Includes information for the planning regions: north-western, north central, north-eastern, south-eastern, south central, south-western. Selecting a given region on the geographical map shows the lower level of districts and selecting a respective district shows the lower level of municipality, which contains the following information in a table form: location of execution, project name, beneficiary, total value, financial grant, paid amounts, status.
Projects	Directly selecting a project gives a table with information for all projects under the operational programme. Selecting the "project name" field yields a more detailed information for the contract itself, which has data on the actually paid amounts by years – financial grant, classified in EU financing, national co-financing and financing from the beneficiary.

Studying the sources of information and the **model requirements shows that the data base will use the annual data on the procedures under the respective operational programmes as its key informational unit**. The annual data on procedures are available in the following kinds: budget, contracted amounts, actually paid amounts, commitment of the Managing Authority as of the end of each year. The first three kinds contain the following fields – EU, government budget, IFI, other financing. The data on the MA commitment contains the fields – EU, government budget, total.

Another source of information, which was looked at in detail for the purposes of the model is the LOTHAR system, which gives useful information for the nature and the time planning of key interventions on the operational programmes. UMIS was selected as the main source of data for the model due to the specifics of the model requirements and the existing slight discrepancies between the information from the two systems.

The main aim of the data processing is to systemize the data in a form, which is in line with the model needs and allows its use in various scenarios and simulations. The direct extraction of the data from UMIS is related to the creation of a large number of Excel documents (for each operational programme and each year).

The next procedure in the data processing concerns the summarisation of all these documents. The main database for the funds' resources is systematized in just one document in Excel. Separate worksheets in this document contain the individual types of existing monetary flows for each operational programme. The procedures are presented in columns and the years – in rows.

The coding of the data is included in a glossary, which is part of the same working document (on a separate worksheet) for easier use. The names of the procedures contain a total of nine symbols, which include the separating underscore symbols. These names represent abbreviations of the operational programme and indicate the type of data (budgeted, contracted,…), the sources of financing (EU, national budget,…) as well as the working number of the procedure.

The documents also contains auxiliary sheets, which allow the automatic summing of the resources from the respective procedures classified by main economic categories.

1.1.2 Classification by main economic categories

The developed model requires the distribution of the data on the EU funds by main economic categories on the demand as well as on the supply side. Actual payments are mainly used for the assessment of the economic impact but the other types of data (budgeted and contracted) are also taken into account.

The individual procedures of the operational programme priorities are classified by economic categories of the aggregate demand and aggregate supply. The names of the individual procedures do not give sufficient information to allow this classification. The classification is therefore made on the basis of a detailed analysis of the specific activities in the projects, included in each procedure. Some procedures include diverse projects, which can be characteristic of more than one category. In these cases, the resources are divided among categories proportionally, using the collected information for the specifics of the relevant projects.

The economic categories, used in this case fully correspond to the framework of the developed model and include the following:

- **Categories of aggregate supply (production factors):**
    - **Capital** (K): Capital corresponds to the procedures for purchase of machinery, equipment, buildings, etc. by the private sector. Such procedures are most often met in OP Competitiveness.
    - **Labour** (L): Labour corresponds to the procedures, aimed at including people, who are economically inactive for one or another reason, in the labour force as well as at the creation of new jobs. Such procedures are met primarily in OP Human Resources.
    - **Technologies** (A): The technologies category corresponds to the procedures, aimed at R&D, information and communication technologies (ICT) as well as at improving the environment and the productivity in the public and private sectors. Such procedures exist

in all operational programmes but OP Administrative Capacity is directed almost fully to this production factor.

- **Human resources** (H): The human resources category corresponds to the procedures, aimed at training of employed and unemployed as well as at raising the quality of and the access to education. Such procedures are present in almost all programmes but are seen the most often in OP Human Resources.
- **Infrastructure** (I): The infrastructure category corresponds to the procedures, aimed at building of new or renovating existing infrastructure in the country (roads, waste disposal facilities, energy efficiency, culture monuments and so on). Such procedures are seen the most often in OP Environment, OP Regional Development and OP Transport.

- **Categories of aggregate demand:**
  - **Public investments** (PUI): The public investments correspond to the resources, already classified in the infrastructure category (I). Resources, classified as capital to be acquired by and for the public administration, are included here as well. For example:
    - Procedures, designed to build information systems in the public sector like BG161PO002-2.4.01 Procurement of hardware for the need of UMIS.
    - The respective share of the resources under procedure BG051PO001-6.1.04 Strengthening the capacity of the Employment Agency for implementing effective active labour market policy through building a modern system for telecommunication and information data transfer and an internal network for consultations.
    - The respective share of the resources under procedure BG051PO001-3.1.01 ICT in education and others
  - **Private investments** (PRI): The private investments correspond mainly to the resources, classified in the Capital category (K) and are to be found mainly in OP Competitiveness.
  - **Public consumption** (PUC): Resources are classified in the public consumption (PUC) category on the basis of the Unified Chart of Accounts for the public expenditures. Technical assistance under the individual programmes, including OP Technical Assistance, is included here. The public consumption corresponds to the resources in the Total factor productivity (A) category, Human resources (H) and Labour (L). 10% of the resources for capital and 20% of the resources for infrastructure.

The classification of the individual procedures under all operational programmes is outlined in the Annexes.

1.1.3 Distribution of the resources from the EU funds till 2015

The assessment of the economic impact of the EU funds requires the availability of monetary flows for the period till 2015. This necessitates the distribution of the resources for the 2011-2015 period since 2010 is the last full year, for which there is information on the made payments. Detailed plans/forecasts for the contracted and actually paid amounts are not available for 2011-2015, which calls for applying an expert approach to the construction of projections for the annual payments under the individual programmes.

The expert approach, used for the initial running of the model and the impact assessment under main alternative scenarios, includes two stages.

First, the difference between the contracted and paid amounts as of 2010 is calculated. This difference suggests projects under way, for which not all payments have been made. For procedures, classified on the supply side as A, H and L, we assume that all contracted amounts will be paid out in equal instalments in 2011 and 2012. For procedures, related to the K and I categories, we assume that the contracted amounts will be paid out equally during the 2011-2013 period due to the fact that these projects usually last longer in time.

Next, the difference between the budgeted and the contracted amounts as of 2010 is calculated. These are resources, which have been envisaged to be absorbed under the respective OP but have not been contracted as yet. In this case, we assume that resources for procedures, related to the A, H and L categories, will be contracted during the 2011-2012 period and we distribute the difference equally among the years. The payment starts during the current year and ends within a two-year period (i.e. in 2013 at the latest). For procedures, related with the K and I categories, we assume that the resources will be contracted till 2012, the payments start during the current year and are made in equal instalments within a four-year period till 2015. Two procedures represent an exception since they have resources classified as K – HR_P_22 (ICT in education) and TA_P_11 (Procurement of hardware for the needs of UMIS), but are treated as in the A, H or L categories due to their shorter-term nature.

The resources, distributed by the above-described methodology, are structured in the electronic annex SCF_database.xls.

1.1.4 Formulating alternative scenarios for funds' absorption

The developed model allows simulating the effects from random alternative scenarios for absorption of the resources. These scenarios might represent both a different combination of programmes and procedures and a different level of absorption on them. The organisation of the data for the funds' absorption allows different levels of aggregation and disaggregation with the lowest level incorporated in the model being the procedure level (sub-priorities) under the individual operational programmes. It is possible in this way to estimate the net effect from each individual operational programme or combination of programmes as well as from each individual priority and combination of priorities and respectively, from each procedure or combination of procedures.

The data on the absorption of the Structural and Cohesion Funds are organised in two documents with electronic tables.

The aggregated data by economic categories and operational programmes are organised in the electronic annex esf_payments.xls. Formulating the main possible alternative scenarios here is automated to a large extent. The choice of scenarios here boils down to selecting a combination of operational programmes, change in the absorption rate as well as a change in the weight of the different economic categories. The choice of combination of operational programmes is related to a fully automated update of the model input data. The other possible choices are only partially automated and require manual change on the part of the user (according to his/her requirements and needs) of the respective data in the worksheets.

The Excel document, described in the previous chapter, contains the primary information with the classified procedures and the distribution of the payments till the end of the programme period (see electronic annex SCF_database.xls). This document can serve in the formulation of additional, much more detailed scenarios than the ones described above. In this case the model user can estimate the effect of each individual procedure on the whole economy as well as a desired combination of procedures and sub-priorities. For this purpose, the respective changes have to be made in this document, after which the change in the aggregate economic categories will be generated automatically. The transpired changes by economic categories have to be inserted in the document with the aggregated data esf_payments.xls.

The practical demonstration of the procedures, described in this part, is made below in the text (see the practical guidelines for using the model at the end of *Part 1*).

1.2 Macroeconomic data

The development of the model has used official statistical data, published by the respective institutions responsible for producing the information. Specifically, the main sources are the National Statistical Institute, the Bulgarian National Bank, the International Monetary Fund and Eurostat as far as the macroeconomic data is concerned.

The variables, measured in value (money) terms, are calculated in two types of prices for the purposes of the model. The indicators are mainly used in prices from the current year as well as in constant prices from 2005, depending on the aims of the particular calculation.

All variables are organised in electronic tables, format Microsoft Excel 97-2003, since this format is one of the most convenient for importing/exporting to the EViews software, which is used for the development, estimation and model simulation. Each electronic table (file with the Excel format) contains one or more worksheets with data, arranged in columns in an ascending order by the monitored time period. Each table also contains a list and glossary of the variables, which can be found in the data worksheets.

During the preparation of the data procurement for the model, it was decided to use the variables abbreviations according to the Eurostat classification. Random names have been generated for variables, which are not included in the Eurostat classification. Own abbreviations have also been constructed when necessary as well as correcting the abbreviations to align them with the requirements of the modeling software. The list with the variable abbreviations, which are used in the model development, is presented in the Annexes.

1.3 Main assumptions regarding the exogenous variables for the 2011-2015 period

The main part of the simulation period encompasses future periods and this suggests the lack of historical data for the respective years. The solving and simulation of the model yields the value of the endogenous variables in the model for these periods but the values of the exogenous variables has to be defined in advance (without them the model cannot be solved and simulations cannot be run for the respective years).

Part of the exogenous variables represents the shares of certain parameters. Generally, these shares have been relatively stable from a historical perspective, which justifies their extrapolation in the future. The last available historical value of the shares has been usually extrapolated. The description of the model contains more details about the cases, in which this approach has been adopted.

Another part of the exogenous variables represent indicators for the external environment:

- Gross domestic product of EU25;

- 12-month EURIBOR;
- Euro/US dollar exchange rate;
- Indices of the international prices of metals, of intermediate industrial products, of energy goods.

Available forecasts have been generally used for the listed variables, published by the sources of the respective data. The last available forecast values have been extrapolated for future periods in cases where forecasts for these years were not available.

A third group of exogenous variables are the so-called dummy variables, which serve as an indicator for the presence of the lack of a certain effect. These variables take the value of 1 for each period when the effect is present and the value of 0 in all other cases.

A fourth type of variables are the result of "satellite" calculations in the model. The average number of education years of the population is the only example for such a variable in our particular case.

The fifth and last type of exogenous variables are the so-called add factors, which, to put it simply, serve for correcting discrepancies between actual and simulated values for past periods with the aim of achieving a better fit to the historical data.

2 Model structure

2.1 Main modeling principles used

The model contains four main sectors – real, monetary, fiscal and external, in line with the project requirement. In addition, several main blocks are also created, modeling human resource accumulation, the basic infrastructure and some aspects of the information and knowledge development in the society. The labour market is also considered within the framework of the mentioned sectors. The model also contains a part, in which the impact of the SCF is disaggregated by individual economic branches.

The model looks at the two sides of the economic processes simultaneously – the demand and the supply side, and the effects might be quantified for both of them.

The effects are reported in three areas on the demand side – public consumption, public investments and private investments. Modeling the effects on the demand side follows the logic of the used data and its classification in the respective macroeconomic categories, carried out by the model development team. In the model, the import is linked with the domestic demand components and therefore, the SCF resources also translate into an increase of the imports.

Modeling the effects on the supply side in the real sector follows the same logic. The constructed production function has three explicitly defined production factors (labour, physical capital and human capital), whose dynamics is determined in the model itself. It also contains a Hicks-neutral technological change, identified with the so-called total factor productivity. In this regard, the effects on the supply are reported directly on the basis of the European funds' spending on:

- Physical capital – through the gross investments in the economy;
- Labour – through the employment of additional people and their inclusion in the production process;
- Human capital – through carrying out professional training of the labour force;
- Increase of the technological level of the economy – through spending on infrastructure, R&D, ICT, etc.

It should be noted that the effects show up simultaneously on the demand and supply side since both sides are driven by the one and the same flows, related to the SCF resources.

The team did not adhere strictly to one specific movement or school in the economic theory during the development of the model. The main principle, which has been followed, is for the model to realistically mirror the structure of the Bulgarian economy and at the same time, to produce results consistent with the historical dynamics of the monitored indicators. In this sense, the model is neither Keynesian, nor Neoclassical, Neokeynesian, nor other. The selected econometric modeling technique treats both the short-term and the long-term effects of the interaction between the individual variables so it can be said that it has both Keynesian and Neoclassical characteristics. It can be said that the model borrows from the endogenous theory and growth empirics as far as the production function, used for modeling the aggregate supply, has neoclassical properties as well as factors, which generate endogenous economic growth.

The principles, which the modeling follows, are based mainly on two types of dependencies – behavioural equations and macroeconomic identities. The interpretation and realisation of the latter in the model is direct (i.e. it is carried out through direct replication of the dependency) but the behavioural equations require calibration of the coefficients on the links between the individual variables. The calibration is done through several main methods:

- Econometric estimate – it is carried out by means of a regression analysis on defined specifications of the equations. The variables in the equations are taken in logarithmic form (with the exception of variables, which represent percentages). This firstly helps for reducing the scale and scope of the data and also helps for easy interpretation of the estimated coefficient values (they are directly interpreted as elasticities in the linear regressions of logarithmic parameters). The macroeconomic variables are often characterized by time trends, which creates problems for achieving reliable estimates and therefore, the modeling resorts to appropriate transformations in order to eliminate the non-stationarity problem;

- Estimating the equations in the so-called error correction form – the first differences (changes) of the variables are included in the equations as well as the past (lagged) values of the dependency between the variables at a long-term level as an explanatory variable. This form of the equations allows the simultaneous studying of both the short-term and the long-term (equilibrium) effects from the change of the independent variable (or variables) on the dependent one. Estimating equations in this form is made only if an error correction process is present. In case the error correction to the long-term equilibrium cannot be estimated, the non-stationary variables enter the equations only with their first differences. In this way, it is only possible to estimate the short-term dependency;

- Use of historical relations, which remain relatively stable in time and their extrapolation on future and past periods;

- Use of results from other empirical research, which are sufficiently affirmed and cited in the economic literature and which find similar dependencies for other economies. This option is used in the cases, in which the value of the respective parameter is not known and cannot be estimated with acceptable quality due to insufficient availability of statistical data.

The complete model consists of 170 equations. Part of them are econometrically estimated (26 of them), others are manually calibrated on the basis of existing economic knowledge or on the basis of stable historical dependencies and third are macroeconomic identities. The model works with 202 variables, out of which 170 are endogenous (the model gives solutions for them) while the remaining 32 are exogenous (they are defined outside the model and are not the result of its solution). The source code of the model is given in the Annexes.

2.2 Real sector

2.2.1 Supply

The supply in the model is modeled through a production function of a neoclassical type with a Hicks-neutral technological change.[1] Three production factors are considered outside the technological level (which represents the long-term growth factor) – labour, physical capital and human capital. The function has the following form:

[1] A technological change is Hicks-neutral if at any selected capital-labour ratio, the ratio between the marginal product of capital and labour remains constant (in other words, the marginal rate of technical substitution is not influenced by the technological progress).

$$
\begin{aligned}
& B1GM\_2005 = \\
& = TFP * INFRKT\_2005^{infrelast} * TECHKT\_2005^{techelast} * \\
& * EMP\_15\_64^{lshare} * KT\_2005^{kshare} * HKT^{(1-lshare-kshare)}
\end{aligned}
$$

where $B1GM\_2005$ is the gross domestic product in constant 2005 prices, TFP is the total factor productivity (represents the unexplained part of the technological level and is calculated as a Solow residual[2]), $INFRKT\_2005$ is the infrastructure capital in the economy, $TECHKT\_2005$ is the accumulated technological capital in the economy, KT_2005 is the physical capital, EMP_15_64 is the labour factor and HKT is the human capital. The coefficients in the powers of the variables represent the production elasticities of the factors: $infrelast$ – of infrastructure, $techelast$ – of the technological capital, $lshare$ – of labour, $kshare$ – of capital, $(1 - lshare - kshare)$ – of human capital.

A Cobb-Douglas form of the production function is selected due to the possibility for perfect factor substitution, its easy handling as well as its traditionally good fit to the empirical data.

Due to the selected function specification, the technological level in the model is to a large extent determined endogenously by the two types of specific "capital" – the infrastructure in the economy, which is formed from specific investments, and the technological capital, which is formed from R&D activities and investments in ICT. In other words, the model can be considered to has characteristics of an endogenous growth model because a substantial part of the technological level is determined endogenously. The only element, which remains exogenous in the production function, is the residual, unexplained part of the technological level, denoted with TFP. The latter means that the model is not entirely endogenous although the value of the residual is very small.

If we use the traditional in the economic literature notation for the technological level – A, then in this specific case it is expressed as:

$$A_t = TFP_t \cdot INFRKT\_2005_t^{infrelast} \cdot TECHKT\_2005_t^{techelast},$$

The function is characterized with constant returns to scale for the physical capital, labour and human capital factors, which is equivalent to the fact that their production elasticities sum up to one. The function, however, is characterized with increasing returns to scale for all endogenous production factors. This logical

[2] For more details see Solow (1957), as well as Barro and Sala-i-Martin (2005).

construction of the production function corresponds to the current situation of the technological lag and the weak infrastructure of the Bulgarian economy. This is valid under the adopted assumption that the building of infrastructure and the investments in new technologies and knowledge are expected to have the highest positive impact for fostering long-term economic growth. This form of the function also means that economic growth will be driven by the residual total factor productivity in the long term (implies lower growth rates) and by the labour, physical capital and human capital factors in the short term (in case the economy is not in equilibrium) after reaching and maintaining "normal" levels of infrastructure and technologies (i.e. achieving saturation).

The values of the production elasticities of the physical capital, labour and human capital in this particular case are taken directly, using the Mankiw, Romer and Weil paper[3], according to which the elasticities of each of these production factors is 1/3. These elasticities are explained with the fact that the physical capital elasticity is the same even when human capital is absent as an explicit production factor and the elasticity of labour is 2/3. In a sense, this might be interpreted as the factor "labour" covering people with no production knowledge and skills in the case where the human capital is explicitly defined. The factor "human capital" in the function represents namely the accumulated knowledge and skills by the employed and, together with labour, gives the full contribution of employment to the output.[4]

Labour

The factor "labour" in the model is identified with total employment according to the Labour Force Survey.[5]

Physical capital

The physical capital most generally represents the stock of means of production (machines, equipment, etc.), which transfer their value on the final products during the production process. These means of production are created through investments so the physical capital in this case corresponds to the

[3] For details see Mankiw, Romer and Weil (1992).

[4] The elasticities of infrastructure and technological capital are explained in the respective chapters, dedicated to these two parameters.

[5] Labour market data pertains to the population, aged between 15 and 64 years

accumulated stock of investments, made in past years and taking also into account amortisation.

There is no available official statistics on the stocks of physical capital in the Bulgarian economy and therefore, the modeling uses reasonable assumptions for the initial value of capital. The values for each subsequent period is derived through the so-call permanent inventory method.

The initial value of capital is determined, using the first available statistical value for the investments in the national accounts for Bulgaria – 1995, according to the latest revisions by the NSI. The calculation is made under the assumption for equilibrium in the initial period. Details on the calculation method are presented in Table 2 below. [6]

The value of the amortisation rate (the physical wear) is defined exogenously at 5% per year, which implies a twenty-year useful life of each capital unit under linear amortisation.

The equation for the dynamics of the stock of capital has the form:

$$\mathrm{KT\_2005} = \mathrm{P5\_2005(-1)} + (1 - \mathrm{deprate}) * \mathrm{KT\_2005(-1)},$$

where $\mathrm{deprate}$ e denotes the capital amortisation rate.

Table 2: Calculating the initial capital stock

Let the equation for the dynamics of the capital stock be:

$$K_t = I_{t-1} + (1-\delta)K_{t-1},$$

where K_t is the capital stock at time t, I_t are the gross investments in time t, and δ is the rate of physical wear of capital (amortisation), which is constant and exogenously defined for the model.

Transforming the equation for the capital stock dynamics in the following form:

$$K_t - K_{t-1} = I_{t-1} - \delta K_{t-1}.$$

Under an assumption for equilibrium, which means $K_t - K_{t-1} = 0$, at time $t = 1$ we have:

[6] All variables from the national accounts, which enter on the supply side, are in constant 2005 prices.

$$K_0 = \frac{I_0}{\delta}.$$

Human capital block

The accumulation of human capital follows a different logic in the model than the three kinds of physical capital (infrastructure, technological capital and total physical capital), which enter as factors in the production function in one or other form. This is nothing unusual since, in contrast to the other three indicators, which characterize inanimate objects, the human capital is an inherent feature of the people, who on their part represent labour as a production factor.

Human capital in the model is defined most generally as the "educational level". On its part, the educational level is formed by three components:

- Formal education (school, university);
- Professional education, financed by resources outside the European funds;
- Professional education, financed by European funds resources.

All three indicators are measured in number of years of education. Data for the formal education are published by the respective statistical offices but the frequency of publishing basically follows the frequency of the population censuses. The data is therefore quite insufficient for the purposes of the model. The number of years of education is therefore calculated, adopting an alternative approach. The calculations of Kyriacou are used[7], who in his research econometrically estimated a dependency, according to which the number of years of education is related to the net enrolment ratios in the primary, secondary and tertiary education, respectively taken with a lag of 15, 5 and 5 years. The research by Kyriacou represents a panel study, which averages the effects for the whole group of countries. The equation sample is adjusted on the basis of expert judgement with a view to achieving a greater degree of consistency of the derived results with the few statistical data

[7] Kyriacou, G., "Level and Growth Effects of Human Capital: A Cross-Country Study of the Convergence Hypothesis.", Economic Research Reports 19-26, C.V. Starr Center for Applied Economics, New York University, 1991.

available.[8] The equation, which calculates the number of formal education years, has the final form:

$$\begin{aligned}&EDU\_ATT = \\ &= 2 + 4.439 * PRIMEDU\_RT(\text{-}15) + 2.665 * SECEDU\_RT(\text{-}5) + \\ &+ 8.092 * HIGHEREDU\_RT(\text{-}5)\end{aligned}$$

where EDU_ATT is the number of education years, $PRIMEDU\_RT$ is the net enrolment ratio in primary education, $SECEDU\_RT$ is the net enrolment ratio in secondary education, a $HIGHEREDU\_RT$ is the net enrolment ratio in tertiary/higher education.

The professional education is also characterized by insufficient frequency of data. NSI provides data only for the number of trained people in 2005 – 151,450 people. The number of hours, dedicated for professional education in the overall economy, is also available for the same year – 6,516,387. The measurement unit, which we use for generating a variable for human capital, is a year so we need the convert the number of hours, assuming that the length of the working day is 8 hours, of the working month – 22 days, of the education year – 9 months (similarly to the formal education).

At the next step we calculate the ratio of the number of trained in 2005 to the number of people in the labour force. We also calculate the average number of years of education per one person trained in 2005.

We determine the initial value of the number of education years for 2000, assuming that each person from the labour force is characterized by the average number of years of professional education as of the beginning of the same year. The number of trained people during the same year accrues to this value.

$$VOC = ACT\_15\_64 * VOCYRS\_2005\_AVG + NUMVOC * VOCYRS\_2005\_AVG$$

The number of trained people for the next periods is equal to the one from the previous period, adding the number of trained people during the current period.[9]

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[8] The adjustment of the sample represents a manual incorporation of a fixed effect for Bulgaria.

[9] Generally, the number of professional education years of the people, who stop working due to retirement, should be subtracted from the sum for each year. The

The number of people, who receive professional training under the European funds, is calculated in a similar manner. The number of people, who are due to receive such training, is available in the data from the operational programmes so it is directly substituted in the formula:

$$VOC\_EU = NUMVOC\_EU * VOCYRS\_2005\_AVG + VOC\_EU(-1),$$

with the initial value of this indicator being zero.

Human capital is derived through summing the three types of years of education/training:

$$HKT = ACT\_15\_64 * EDU\_ATT + VOC + VOC\_EU$$

Infrastructure block

The Infrastructure block represents one of the model parts, which generates long-term endogenous economic growth. There is a lack of official statistical data on the infrastructure in the country and therefore, some approaches are adopted here, which were also used in the calculation of the physical capital as a production factor. In particular, the calculation of the variable uses statistical data, which is the closest in meaning to the term "infrastructure", as well as to the direction of part of the spending under the European funds, classified by the expert team as infrastructure spending.

The main used statistical indicator is the gross fixed capital formation by types of assets, provided by Eurostat.[10] The indicator "Other buildings and structures" (AN.1112) is the closest to the definition of infrastructure from the six types of assets. Its definition includes non-residential buildings (AN.11121) and other structures (AN.11122). Taking into account that the indicators contains all construction outside the residential construction, it should certainly include the road network, the sewerage infrastructure, industrial buildings, public buildings (including entertainment buildings) and so on. In this sense, the infrastructure in the model has a broader interpretation. However, this in no way should change the modeling logic since all of the above-mentioned examples of infrastructure

professional education focuses mainly on people, who are not to retire in the short- to mid-term, so this form of the equation should not lead to significant distortion in the data.

[10] The classification can be found on this site: http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/EN/nama_esms.htm

contribute to improving the productivity in the economy by leading to economies of scale. The used assumption and the respective construction of an approximate variable are legitimate since the objective is to estimate the impact of the infrastructure investments, made under the European funds and part of which are directed to building all kinds of infrastructure objects.

The values of the indicator are taken in constant prices and an assumption for a 10% annual amortisation rate of the infrastructure capital is imposed.[11] In this respect, the assumption means that this capital would become completely useless after 10 years under linear amortisation and without investments in maintenance. Consequently, the initial value of the infrastructure capital is calculated through dividing the first available value by the amortisation rate (similarly to the approach, used in the physical capital):

$$INFRKT\_2005 = CPA\_FB\_2005/infrdeprate$$

The next values after the initial one are calculated, using the permanent inventory method:

$$\begin{aligned} &INFRKT\_2005 = \\ &= CPA\_FB\_2005(-1) + INFREXP\_EU\_2005(-1) + INFRKT\_2005(-1) * (1 - infrdeprate) \end{aligned}$$

Infrastructure spending under the European funds are added in the formula. The effect of the infrastructure investments, financed by the SCF, is modeled on the supply side, using this dependency.

In this case we identify the elasticity of the infrastructure in the production function with the public capital elasticity (which on its part is mainly infrastructure), according to the empirical studies in the economic literature. On the one hand, this is dictated by our main focus on the effect of the public investments in infrastructure, financed by EU resources, and on the other hand, by the lack of calculations on the elasticity, which use a infrastructure indicator defined in a similar way to the present model. The value of the elasticity, with

[11] Hurrigan (1999), as well as Yeaple and Golub (2007) for example use an amortisation rate of 0.15. We use a lower rate in the model, which allows for a longer useful life of the infrastructure capital. This is justified by the lower intensity of the infrastructure use on the one hand and on the other, by the lack of adequate investments in new infrastructure, which leads to forced longer use of the old one.

which the infrastructure capital enters the production function, is defined at 0.3, based on the results of empirical studies for other countries.[12]

Technological capital block

The second factor besides infrastructure, which determines the endogenous nature of the technological development, is the technological capital. This variable encompasses the R&D spending as well as the spending on ICT, including spending financed by SCF resources:

$$TECHEXP = GERD\_TOTAL + ITEXPEN + COMMEXP + TECHEXP\_EU$$

Technological capital is generated as a variable using a similar approach to the accumulation of physical capital as a main production factor and infrastructure capital as a factor, determining the technological development. Data on the R&D spending and ICT spending is published only in current prices so they are converted into constant prices, using the deflator of the total investments.

The amortisation rate is also set at 10% (as in the case of infrastructure)[13], and the factor elasticity in the production function is 0.17.[14]

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[12] See for example Aschauer (1988), Holtz-Eakin (1994), Munnel (1990) and others. La Ferrara and Marcellino (2004) apply various methods for calculating the indicator with the derived values varying from negative, to zero or positive. Bom and Ligthart (2008) derive values in the range of 0.06 and 0.15, again depending on the methodology. Ligthart (2011) derives an interval estimate for the elasticity in the range of 0.2-0.4.

[13] Park, Shin and Park (2006) for example report an amortisation rate of around 0.12-0.14. We again adopt here a lower rate in order to take into account the longer life cycle, respectively the lower turnover of technological capital, in the Bulgarian economy.

[14] The value coincides with the calculated elasticity of the R&D spending for 16 OECD countries – see Guellec (2001) for details. ICT spending does not feature in this study but other studies like Dunnewijk, Meijers and van Zon (2007) for example find an elasticity of the technological level to software investments of 0.127 and to investments in telecommunications – 0.098 (although the elasticity to the investments in software is statistically insignificant). Adopting the higher value of 0.17 is appropriate with a view to the relatively lower technological development of the economy, due to which the effects on the production are slightly higher than the estimated for more developed countries in this sense.

Consequently, the initial stock of technological capital and the values for the next periods are determined by the equations:

$$TECHKT\_2005 = TECHEXP\_2005/techdeprate$$
$$TECHKT\_2005 = TECHEXP\_2005(-1) + (1 - techdeprate) * TECHKT\_2005(-1)$$

Total factor productivity

As is mentioned above, part of the technological development in the economy remains unexplained and therefore, enters the model exogenously. We call the indicator a "Solow residual" in parts of this documents but it should be kept in mind that it is still different in meaning from the original Solow residual as far as the GDP dynamics is also explained with the two endogenous factors of infrastructure and technological capital. Direct analogy is acceptable only with respect to the technique for its calculation, which is the following – a log is taken on the two sides of the production function, after which only the logarithm of TFP remains on the left side of the equation and all the rest is on the other side (for which there is already available statistical data or additionally derived values)[15]:

$$\begin{aligned} &\log(TFP) = \\ &= \log(B1GM\_2005) - kshare * \log(KT\_2005) - lshare * \log(EMP\_15\_64) - \\ &- (1 - lshare - kshare) * \log(HKT) - \\ &- infrelast * \log(INFRKT\_2005) - techelast * \log(TECHKT\_2005) \end{aligned}$$

The indicator is a residual in the model and therefore, cannot be subject to full forecasting so its value for the 2011-2015 period is extrapolated through the so-called naïve forecast – i.e. it is set equal to the last available historical value.

2.2.2 Interest rates

Two approaches with respect to interest rates are most generally known in the development of macroeconomic models. The first of them selects indicators from the interest statistics to be identified with the macroeconomic term while the second is for the interest rates to be fundamentally derived from the model itself. This model selects the second approach. The choice is motivated by the fact that selecting an indicator from the interest rate statistics would have been subjective

[15] This approach is formally called "growth accounting". See Solow (1957) for the application of the method, because of which the residual is called a "Solow residual".

on the one side and on the other, the interest rate would have potentially reflected financial market distortions and would have therefore diverged from the return on capital, which is actually the investment stimulating factor.

An assumption is used that the companies in the economy are aiming to maximize their profit, which is equal to the revenues minus costs:

$$profit_t = A_t * KT\_2005_t^{\text{kshare}} * EMP\_15\_64_t^{\text{lshare}} * HKT_t^{1-\text{lshare}-kshare} - \\ -(RINTRATE_t + deprate) * KT\_2005_t - WAGE\_TOTAL_t * EMP\_15\_64_t$$

Following the necessary condition for a maximum, according to which the marginal capital productivity should be equal to the cost of its factor services $(RINTRATE_t + deprate)$, we arrive at the following after some transformations:

$$RINTRATE_t = \\ = TFP_t * INFRKT\_2005^{\text{infrelast}} * \text{kshare} * KT\_2005_t^{\text{kshare}-1} * \\ * EMP\_15\_64_t^{\text{lshare}} HKT_t^{1-\text{kshare}-\text{lshare}} - deprate$$

The production function works only with real variables so the derived interest rate is also in real terms. The nominal interest rate is calculated after adding the inflation rate for the respective period:

$$INTRATE_t = RINTRATE_t + \Delta\log(CP00\_AVX_t)$$

The interest rates, derived in this way, are used in the modeling of dependencies and in the remaining parts of the model.

Besides the derived real and nominal interest rates for the Bulgarian economy, the calculations also use an indicator for the external interest rate levels, which in this case is the 12-month EURIBOR. An interest spread is consequently calculated, which most generally shows the size of the premium on the external interest rate to arrive at the domestic nominal interest rate.

2.2.3 Prices

Modeling prices in the model boils down to modeling the consumer price index as well as the deflators of the main GDP components on the demand side.

Firstly, the consumer price index is modeled as depending on the dynamics of energy prices on the international markets and the labour productivity in the country:

$$\Delta\log(\text{CP00\_AVX}) = \text{f}(\text{ECM}, \Delta\log(\text{B1GM\_2005/EMP\_15\_64})),$$

where ECM represents the "error" – the deviation from the equilibrium in the previous period. In this case we have:

$$ECM = \\ = \log(CP00\_AVX(-1)) - \alpha * \log(PNRG(-1)) - \beta * \log(B1GM\_2005(-1)/EMP\_15\_64(-1))$$

The logic of the dependency, describing the consumer price index dynamics, is the following – the increase of the energy prices on the international prices translates into an increase in the domestic price level since the Bulgarian economy is very open and highly energy intensive. The interpretation of the labour productivity as an explanatory factor is slightly more complicated. The main assumption is related to the existence of a Balassa-Samuelson effect, according to which the increase of the labour productivity in the tradeable sector leads to higher prices and wages in the non-tradeable sector (while at the same time the labour productivity in the non-tradeable sector remains unchanged), which leads to inflation.

The deflator of the private consumption is explained by the consumer price index:

$$\Delta\log(P3\_S14\_S15\_CPI05) = f(\Delta\log(CP00\_AVX), ECM)$$
$$ECM = \log(P3\_S14\_S15\_CPI05(-1) - \alpha * \log(CP00\_AVX(-1))$$

The dependency for the deflator of the government consumption is analogous:

$$\Delta\log(P3\_S13\_CPI05) = f(\Delta\log(CP00\_AVX), ECM)$$
$$ECM = \log(P3\_S13\_CPI05(-1)) - \alpha * \log(CP00\_AVX(-1))$$

Both the consumer price index and the index for the international prices of industrial goods enter the equation for the investment deflator[16].

$$\Delta\log(P5\_CPI05) = f(\Delta\log(CP00\_AVX), \Delta\log(PINDU(-1)/EURUSD\_AVG(-1)), ECM)$$
$$ECM = \log(P5\_CPI05(-1)) - \alpha * \log(CP00\_AVX(-1))$$

The deflator of the export of goods and services is determined by the indices of the energy prices on the international markets [17] and metals[18]:

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[16] This price index includes both the index of the agricultural commodities and the index of metal prices.

$$\Delta \log(P6\_CPI05) = f(\Delta \log(PNRG/EURUSD\_AVG), \Delta \log(PMETA/EURUSD\_AVG), ECM)$$
$$ECM = \log(P6\_CPI05(-1)) - \alpha * \log(PNRG(-1)/EURUSD\_AVG(-1)) -$$
$$- \beta * \log(PMETA(-1)/EURUSD\_AVG(-1)))$$

The deflator of the imports of goods and services is respectively determined by the indices of energy prices on the international markets and the intermediate industrial goods:

$$\Delta \log(P7\_CPI05) = f(\Delta \log(PNRG/EURUSD\_AVG), ECM\ )$$
$$ECM = \log(P7\_CPI05(-1)) - \alpha * \log(PNRG(-1)/EURUSD\_AVG(-1)) -$$
$$- \beta * \log(PINDU(-1)/EURUSD\_AVG(-1)))$$

The deflator of the total consumption is constructed, using the deflators of the private and government consumption:

$$P3\_CPI05$$
$$= (P3\_S13\_2005/P3\_S13\_2005(-1) * P3\_S13(-1) * P3\_S13\_CPI05 +$$
$$+ P3\_S14\_S15\_2005/P3\_S14\_S15\_2005(-1) * P3\_S14\_S15(-1) * P3\_S14\_S15\_CPI05)/$$
$$/(P3\_S13\_2005/P3\_S13\_2005(-1) * P3\_S13(-1) +$$
$$+ P3\_S14\_S15\_2005/P3\_S14\_S15\_2005(-1) * P3\_S14\_S15(-1))$$

The GDP deflator on its part is derived by means of the deflators of its components – consumption, investments, import and export of goods and services:

$$B1GM\_CPI05 = (P3\_2005/P3\_2005(-1) * P3(-1) * P3\_CPI05 +$$
$$+ P5\_2005/P5\_2005(-1) * P5(-1) * P5\_CPI05 +$$
$$+ P6\_2005/P6\_2005(-1) * P6(-1) * P6\_CPI05 -$$
$$- P7\_2005/P7\_2005(-1) * P7(-1) * P7\_CPI05)/(B1GM\_2005/B1GM\_2005(-1) * B1GM(-1))$$

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[17] Includes crude oil, natural gas and coal.

[18] Includes the price indices of copper, aluminium, iron ores, tin, nickel, zinc, lead and uranium.

2.2.4 Demand

Variables in constant prices

The part on demand also concerns the disaggregation of GDP by elements of final demand. The variables in it are initially modeled in constant 2005 prices with the variables in current prices are constructed subsequently, using the calculated deflators.

The private consumption function has the following general form:

$$\Delta \log(\text{P3\_S14\_S15\_2005}) = f(\text{RINTRATE}, \Delta \log(\text{DISPY\_2005}), \text{ECM})$$
$$\text{ECM} = \log(\text{P3\_S14\_S15\_2005(-1)}) - \alpha * \log(\text{DISPY\_2005(-1)}),$$

where DISPY_2005 is the disposable income in constant 2005 prices, defined as the difference between GDP and the sum of all direct taxes (also in 2005 prices). The private consumption in the model is not disaggregated into parts financed by the SCF and parts financed outside the SCF since there are no SCF resources, which directly impact the private consumption. Besides the disposable income, another factor behind the consumption dynamics is also the real interest rate, which is used by the households as a criterion for their choice between savings and consumption.

The government consumption in the model is fixed in constant prices for the 2011-2015 period at its last historical value while its nominal value is determined solely by the prices, which explain its deflator.

The factors, traditionally known from Keynesian models, enter the investment function – the aggregate income and the real interest rate. We, however, already noted in the description of the general modeling approach that the estimate of the equation incorporates both the long-term dependencies and the short-term ones, due to which the calculations include the Keynesian effects but not only. In this particular case, we econometrically model only the dynamics of the private investments without the EU-financed ones as dependent on the real interest rate, the interest margin and the GDP in constant prices:

$$\Delta \log(\text{P5\_x\_S13\_x\_EU\_2005}) = f(\text{RINTRATE}, \text{INT\_DIFF}, \text{ECM})$$
$$\text{ECM} = \log(\text{P5\_x\_S13\_x\_EU\_2005(-1)}) - \alpha * \log(\text{B1GM\_2005(-1)})$$

Similarly to the government consumption in constant prices, we also fix the government investments in constant prices at their last historical value and again, their nominal value is determined by the deflator dynamics (in the model we use only the total investment deflator – irrespective of whether it is about the public or private investments).

The total investments in constant prices are equal to the private investments in constant prices plus the public investments in constant prices:

$$P5\_2005 = P5\_x\_s13\_2005 + P5\_s13\_2005$$

The export of goods and services is modeled as depending on the one side on the domestic demand of Bulgarian goods and services (the specific variable, which is used to measure it, is the EU25 GDP) and on the other side, on the cost competitiveness of the Bulgarian economy (in this case it is measured by the nominal unit labour costs).

$$\Delta\log(P6\_2005) = f(DUMEXP0506, \Delta\log(EU\_B1GM\_2000), ECM)$$
$$ECM = \log(P6\_2005(-1)) - \alpha * \log(NULC\_2005(-1)) - \beta * \log(EU\_B1GM\_2000(-1))$$

A dummy variable also enters the equation and controls for a methodological change in the export accounting.

The import of goods and services on its part is function of the private consumption, the investments and exports since the use of imports is in these three directions:

$$\Delta\log(P7\_2005) = f(\Delta\log(P3\_S14\_S15\_2005), \Delta\log(P5\_2005), \Delta\log(P6\_2005), DUM1, ECM)$$
$$ECM = \log(P7\_2005(-1)) - \alpha * \log(P6\_2005(-1)) - \beta * \log(P5\_2005(-1))$$

The dummy variable DUM1 controls for the effect of the 2009-2010 economic crisis.

Completing the model in constant prices is done through constructing the production function with the help of the simulated (derived by solving the model) factors, which explain it. We use and additional exogenous variable – the so-called add factor with a view to achieving consistency between the simulated and the actual value of GDP in constant prices for the first simulation period.

Variables in current prices

The private consumption is derived through multiplying the indicator in constant 2005 prices by its deflator:

$$P3\_S14\_S15 = P3\_S14\_S15\_2005 * P3\_S14\_S15\_CPI05/100$$

The total consumption is derived as a sum of the private and public consumption:

$$P3 = P3\_S13 + P3\_S14\_S15$$

The total investments are derived as a sum of the private and government investments:

$$P5 = P5\_x\_s13 + P5\_s13$$

The import and export of goods and services are derived through multiplying the indicators in constant prices by their respective deflators:

$$P6 = P6\_2005 * P6\_CPI05/100$$
$$P7 = P7\_2005 * P7\_CPI05/100$$

Finally, completing the model in current prices is done through the well-known identity between income and spending:

$$B1GM = P3\_S13 + P3\_S14\_S15 + P5 + P6 - P7$$

2.2.5 Sector disaggregation of the effects from the European funds

Taking into account the important of the European funds for certain sectors of the Bulgarian economy, care has been taken in the model development to simulating the effects by the individual groups of products and branches. Unfortunately, the available data does not allow the construction of production functions for the separate economic branches, which in turn limits the possibility for modeling the supply of goods and services by each one of them. The developed model analyses the effects for the individual branches through building a small solvable general equilibrium model in order to overcome these difficulties.[19] The idea can be illustrated in short with the following steps:

1. Modeling the effects on the demand in the economy, which can be both direct (for example through increasing investments) and indirect (through the higher income on the demand side, leading to more consumption and investments).
2. Decomposing demand by separate product groups.
3. Modeling supply by using the input-output matrix.

The products/branches in the economy are divided in four groups for the purposes of the analysis of the European funds' effects:

[19] In practice this case is figuratively speaking a "model in the model".

- Agriculture and forestry;
- Industry;
- Construction;
- Services.

The calibration of individual coefficients for the sector disaggregation and inter-sectoral links is done on the basis of the input-output tables for 2005. The sector breakdown in this model is made in constant 2005 prices.

Decomposing demand

Decomposing the effects by product groups is done for the following aggregate demand components:

- Final consumption of households and the non-profit institutions serving households;
- Government consumption;
- Investments;
- Export of goods and services.

Working with the Input-Output tables for 2005 allows the exclusion of the effects from the SCF, observed during the past years while at the same time it gives the economy structure, which is close to the one, observed during the economic boom from 2006-2008.

The direct effects from the European funds on the demand are reflected as follows:

- Government consumption, financed by EU resources – on the demand for services;
- Government investments, financed by EU resources – on the demand for construction goods/services;
- Private investments, financed by EU resources – on the demand for industrial goods. As much as a large part of them are not produced in Bulgaria, this also reflects on the import of industrial goods in the economy.

When modeling supply, an explicit differentiation is made between branches and goods/services. It is modeled by the use of the term ”economic activities”. For each branch a unit of “economic activities” leads to the production of a certain quantity of all kinds of goods/services. This allows for one branch to produce several kinds of goods/services as well as a certain good/service to be produced by several branches. Then, the supply of goods and services by the individual branches can be expressed in the following matrix form:

$$\begin{pmatrix} P1_{AB} \\ P1_{C\_TO\_E} \\ P1_{F} \\ P1_{G\_TO\_P} \end{pmatrix} = \begin{pmatrix} a_{AB}^{AB} & a_{AB}^{C\_TO\_E} & a_{AB}^{F} & a_{AB}^{G\_TO\_P} \\ a_{C\_TO\_E}^{AB} & a_{C\_TO\_E}^{C\_TO\_E} & a_{C\_TO\_E}^{F} & a_{C\_TO\_E}^{G\_TO\_P} \\ a_{F}^{AB} & a_{F}^{C\_TO\_E} & a_{F}^{F} & a_{F}^{G\_TO\_P} \\ a_{G\_TO\_P}^{AB} & a_{G\_TO\_P}^{C\_TO\_E} & a_{G\_TO\_P}^{F} & a_{G\_TO\_P}^{G\_TO\_P} \end{pmatrix} \begin{pmatrix} Act_{AB} \\ Act_{C\_TO\_E} \\ Act_{F} \\ Act_{G\_TO\_P} \end{pmatrix},$$

where Act_i is the quantity of economic activity of the i[th] branch, $P1_j$ is the produced quantity of the j[th] good, and a_j^i are the respective coefficients, taken from the input-output tables. The previous equation can be written in the short form:

$$P1 = A\,Act\,.$$

At the same time the economic activities of the individual branches determine the necessity of production factors in terms of intermediate goods/services and labour. The similar matrix expression has the form:

$$\begin{pmatrix} P2_{AB} \\ P2_{C\_TO\_E} \\ P2_{F} \\ P2_{G\_TO\_P} \end{pmatrix} = \begin{pmatrix} b_{AB}^{AB} & b_{AB}^{C\_TO\_E} & b_{AB}^{F} & b_{AB}^{G\_TO\_P} \\ b_{C\_TO\_E}^{AB} & b_{C\_TO\_E}^{C\_TO\_E} & b_{C\_TO\_E}^{F} & b_{C\_TO\_E}^{G\_TO\_P} \\ b_{F}^{AB} & b_{F}^{C\_TO\_E} & b_{F}^{F} & b_{F}^{G\_TO\_P} \\ b_{G\_TO\_P}^{AB} & b_{G\_TO\_P}^{C\_TO\_E} & b_{G\_TO\_P}^{F} & b_{G\_TO\_P}^{G\_TO\_P} \end{pmatrix} \begin{pmatrix} Act_{AB} \\ Act_{C\_TO\_E} \\ Act_{F} \\ Act_{G\_TO\_P} \end{pmatrix}$$

$$\begin{pmatrix} L_{AB} \\ L_{C\_TO\_E} \\ L_F \\ L_{G\_TO\_P} \end{pmatrix} = \begin{pmatrix} l_{AB} & 0 & 0 & 0 \\ 0 & l_{C\_TO\_E} & 0 & 0 \\ 0 & 0 & l_F & 0 \\ 0 & 0 & 0 & l_{G\_TO\_P} \end{pmatrix} \begin{pmatrix} Act_{AB} \\ Act_{C\_TO\_E} \\ Act_F \\ Act_{G\_TO\_P} \end{pmatrix},$$

where $P2_j$ is the intermediate consumption of the j[th] good, L_i are the employed in the i[th] branch, and b_j^i and l_i are the respective coefficients, taken from the input-output tables. The previous equations can be expressed in the short form:

$$P2 = B\,Act, L = l\,Act\,.$$

Consequently, both the total output of all kinds of goods/services and the intermediate consumption of all goods/services, supporting this production, can be calculated for given quantities of "economic activities" of the individual branches. The difference between output and intermediate consumption thus determines the final demand of goods and services in the economy.

$$FD = (A - B)Act$$

Given that the model is linear, the economic activities by individual branches, necessary for meeting the final demand, can be uniquely calculated if the quantities goods/services demanded are given.

$$Act = (A - B)^{-1} FD$$

It should be noted that the import is also included in the supply in the economy. It is modeled for the whole economy, after which it is decomposed in kinds of goods/services using the input-output tables.

Modeling supply

When modeling supply, an explicit differentiation is made between branches and goods/services. It is modeled by the use of the term "economic activities". For each branch a unit of "economic activities" leads to the production of a certain quantity of all kinds of goods/services and also determines the necessity of production factors in terms of intermediate goods/services and labour. This allows for one branch to produce several kinds of goods/services as well as a certain good/service to be produced by several branches. Consequently, both the total output of all kinds of goods/services and the intermediate consumption of all goods/services, supporting this production, can be calculated for given quantities of "economic activities" of the individual branches. The difference between output and intermediate consumption thus determines the final demand of goods and services in the economy.

Output in producer prices and output in market prices

Completing the sector model is realised through equality of the supplied and demanded goods and services. Unfortunately, this is not trivial since the supply is calculated in producer prices and demand – in market prices. The difference between the two are the trader margins and the transport costs as well as the net product taxes.

The following facts should be taken in account when modeling the trader margins and the transport costs:

- Their sum on all goods/services is zero. As long as they are in essence services, then the margins and the transport costs, made for the other kinds of goods/services, should be subtracted from the supply of services.

- The construction goods/services do not have margins and transport costs.

In the present model we model the margins and the transport costs for the agriculture and industrial goods as a fixed ratio to the total supply. Consequently, their sum is subtracted from the supply of services.

The net taxes on products are modeled as a fixed ratio to the supplied goods/services together with the included trader margins and transport costs.

2.2.6 Labour market

Modeling the labour market part boils down to just a few number of equations, which describe the behaviour of the demand and supply of labour as well as the nominal work wage.

Demand for labour is identified with the employment in the economy and is derived from the branch decomposition, described above. A main assumption, although not fully precise, is that the employers succeed in filling all free positions with people who seek jobs on the labour market. The main inaccuracy of this assumption is neglecting the so-called frictional unemployment – i.e. the people, who are in the process of changing their job. Neglecting this element should not be a significant problem as long as the model works with annual data since, all other things held equal, the change of job is carried out in a period of less than a year.

$$\begin{aligned}&EMP\_15\_64 = EMP\_15\_64\_A\_B + EMP\_15\_64\_C\_TO\_E + \\ &+ EMP\_15\_64\_F + EMP\_15\_64\_G\_TO\_P + EMP\_EU\end{aligned}$$

Employment, financed by SCF, also enters the employment equation. An assumption is made in this case that there are no substitution effects – i.e. this employment would not have been created in the absence of EU resources and on the other hand, it does not lead to reduction of the employment, financed by resources outside the SCF.

The similarity of the economic structure to the structure in 2005 affects the labour demand, respectively employment, so we use an additional exogenous variable in the model – add factor. This allows us on the one side to ensure maximum correspondence between the derived initial value with the actual historical data and on the other, to prevent a situation, in which there is no convergence when solving the model.

The supply of labour on the other hand is identified with the labour force. This assumption is based on the very definition of the labour force – it is people, who are firstly in working age and secondly (and more importantly in this case), they work or are willing to work at the current wage rate. In this particular case the labour supply is dependent on the employment dynamics with the logic being that people are more willing to join the labour force when employment rises and vice versa – to fall out of the labour force when employment falls. The presence of the crisis dummy variable DUM1 in the equation controls for the peculiarities of the employment reaction in 2009 and 2010, stemming from some psychological effects related to the expectations for the length of the crisis as well as from some inflexibility of the labour market.

$$\begin{aligned}&\Delta \log(ACT\_15\_64) = f(DUM1, ECM) \\ &ECM = \log(ACT\_15\_64(-1)) - \alpha * LOG(EMP\_15\_64(-1))\end{aligned}$$

The working wage dynamics in the model is determined by the economic growth. The second difference of the logarithm of the working wage enters the equation as a dependent variable since the first difference is also non-stationary. The dummy variable DUM2 controls for the effect of the economic boom in the country during 2007 and 2009 when the wage growth rate was extraordinarily high:

$$\Delta \log(WAGE\_TOTAL,2) = f(\Delta \log(B1GM\_2005),*DUM2)$$

The unemployment in the model is determined endogenously by taking the difference between the labour force and the employment. Consequently, the unemployment rate is derived by taking the ratio of the number of unemployed to the labour force.

$$UNE\_15\_64 = ACT\_15\_64 - EMP\_15\_64$$
$$UNE\_RT\_15\_64 = UNE\_15\_64/ACT\_15\_64 * 100$$

2.3 Fiscal sector

The fiscal sector is considered in three main aspects – revenues, expenditures and financing. Each one of them is described in detail as follows.

Revenues

The revenues include the indirect taxes (VAT, excises and custom duties), other taxes, the income taxes (personal income tax and corporate income tax), the social security and health insurance contributions, the non-tax revenues and grants. Grants on their part are divided in grants related to the SCF and grants coming to the national budget (from non-EU related sources).

The most simplified approach possible is adopted when modeling the revenue side of the budget, in which the shares of the indicators in the respective revenue base are first defined and afterwards, the indicators themselves are calculated in the simulations as a share in the derived revenue bases. The shares themselves are extrapolated for the simulation period, using their last historical values.

Specifically, we have for the indirect taxes, other taxes, direct taxes, property income and the grants, excluding the EU resources:

$$\begin{aligned} D21 &= SHR\_D21 * P3 \\ D29 &= SHR\_D29 * B1GM \\ D5\_D61 &= SHR\_D5\_D61 * B1GM \qquad , \\ D4 &= SHR\_D4 * B1GM \\ D92\_X\_EU &= SHR\_D92\_X\_EU * B1GM \end{aligned}$$

i.e. each indicator is modeled as a share of the respective revenue base.

Total grants are derived from the equality:

$$D92 = D92\_X\_EU + D92\_EU$$

The sum of all budget revenues is:

$$TR = D21 + D29 + D5\_D61 + D4 + D92$$

Expenditures

The main three components of the government expenditures are the current spending, the capital spending and the contribution to the EU budget. The current spending includes the government consumption, subsidies, social payments (including in kind) and others, as well as the interest outlays. The government consumption and the government investments are also divided according to the financing source (EU or the national budget).

As was mentioned above, the government consumption and the government investments, which are financed by the national budget, are fixed in constant prices. Consequently, their nominal values are derived after multiplying the constant-price indicators by their deflators:

$$\begin{aligned}
&P5_S13_x_EU_2005 = P5_S13_x_EU_2005(-1)\\
&P3_S13_x_EU_2005 = P3_S13_x_EU_2005(-1)\\
&P5_S13_x_EU = P5_S13_x_EU_2005 * P5_CPI05/100\\
&P3_S13_x_EU = P3_S13_x_EU_2005 * P3_S13_CPI05/100
\end{aligned}$$

The amount of the subsidies and the social transfers is determined by a similar approach to the one used in the case of the revenues:

$$D3\_D62\_D63\_D7 = B1GM * SHR\_D3\_D62\_D63\_D7$$

The interest payments and the contribution to the EU budget are modeled by estimating econometric dependencies. The interest payments are determined by the accumulated government debt stock as of the previous period:

$$\begin{aligned}
&\Delta \log(D41) = f(ECM)\\
&ECM = \log(D41(-1)) - \alpha * \log(GD(-1))
\end{aligned}$$

At the same time, the contribution to the EU budget follows the dynamics of the current transfer outflows of the government:

$$EUBUDGET = f(DUM\_EU, BOP380DT)$$

with the dummy variable DUM_EU controlling for the effect of the Bulgarian membership in the EU.

The remaining equations in the part on the spending are identities. The government investments are equal to the investments, financed by the national budget and the investments, financed by the EU:

$$P5\_S13 = P5\_S13\_x\_EU + P5\_S13\_EU$$

Similarly, the government consumption is equal to the consumption, financed by the national budget and the consumption, financed by EU resources:

$$P3\_S13 = P3\_S13\_x\_EU + P3\_S13\_EU$$

The current expenditures are equal to the sum of the government consumption, the subsidies and the social transfers and interest payments:

$$CURREXP = P3\_S13 + D3\_D62\_D63\_D7 + D41$$

The total budget expenditures are equal to the sum of the current expenditures, the government investments and the contribution to the EU budget:

$$TE = CURREXP + P5\_S13 + EUBUDGET$$

Financing

The budget balance is firstly defined in this part:

$$B9\_S13 = TR - TE$$

Some conditionality is accepted in the part on the financing since the financing operations do not depend on the economic situation but on specific political decisions. Firstly, a minimal level of the fiscal reserve is assumed and the government must not allow a lower level to be reached. In the specific case, the value of the minimal fiscal reserve is BGN 4bn. Secondly, a rule is incorporated, envisaging that the government should issue debt to achieve the minimal fiscal reserve level in case the reserve has dropped below it (due to budget deficits). In the reverse case when the fiscal reserve exceeds its minimal level (there is a balanced budget or a budget surplus), the government does not issue debt. The rule consists of the following dependencies:

$$FISCRULE = FISCRES(-1) + B9\_S13 > !min\_fisc\_res\_level$$
$$FISCRES = FISCRULE * (FISCRES(-1) + B9\_S13) + (1 - FISCRULE) * !min\_fisc\_res\_level$$
$$GD = GD(-1) - B9\_S13 + FISCRES - FISCRES(-1)$$

The first dependency represents a logical check, according to which the variable FISCRULE adopts a value of 1 in case the inequality on the right side is satisfied and a value of zero in the reverse case. The second dependency determines the dynamics of the fiscal reserve, and the third – of the public debt.

The liabilities of the BNB to the government are also affected by the financing operations (they practically represent the largest part of the fiscal reserve) so there is an econometrically estimated equation in this part, which sets the relationship between these liabilities and the fiscal reserve level:

$$\Delta(\mathrm{LIABGOV}) = f(\mathrm{DUM1}, \mathrm{ECM})$$
$$\mathrm{ECM} = \mathrm{LIABGOV}(-1) - \alpha * \mathrm{FISCRES}(-1)$$

2.4 External sector

The foreign assets, reduced with the BNB reserve assets, are firstly defined in the external sector. The financial account balance, reduced with the BNB reserve asset change, is defined as well. The errors and omissions item is re-calculated again in the model with a view to use them in other dependencies:

$$\mathrm{IIP988\_x\_802} = \mathrm{IIP988} - \mathrm{IIP802}$$
$$\mathrm{BOP995\_x\_802nt} = \mathrm{BOP995nt} - \mathrm{BOP802nt}$$
$$\mathrm{BOP998NT} = -\mathrm{BOP993NT} - \mathrm{BOP994NT} - (d(\mathrm{IIP989}) - d(\mathrm{IIP988\_x\_802})) - \mathrm{BOP802NT}$$

The income outflow in the current account is modeled as depending on the total liabilities in the financial account:

$$\Delta\log(-\mathrm{BOP300DT}) = f(\Delta\log(\mathrm{IIP989}), \mathrm{ECM})$$
$$\mathrm{ECM} = \log(-\mathrm{BOP300DT}(-1)) - \alpha * \log(\mathrm{IIP989}(-1))$$

The inflow of investment income in Bulgaria is modeled in a "mirror" way – as depending on the total amount of the assets in the financial account:

$$\mathrm{dlog}(\mathrm{BOP320KT}) = f(\mathrm{ECM})$$
$$\mathrm{ECM} = \log(\mathrm{BOP320KT}(-1)) - \alpha * \log(\mathrm{IIP988}(-1))$$

The inflow of labour income (compensation of employed) is modeled with a dependency, under which the short-term changes in the indicator are influenced by its value for the previous year and from the real GDP two periods back:

$$\Delta\log(\mathrm{BOP310KT}) = f(\log(\mathrm{BOP310KT}(-1)), \log(\mathrm{B1GM\_2005}(-2)))$$

The private transfers from and to the country are determined by the real economic growth in Bulgaria.:

$$\Delta\log(\text{BOP390KT}) = f(\Delta\log(\text{B1GM\_2005}), \text{ECM})$$
$$\text{ECM} = \log(\text{BOP390KT(-1)}) - \alpha * \log(\text{B1GM\_2005(-1)})$$
$$\Delta\log(\text{-BOP390DT}) = f(\Delta\log(\text{B1GM\_2005}))$$

At the same time, the outflowing government transfers are determined by the nominal GDP value:

$$\log(\text{-BOP380dt}) = f(\text{DUM\_EU}, \log(\text{B1GM}))$$

According to the mode, the foreign investments in the country are determined by their value from the previous period (i.e. there is inertia) and by the changes in the real return on capital in the Bulgarian economy:

$$\text{DLOG(IIP555)} = \text{C(1)} * \text{DLOG(IIP555(-1))} + \text{C(2)} * \text{D(RINTRATE)}$$

The total foreign liabilities in the financial account depend on the nominal GDP, the interest spread and the changes in the nominal interest rate:

$$\Delta\log(\text{iip989}) = f(\Delta(\text{INTRATE}), \text{ECM})$$
$$\text{ECM} = \log(\text{IIP989(-1)}) - \alpha * \log(\text{B1GM(-1)}) - \beta * \text{INT\_DIFF(-1)}$$

Regarding the foreign assets (excluding the central bank's reserve assets), the explanatory factors are the changes in the 12-month EURIBOT and the GDP growth:

$$\Delta\log(\text{IIP988\_x\_802}) = f(\Delta(\text{EURIBOR\_12}), \Delta\log(\text{B1GM\_2005}), \text{ECM})$$
$$\text{ECM} = \log(\text{IIP988\_x\_802(-1)}) - \alpha * \log(\text{B1GM\_2005(-1)})$$

The remaining equations on the balance of payments are identities. The income on the current account is equal to the inflow of labour incomes (compensation of employed) plus the investment income:

$$\text{BOP300KT} = \text{BOP310KT} + \text{BOP320KT}$$

The net income is equal to the inflows minus the outflows on the income account:

$$\text{BOP300NT} = \text{BOP300KT} + \text{BOP300DT}$$

The outflowing/inflowing current transfers are the sum of the private and the public outflowing/inflowing transfers:

$$\text{BOP379DT} = \text{BOP380DT} + \text{BOP390DT}$$
$$\text{BOP379KT} = \text{BOP380KT} + \text{BOP390KT}$$

The net transfer balance is consequently the sum of the inflows and the outflows (the latter taken with a minus sign):

$$BOP379NT = BOP379KT + BOP379DT$$

The net goods and services trade balance is derived as the difference between the export and import of goods and services, calculated in the real sector part of the model:

$$BOP100\_200NT = P6 - P7$$

Finally, the current account balance is the sum from the net balances of the trade with goods and services, of the income and of the transfers:

$$BOP993NT = BOP100\_200NT + BOP300NT + BOP379NT$$

The net foreign direct investments in the country from the financial account are identically equal to the change of the same indicator from the international investment position:

$$BOP555NT = IIP555 - IIP555(-1)$$

The change in the financial account balance, excluding the BNB reserve assets, is equal to the change of the liabilities in the international investment position, reduced with the change of the assets in the international investment position, excluding the BNB reserve assets:

$$BOP995\_x\_802NT = (IIP989 - IIP989(-1)) - (IIP988\_x\_802 - IIP988\_x\_802(-1))$$

On their part, the BNB reserve assets in the international investment position are equal to their value from the previous period, increased with the BNB reserve asset flow from the balance of payments (the decrease in the reserves in this item is denoted with a plus sign, while the increase – with a minus sign, due to which the sign in the equation is minus):

$$IIP802 = IIP802(-1) - BOP802NT$$

Similarly, the assets in the international investment position are equal to the assets (excluding the BNB reserve assets) plus the BNB reserve assets:

$$IIP988 = IIP988\_x\_802 + IIP802$$

The capital account in the model is determined as a share in nominal GDP with the share for the simulation period being equal to the last observed historical value:

$$BOP994NT = SHR\_BOP994NT * B1GM$$

The current transfers to the government, excluding the SCF transfers, are determined in the same way:

$$BOP380KT\_x\_EU = SHR\_BOP380KT\_x\_EU * B1GM$$

The total current transfers to the government include the SCF transfers and all the rest:

$$BOP380KT = BOP380KT\_x\_EU + D92\_EU$$

2.5 Monetary sector

The monetary sector, similarly to the fiscal sector, is modeled in a simplified way since its dynamics is not crucial for the effects, which have to be traced with the help of the developed model. Therefore, the main equations in the sector represent mainly identities. Only two equations are econometrically estimated – the equation for the quasi-money and the overnight deposits. Determining factors in the first equation are the consumption, export and GDP in current prices, the inflation and the nominal interest rate:

$$\Delta\log(QUASI) = f(\Delta\log(P3\_2005), ECM)$$
$$ECM = \log(QUASI(-1)) - \alpha * INTRATE(-1) - \beta * \log(CP00\_AVX(-1)) -$$
$$- \gamma * \log(B1GM\_2005(-1))$$

The only determining factor in the second equation is the volume of consumption:

$$\Delta\log(OVERN1) = f(\Delta\log(P3\_2005), ECM)$$
$$ECM = \log(OVERN1(-1)) - \alpha * \log(P3\_2005(-1))$$

The most important identities relate to the monetary aggregates M1 and M2:

$$M1 = NOTESCOINS + OVERN1$$
$$M2 = M1 + QUASI$$

The liabilities to the banks (the bank reserves) are determined as the sum of all deposits, which are part of M2, while the liabilities to other depositors – as a share in the total liabilities of the Issue Department of the BNB (the shares for the simulation period are again set equal to the last available historical values):

$$LIABBANKS = SHR\_LIABBANKS * (OVERN1 + QUASI)$$
$$LCBOTHER = SHR\_LCBOTHER * CBASSETS$$

The liabilities of the Issue Department are identically equal to the reserve assets of the BNB in line with the international investment position statistics:

$$CBASSETS = IIP802$$

Banknotes and coins in circulation are equal to the liabilities of the Issue Department, reduced with the liabilities to banks, to the government and to other depositors:

$$NOTESCOINS = CBASSETS - LIABBANKS - LIABGOV - LCBOTHER$$

3 Estimating and validating the model. Practical advice for its use.

3.1 Calibrating the equation coefficients

3.1.1 Econometric estimate

The econometric estimation of the equations is also carried out automatically. As already mentioned, the equations are estimated in an error correction form when possible. The estimated in this way equations are directly added in the system of equations, which is solved subsequently. The specification of the equations, which is incorporated in the source code, suggests previous work on each separate equation in order to achieve a good estimate of the regression parameters. It is not necessary in this case for the model user to do additional actions on the specification and the estimation of the equations since this task is already carried out by the model development team for the available data. At a later stage, after new statistical data is generated, the following actions can be taken:

1. To change the period for estimation of the regression equations by expanding it by one (or more) years. This is done by changing the value of the !ylast variable in the source code. This variable takes the value of 2010 at the moment of preparing the model documentation – i.e. the last year, for which statistical data is available.

2. To change the specification of the equations in case the new statistical data change the nature of the strength of the dependencies.

3.1.2 Manual calibration of the coefficients in the remaining behavioural equations

The equations, which are not econometrically estimated but determine the relationship between separate variables through the values of certain coefficients (i.e. they are not identities), are calibrated manually. This is done by writing the equations with an explicitly setting the values of the parameters (instead of their symbolic denotations) and the corresponding equations are added with the command “append” to the model. The coefficients of the manually calibrated equations are taken directly from the economic theory and empirics (i.e. from other studies) or are calculated on the basis of historical ratios.

3.2 Solving the model

The model practically represents a system of equations, which can be solved and the solution yields the simulated values of the endogenous variables. The EViews software allows several solution methods – the Newton method, the Broyden method and the Gauss-Seidel method.

The Gauss-Seidel method is selected for solving the present model, which is also the default method in EViews.[20]

The solving is carried out after importing the data, calibrating the equation coefficients and adding the equations themselves, together with the identities, to the system.

3.3 Model validation and sensitivity analysis

The sensitivity analysis, which is carried out, aims to study the reaction of the results from the developed model after a change of key exogenous variables. This analysis is necessary since the model works with economic data, which are inherently characterized by uncertainty. Studying the change of the model results, stemming from a change in the assumptions on the exogenous variables, is very important for the model users. Learning these effects, they will be able to build for themselves preliminary expectations, sense and better understanding of the model properties. At the same time, they will be able to more successfully interpret the derived results when new statistical data is available as well as to make potential changes in the structure and logic of the model.

Several types of shocks are defined for the purposes of the sensitivity analysis and the long-term behaviour of main endogenous variables is considered (till 2020 in the particular case):

- A 1% increase of the total factor productivity (the residual unexplained part of the technological level)
- A 10% increase of the government consumption
- A 10% increase of the international prices of energy goods.

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[20] For the properties of the application of the individual solution methods in EViews, see Quantitative Micro Software, *EViews User's Guide*, vol. 2, pp. 552-553, pp. 759-761.

The results from the sensitivity analysis are presented in a graphical format on the following three graphs with each of them successively reflecting the effects from the three above-mentioned shocks:

Figure 1: Effects from a 1% increase of the total factor productivity

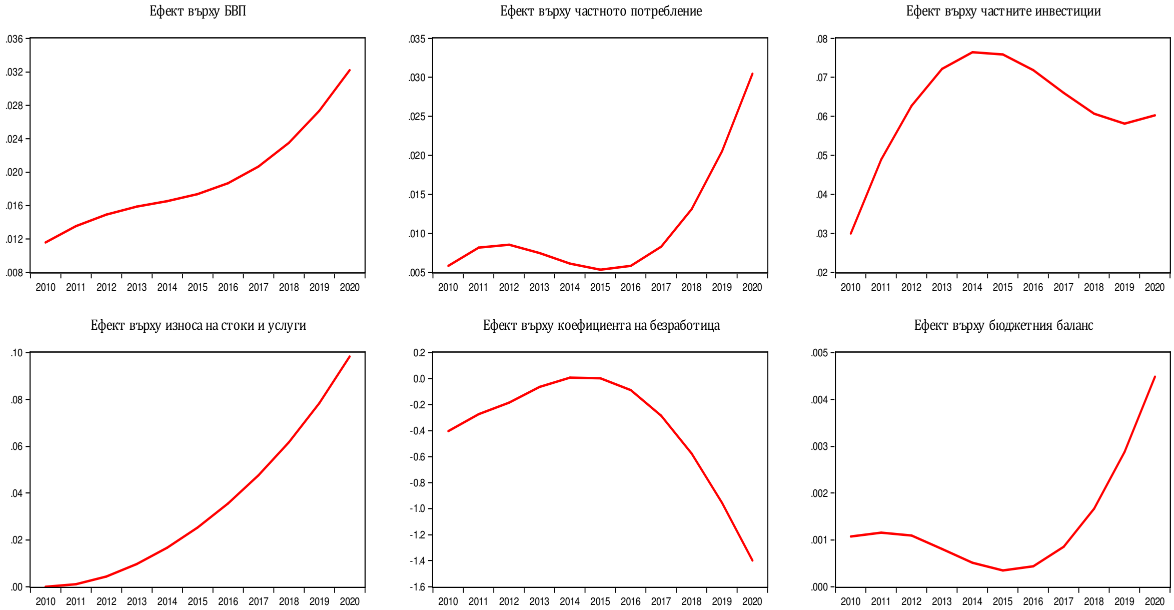


Figure 2: Effects from a 10% increase of the government consumption

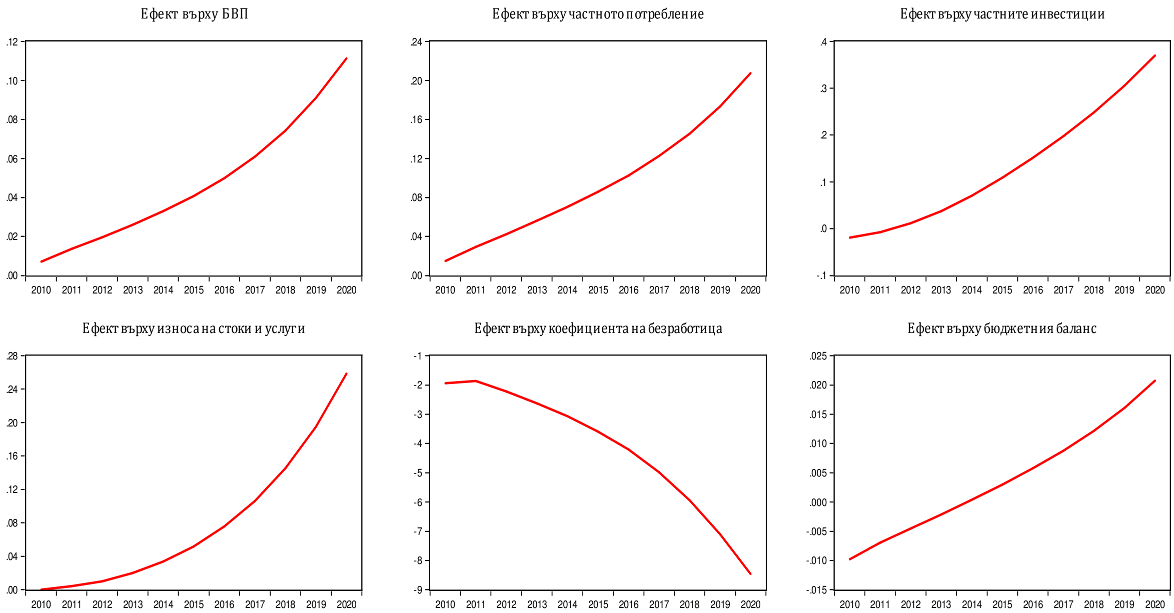
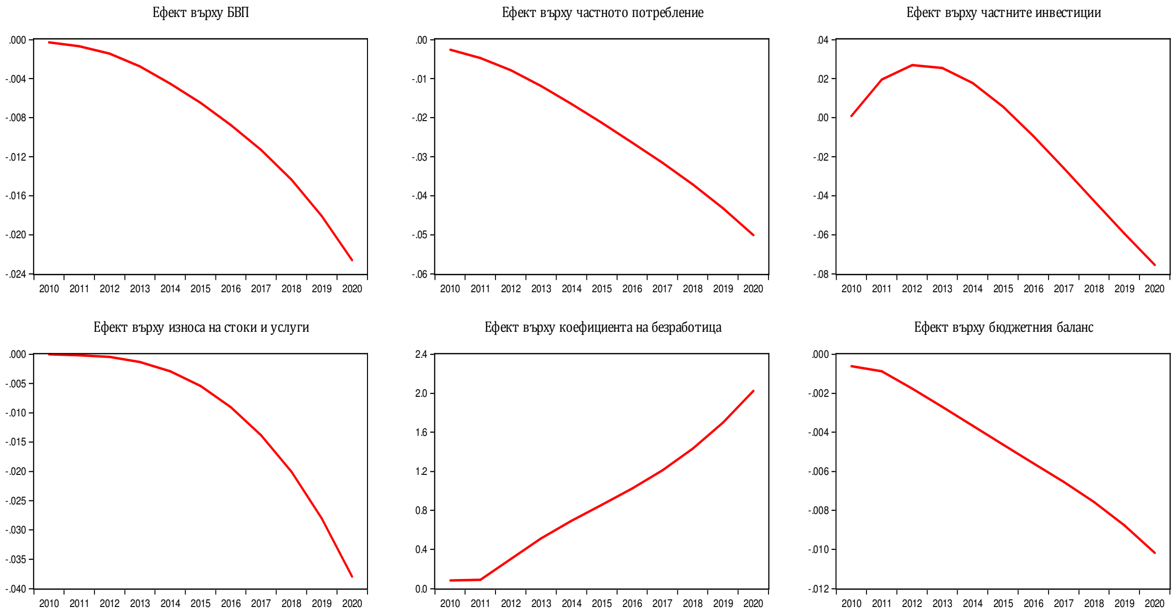


Figure 3: Effects from a 10% increase of the international prices of energy goods



PART 2: TECHNICAL APPENDICES

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Zaleski, J. et. al. (2004) "Revision of the Polish HERMIN Model Using the New National Accounts: 1995 – 2002", WARR.

EViews code

```
'=================================================================
======================
'                    A Macroeconomic Model for the Assessmentestimate effects of
ESFs in Bulgaria
'                                                version 22 July 2011
'=================================================================
======================

' Set working directory - All datafiles that variables are read from should be put
in this directory!
'                    !!! DO NOT FORGET THE BACKSLASH (\) AT THE END !!!

%workdir = "i:\Docs\_Kaloyan\Projects\NSRF\_model\"
cd %workdir

' Create annual-data workfile ranging from 1990 to 2030
wfcreate(wf=bgmodel_esf, page=annual) a 1980 2030

'==========================================
' Define variables which set model-specific dates
'==========================================

' Last year used in calibration through econometric estimation
!ylast = 2010

' First year used in simulation
!firstsim = 2010

' Last year used in simulation
!lastsim = 2020

'========================================
'                    EXCEL DATA IMPORT
'========================================

' Set sample to education and population data range
smpl 1980 !lastsim

' Read data on education
read(s=edu) edu_hc.xls POP_5_9 POP_10_14 POP_15_19 POP_20_24
    POP_25_29    POP_30_34    POP_35_39    POP_40_44    POP_45_49
```

```
    POP_50_54    POP_55_59    POP_60_64    EDU_1_4    EDU_5_8
    EDU_9_13 EDU_SPEC    EDU_HIGH POP_15_64

' Set sample to all other data range
smpl 1995 !lastsim

' Read Balance of payments data
read(s=bop) bop.xls
BOP993NT BOP100NT BOP100KT BOP100DT BOP200NT BOP200KT
    BOP205KT BOP236KT BOP981KT BOP200DT BOP205DT BOP236DT
    BOP981DT BOP300NT BOP300KT BOP310KT BOP320KT BOP330KT
    BOP339KT BOP370KT BOP300DT BOP310DT BOP320DT BOP330DT
    BOP339DT BOP370DT BOP379NT BOP379KT BOP380KT BOP390KT
    BOP379DT BOP380DT BOP390DT BOP996NT BOP994NT BOP401KT
    BOP995NT BOP500NT BOP505NT BOP555NT BOP560NT BOP575NT
    BOP580NT BOP599NT BOP600NT BOP602NT BOP610NT BOP619NT
    BOP602NT BOP652NT BOP669NT BOP700NT BOP703NT BOP759NT
    BOP714NT BOP718NT BOP721NT BOP728NT BOP730NT BOP732NT
    BOP733NT BOP734NT BOP736NT BOP753NT BOP759NT BOP764NT
    BOP769NT BOP772NT BOP775NT BOP780NT BOP786NT BOP802NT
    BOP998NT

' Read consolidated budget data
read(s=revenue_exp)  budget.xls TR   TAXR    D51B D51A D211 D214 D212
    D61   D29   SUGARTAX    D4D92   TECURREXP  WAGESSOC   MAINT
    SUBS    SUBSNGO SUBSFIN   SUBSHEALTH    D41   D41_S1 D41_S2
    SOCEXP    P5_S13 EUBUDGET   B9_S13 FIN    FINEXT FINDOM
    PRIVETC   PRIV GSM BANKPRIV P3_S13_EU    P5_S13_EU    D92_EU
    P5_S13_X_EU    GD    FISCRES

' Read data on expenditures on R&D, ICT and communication (Eurostat)
read(s=data) ict_comm_rd.xls GERD_TOTAL   ITEXPEN    COMMEXP

' Read data on GDP by production method at current prices
read(s=prod_current)  gdp.xls B1G_A_B  B1G_C_D_E B1G_F B1G_G_H_I
    B1G_J_K    B1G_L_TO_P B1G_TOTAL   D2_M_D3   B1GM

' Read data on GDP by production method at 2005 prices
read(s=prod_2005)  gdp.xls B1G_A_B_20055   B1G_C_D_E_2005
    B1G_F_2005  B1G_G_H_I_2005    B1G_J_K_2005   B1G_L_TO_P_2005
    B1G_TOTAL_2005  D2_M_D3_2005  B1GM_2005

' Read data on GDP by final use method at current prices
```

```
read(s=expend_current)  gdp.xls P3 P31  P31_S14    P31_S15    P31_S13
   P32_S13    P5 P51   P52   P6 P61   P62   P7 P71   P72   P3_S13
   P3_S14_S15

' Read data on GDP by final use method at 2005 prices
read(s=expend_2005)  gdp.xls P3_2005  P31_2005  P31_S14_2005
   P31_S15_2005 P31_S13_2005 P32_S13_2005   P5_2005    P51_2005
   P52_2005   P6_2005    P61_2005  P62_2005  P7_2005    P71_2005
   P72_2005   P3_S13_2005 P3_S14_S15_2005

' Read data on gross fixed capital formation by 6  asset types (Eurostat) - other construction used to generate infrastructure series
read(s=2005) gfcf_assettypes.xls CPA_TOTAL_2005CPA_A_B_2005
   CPA_DJ28xDL_DN36_2005  CPA_DM_2005   CPA_FA_2005
   CPA_FB_2005    CPA_OTH_2005

' Read data on deflators
read(s=defl_2005)  gdp.xls B1G_A_B_CPI05 B1G_C_D_E_CPI05
B1G_F_CPI05 B1G_G_H_I_CPI05 B1G_J_K_CPI05 B1G_L_TO_P_CPI05
B1G_TOTAL_CPI05D2_M_D3_CPI05B1GM_CPI05  P3_CPI05   P31_CPI05
   P31_S14_CPI05  P31_S15_CPI05  P31_S13_CPI05  P32_S13_CPI05
   P5_CPI05   P51_CPI05 P52_CPI05 P6_CPI05   P61_CPI05 P62_CPI05
   P7_CPI05   P71_CPI05 P72_CPI05 P3_S13_CPI05    P3_S14_S15_CPI05

' Read inflation data
read(s=hicp)  hicp.xls CP00_ANR   CP00_AVR     CP00_AVX

' Read labour market data
read(s=lfs)  labour_lfs.xls  ACT_15_64ACT ACT_RT ACT_RT_15_64
ACT_RT_15_24 ACT_RT_20_64 ACT_RT_25_54 ACT_RT_55_64
UNE_RT_15_24 EMP_LFS EMP_15_64  EMP_RT_15_64  EMP_RT_20_64
   EMP_RT_15_24  EMP_RT_25_54  EMP_RT_55_64  UNE  UNE_RT
   UNE_15_64    UNE_RT_15_64

' Read wages data
read(s=wages)  wages.xls WAGE_TOTAL

' Read data on monetary aggregates
read(s=aggregates)  monetary.xls  M3  M1 CASH  OVERN1    OVERN1BGN
   OVERN1FX    M2    QUASI   DEP1_2Y   DEP1_2YBGNDEP1_2YFX
   DEP1_3M   DEP1_3MBGN    DEP1_3MFX   QUASI2 QUASI2BGN
   QUASI2FX

' Read data on OMFI analytical reporting
```

```
read(s=omfi)  monetary.xls ASSETS NFA
FASSETS  FLIAB    RES  CVAULTS  DEPBNB    NCLAIMS_PUBLIC
   CLAIMS_PRIVATE  CLAIMS_ENT CLAIMS_HH   LIAB  DEP  OVERN
   OVERNBGN   OVERNFX  DEP_2Y DEP_2YBGN  DEP_2YFX DEP_3M
   DEP_3MBGN  DEP_3MFX

' Read data on Issue Dept. balance sheet
read(s=issuedpt)  monetary.xls CBASSETS NOTESCOINS    LIABBANKS
   BANKDEPT    LIABGOV

' Read net international investment position
read(s=iip)  iip.xls IIP995 IIP988 IIP505    IIP506    IIP530    IIP602    IIP610
   IIP619    IIP620    IIP630    IIP900    IIP703    IIP706    IIP714    IIP715
   IIP719    IIP722    IIP725    IIP730    IIP736    IIP737    IIP740    IIP743
   IIP746    IIP802    IIP989    IIP555    IIP556    IIP580    IIP652    IIP660
   IIP669    IIP670    IIP680    IIP905    IIP753    IIP756    IIP764    IIP765
   IIP769    IIP772    IIP775    IIP780    IIP786    IIP787    IIP790    IIP793
   IIP796

' Read data on external environment
smpl 1995 !lastsim
read(s=data)  world_vars.xls EU_B1GM US_B1GM EU_B1GM_PREV
EU_B1GM_2000 US_B1GM_2000 EU_B1GM_PCH US_B1GM_PCH
EURUSD_END EURUSD_AVG EURIBOR_12 EU_CP00_AVX EU_CP00_AVR
EU_CP00_ANR   EU_NULC_I2000 EU_RULC_I2000 EU_NULC_I2005
   EU_RULC_I2005 PALLFNF  PNFUEL    PFANDB    PFOOD  PBEVE
   PINDU   PRAWM PMETA  PNRG    POILAPSP

' Create model object

model model_bg

'==============================
'               DUMMY SECTION
'==============================

'define dummy for EU accession
smpl 1990 2006
series dum_eu = 0
smpl 2007 2030
series dum_eu = 1

'define dummy for crisis 2009-2010
smpl 1995 2020
series dum1 = 0
```

```
smpl 2009 2010
series dum1 = 1
smpl 1995 2010

'define dummy for boom
smpl 1995 2020
series dum2 = 0
smpl 2007 2008
series dum2 = 1
smpl 1995 2010

'define dummy for exports 2005-2006
smpl 1995 2020
series dumexp0506 = 0
smpl 2005 2005
series dumexp0506 = -1
smpl 2006 2006
series dumexp0506 = 1
smpl 1995 2010

'=======================================================================
'         DEFINITION OF SOME AGGREGATES WHICH ARE USED MODEL-WIDE
'=======================================================================

'-------------------------------------------------------
' Set some EU-related expenditures to zero
'-------------------------------------------------------

smpl @all
' EU-financed private investment...
series P5_x_S13_EU = 0

' EU-financed employment...
series EMP_EU = 0

' EU-financed infrastructure expenditure...
series INFREXP_EU = 0

' Human capital generated through EU-financed vocational training
series VOC_EU = 0

' Number of persons to undergo EU-financed vocational training...
```

```
series NUMVOC_EU = 0

' EU-related expenditure on technology...
series TECHEXP_EU = 0

' Define direct taxes
series D5_D61 = D51A + D51B + D61

' Define indirect taxes
series D21 = D211 + D212 + D214

' Define disposable income
series DISPY = B1GM - D5_D61

' Merge disposable income to model
model_bg.append DISPY = B1GM - D5_D61

' Generate real disposable income
series DISPY_2005 = (B1GM - D5_D61)/CP00_AVX*100

' Merge real disposable income to model
model_bg.append DISPY_2005 = (B1GM - D5_D61)/CP00_AVX*100

' Calculate private investment at current prices
series P5_x_S13 = P5 - P5_S13

' Calculate private investment at 2005 prices
series P5_x_S13_2005 = P5_x_S13/P5_CPI05*100

' Calculate private investment less EU-financed private investment at current
prices
series P5_x_S13_x_EU = P5_x_S13 - P5_x_S13_EU

' Calculate private investment less EU-financed private investment at 2005
prices
series P5_x_S13_x_EU_2005 = P5_x_S13_x_EU/P5_CPI05*100

' Calculate EU-funds-financed private investment at 2005 prices
series P5_x_S13_EU_2005 = P5_x_S13_EU/P5_CPI05*100

' Calculate EU-financed public investment at current prices
series P5_S13_EU_2005 = P5_S13_EU/P5_CPI05*100

' Merge to model EU-financed public investment at current prices
model_bg.append P5_S13_EU_2005 = P5_S13_EU/P5_CPI05*100
```

```
' Merge to model investment less EU-financed investment at 2005 prices
model_bg.append P5_x_EU_2005 = P5_x_S13_x_EU_2005 +
P5_S13_x_EU_2005

' Merge to model private investment less EU-financed private investment at
2005 prices
model_bg.append P5_x_S13_EU_2005 = P5_x_S13_EU/P5_CPI05*100

' Merge to model private investment at 2005 prices
model_bg.append P5_x_S13_2005 = P5_x_S13_EU_2005 +
P5_x_S13_x_EU_2005

' Merge to model private investment at current prices
model_bg.append P5_x_S13 = P5_x_S13_2005*P5_CPI05/100

' Merge to model government consumption at constant prices
model_bg.append P3_S13_2005 = P3_S13/P3_S13_CPI05*100

' Generate government investment at constant prices
series P5_S13_2005 = P5_S13/P5_CPI05*100

' Merge to model government investment at constant prices
model_bg.append P5_S13_2005 = P5_S13/P5_CPI05*100

' Define real wage
series WAGE_TOTAL_2005 = WAGE_TOTAL/CP00_AVX*100

' Merge real wage equation to model
model_bg.append WAGE_TOTAL_2005 = WAGE_TOTAL/CP00_AVX*100

' Define proxy for real unit labour costs
series RULC_2005 = WAGE_TOTAL/(B1GM/EMP_15_64)

' Merge equation for proxy for real unit labour costs to model
model_bg.append RULC_2005 = WAGE_TOTAL/(B1GM/EMP_15_64)

' Define proxy for nominal unit labour costs
series NULC_2005 = WAGE_TOTAL/(B1GM_2005/EMP_15_64)

' Merge equation for proxy for nominal unit labour costs to model
model_bg.append NULC_2005 = WAGE_TOTAL/(B1GM_2005/EMP_15_64)

'============================================
'                        HUMAN CAPITAL BLOCK
```

```
'=============================================
smpl @all

'Calculate numbers of students in primary, secondary and tertiary education
series PRIMEDU = EDU_1_4 + EDU_5_8
series SECEDU = EDU_9_13 + EDU_SPEC
series HIGHEREDU = EDU_HIGH

'Calculate enrollment rates
series PRIMEDU_RT = PRIMEDU/(POP_5_9 + POP_10_14)
series SECEDU_RT = SECEDU/POP_15_19
series HIGHEREDU_RT = HIGHEREDU/POP_20_24

' Calculate educational attainment (average number of years of education),
following Kyriacou (1991)
' We introduce an intercept shift (pseudo-fixed effect) from 0.05 to 2 to better
match obtained data to the few historical datapoints (from census)
' and other studies (e.g. Barro and Lee 2000)
series EDU_ATT =  2 + 4.439*PRIMEDU_RT(-15) + 2.665*SECEDU_RT(-5) +
8.092*HIGHEREDU_RT(-5)

' Introduce the only available datapoint on the number of persons who have
passed vocational training for 2005
smpl 2005 2005
scalar NUMVOC_2005 = 151450

' Introduce the only available datapoint on total hours spent on vocational
training for 2005
scalar VOCHOURS_2005 = 6516387

' Convert to years assuming 9 months average education year, 22 working days
per month, 8 hours per study day
scalar VOCYRS_2005 = VOCHOURS_2005/8/22/9

' Calculate ratio of NUMVOC_2005 to labour force
scalar NUMVOC_2005_RT =
NUMVOC_2005/@elem(ACT_15_64,"2005")/1000

' Calculate the per person number of years of education received through
vocational training for 2005
scalar VOCYRS_2005_AVG = VOCYRS_2005/NUMVOC_2005

' Generate the series of number of participants in vocational training
smpl 2000 !ylast
series NUMVOC = NUMVOC_2005_RT*ACT_15_64
```

```
' Merge to model the equation of number of participants in vocational training
model_bg.append NUMVOC = NUMVOC_2005_RT*ACT_15_64

' Generate human capital obtained through vocational training
' For the initial amount of vocational training at the beginning of 2000 we
assume that all the labour force has received the average number of vocational
training years
smpl 2000 2000
series VOC = ACT_15_64*VOCYRS_2005_AVG +
NUMVOC*VOCYRS_2005_AVG
for !i = 2001 to 2010
    smpl !i !i
    series VOC = NUMVOC*VOCYRS_2005_AVG + VOC(-1)
next !i

' Merge to model human capital obtained through vocational training
model_bg.append VOC = NUMVOC*VOCYRS_2005_AVG + VOC(-1)

' Generate human capital obtained through EU-financed vocational training
series VOC_EU = NUMVOC_EU*VOCYRS_2005_AVG + VOC_EU(-1)

' Merge to model human capital obtained through EU-financed vocational
training
model_bg.append VOC_EU = NUMVOC_EU*VOCYRS_2005_AVG +
VOC_EU(-1)

' Generate human capital (augmented educational attainment)
smpl 1995 !ylast
series HKT = ACT_15_64*EDU_ATT + VOC + VOC_EU

' Merge to model human capital equation
model_bg.append HKT = ACT_15_64*EDU_ATT + VOC + VOC_EU




'==========================================
'                 INFRASTRUCTURE BLOCK
'==========================================

' Set infrastructure depreciation rate
scalar infrdeprate = 0.1

' Define EU-finance infrastructure expenditure at 2005 prices
```

```
series  INFREXP_EU_2005 = INFREXP_EU/P5_CPI05*100

' Generate initial stock of infrastructure capital
smpl 2000 2000
series INFRKT_2005 = CPA_FB_2005/infrdeprate

' Generate next values of infrastructure capital
for !i = 2001 to !ylast
    smpl !i !i
    INFRKT_2005 = CPA_FB_2005(-1) + INFREXP_EU_2005(-1) +
INFRKT_2005(-1)*(1-infrdeprate)
next !i

' Append real infrastructure flows to model - use mean share in real GDP
model_bg.append CPA_FB_2005 = 0.08*B1GM_2005

' Append EU-funds-financed infrastructure expenditure at 2005 prices

model_bg.append INFREXP_EU_2005 = INFREXP_EU/P5_CPI05*100

' Append infrastructure capital equation to model
model_bg.append INFRKT_2005 = CPA_FB_2005(-1) + INFREXP_EU_2005(-
1) + INFRKT_2005(-1)*(1-infrdeprate)

'============================================
'                    R&D, ICT and communication
'============================================

' Set technology capital depreciation rate
scalar techdeprate = 0.1

' Calculate share of IT expenditure in GDP
smpl 2006 2009
series SHR_ITEXPEN = ITEXPEN/B1GM

' Calculate mean share of IT expenditure in GDP
scalar MSHR_ITEXPEN = @mean(SHR_ITEXPEN)

' Calculate share of communication expenditure in GDP
series SHR_COMMEXP = COMMEXP/B1GM

' Calculate mean share of communication expenditure in GDP
scalar MSHR_COMMEXP = @mean(SHR_COMMEXP)

' Backcast ICT and communication expenditure
```

```
smpl 2000 2005
series ITEXPEN = MSHR_ITEXPEN*B1GM
series COMMEXP = MSHR_COMMEXP*B1GM

' Forecast ICT and communication expenditure
smpl !ylast !ylast
series ITEXPEN = MSHR_ITEXPEN*B1GM
series COMMEXP = MSHR_COMMEXP*B1GM

' Merge IT and communication expenditure equations to model
model_bg.append ITEXPEN = MSHR_ITEXPEN*B1GM
model_bg.append COMMEXP = MSHR_COMMEXP*B1GM

' Calculate share of R&D expenditure in GDP
smpl 2000 !ylast-1
series SHR_GERD_TOTAL = GERD_TOTAL/B1GM

' Calculate mean share of R&D expenditure in GDP
scalar MSHR_GERD_TOTAL = @mean(SHR_GERD_TOTAL)

' Forecast R&D expenditure
smpl !ylast !ylast
series GERD_TOTAL = MSHR_GERD_TOTAL*B1GM

' Merge R&D expenditure equation to model
model_bg.append GERD_TOTAL = MSHR_GERD_TOTAL*B1GM

' Generate expenditure on technology
smpl 2000 !ylast
series TECHEXP = GERD_TOTAL + ITEXPEN + COMMEXP + TECHEXP_EU

' Merge to model expenditure on technology
model_bg.append TECHEXP = GERD_TOTAL + ITEXPEN + COMMEXP +
TECHEXP_EU

' Generate expenditure on technology at 2005 prices
series TECHEXP_2005 = TECHEXP/P5_CPI05*100

' Merge to model expenditure on technology at 2005 prices
model_bg.append TECHEXP_2005 = TECHEXP/P5_CPI05*100

' Initial stock of technology capital
smpl 2000 2000
series TECHKT_2005 = TECHEXP_2005/techdeprate
```

```
' Generate technology capital stock series
for !i = 2001 to !ylast
    smpl !i !i
    TECHKT_2005 = TECHEXP_2005(-1) + (1-techdeprate)*TECHKT_2005(-1)
next !i

' Merge to model technology capital stock series
model_bg.append TECHKT_2005 = TECHEXP_2005(-1) + (1-
techdeprate)*TECHKT_2005(-1)

'=====================================================
'                    REAL SECTOR - SUPPLY SIDE
'=====================================================

' Set depreciation rate of physical capital stock at 5% annually
scalar deprate= 0.05

' Initial physical capital stock
smpl 1995 1995
series KT_2005 = P5_2005/deprate

' Generate capital stock series by PIM
for !i = 1996 to !ylast
    smpl !i !i
    KT_2005 = P5_2005(-1) + (1-deprate)*KT_2005(-1)
next !i
smpl 1995 !ylast

' Merge capital equation to model
model_bg.append KT_2005 = P5_2005(-1) + (1-deprate)*KT_2005(-1)

' Set labour and physical capital shares (following Mankiw, Romer and Weil
1992)
scalar lshare = 1/3
scalar kshare = 1/3

' Set infrastructure elasticity
scalar infrelast = 0.3

' Set technology elasticity
scalar techelast = 0.17

' Calculate total factor productivity (TFP) as a Solow residual
```

```
series log(TFP) = log(B1GM_2005) - kshare*log(KT_2005) -
lshare*log(EMP_15_64) - (1-lshare-kshare)*log(HKT) -
infrelast*log(INFRKT_2005) - techelast*log(TECHKT_2005)

' Append supply-side GDP equation to model
model_bg.append B1GM_2005 =
TFP*EMP_15_64^lshare*KT_2005^kshare*HKT^(1-lshare-
kshare)*INFRKT_2005^(infrelast)*TECHKT_2005^(techelast)

model_bg.addassign(v) B1GM_2005

series B1GM_2005_A = -440


'============================================================
==============
'        UNDERLYING INTEREST RATES - EXTRACT FROM ECONOMIC
FUNDAMENTALS
'============================================================
==============

' Calculate nominal net capital return
series INTRATE = TFP*kshare*KT_2005^(kshare-
1)*EMP_15_64^lshare*HKT^(1-lshare-
kshare)*INFRKT_2005^(infrelast)*TECHKT_2005^(techelast) - deprate +
dlog(CP00_AVX)

' Append nominal net capital return equation to model
model_bg.append INTRATE = TFP*kshare*KT_2005^(kshare-
1)*EMP_15_64^lshare*HKT^(1-lshare-
kshare)*INFRKT_2005^(infrelast)*TECHKT_2005^(techelast) - deprate +
dlog(CP00_AVX)

' Calculate real net capital return
series RINTRATE = TFP*kshare*KT_2005^(kshare-
1)*EMP_15_64^lshare*HKT^(1-lshare-
kshare)*INFRKT_2005^(infrelast)*TECHKT_2005^(techelast) - deprate

' Append real net capital return equation to model
model_bg.append RINTRATE = TFP*kshare*KT_2005^(kshare-
1)*EMP_15_64^lshare*HKT^(1-lshare-
kshare)*INFRKT_2005^(infrelast)*TECHKT_2005^(techelast) - deprate

' Calculate interest rate differential between INTRATE and 12m Euribor
series INT_DIFF = INTRATE - EURIBOR_12/100
```

```
' Append interest rate differential between INTRATE and 12m Euribor to model
model_bg.append INT_DIFF = INTRATE - EURIBOR_12/100

'==========================================
'                    PRICES - CPI & DEFLATORS
'==========================================

' CPI equation - estimate
smpl 2000 !ylast
equation eq_cp00_avx.ls(n) DLOG(CP00_AVX) =c(2)*(log(CP00_AVX(-1)) -
0.19*log(PNRG(-1)) - 1.42*LOG(B1GM_2005(-1)/EMP_15_64(-1)))+
C(5)*DLOG(B1GM_2005/EMP_15_64)

' CPI equation - merge to model
model_bg.merge eq_cp00_avx

' Private consumption deflator equation - estimate
smpl 1998 !ylast
equation eq_p3_s14_s15_cpi05.ls dlog(P3_S14_S15_CPI05) =
c(1)*dlog(CP00_AVX) + c(2) + c(3)*(log(P3_S14_S15_CPI05(-1))-
0.735*log(CP00_AVX(-1)))

' Private consumption deflator equation - merge to model
model_bg.merge eq_p3_s14_s15_cpi05

' Government consumption deflator equation - estimate
smpl 1998 !ylast
equation eq_p3_s13_cpi05.ls dlog(P3_S13_CPI05) = c(1) +
c(2)*dlog(CP00_AVX) + c(3)*(log(P3_S13_CPI05(-1))-1.125*log(CP00_AVX(-
1)))

' Government consumption deflator equation - merge to model
model_bg.merge eq_p3_s13_cpi05

' Investment deflator equation - estimate
smpl 2000 !ylast
equation eq_p5_cpi05.ls dlog(P5_CPI05) = c(1) + c(2)*dlog(CP00_AVX) +
c(3)*(log(P5_CPI05(-1)) -log(CP00_AVX(-1))) + c(4)*dlog(PINDU(-
1)/EURUSD_AVG(-1))

' Investment deflator equation - merge to model
model_bg.merge eq_p5_cpi05

' Exports of goods and services deflator equation - estimate
```

```
equation eq_p6_cpi05.ls dlog(P6_CPI05) = c(1) +
c(2)*dlog(PNRG/EURUSD_AVG) + c(3)*dlog(PMETA/EURUSD_AVG) +
c(4)*(log(P6_CPI05(-1)) - 0.3*log(PNRG(-1)/EURUSD_AVG(-1)) - 0.22
*log(PMETA(-1)/EURUSD_AVG(-1)))

' Exports of goods and services deflator equation - merge to model
model_bg.merge eq_p6_cpi05

' Imports of goods and services deflator equation - estimate
equation eq_p7_cpi05.ls dlog(P7_CPI05) = c(1) +
c(2)*dlog(PNRG/EURUSD_AVG) + c(3)*(log(P7_CPI05(-1)) - 0.35*log(PNRG(-
1)/EURUSD_AVG(-1)) - 0.18*log(PINDU(-1)/EURUSD_AVG(-1)))

' Imports of goods and services deflator equation - merge to model
model_bg.merge eq_p7_cpi05

' Define consumption deflator
model_bg.append P3_CPI05 = (P3_S13_2005/P3_S13_2005(-1)*P3_S13(-
1)*P3_S13_CPI05 + P3_S14_S15_2005/P3_S14_S15_2005(-
1)*P3_S14_S15(-1)*P3_S14_S15_CPI05)/(P3_S13_2005/P3_S13_2005(-
1)*P3_S13(-1) + P3_S14_S15_2005/P3_S14_S15_2005(-1)*P3_S14_S15(-1))

' Define GDP deflator
model_bg.append B1GM_CPI05 = (P3_2005/P3_2005(-1)*P3(-1)*P3_CPI05 +
P5_2005/P5_2005(-1)*P5(-1)*P5_CPI05 + P6_2005/P6_2005(-1)*P6(-
1)*P6_CPI05 - P7_2005/P7_2005(-1)*P7(-
1)*P7_CPI05)/(B1GM_2005/B1GM_2005(-1)*B1GM(-1))




'=============================================================
'              REAL SECTOR - DEMAND SIDE, CONSTANT 2005 PRICES
'=============================================================

' Private consumption equation - estimate
smpl 2000 !ylast
equation eq_p3_s14_s15_2005.ls dlog(P3_S14_S15_2005) = c(1)
+c(2)*(log(P3_S14_S15_2005(-1)) - log(DISPY_2005(-1))) +
c(4)*(dlog(DISPY_2005)) + c(5)*RINTRATE

' Private consumption equation - append to model
model_bg.merge eq_p3_s14_s15_2005
```

```
' Private gross capital investment less EU funds equation - estimate
smpl 2000 !ylast
equation eq_p5_x_s13_x_EU_2005.ls dlog(P5_x_S13_x_EU_2005) = c(1) +
c(2)*(log(P5_x_S13_x_EU_2005(-1)) -  1 * log(B1GM_2005(-1))) +
c(3)*RINTRATE + c(4)*INT_DIFF

' Private gross capital investment less EU funds equation - append to model
model_bg.merge eq_p5_x_s13_x_EU_2005

' Export of goods and services equation - estimate
smpl 2000 !ylast
equation eq_p6_2005.ls dlog(P6_2005) = c(1) +c(2)*DUMEXP0506 +
c(3)*dlog(EU_B1GM_2000) + c(4)*(log(P6_2005(-1)) - 0.9* log(NULC_2005(-1))
- 0.5* log(EU_B1GM_2000(-1)))

' Export of goods and services equation - append to model
model_bg.merge eq_p6_2005
model_bg.append

' Import of goods and services equation - estimate
smpl 1995 !ylast
equation eq_p7_2005.ls dlog(P7_2005) = c(1)*dlog(P3_S14_S15_2005) +
c(2)*dlog(P5_2005) + c(3)*dlog(P6_2005) + c(4)*(log(P7_2005(-1))-
0.716*log(P6_2005(-1))-0.326*log(P5_2005(-1))) + c(5)*DUM1


' Import of goods and services equation - append to model
model_bg.merge eq_p7_2005

' Merge to model gross capital investment at 2005 prices identity
model_bg.append P5_2005 = P5_x_s13_2005 + P5_s13_2005

' Merge to model consumption at 2005 prices
model_bg.append P3_2005 = P3/P3_CPI05*100

smpl 1995 !ylast

'===============================================================
========================
'                   SECTORAL DECOMPOSITION - FROM SUPPLY-USE TABLE
2005
'===============================================================
========================

' Create supply matrix
```

```
matrix(5,8) supply_table

' Read data into supply matrix
supply_table.read(t=xls,s=supply_table)  SAM_base2005.xls

' Create use matrix
matrix(12,9) use_table

' Read data into use matrix
use_table.read(t=xls,s=use_table)  SAM_base2005.xls

' Create matrix of technical coefficients
matrix(4,4) tech_coefs

' Fill matrix of technical coefficients
for !i = 1 to 4
    for !j = 1 to 4
        tech_coefs(!i,!j) = use_table(!i,!j)/use_table(11,!j)
    next !j
next !i

' Create coefficient scalars and assign values

scalar coef_P2_A_B_BY_A_B = tech_coefs(1,1)
scalar coef_P2_C_TO_E_BY_A_B = tech_coefs(2,1)
scalar coef_P2_F_BY_A_B = tech_coefs(3,1)
scalar coef_P2_G_TO_P_BY_A_B = tech_coefs(4,1)

scalar coef_P2_A_B_BY_C_TO_E = tech_coefs(1,2)
scalar coef_P2_C_TO_E_BY_C_TO_E = tech_coefs(2,2)
scalar coef_P2_F_BY_C_TO_E = tech_coefs(3,2)
scalar coef_P2_G_TO_P_BY_C_TO_E = tech_coefs(4,2)

scalar coef_P2_A_B_BY_F = tech_coefs(1,3)
scalar coef_P2_C_TO_E_BY_F = tech_coefs(2,3)
scalar coef_P2_F_BY_F = tech_coefs(3,3)
scalar coef_P2_G_TO_P_BY_F = tech_coefs(4,3)

scalar coef_P2_A_B_BY_G_TO_P = tech_coefs(1,4)
scalar coef_P2_C_TO_E_BY_G_TO_P = tech_coefs(2,4)
scalar coef_P2_F_BY_G_TO_P = tech_coefs(3,4)
scalar coef_P2_G_TO_P_BY_G_TO_P = tech_coefs(4,4)

' Append sectoral equations to model
```

```
model_bg.append P2_A_B_BY_A_B = coef_P2_A_B_BY_A_B * activity_A_B
model_bg.append P2_C_TO_E_BY_A_B = coef_P2_C_TO_E_BY_A_B *
activity_A_B
model_bg.append P2_F_BY_A_B = coef_P2_F_BY_A_B * activity_A_B
model_bg.append P2_G_TO_P_BY_A_B = coef_P2_G_TO_P_BY_A_B *
activity_A_B

model_bg.append P2_A_B_BY_C_TO_E = coef_P2_A_B_BY_C_TO_E *
activity_C_TO_E
model_bg.append P2_C_TO_E_BY_C_TO_E =
coef_P2_C_TO_E_BY_C_TO_E * activity_C_TO_E
model_bg.append P2_F_BY_C_TO_E = coef_P2_F_BY_C_TO_E *
activity_C_TO_E
model_bg.append P2_G_TO_P_BY_C_TO_E =
coef_P2_G_TO_P_BY_C_TO_E * activity_C_TO_E

model_bg.append P2_A_B_BY_F = coef_P2_A_B_BY_F * activity_F
model_bg.append P2_C_TO_E_BY_F = coef_P2_C_TO_E_BY_F * activity_F
model_bg.append P2_F_BY_F = coef_P2_F_BY_F * activity_F
model_bg.append P2_G_TO_P_BY_F = coef_P2_G_TO_P_BY_F * activity_F

model_bg.append P2_A_B_BY_G_TO_P = coef_P2_A_B_BY_G_TO_P *
activity_G_TO_P
model_bg.append P2_C_TO_E_BY_G_TO_P =
coef_P2_C_TO_E_BY_G_TO_P * activity_G_TO_P
model_bg.append P2_F_BY_G_TO_P = coef_P2_F_BY_G_TO_P *
activity_G_TO_P
model_bg.append P2_G_TO_P_BY_G_TO_P =
coef_P2_G_TO_P_BY_G_TO_P * activity_G_TO_P

model_bg.append P2_A_B = P2_A_B_BY_A_B + P2_A_B_BY_C_TO_E +
P2_A_B_BY_F + P2_A_B_BY_G_TO_P
model_bg.append P2_C_TO_E = P2_C_TO_E_BY_A_B +
P2_C_TO_E_BY_C_TO_E + P2_C_TO_E_BY_F + P2_C_TO_E_BY_G_TO_P
model_bg.append P2_F = P2_F_BY_A_B + P2_F_BY_C_TO_E + P2_F_BY_F
+ P2_F_BY_G_TO_P
model_bg.append P2_G_TO_P = P2_G_TO_P_BY_A_B +
P2_G_TO_P_BY_C_TO_E + P2_G_TO_P_BY_F + P2_G_TO_P_BY_G_TO_P

' Create matrix of demand coefficients
matrix(4,5) demand_coef

' Fill matrix of demand coefficients
for !i = 1 to 4
   for !j = 1 to 5
```

```
        demand_coef(!i,!j) = use_table(!i,!j + 4)/use_table(5,!j + 4)
    next !j
next !i

' Create coefficient scalars and assign values
scalar coef_P3_S14_S15_A_B = demand_coef(1,1)
scalar coef_P3_S14_S15_C_TO_E = demand_coef(2,1)
scalar coef_P3_S14_S15_F = demand_coef(3,1)
scalar coef_P3_S14_S15_G_TO_P = demand_coef(4,1)

scalar coef_P3_S13_A_B = demand_coef(1,2)
scalar coef_P3_S13_C_TO_E = demand_coef(2,2)
scalar coef_P3_S13_F = demand_coef(3,2)
scalar coef_P3_S13_G_TO_P = demand_coef(4,2)

scalar coef_P51_A_B = demand_coef(1,3)
scalar coef_P51_C_TO_E = demand_coef(2,3)
scalar coef_P51_F = demand_coef(3,3)
scalar coef_P51_G_TO_P = demand_coef(4,3)

scalar coef_P52_A_B = demand_coef(1,4)
scalar coef_P52_C_TO_E = demand_coef(2,4)
scalar coef_P52_F = demand_coef(3,4)
scalar coef_P52_G_TO_P = demand_coef(4,4)

scalar coef_P6_A_B = demand_coef(1,5)
scalar coef_P6_C_TO_E = demand_coef(2,5)
scalar coef_P6_F = demand_coef(3,5)
scalar coef_P6_G_TO_P = demand_coef(4,5)

' Decompose demand and merge equations to model
model_bg.append P3_S14_S15_A_B = coef_P3_S14_S15_A_B *
P3_S14_S15_2005
model_bg.append P3_S14_S15_C_TO_E = coef_P3_S14_S15_C_TO_E *
P3_S14_S15_2005
model_bg.append P3_S14_S15_F = coef_P3_S14_S15_F *
P3_S14_S15_2005
model_bg.append P3_S14_S15_G_TO_P = coef_P3_S14_S15_G_TO_P *
P3_S14_S15_2005

model_bg.append P3_S13_A_B = coef_P3_S13_A_B * P3_S13_2005
model_bg.append P3_S13_C_TO_E = coef_P3_S13_C_TO_E * P3_S13_2005
model_bg.append P3_S13_F = coef_P3_S13_F* P3_S13_2005
model_bg.append P3_S13_G_TO_P = coef_P3_S13_G_TO_P * P3_S13_2005
```

```
model_bg.append P3_A_B = P3_S13_A_B + P3_S14_S15_A_B
model_bg.append P3_C_TO_E = P3_S13_C_TO_E + P3_S14_S15_C_TO_E
model_bg.append P3_F = P3_S13_F + P3_S14_S15_F
model_bg.append P3_G_TO_P = P3_S13_G_TO_P + P3_S14_S15_G_TO_P

model_bg.append P5_A_B  = coef_P51_A_B * P5_x_EU_2005
model_bg.append P5_C_TO_E  = coef_P51_C_TO_E * P5_x_EU_2005 +
P5_x_s13_EU_2005
model_bg.append P5_F  = coef_P51_F * P5_x_eu_2005 + P5_S13_EU_2005
model_bg.append P5_G_TO_P  = coef_P51_G_TO_P * P5_x_EU_2005

model_bg.append P6_A_B = coef_P6_A_B * P6_2005
model_bg.append P6_C_TO_E = coef_P6_C_TO_E * P6_2005
model_bg.append P6_F = coef_P6_F * P6_2005
model_bg.append P6_G_TO_P = coef_P6_G_TO_P * P6_2005

' Create matrix of supply coefficients
matrix(4,8) supply_coef
matrix(4,4) mat_supply_coef

' Fill matrix of supply coefficients
for !i = 1 to 4
    for !j = 1 to 4
        supply_coef(!i,!j) = supply_table(!i,!j)/supply_table(5,!j)
        mat_supply_coef(!i,!j) = supply_coef(!i,!j)
    next !j
    supply_coef(!i,6) = supply_table(!i,6)/supply_table(5,6)
next !i

' Create and calculate inverse matrix of supply coefficients
matrix(4,4) invmat_supply_coef
invmat_supply_coef = @inverse(mat_supply_coef)

' Create supply coefficient scalars and assign values
scalar coef_P1_A_B_BY_A_B = supply_coef(1,1)
scalar coef_P1_C_TO_E_BY_A_B = supply_coef(2,1)
scalar coef_P1_F_BY_A_B = supply_coef(3,1)
scalar coef_P1_G_TO_P_BY_A_B = supply_coef(4,1)

scalar coef_P1_A_B_BY_C_TO_E = supply_coef(1,2)
scalar coef_P1_C_TO_E_BY_C_TO_E = supply_coef(2,2)
scalar coef_P1_F_BY_C_TO_E = supply_coef(3,2)
scalar coef_P1_G_TO_P_BY_C_TO_E = supply_coef(4,2)

scalar coef_P1_A_B_BY_F = supply_coef(1,3)
```

```
scalar coef_P1_C_TO_E_BY_F = supply_coef(2,3)
scalar coef_P1_F_BY_F = supply_coef(3,3)
scalar coef_P1_G_TO_P_BY_F = supply_coef(4,3)

scalar coef_P1_A_B_BY_G_TO_P = supply_coef(1,4)
scalar coef_P1_C_TO_E_BY_G_TO_P = supply_coef(2,4)
scalar coef_P1_F_BY_G_TO_P = supply_coef(3,4)
scalar coef_P1_G_TO_P_BY_G_TO_P = supply_coef(4,4)

scalar coef_P7_A_B = supply_coef(1,6)
scalar coef_P7_C_TO_E = supply_coef(2,6)
scalar coef_P7_F = supply_coef(3,6)
scalar coef_P7_G_TO_P = supply_coef(4,6)

scalar coef_tm_A_B = supply_table(1,7) / (supply_table(1,5) +
supply_table(1,6))
scalar coef_tm_C_TO_E = supply_table(2,7) / (supply_table(2,5) +
supply_table(2,6))

scalar coef_pt_A_B = supply_table(1,8) / (supply_table(1,5) + supply_table(1,6)
+ supply_table(1,7))
scalar coef_pt_C_TO_E = supply_table(2,8) / (supply_table(2,5) +
supply_table(2,6) + supply_table(2,7))
scalar coef_pt_F = supply_table(3,8) / (supply_table(3,5) + supply_table(3,6) +
supply_table(3,7))
scalar coef_pt_G_TO_P = supply_table(4,8) / (supply_table(4,5) +
supply_table(4,6) + supply_table(4,7))

' Append equations to model
model_bg.append activity_A_B = invmat_supply_coef(1,1) * P1_A_B +
invmat_supply_coef(1, 2) * P1_C_TO_E + invmat_supply_coef(1,3) * P1_F +
invmat_supply_coef(1,4) * P1_G_TO_P
model_bg.append activity_C_TO_E = invmat_supply_coef(2,1) * P1_A_B +
invmat_supply_coef(2, 2) * P1_C_TO_E + invmat_supply_coef(2,3) * P1_F +
invmat_supply_coef(2,4) * P1_G_TO_P
model_bg.append activity_F = invmat_supply_coef(3,1) * P1_A_B +
invmat_supply_coef(3, 2) * P1_C_TO_E + invmat_supply_coef(3,3) * P1_F +
invmat_supply_coef(3,4) * P1_G_TO_P
model_bg.append activity_G_TO_P = invmat_supply_coef(4,1) * P1_A_B +
invmat_supply_coef(4, 2) * P1_C_TO_E + invmat_supply_coef(4,3) * P1_F +
invmat_supply_coef(4,4) * P1_G_TO_P

model_bg.append P7_A_B = coef_P7_A_B * P7_2005
model_bg.append P7_C_TO_E = coef_P7_C_TO_E * P7_2005
model_bg.append P7_F = coef_P7_F * P7_2005
```

```
model_bg.append P7_G_TO_P = coef_P7_G_TO_P * P7_2005

model_bg.append P118_A_B = (P1_A_B + P7_A_B) * coef_tm_A_B
model_bg.append P118_C_TO_E = (P1_C_TO_E + P7_C_TO_E ) *
coef_tm_C_TO_E
model_bg.append P118_F = 0
model_bg.append P118_G_TO_P = -(P118_A_B + P118_C_TO_E + P118_F)

model_bg.append P1_A_B + P7_A_B = (P2_A_B + P3_A_B + P5_A_B +
P6_A_B) / (1 + coef_pt_A_B) - P118_A_B
model_bg.append P1_C_TO_E + P7_C_TO_E = (P2_C_TO_E + P3_C_TO_E
+ P5_C_TO_E + P6_C_TO_E) / (1 + coef_pt_C_TO_E) - P118_C_TO_E
model_bg.append P1_F + P7_F = (P2_F + P3_F + P5_F+ P6_F) / (1 +
coef_pt_F) - P118_F
model_bg.append P1_G_TO_P + P7_G_TO_P = (P2_G_TO_P + P3_G_TO_P
+ P5_G_TO_P + P6_G_TO_P) / (1 + coef_pt_G_TO_P) - P118_G_TO_P

'==========================================================
'               REAL SECTOR - DEMAND SIDE, CURRENT PRICES
'==========================================================

' Generate nominal private consumption and merge to model
model_bg.append P3_S14_S15 =
P3_S14_S15_2005*P3_S14_S15_CPI05/100

' Generate nominal total consumption and merge to model
model_bg.append P3 = P3_S13 + P3_S14_S15

' Generate nominal investment and merge to model
model_bg.append P5 = P5_x_s13 + P5_s13

' Generate nominal export of goods and services and merge to model
model_bg.append P6 = P6_2005*P6_CPI05/100

' Generate nominal import of goods and services and merge to model
model_bg.append P7 = P7_2005*P7_CPI05/100

' Generate nominal GDP and merge to model and merge to model (Y = C + I +
G + X)
model_bg.append B1GM = P3_S13 + P3_S14_S15 + P5 + P6 - P7


'======================================
'                    LABOUR MARKET
'======================================
```

```
' Wage equation - estimate
equation eq_wage_total.ls DLOG(WAGE_TOTAL,2) = C(1) +
C(3)*DLOG(B1GM_2005) + C(4)*DUM2

' Wage equation - merge to model
model_bg.merge eq_wage_total

' Participation rate equation - estimate
smpl 2003 !ylast
equation eq_act_15_64.ls DLOG(ACT_15_64) = C(1)+C(2)*(LOG(ACT_15_64(-
1)) -0.53*LOG(EMP_15_64(-1))) + C(4)*DUM1

' Participation rate equation - merge to model
model_bg.merge eq_act_15_64

' Labour demand - from sectoral decomposition
scalar coef_ld_A_B = use_table(12,1)/use_table(11,1)
scalar coef_ld_C_TO_E = use_table(12,2)/use_table(11,2)
scalar coef_ld_F = use_table(12,3)/use_table(11,3)
scalar coef_ld_G_TO_P = use_table(12,4)/use_table(11,4)

model_bg.append EMP_15_64_A_B = coef_ld_A_B * activity_A_B
model_bg.append EMP_15_64_C_TO_E = coef_ld_C_TO_E *
activity_C_TO_E
model_bg.append EMP_15_64_F = coef_ld_F * activity_F
model_bg.append EMP_15_64_G_TO_P = coef_ld_G_TO_P *
activity_G_TO_P

model_bg.append EMP_15_64 = EMP_15_64_A_B + EMP_15_64_C_TO_E +
EMP_15_64_F + EMP_15_64_G_TO_P  + EMP_EU

model_bg.addassign(v) EMP_15_64

series EMP_15_64_A = -120

' Define unemployment endogenously
model_bg.append UNE_15_64 = ACT_15_64 - EMP_15_64
model_bg.append UNE_RT_15_64 = UNE_15_64/ACT_15_64*100


'=====================================================
'                   FISCAL SECTOR - REVENUE SIDE
'=====================================================
```

```
smpl 1995 !ylast

' Generate grants other than EU grants
series D92_x_EU = D92 - D92_EU

' Generate ratio of indirect taxes to consumption
series SHR_D21 = D21 / P3

' Generate ratio of other taxes on production to nominal GDP
series SHR_D29 = D29 / B1GM

' Generate ratio of direct taxes to nominal GDP
series SHR_D5_D61 = D5_D61 / B1GM

' Generate ratio of non-tax revenue to nominal GDP
series SHR_D4 = D4 / B1GM

' Generate ratio of other-than-EU grants to nominal GDP
series SHR_D92_x_EU = D92_x_EU / B1GM

'----------------------------------------
' Revenues equations
'----------------------------------------
model_bg.append D21 = SHR_D21 * P3
model_bg.append D29 = SHR_D29 * B1GM
model_bg.append D5_D61 = SHR_D5_D61 * B1GM
model_bg.append D4 = SHR_D4 * B1GM
model_bg.append D92_X_EU = SHR_D92_X_EU * B1GM

'----------------------------------------
' Revenues side identities
'----------------------------------------

' Total grants
model_bg.append D92 = D92_X_EU + D92_EU

' Total revenues
model_bg.append TR = D21+ D29 + D5_D61 + D4 + D92


'=====================================================
'                    FISCAL SECTOR - EXPENDITURE SIDE
'=====================================================
```

```
' Generate the sum of Subsidies, Social benefits other than social transfers in kind, Social transfers in kind and Other current transfers
' The sum is equal to current expenditure less government consumption and interest expenditure
series D3_D62_D63_D7 = CURREXP - P3_S13 - D41

' Generate government capital expenditure financed through sources other than EU
series P5_S13_x_EU = P5_S13 - P5_S13_EU

' Generate government capital expenditure financed through sources other than EU  at 2005 prices
series P5_S13_x_EU_2005 = P5_S13_x_EU/P5_CPI05*100

' Generate government consumption financed through sources other than EU
series P3_S13_x_EU = P3_S13 - P3_S13_EU

' Generate government consumption financed through sources other than EU at 2005 prices
series P3_S13_x_EU_2005 = P3_S13_x_EU/P3_S13_CPI05*100

' Generate ratios of D3_D62_D63_D7 to nominal GDP
series SHR_D3_D62_D63_D7 = D3_D62_D63_D7 / B1GM
' Generate ratios of public investment and public consumption to GDP at constant prices
series SHR_P5_S13_x_EU_2005 = P5_S13_x_EU_2005 / B1GM_2005
series SHR_P3_S13_x_EU_2005 = P3_S13_x_EU_2005 / B1GM_2005

'----------------------------------
' Expenditure equations
'----------------------------------
model_bg.append P5_S13_x_EU_2005 = P5_S13_x_EU_2005(-1)
model_bg.append P3_S13_x_EU_2005 = P3_S13_x_EU_2005(-1)
model_bg.append P5_S13_x_EU = P5_S13_x_EU_2005*P5_CPI05/100
model_bg.append P3_S13_x_EU = P3_S13_x_EU_2005*P3_S13_CPI05/100
model_bg.append D3_D62_D63_D7 = B1GM * SHR_D3_D62_D63_D7

' Interest payments equation - estimate
smpl 2003 !ylast
equation eq_d41.ls dlog(D41) = c(1) +c(2)*(log(D41(-1)) - log(GD(-1)))

' Interest payments equation - merge to model
model_bg.merge eq_d41

' EU budget contribution - estimate
```

```
equation eq_eubudget.ls EUBUDGET = c(1)*(-DUM_EU*BOP380dt)

' EU budget contribution - merge to model
model_bg.merge eq_eubudget

'----------------------------------
'Expenditure side identities
'----------------------------------
model_bg.append P5_S13 = P5_S13_x_EU + P5_S13_EU
model_bg.append P3_S13 = P3_S13_x_EU + P3_S13_EU
model_bg.append CURREXP = P3_S13 + D3_D62_D63_D7 + D41
model_bg.append TE = CURREXP + P5_S13 + EUBUDGET


' Populate the last share to be used in the forecast
for !i = !ylast + 1 to 2030
    smpl !i !i
    SHR_D3_D62_D63_D7 = SHR_D3_D62_D63_D7(-1)
    SHR_P5_S13_x_EU_2005 = SHR_P5_S13_x_EU_2005(-1)
    SHR_P3_S13_x_EU_2005 = SHR_P3_S13_x_EU_2005(-1)
    SHR_D21 = SHR_D21(-1)
    SHR_D29 = SHR_D29(-1)
    SHR_D4 = SHR_D4(-1)
    SHR_D5_D61= SHR_D5_D61(-1)
    SHR_D92_x_EU = SHR_D92_x_EU(-1)
next !i

smpl 1995 !ylast

'=====================================================
'                         FISCAL SECTOR - FINANCING
'=====================================================
' Set fiscal reserve mimimum value
!min_fisc_res_level = 4000

' Append Net lending (+) /net borrowing (-) equation to model
model_bg.append B9_S13 = TR - TE

' Check whether the fiscal reserve is above the minimum required level - 1 if
true, 0 if false
model_bg.append FISCRULE = FISCRES(-1) + B9_S13 > !min_fisc_res_level

' Append to model fiscal rule which requires that the fiscal reserve does not fall
below the minimum amount
```

```
model_bg.append FISCRES = FISCRULE * (FISCRES(-1) + B9_S13) + (1 - FISCRULE) * !min_fisc_res_level

' Append government debt equation to model
model_bg.append GD = GD(-1) - B9_S13 + FISCRES - FISCRES(-1)

' Government deposit in BNB - estimate equation
smpl 2003 !ylast
equation eq_liabgov.ls d(LIABGOV) = c(1) + c(2)*(LIABGOV(-1) - 0.6 *FISCRES(-1)) + c(3)*DUM1

' Government deposit in BNB - estimate equation - merge equation to model
model_bg.merge eq_liabgov

'==============================================
'                    EXTERNAL SECTOR
'==============================================

smpl 1995 !ylast
' Calculate foreign assets excluding the BNB reserves
series IIP988_x_802 = IIP988 - IIP802

' Calculate financial account (FA) excluding the change of BNB reserves
series BOP995_x_802nt = BOP995nt - BOP802nt

' Recalculate net errors and omissions
smpl !ylast+1 @last
series BOP998NT = 0
smpl 1995 !ylast
series BOP998NT = -BOP993NT - BOP994NT - (d(IIP989)- d(IIP988_x_802)) - BOP802NT

' Current account (CA) - income debit - estimate
smpl 1995 !ylast
equation eq_bop300dt.ls dlog(-BOP300DT) = c(1) + c(2)*dlog(IIP989) + c(3)*(log(-BOP300DT(-1)) - 0.8*log(IIP989(-1)))

' Current account (CA) - income debit - merge to model
model_bg.merge eq_bop300dt

' CA - investment income credit - estimate
smpl 2001 !ylast
equation eq_bop320kt.ls dlog(BOP320KT) = c(1) + c(2)*(log(BOP320KT(-1)) - 0.5 * log(IIP988(-1)))
```

```
' CA - investment income credit - merge to model
model_bg.merge eq_bop320kt

' CA - labour income credit - estimate
smpl 2001 !ylast
equation eq_bop310kt.ls dlog(BOP310KT) = c(1) + c(2)*log(BOP310KT(-1)) + c(3)*log(B1GM_2005(-2))

' CA - labour income credit - merge to model
model_bg.merge eq_bop310kt

' CA - private current transfers credit - estimate
smpl 2001 !ylast
equation eq_bop390kt.ls dlog(BOP390KT) = c(1) + c(2)*dlog(B1GM_2005) +c(3)*(log(BOP390KT(-1)) - 1.7*log(B1GM_2005(-1)))

' CA - private current transfers credit - merge to model
model_bg.merge eq_bop390kt

' CA - government current transfers debit - estimate
smpl 2001 !ylast
equation eq_bop380dt.ls log(-BOP380dt) = c(1) +c(2)*DUM_EU*log(B1GM)

' CA - government current transfers debit - merge to model
model_bg.merge eq_bop380dt

' CA - private current transfers debit - estimate
smpl 2001 !ylast
equation eq_bop390dt.ls dlog(-BOP390DT) = c(1) + c(2)*dlog(B1GM_2005)

' CA - private current transfers debit - merge to model
model_bg.merge eq_bop390dt

' IIP FDI equation - estimate
smpl 1995 !ylast
equation eq_iip555.ls DLOG(IIP555) =  C(1)*DLOG(IIP555(-1)) + C(2)*D(RINTRATE)

' IIP FDI equation - merge to model
model_bg.merge eq_iip555

' IIP Liabilities - estimate
smpl 1995 !ylast
equation eq_iip989.ls dlog(IIP989) = c(1) + c(2)*(log(IIP989(-1)) - 2*log(B1GM(-1))-5*INT_DIFF(-1)) + c(3)*d(INTRATE)
```

```
' IIP Liabilities - merge to model
model_bg.merge eq_iip989

' IIP assets - estimate
smpl 1995 !ylast
equation eq_IIP988_x_802.ls dlog(IIP988_x_802) = c(1) +
c(2)*d(EURIBOR_12) + c(3)*dlog(B1GM_2005) +c(4)*(log(IIP988_x_802(-1)) -
log(B1GM_2005(-1)))

' IIP assets - merge to model
model_bg.merge eq_iip988_x_802

'CA - income identities
model_bg.append BOP300KT = BOP310KT + BOP320KT
model_bg.append BOP300NT = BOP300KT + BOP300DT

'CA - current transfers identities
model_bg.append BOP379DT = BOP380DT + BOP390DT
model_bg.append BOP379KT = BOP380KT + BOP390KT
model_bg.append BOP379NT = BOP379KT + BOP379DT

'CA identities
model_bg.append BOP100_200NT = P6 - P7
model_bg.append BOP993NT = BOP100_200NT + BOP300NT + BOP379NT

'FA & IIP identities
model_bg.append BOP555NT = IIP555 - IIP555(-1)
model_bg.append BOP995_x_802NT = (IIP989 - IIP989(-1))- (IIP988_x_802 -
IIP988_x_802(-1))
model_bg.append BOP802NT = 0.1*(-BOP993NT - BOP994NT -
BOP995_x_802NT) ' - BOP998NT
model_bg.append IIP802 = IIP802(-1) - BOP802NT
model_bg.append IIP988 = IIP988_x_802 + IIP802

' Calculate share of capital account as % of GDP
smpl 1995 !ylast
series SHR_BOP994NT = BOP994NT/B1GM

' Extent the share of the capital account over the simulation period
for !i = !ylast + 1 to !lastsim
    smpl !i !i
    series SHR_BOP994NT = SHR_BOP994NT(-1)
next !i
```

```
'Append capital account equation to model
model_bg.append BOP994NT = SHR_BOP994NT*B1GM

' Calculate current transfers to government less ESF money
smpl 1995 !ylast
series BOP380KT_x_EU = BOP380KT - D92_EU

' Calculate share of current transfers to government less ESF money in GDP
series SHR_BOP380KT_x_EU  = BOP380KT_x_EU/B1GM

' Extend share to simulation period
for !i = !ylast + 1 to !lastsim
    smpl !i !i
    series SHR_BOP380KT_x_EU = SHR_BOP380KT_x_EU(-1)
next !i

' Append current transfers to government less ESF money equation to model
model_bg.append BOP380KT_x_EU = SHR_BOP380KT_x_EU*B1GM

' Append current transfers equation to model
model_bg.append BOP380KT = BOP380KT_x_EU + D92_EU

'============================================
'                          MONETARY SECTOR
'============================================
smpl 1995 !ylast

series LCBOTHER = CBASSETS - NOTESCOINS - LIABBANKS - LIABGOV

series SHR_LCBOTHER = LCBOTHER / CBASSETS
series SHR_LIABBANKS = LIABBANKS / (OVERN1 + QUASI)

smpl 1999 !ylast
equation eq_quasi.ls dlog(quasi) = c(1) + c(2)*dlog(p3_2005) + c(3)*(log(quasi(-
1))  -  3*intrate(-1) - 3*log(cp00_avx(-1))-log(b1gm_2005(-1)))
model_bg.merge eq_quasi

smpl 1999 !ylast
equation eq_overn1.ls dlog(overn1) = c(1) + c(2)*dlog(p3_2005) +
c(3)*(log(overn1(-1)) - 4.5 *log(p3_2005(-1)))
model_bg.merge eq_overn1

model_bg.append M2 = M1 + quasi
model_bg.append M1 = NOTESCOINS + overn1
model_bg.append LIABBANKS = SHR_LIABBANKS * (OVERN1 + QUASI)
```

```
model_bg.append LCBOTHER = SHR_LCBOTHER * CBASSETS
model_bg.append CBASSETS = IIP802
model_bg.append NOTESCOINS = CBASSETS - LIABBANKS - LIABGOV -
LCBOTHER

' Populate the last share to be used in the forecast
for !i = !ylast + 1 to 2030
    smpl !i !i
    SHR_LCBOTHER = SHR_LCBOTHER(-1)
    SHR_LIABBANKS = SHR_LIABBANKS(-1)
next !i

smpl 1995 !ylast


'==============================================================
'             Extend dataset with values of exogenous variables until 2015
'==============================================================

smpl !ylast+1 !lastsim
series dlog(TFP) = 0

'==============================================================
'                         SOLVING THE MODEL
'==============================================================
' Set scenario to baseline
model_bg.scenario(n,a=_nm) "No_EU_Funds"

' Set all EU-funds related variables to zero
smpl !firstsim !lastsim
series P3_S13_EU_NM = 0
series P5_S13_EU_NM = 0
series P5_x_S13_EU_NM = 0
series INFREXP_EU_NM = 0
series EMP_EU_NM = 0
series NUMVOC_EU_NM = 0
series TECHEXP_EU_NM = 0
series D92_EU_NM = 0

' Override exogenous variables listed above
model_bg.override P3_S13_EU P5_S13_EU P5_x_S13_EU INFREXP_EU
EMP_EU NUMVOC_EU TECHEXP_EU D92_EU

' Set solution sample
smpl !firstsim !lastsim
```

```
' Set solution options and solve the model
model_bg.solve(o=g)

'Set sample back to initial state
smpl 1995 !ylast

'=========================================================
'                ALTERNATIVE SCENARIOS & SIMULATIONS
'=========================================================

' Load ESF data
smpl 1995 !lastsim
read(s=total)  esf_payments.xls A_P_EU H_P_EUL_P_EU I_P_EU  A_P_BG
    H_P_BG    L_P_BG I_P_BG  PUI_P_EU  PRI_P_EU  PUC_P_EU
    PUI_P_BG PRI_P_BG PUC_P_BG

model_bg.scenario(n,a=_alt) "AltScen"

' Make government consumption and investment less EU-financed government
consumption and investment
' equal to the "no EU funds" (nm) scenario
smpl 2000 !lastsim
series P3_S13_x_EU_alt = P3_S13_x_EU_nm
series P5_S13_x_EU_alt = P5_S13_x_EU_nm

' Calculate input variables related to EU funds
series TECHEXP_EU_alt = A_P_EU + A_P_BG
series INFREXP_EU_alt = I_P_EU + I_P_BG

' Assume monthly cost of 1 working place BGN 300, annual cost BGN 3600
series EMP_EU_alt = (L_P_EU + L_P_BG)/3600*1000

' Assume average cost of voc.training of 1 person BGN 520
series NUMVOC_EU_alt = (H_P_EU + H_P_BG)*1000/520
series P5_S13_EU_alt = PUI_P_EU + PUI_P_BG
series P5_x_S13_EU_alt = PRI_P_EU + PRI_P_BG
series P3_S13_EU_alt = PUC_P_EU + PUC_P_BG
series D92_EU_alt = PUI_P_EU + PRI_P_EU + PUC_P_EU

' Override model variables for this scenario
model_bg.override P3_S13_x_EU P5_S13_x_EU TECHEXP_EU
INFREXP_EU EMP_EU NUMVOC_EU P5_S13_EU P5_x_S13_EU
P3_S13_EU D92_EU
```

```
' Set solution sample
smpl !firstsim !lastsim

' Set solution options and solve the model
model_bg.solve(o=g,e=f)

'Set sample back to initial state
smpl 1995 !ylast


'=========================================================
'   WRITE SELECTED SERIES TO AN XLS FILE
'=========================================================

smpl 2005 2020
write(t=xls,t)  model_bg_output.xls b1gm_2005_nm b1gm_2005_alt
p3_s14_s15_2005_nm p3_s14_s15_2005_alt p3_s13_2005_nm
p3_s13_2005_alt p5_x_s13_2005_nm p5_x_s13_2005_alt p5_s13_2005_nm
p5_s13_2005_alt p6_2005_nm p6_2005_alt p7_2005_nm p7_2005_alt
act_15_64_nm act_15_64_alt emp_15_64_nm emp_15_64_alt une_15_64_nm
une_15_64_alt une_rt_15_64_nm une_rt_15_64_alt dlog(cp00_avx_nm)
dlog(cp00_avx_alt) b9_s13_nm/b1gm_nm b9_s13_alt/b1gm_alt fiscres_nm
fiscres_alt gd_nm gd_alt gd_nm/b1gm_nm gd_alt/b1gm_alt
bop993nt_nm/b1gm_nm bop993nt_alt/b1gm_alt wage_total_nm wage_total_alt


'=========================================================
'                         SAVE WORKFILE
'=========================================================

%date = @strnow("yyyymmdd")
!dateval = @val(%date)

wfsave bgmodel_esf_!dateval
```

Estimation output

Dependent Variable: DLOG(ACT_15_64)
Method: Least Squares
Sample: 2003 2010
Included observations: 8
DLOG(ACT_15_64) = C(1)+C(2)*(LOG(ACT_15_64(-1)) -0.53
*LOG(EMP_15_64(-1))) + C(4)*DUM1

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	3.498171	0.611586	5.719837	0.0023
C(2)	-0.899766	0.157721	-5.704785	0.0023
C(4)	-0.041233	0.006082	-6.779801	0.0011

R-squared	0.924223	Mean dependent var	0.001498
Adjusted R-squared	0.893913	S.D. dependent var	0.021848
S.E. of regression	0.007116	Akaike info criterion	-6.772881
Sum squared resid	0.000253	Schwarz criterion	-6.743090
Log likelihood	30.09152	Hannan-Quinn criter.	-6.973806
F-statistic	30.49165	Durbin-Watson stat	3.028989
Prob(F-statistic)	0.001581		

Dependent Variable: DLOG(-BOP300DT)
Method: Least Squares
Sample (adjusted): 2000 2010
Included observations: 11 after adjustments
DLOG(-BOP300DT) = C(1) + C(2)*DLOG(IIP989) + C(3)*(LOG(
-BOP300DT(-1)) - 0.8*LOG(IIP989(-1)))

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.881161	0.203582	-4.328287	0.0025
C(2)	1.904301	0.386417	4.928094	0.0012
C(3)	-0.883620	0.194462	-4.543922	0.0019

R-squared	0.793625	Mean dependent var	0.143932
Adjusted R-squared	0.742031	S.D. dependent var	0.294404
S.E. of regression	0.149530	Akaike info criterion	-0.735638
Sum squared resid	0.178874	Schwarz criterion	-0.627121
Log likelihood	7.046010	Hannan-Quinn criter.	-0.804043
F-statistic	15.38215	Durbin-Watson stat	2.137205
Prob(F-statistic)	0.001814		

Dependent Variable: DLOG(BOP310KT)
Method: Least Squares
Sample: 2001 2010
Included observations: 10
DLOG(BOP310KT) = C(1) + C(2)*LOG(BOP310KT(-1)) + C(3)
*LOG(B1GM_2005(-2))

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	26.49188	4.072440	6.505161	0.0003
C(2)	-0.609274	0.082534	-7.382120	0.0002
C(3)	-2.074103	0.397367	-5.219616	0.0012

R-squared	0.945467	Mean dependent var	0.152111
Adjusted R-squared	0.929886	S.D. dependent var	0.730599
S.E. of regression	0.193455	Akaike info criterion	-0.204215
Sum squared resid	0.261975	Schwarz criterion	-0.113439
Log likelihood	4.021073	Hannan-Quinn criter.	-0.303795
F-statistic	60.68133	Durbin-Watson stat	2.833362
Prob(F-statistic)	0.000038		

Dependent Variable: DLOG(BOP320KT)
Method: Least Squares
Sample: 2001 2010
Included observations: 10
DLOG(BOP320KT) = C(1) + C(2)*(LOG(BOP320KT(-1)) - 0.5 * LOG(IIP988(
-1)))

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	1.057767	0.325752	3.247155	0.0118
C(2)	-0.863348	0.268791	-3.211964	0.0124

R-squared	0.563240	Mean dependent var	0.022474
Adjusted R-squared	0.508646	S.D. dependent var	0.212635
S.E. of regression	0.149050	Akaike info criterion	-0.792215
Sum squared resid	0.177727	Schwarz criterion	-0.731698
Log likelihood	5.961073	Hannan-Quinn criter.	-0.858602
F-statistic	10.31672	Durbin-Watson stat	1.926459
Prob(F-statistic)	0.012388		

Dependent Variable: LOG(-BOP380DT)
Method: Least Squares
Sample: 2001 2010
Included observations: 10
LOG(-BOP380DT) = C(1) +C(2)*DUM_EU*LOG(B1GM)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	3.940697	0.119689	32.92439	0.0000
C(2)	0.251107	0.017031	14.74402	0.0000

R-squared	0.964505	Mean dependent var	5.056774
Adjusted R-squared	0.960069	S.D. dependent var	1.467161
S.E. of regression	0.293181	Akaike info criterion	0.560802
Sum squared resid	0.687640	Schwarz criterion	0.621319
Log likelihood	-0.804010	Hannan-Quinn criter.	0.494415
F-statistic	217.3861	Durbin-Watson stat	2.373709
Prob(F-statistic)	0.000000		

Dependent Variable: DLOG(-BOP390DT)
Method: Least Squares
Sample: 2001 2010
Included observations: 10
DLOG(-BOP390DT) = C(1) + C(2)*DLOG(B1GM_2005)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.296192	0.113275	-2.614806	0.0309
C(2)	8.571126	2.091865	4.097361	0.0035

R-squared	0.677268	Mean dependent var	0.044490
Adjusted R-squared	0.636926	S.D. dependent var	0.403724
S.E. of regression	0.243266	Akaike info criterion	0.187536
Sum squared resid	0.473428	Schwarz criterion	0.248053
Log likelihood	1.062320	Hannan-Quinn criter.	0.121149
F-statistic	16.78837	Durbin-Watson stat	1.174455
Prob(F-statistic)	0.003450		

Dependent Variable: DLOG(BOP390KT)
Method: Least Squares
Sample: 2001 2010
Included observations: 10
DLOG(BOP390KT) = C(1) + C(2)*DLOG(B1GM_2005) +C(3)
*(LOG(BOP390KT(-1)) - 1.7*LOG(B1GM_2005(-1)))

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-9.558794	2.424131	-3.943183	0.0056
C(2)	2.320367	1.057807	2.193564	0.0643
C(3)	-0.873384	0.221088	-3.950386	0.0055

R-squared	0.744072	Mean dependent var	0.106382
Adjusted R-squared	0.670950	S.D. dependent var	0.214447
S.E. of regression	0.123013	Akaike info criterion	-1.109727
Sum squared resid	0.105926	Schwarz criterion	-1.018952
Log likelihood	8.548635	Hannan-Quinn criter.	-1.209308
F-statistic	10.17572	Durbin-Watson stat	2.412594
Prob(F-statistic)	0.008480		

Dependent Variable: DLOG(CP00_AVX)
Method: Least Squares

Sample (adjusted): 2001 2010
Included observations: 10 after adjustments
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 3.0000)
DLOG(CP00_AVX) =C(2)*(LOG(CP00_AVX(-1)) -0.19*LOG(PNRG(-1)) - 1.42*LOG(B1GM_2005(-1)/EMP_15_64(-1)))+ C(5) *DLOG(B1GM_2005/EMP_15_64)

	Coefficient	Std. Error	t-Statistic	Prob.
C(2)	-0.432862	0.052835	-8.192746	0.0000
C(5)	0.839333	0.064050	13.10432	0.0000

R-squared	0.678463	Mean dependent var	0.058080
Adjusted R-squared	0.638271	S.D. dependent var	0.027336
S.E. of regression	0.016441	Akaike info criterion	-5.201250
Sum squared resid	0.002162	Schwarz criterion	-5.140733
Log likelihood	28.00625	Hannan-Quinn criter.	-5.267637
Durbin-Watson stat	2.193454		

Dependent Variable: DLOG(D41)
Method: Least Squares
Sample: 2003 2010
Included observations: 8
DLOG(D41) = C(1) +C(2)*(LOG(D41(-1)) - LOG(GD(-1)))

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.709272	0.221217	-3.206234	0.0185
C(2)	-0.223864	0.074795	-2.993047	0.0242

R-squared	0.598886	Mean dependent var	-0.047865
Adjusted R-squared	0.532033	S.D. dependent var	0.042184
S.E. of regression	0.028857	Akaike info criterion	-4.040615
Sum squared resid	0.004996	Schwarz criterion	-4.020754
Log likelihood	18.16246	Hannan-Quinn criter.	-4.174565
F-statistic	8.958329	Durbin-Watson stat	1.936435
Prob(F-statistic)	0.024225		

Dependent Variable: EUBUDGET
Method: Least Squares
Sample (adjusted): 2007 2010
Included observations: 4 after adjustments
EUBUDGET = C(1)*(-DUM_EU*BOP380DT)

	Coefficient	Std. Error	t-Statistic	Prob.

C(1)	0.806272	0.033444	24.10806	0.0002

R-squared	0.272367	Mean dependent var	682.8104
Adjusted R-squared	0.272367	S.D. dependent var	66.47089
S.E. of regression	56.70061	Akaike info criterion	11.12576
Sum squared resid	9644.877	Schwarz criterion	10.97234
Log likelihood	-21.25153	Hannan-Quinn criter.	10.78908
Durbin-Watson stat	1.696132		

Dependent Variable: DLOG(IIP555)
Method: Least Squares
Sample (adjusted): 2001 2010
Included observations: 10 after adjustments
DLOG(IIP555) = C(1)*DLOG(IIP555(-1)) + C(2)*D(RINTRATE)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.966161	0.081955	11.78891	0.0000
C(2)	8.766204	3.555775	2.465343	0.0390

R-squared	0.770561	Mean dependent var	0.251412
Adjusted R-squared	0.741882	S.D. dependent var	0.147667
S.E. of regression	0.075023	Akaike info criterion	-2.165199
Sum squared resid	0.045027	Schwarz criterion	-2.104682
Log likelihood	12.82599	Hannan-Quinn criter.	-2.231586
Durbin-Watson stat	1.400513		

Dependent Variable: DLOG(IIP988_X_802)
Method: Least Squares
Sample (adjusted): 2000 2010
Included observations: 11 after adjustments
DLOG(IIP988_X_802) = C(1) + C(2)*D(EURIBOR_12) + C(3)
DLOG(B1GM_2005) +C(4)(LOG(IIP988_X_802(-1)) -
LOG(B1GM_2005(-1)))

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.692562	0.271196	-2.553731	0.0379
C(2)	0.156818	0.047958	3.269876	0.0137
C(3)	-5.558999	1.818861	-3.056308	0.0184
C(4)	-0.817062	0.238881	-3.420366	0.0111

R-squared	0.708844	Mean dependent var	0.067314
Adjusted R-squared	0.584062	S.D. dependent var	0.180781
S.E. of regression	0.116592	Akaike info criterion	-1.184993
Sum squared resid	0.095155	Schwarz criterion	-1.040304
Log likelihood	10.51746	Hannan-Quinn criter.	-1.276199
F-statistic	5.680685	Durbin-Watson stat	2.709239
Prob(F-statistic)	0.027257		

Dependent Variable: DLOG(IIP989)
Method: Least Squares
Sample (adjusted): 2001 2010
Included observations: 10 after adjustments

DLOG(IIP989) = C(1) + C(2)*(LOG(IIP989(-1)) - 2*LOG(B1GM(-1))-5
*INT_DIFF(-1)) + C(3)*D(INTRATE)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-5.929756	1.285307	-4.613495	0.0024
C(2)	-0.545027	0.115112	-4.734740	0.0021
C(3)	2.243526	0.561941	3.992461	0.0052

R-squared	0.824123	Mean dependent var	0.139994
Adjusted R-squared	0.773873	S.D. dependent var	0.145062
S.E. of regression	0.068981	Akaike info criterion	-2.266649
Sum squared resid	0.033309	Schwarz criterion	-2.175874
Log likelihood	14.33325	Hannan-Quinn criter.	-2.366230
F-statistic	16.40030	Durbin-Watson stat	1.414970
Prob(F-statistic)	0.002282		

Dependent Variable: D(LIABGOV)
Method: Least Squares
Sample: 2003 2010
Included observations: 8
D(LIABGOV) = C(1) + C(2)*(LIABGOV(-1) - 0.6 *FISCRES(-1)) + C(3)
*DUM1

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-430.7469	51.99821	-8.283880	0.0004
C(2)	-0.546382	0.033471	-16.32410	0.0000
C(3)	1084.508	54.12321	20.03775	0.0000

R-squared	0.990502	Mean dependent var	512.0853
Adjusted R-squared	0.986703	S.D. dependent var	549.7874
S.E. of regression	63.39824	Akaike info criterion	11.41675
Sum squared resid	20096.68	Schwarz criterion	11.44654
Log likelihood	-42.66698	Hannan-Quinn criter.	11.21582
F-statistic	260.7106	Durbin-Watson stat	2.597669
Prob(F-statistic)	0.000009		

Dependent Variable: DLOG(OVERN1)
Method: Least Squares
Sample: 1999 2010
Included observations: 12
DLOG(OVERN1) = C(1) + C(2)*DLOG(P3_2005) + C(3)*(LOG(OVERN1(
-1)) - 4.5 *LOG(P3_2005(-1)))

	Coefficient	Std. Error	t-Statistic	Prob.

C(1)	-14.45525	5.477512	-2.639018	0.0270
C(2)	3.394107	0.710072	4.779945	0.0010
C(3)	-0.373510	0.141098	-2.647159	0.0266

R-squared	0.717621	Mean dependent var	0.142960
Adjusted R-squared	0.654870	S.D. dependent var	0.149893
S.E. of regression	0.088059	Akaike info criterion	-1.809306
Sum squared resid	0.069789	Schwarz criterion	-1.688080
Log likelihood	13.85584	Hannan-Quinn criter.	-1.854189
F-statistic	11.43602	Durbin-Watson stat	2.589163
Prob(F-statistic)	0.003379		

Dependent Variable: DLOG(P3_S13_CPI05)
Method: Least Squares
Sample: 1998 2010
Included observations: 13
DLOG(P3_S13_CPI05) = C(1) + C(2)*DLOG(CP00_AVX) + C(3)
*(LOG(P3_S13_CPI05(-1))-1.125*LOG(CP00_AVX(-1)))

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.536492	0.038580	-13.90580	0.0000
C(2)	0.925768	0.108362	8.543265	0.0000
C(3)	-0.949723	0.072641	-13.07425	0.0000

R-squared	0.987896	Mean dependent var	0.092093
Adjusted R-squared	0.985476	S.D. dependent var	0.091735
S.E. of regression	0.011056	Akaike info criterion	-5.972563
Sum squared resid	0.001222	Schwarz criterion	-5.842190
Log likelihood	41.82166	Hannan-Quinn criter.	-5.999360
F-statistic	408.0958	Durbin-Watson stat	2.240564
Prob(F-statistic)	0.000000		

Dependent Variable: DLOG(P3_S14_S15_2005)
Method: Least Squares
Sample: 2000 2010
Included observations: 11
DLOG(P3_S14_S15_2005) = C(1) +C(2)*(LOG(P3_S14_S15_2005(-1)) - LOG(DISPY_2005(-1))) + C(4)*(DLOG(DISPY_2005)) + C(5)
*RINTRATE

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.362619	0.066970	-5.414681	0.0010
C(2)	-0.713856	0.123189	-5.794824	0.0007
C(4)	0.627526	0.238193	2.634533	0.0337
C(5)	2.763678	0.779897	3.543645	0.0094

R-squared	0.945021	Mean dependent var	0.045290
Adjusted R-squared	0.921458	S.D. dependent var	0.050121
S.E. of regression	0.014046	Akaike info criterion	-5.417610
Sum squared resid	0.001381	Schwarz criterion	-5.272921
Log likelihood	33.79686	Hannan-Quinn criter.	-5.508816
F-statistic	40.10702	Durbin-Watson stat	2.593782
Prob(F-statistic)	0.000089		

Dependent Variable: DLOG(P3_S14_S15_CPI05)

Method: Least Squares

Sample: 1998 2010

Included observations: 13

DLOG(P3_S14_S15_CPI05) = C(1)*DLOG(CP00_AVX) + C(2) + C(3)
*(LOG(P3_S14_S15_CPI05(-1))-0.735*LOG(CP00_AVX(-1)))

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.872607	0.127631	6.836939	0.0000
C(2)	1.136589	0.351385	3.234596	0.0090
C(3)	-0.943779	0.287438	-3.283423	0.0082

R-squared	0.886223	Mean dependent var	0.050477
Adjusted R-squared	0.863467	S.D. dependent var	0.047868
S.E. of regression	0.017687	Akaike info criterion	-5.032748
Sum squared resid	0.003128	Schwarz criterion	-4.902375
Log likelihood	35.71286	Hannan-Quinn criter.	-5.059545
F-statistic	38.94549	Durbin-Watson stat	1.956612
Prob(F-statistic)	0.000019		

Dependent Variable: DLOG(P5_CPI05)

Method: Least Squares

Sample: 2000 2010

Included observations: 11

DLOG(P5_CPI05) = C(1) + C(2)*DLOG(CP00_AVX) + C(3)
*(LOG(P5_CPI05(-1)) -LOG(CP00_AVX(-1))) + C(4)*DLOG(PINDU(-1)
/EURUSD_AVG(-1))

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.008468	0.010939	0.774100	0.4642
C(2)	0.832394	0.186206	4.470297	0.0029
C(3)	-0.533612	0.086324	-6.181479	0.0005
C(4)	0.117412	0.032600	3.601541	0.0087

R-squared	0.917352	Mean dependent var	0.047050
Adjusted R-squared	0.881932	S.D. dependent var	0.037402

S.E. of regression	0.012852	Akaike info criterion	-5.595372
Sum squared resid	0.001156	Schwarz criterion	-5.450683
Log likelihood	34.77454	Hannan-Quinn criter.	-5.686578
F-statistic	25.89891	Durbin-Watson stat	1.265621
Prob(F-statistic)	0.000366		

Dependent Variable: DLOG(P5_X_S13_X_EU_2005)
Method: Least Squares
Sample: 2000 2010
Included observations: 11
DLOG(P5_X_S13_X_EU_2005) = C(1) + C(2)*(LOG(P5_X_S13_X_EU_20
05(-1)) - 1 * LOG(B1GM_2005(-1))) + C(3)*RINTRATE + C(4)
*INT_DIFF

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-1.314413	0.176528	-7.445931	0.0001
C(2)	-0.230940	0.061412	-3.760516	0.0071
C(3)	9.156267	2.633147	3.477310	0.0103
C(4)	2.440973	1.113959	2.191259	0.0646

R-squared	0.915373	Mean dependent var	0.088455
Adjusted R-squared	0.879104	S.D. dependent var	0.174018
S.E. of regression	0.060506	Akaike info criterion	-2.496851
Sum squared resid	0.025627	Schwarz criterion	-2.352162
Log likelihood	17.73268	Hannan-Quinn criter.	-2.588057
F-statistic	25.23864	Durbin-Watson stat	3.368186
Prob(F-statistic)	0.000397		

Dependent Variable: DLOG(P6_2005)
Method: Least Squares
Sample (adjusted): 2001 2010
Included observations: 10 after adjustments
DLOG(P6_2005) = C(1) +C(2)*DUMEXP0506 + C(3)*DLOG(EU_B1GM_20
00) + C(4)*(LOG(P6_2005(-1)) - 0.9* LOG(NULC_2005(-1)) - 0.5*
LOG(EU_B1GM_2000(-1)))

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.576761	0.249141	-2.314994	0.0599
C(2)	0.255316	0.024070	10.60702	0.0000
C(3)	3.382036	0.486206	6.955976	0.0004
C(4)	-0.194616	0.079872	-2.436596	0.0507

R-squared	0.976609	Mean dependent var	0.070291
Adjusted R-squared	0.964913	S.D. dependent var	0.160443

S.E. of regression	0.030053	Akaike info criterion	-3.882524
Sum squared resid	0.005419	Schwarz criterion	-3.761490
Log likelihood	23.41262	Hannan-Quinn criter.	-4.015298
F-statistic	83.50290	Durbin-Watson stat	1.547060
Prob(F-statistic)	0.000028		

Dependent Variable: DLOG(P6_CPI05)
Method: Least Squares
Sample: 2000 2010
Included observations: 11
DLOG(P6_CPI05) = C(1) + C(2)*DLOG(PNRG/EURUSD_AVG) + C(3)
DLOG(PMETA/EURUSD_AVG) + C(4)(LOG(P6_CPI05(-1)) - 0.3
*LOG(PNRG(-1)/EURUSD_AVG(-1)) - 0.22 *LOG(PMETA(-1)
/EURUSD_AVG(-1)))

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	1.370375	0.263018	5.210188	0.0012
C(2)	0.243873	0.022888	10.65512	0.0000
C(3)	0.084450	0.027074	3.119164	0.0169
C(4)	-0.569244	0.110692	-5.142616	0.0013

R-squared	0.975276	Mean dependent var	0.051555
Adjusted R-squared	0.964680	S.D. dependent var	0.078925
S.E. of regression	0.014833	Akaike info criterion	-5.308647
Sum squared resid	0.001540	Schwarz criterion	-5.163958
Log likelihood	33.19756	Hannan-Quinn criter.	-5.399854
F-statistic	92.04123	Durbin-Watson stat	2.598996
Prob(F-statistic)	0.000005		

Dependent Variable: DLOG(P7_2005)
Method: Least Squares
Sample (adjusted): 1996 2010
Included observations: 15 after adjustments
DLOG(P7_2005) = C(1)*DLOG(P3_S14_S15_2005) + C(2)
*DLOG(P5_2005) + C(3)*DLOG(P6_2005) + C(4)*(LOG(P7_2005(-1))
-0.716*LOG(P6_2005(-1))-0.326*LOG(P5_2005(-1))) + C(5)*DUM1

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.535821	0.061459	8.718363	0.0000
C(2)	0.217902	0.016925	12.87446	0.0000
C(3)	0.777764	0.025849	30.08912	0.0000
C(4)	-0.548692	0.075093	-7.306854	0.0000

C(5)	-0.027586	0.011292	-2.443072	0.0347

R-squared	0.994589	Mean dependent var	0.071394
Adjusted R-squared	0.992424	S.D. dependent var	0.166873
S.E. of regression	0.014524	Akaike info criterion	-5.364800
Sum squared resid	0.002110	Schwarz criterion	-5.128784
Log likelihood	45.23600	Hannan-Quinn criter.	-5.367315
Durbin-Watson stat	2.566621		

Dependent Variable: DLOG(P7_CPI05)

Method: Least Squares

Sample: 2000 2010

Included observations: 11

DLOG(P7_CPI05) = C(1) + C(2)*DLOG(PNRG/EURUSD_AVG) + C(3)
*(LOG(P7_CPI05(-1)) - 0.35*LOG(PNRG(-1)/EURUSD_AVG(-1)) - 0.18
*LOG(PINDU(-1)/EURUSD_AVG(-1)))

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	1.558306	0.159467	9.771974	0.0000
C(2)	0.291455	0.011362	25.65133	0.0000
C(3)	-0.667185	0.068716	-9.709374	0.0000

R-squared	0.988032	Mean dependent var	0.037535
Adjusted R-squared	0.985040	S.D. dependent var	0.069858
S.E. of regression	0.008545	Akaike info criterion	-6.460049
Sum squared resid	0.000584	Schwarz criterion	-6.351532
Log likelihood	38.53027	Hannan-Quinn criter.	-6.528453
F-statistic	330.2159	Durbin-Watson stat	3.008673
Prob(F-statistic)	0.000000		

Dependent Variable: DLOG(QUASI)

Method: Least Squares

Date: 07/22/11 Time: 20:07

Included observations: 10 after adjustments

DLOG(QUASI) = C(1) + C(2)*DLOG(P3_2005) + C(3)*(LOG(QUASI(-1)) - 3
*INTRATE(-1) - 3*LOG(CP00_AVX(-1))-LOG(B1GM_2005(-1)))

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-5.660773	1.318335	-4.293880	0.0036
C(2)	1.704507	0.285405	5.972241	0.0006
C(3)	-0.372070	0.084322	-4.412483	0.0031

R-squared	0.836114	Mean dependent var	0.185324
Adjusted R-squared	0.789289	S.D. dependent var	0.062445

S.E. of regression	0.028664	Akaike info criterion	-4.022998
Sum squared resid	0.005752	Schwarz criterion	-3.932222
Log likelihood	23.11499	Hannan-Quinn criter.	-4.122579
F-statistic	17.85626	Durbin-Watson stat	2.294919
Prob(F-statistic)	0.001782		

Dependent Variable: DLOG(WAGE_TOTAL,2)
Method: Least Squares
Sample (adjusted): 2002 2010
Included observations: 9 after adjustments
DLOG(WAGE_TOTAL,2) = C(1) + C(3)*DLOG(B1GM_2005) + C(4)*DUM2

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.057038	0.006348	-8.985633	0.0001
C(3)	1.132399	0.118289	9.573194	0.0001
C(4)	0.051789	0.011029	4.695734	0.0033

R-squared	0.962556	Mean dependent var	-0.000636
Adjusted R-squared	0.950075	S.D. dependent var	0.058760
S.E. of regression	0.013129	Akaike info criterion	-5.566757
Sum squared resid	0.001034	Schwarz criterion	-5.501015
Log likelihood	28.05041	Hannan-Quinn criter.	-5.708627
F-statistic	77.12064	Durbin-Watson stat	2.809282
Prob(F-statistic)	0.000052		