2017

Methods of analysing policy implications using economic models

„Analysis of selected measures of OP Innovative Economy at the sector and macroeconomic level using the input-output economic model"

Jan Gąska
Maciej Bukowski, PhD

Wroclaw, 22nd of June 2017

Fundusze Europejskie Inteligentny Rozwój
PARP
Unia Europejska Europejski Fundusz Rozwoju Regionalnego

Description of the project

- Prepared for PARP
- By the consortium WiseEuropa and OPI OŚRODEK PRZETWARZANIA INFORMACJI PAŃSTWOWY INSTYTUT BADAWCZY
- Beginning of the project - **1st of December 2016**
- End of the project – **22nd of September 2017**

Goal of the project

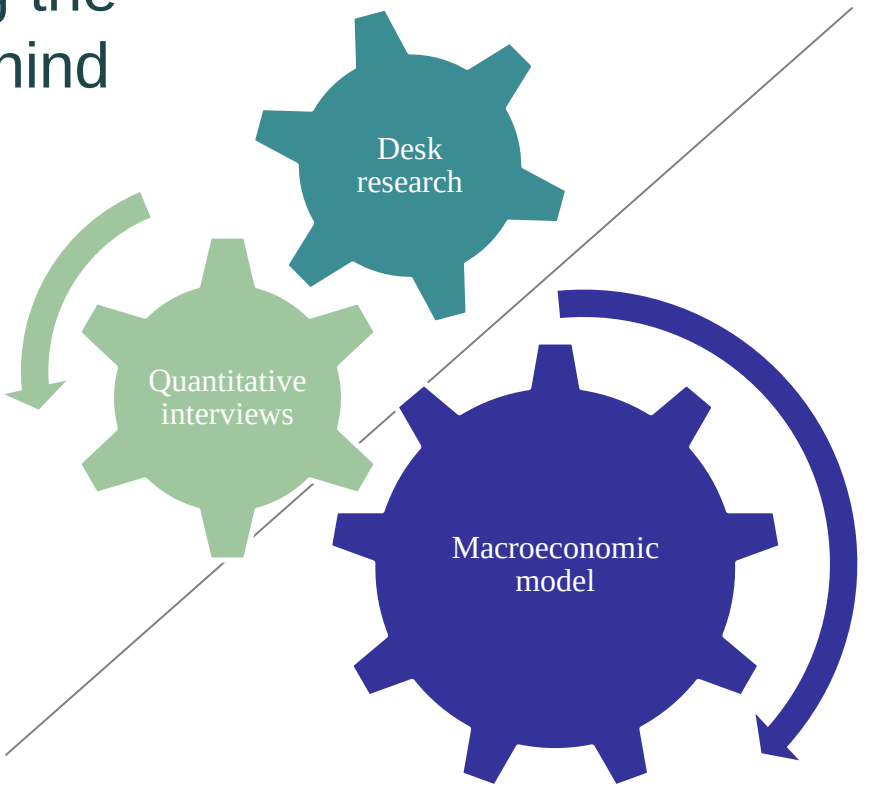
The main goal of the project is to estimate the impact of selected measures of Operational Programme Innovative Economy on the economy.

Analysis should allow to estimate the following effects:

- **Indirect** – resulting from potential growth of output/services by the beneficiaries and induced gains for companies which are not beneficiaries but are part of supply chains;
- **Induced** – resulting from increase in total demand due to growth of wages of employees of companies which are direct or indirect beneficiaries of the Programme;
- **Fiscal –** (changes in revenues of public sector) due to the changes in tax revenues due to the increased activity or economic efficiency due to the Programme;

Methodology

Understanding the economics behind intervention



Estimating the effect

Innovative methodology (1/2)

- **First evaluation report**, in which support for enterprises is modelled through the capital market imperfections;
- **Significant component** of model development so the intervention logic is quite closely reflected in the DSGE model;
- For the calibration of the model **KSI SIMIK** microdata will be used, so it will be more precise than models estimated on the basis of macroeconomic data.

Innovative methodology (2/2)

- **Model is equipped with the significant regional dimension with R&D sector modelled at that level** what allows for modelling of spatial spillover effects between regions;
- **Endogenous technological progress is also included with** the progress directed to improvement of labour or energy productivity or decrease of material intensity;
- **Imperfect capital market component** allows for the analysis of the impact of eliminating barriers in access to capital on the economy and socio-economic situation.

Evolution of econometric impact assessment tools

- Simple linear econometric models;
- Structural, multiple-equations econometric models;
- Input-output analysis;
- Computable General Equilibrium models (CGE), static and dynamic;
- Large scale dynamic, stochastic general equilibrium models (DSGE).

Simple linear models;

- Very simple – they are perfect starting points for more in-depth analysis;
- Based either on macroeconomic data (e.g. at the regional level) or on enterprise level microdata;
- The development of computing power and the increased availability of well described and accurate microeconomic data led to increase in popularity of such tools in recent years;
- *Difference-in-differences* and *regression discontinuity* recently gained popularity and became important, as they are one of the best impact assessment tools at the microeconomic level.

Multiple-equations, structural econometric models

- The renowned example is HERMIN, widely used for impact assessment of the EU funds on the economy (especially in the CEE countries);
- Based on the number of equations that link together macroeconomic aggregates;
- Coefficients are estimated on the basis of past data, so they are prone to Lucas critique;
- These kinds of tools rarely used in peer reviewed academic papers as they are based on arbitrary assumptions and do not take into account the logic of the intervention.

Input-output analysis

- Input-output analysis can be used to assess how changing demand for one product will impact the demand and supply of other products;
- It was proposed by Vasily Leontief in 1950s;
- Input-Output tables are developed every five years by the Central Statistical Office (GUS), they are also products of research projects (such as WIOD, GTAP) and are commercially available (GTAP);
- At the regional level they were developed for Poland within the NCN research project by K. Zawalińska with the team and were used to analyse the impact of R&D sector on the economy.

CGE modelling

- Simple CGE models are an extension of the I-O analysis – other production factors (such as capital and labour) and substitution possibilities between them are added;
- The substitution between other products or inputs can be also analysed (e.g. between coal, oil and gas);
- Proper CGE analysis requires good data on inputs and parameters which are sometimes estimated using microeconomic data.

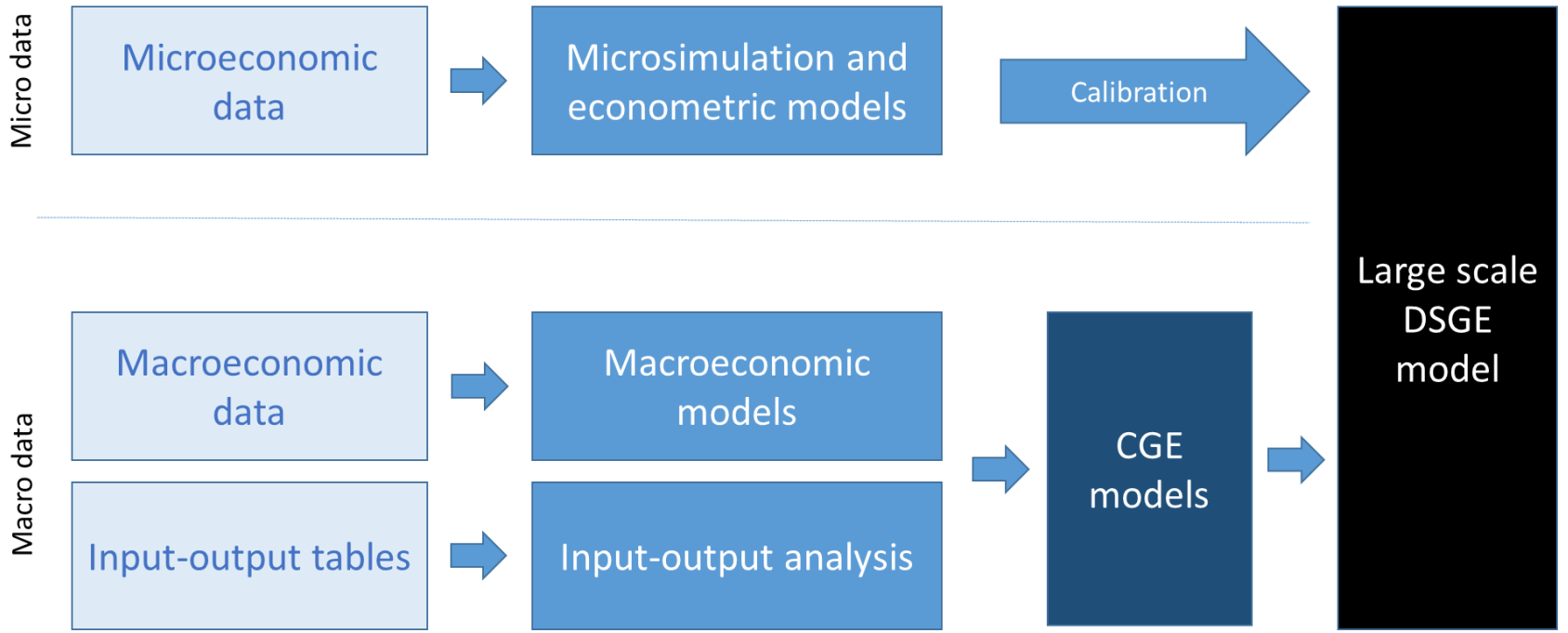
DSGE modelling

- Initially DSGE models were used for the analysis of consequences of monetary and fiscal policies, as they allow for an inclusion of expectations as well as price rigidities in the analysis;
- Recently development of computing power allowed for enrichment of these models with sectoral structure known from CGE models;
- Similarly to CGE models, DSGE models are also increasingly using microeconomic data to estimate parameters to bring the modelling closer to reality;
- The DSGE model used in this study combines the sectoral structure known from the CGE models (with separate regions) and the advantages of using microeconomic data from the KSI SIMIK database.

Changes of tools in economics

Economist.com

DSGE model - summary



Economic rationale for the analysed policy

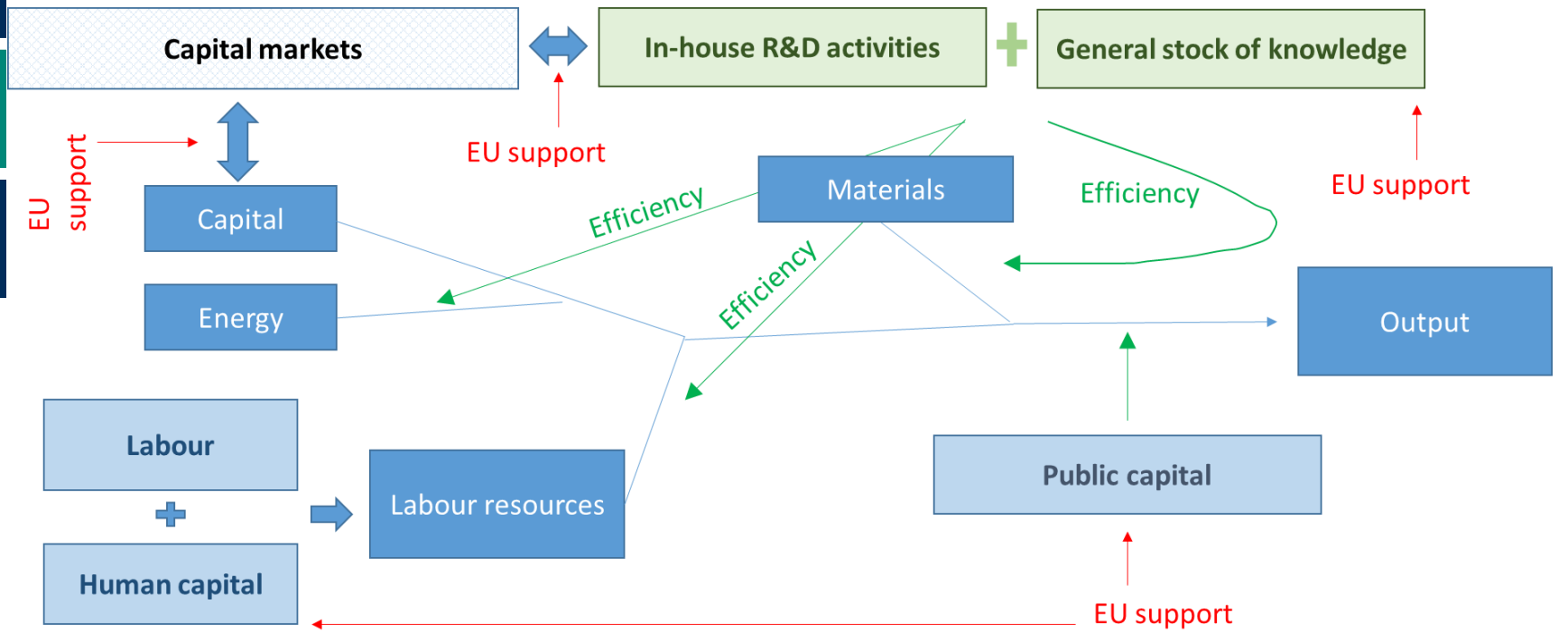
Logic of the intervention

- To analyse the impact of any intervention using economic model one must understand the problems and markets imperfections that the intervention is to solve, and then translate it into mathematical language (i.e. equations);
- We identified the following types of actions to be analysed within the selected measures of OP IE:
  - Direct support for R&D sector and institutions, affecting the ability of businesses to increase productivity using their own research resources;
  - Support for enterprises to mitigate the negative effects of insufficient access to capital markets.

Translation to productivity improvements

- Productivity of enterprises depends on the technological frontier which is understood as the combination of certain stock of general knowledge available to all businesses at any time and the result of their own R&D expenditures;
- If the technology frontier is higher, then the efficiency of in-house R&D spending is improved;
- R&D expenditures in the enterprises are also suboptimal due to the high risk associated with such investment and the unwillingness of banks and capital markets to finance such activities.
- In addition, labour productivity can be increased through the development of human capital stock and public infrastructure.

Logic of the intervention - summary



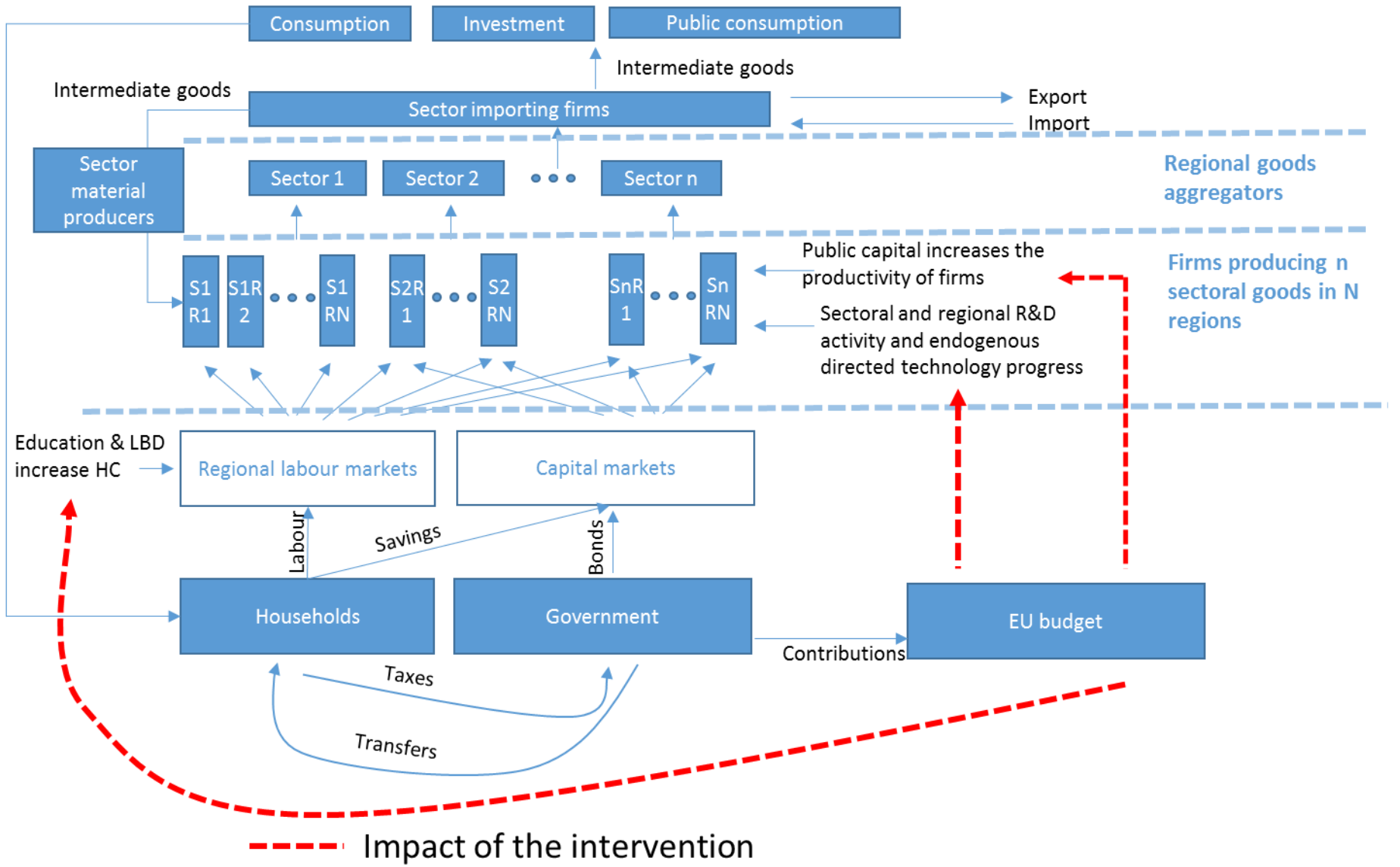
Wroclaw, 22nd of June 2017

VESPA 2 model

Fundusze Europejskie
Inteligentny Rozwój

PARP

Unia Europejska
Europejski Fundusz Rozwoju Regionalnego


Consumption
Investment
Public consumption
Intermediate goods
Intermediate goods
Sector importing firms
Export
Import
Sector material producers
Sector 1
Sector 2
Sector n
Regional goods aggregators
S1 R1
S1R 2
S1 RN
S2R 1
S2 RN
SnR 1
Sn RN
Public capital increases the productivity of firms
Sectoral and regional R&D activity and endogenous directed technology progress
Firms producing n sectoral goods in N regions
Education & LBD increase HC
Regional labour markets
Capital markets
Labour
Savings
Bonds
Households
Government
EU budget
Contributions
Taxes
Transfers
Impact of the intervention

EU support in VESPA 2 model

- EU support in VESPA 2 is modelled at five levels reflecting the different areas of the intervention and different problems to be solved:
  - Direct support for R&D activities which moves the general knowledge stock available to all companies forward and impact the technology frontier;
  - Loans for the development of technology, which mitigates the burden resulting from insufficient access of enterprises to capital markets;
  - Direct support for enterprises to reduce their investment costs;
  - Improvement in public infrastructure which directly affects business productivity;
  - Support for increase in human capital, which affects labour productivity.

Regional structure of VESPA 2 model

- The distinguishing feature of the VESPA 2 model is very rich regional structure – the production process is modelled at the voivodship (and sectoral) level;
- Such construction allows for:
  - Including not only the differences in sectoral structure of the regional economies but also heterogeneity within it, e.g. different capital intensity, labour intensity and energy intensity of each sector;
  - Taking into account specific features of particular regions, such as the high share of people with tertiary education (through the level of human capital) or high level of structural unemployment (through labour markets rigidities) and even the differences in intensity of R&D.

Wroclaw, 22nd of June 2017

Extensions of VESPA 2 model within the project

Estimation of the model using Bayesian methods

- The model will be estimated using Bayesian methods on the basis of microdata from the KSI SIMIK database;
- In Bayesian methods the estimation procedure consists of 3 steps:
  - *a priori* distribution is assumed which reflects certain "reasonable" values;
  - In the second step *a priori* distribution is "updated" on the basis of observed data;
  - Formally the following relationship is used: $p(\theta \mid Y) = p(Y \mid \theta)\, p(\theta)$

Where $p(\theta)$ is *a priori* distribution, $p(\theta \mid Y)$ is *a posteriori* distribution, $p(Y \mid \theta)$ is likelihood function describing the likelihood of observing particular values given *a priori* distribution.

Building the scenarios and assessment of the impact of EU funds

- Analysis of the impact of EU funds requires the construction of the baseline (with intervention) scenario and counterfactual scenario without intervention;
- The difference between the macroeconomic variables in the baseline and the counterfactual scenario allows for computation of the net effect of the intervention;
- It is also possible to perform simulations for only part of the intervention, e.g. to isolate the impact of individual measures in order to calculate the synergy effects.

Sensitivity analysis

- Uncertainty regarding the results of the model can be divided into three main groups:
  - Uncertainty involved in the construction of the baseline scenario and the development of future path of main parameters - simulations will be calculated using two additional baseline scenarios;
  - Uncertainty regarding the values of model parameters - simulations will be run for a few sets of parameters values;
  - Uncertainty associated with unexpected shocks in the economy – we will present confidence intervals for estimates with embodied e.g. productivity shocks.

2017

Thank you!