



Fiscal Adjustment in Slovakia

**Findings from a Medium-Scale Econometric
Model**

Miroslav Klucik

Working Paper No. 1/2015

© SECRETARIAT OF THE COUNCIL FOR BUDGET RESPONSIBILITY

This study represents the views of the authors and do not necessarily reflect those of the Council for Budget Responsibility (CBR). The Working Papers constitute “work in progress”. They are published to stimulate discussion and contribute to the advancement of our knowledge of economic matters.

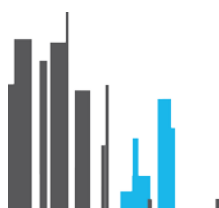
This publication is available on the CBR website (<http://www.rozpocovarada.sk/>).

Copyright ©

The Secretariat of the CBR (Kancelária Rady pre rozpočtovú zodpovednosť) respects all third-party rights, in particular rights relating to works protected by copyright (information or data, wordings and depictions, to the extent that these are of an individual character). CBR Secretariat publications containing a reference to a copyright (© Secretariat of the Council for Budget Responsibility/Secretariat of the CBR, Slovakia/year, or similar) may, under copyright law, only be used (reproduced, used via the internet, etc.) for non-commercial purposes and provided that the source is mentioned. Their use for commercial purposes is only permitted with the prior express consent of the CBR Secretariat. General information and data published without reference to a copyright may be used without mentioning the source. To the extent that the information and data clearly derive from outside sources, the users of such information and data are obliged to respect any existing copyrights and to obtain the right of use from the relevant outside source themselves.

Limitation of Liability

The CBR Secretariat accepts no responsibility for any information it provides. Under no circumstances will it accept any liability for losses or damage which may result from the use of such information. This limitation of liability applies, in particular, to the topicality, accuracy, validity and availability of the information.



Fiscal Adjustment in Slovakia: Findings from a Medium-Scale Econometric Model ¹

Miroslav Klucik²

Abstract

Alternative fiscal consolidation strategies are examined in the context of a medium-scale econometric model estimated on Slovak data. The multipliers associated with adjustment on the spending side are generally larger than on the revenue side, which is not uncommon for this class of models. In particular, government spending on investment, wages, and goods and services are associated with strong real-economy consequences. On the revenue side, corporate income tax, social security contributions of employees and personal income tax increases are found to be most harmful for growth. Social contributions and personal income tax adjustments also have the most pronounced effect on employment. The policy implication is that a short-run growth-friendly consolidation strategy should avoid placing too much weight on these budgetary items.

Keywords: error correction model, fiscal rules, fiscal multipliers, neoclassical synthesis

JEL Classification: C54, E37, E62, E63

¹ The author would like to thank the National Bank of Slovakia for providing the core econometric model, especially Branislav Relovsky and Miroslav Gavura for guidance and support during the setup of the model. Special thank goes also to Michal Horváth, Matus Senaj and Markku Lehmus for valuable comments and suggestions. All remaining errors are the sole responsibility of the author.

² Corresponding author. Address: Council for Budget Responsibility, I. Karvaša 1, 813 25 Bratislava, Slovakia, klucik@rrz.sk



Contents

Non-technical summary.....	5
1. Introduction.....	6
1.1. Fiscal multipliers.....	7
1.2. Main results.....	8
2. The model.....	9
2.1. Supply side.....	9
2.2. Demand side and prices.....	13
2.3. The household budget identity.....	15
2.4. The budget identity of firms.....	16
2.5. The government budget constraint.....	17
2.6. Fiscal rules.....	19
3. Solution of the model.....	20
3.1. Calibration and estimation.....	20
3.2. Ensuring the convergence of the model.....	22
4. Simulations.....	23
4.1. The basic dynamics of the model.....	24
4.2. Consequences of revenue-side policy shocks.....	27
4.3. Consequences of expenditure-side policy shocks.....	30
5. Conclusions.....	33
References.....	34



Non-technical summary

The CBR has developed a standard medium-scale macroeconomic model to produce short- and medium-term macroeconomic forecasts. Implicitly, the model provides measurements of analytical nature such as fiscal multipliers and estimates of the elasticity of labour and investment to fiscal policies at various horizons.

The model is an extension of the former econometric model of the National Bank of Slovakia generally following the spirit of the ECB's Multi-Country Model type (MCM). The most significant extension is the inclusion of a detailed fiscal block in the model. The MCM is a multiple behavioural equations model with an embedded theoretical structure. The model is a useful benchmark or complement to the theoretically sounder DSGE frameworks.

The underlying theoretical structure consists of a neo-classical long-term production block defining potential output; short-term deviations from the potential are driven by labour and product market frictions that prevent instantaneous adjustment in prices and wages to shocks in the economy. The demand side of the model is built on historical data and therefore, the predictions of the model are valid insofar as past relationships continue to hold in the future and under alternative policies. Expectation formation is assumed to be adaptive (i.e. backward-looking).

The data definitions of the theoretical structure have changed to allow evaluation of alternative fiscal policy strategies. The long-run level of potential output is assumed to be reduced permanently due to consolidation using personal income tax and social contributions of employees.

The basic dynamics of the model are presented through an evaluation of the performance of the model in the wake of supply, demand and price shocks. The simulation exercises present several fiscal consolidation scenarios defined as permanent increases (reductions) in various revenue (expenditure) items from the model's long-run steady state. The consequences of such policies are characterized by implied fiscal multipliers.

The multipliers associated with adjustment on the spending side are generally larger than on the revenue side, which is not uncommon for this class of models. In particular, government spending on investment, wages, and goods and services are associated with strong real-economy consequences. On the revenue side, corporate income tax, social security contributions of employees and personal income tax increases are found to be most harmful for growth. Consolidation strategies using corporate income tax and the cuts in public capital investments reduce the growth of potential itself with larger consequences in the long-run. The policy implication is that a growth-friendly consolidation strategy should avoid placing too much of a weight on these budgetary items.



1. Introduction

The Council for Budget Responsibility (CBR) is an independent fiscal institution whose mandate often requires the assessment of the short- and medium-term impact of fiscal policy measures. In order to be able to provide these in a transparent manner, this paper introduces one of the approaches the CBR will use to assess the aggregate consequences of changes in taxation and government spending. The model in the context of which such inferences will be made is primarily used for the production of short- and medium-term macroeconomic forecasts. However, it also implicitly provides measurements of analytical nature such as estimates of fiscal multipliers and elasticity of labour and investment to fiscal policies at various horizons.

The model is an extension of the former econometric model of the National Bank of Slovakia (Relovsky, Siroka, 2009) from the original line of Eurosystem' central banks models following the spirit of the Multi-Country Model (MCM) described in Fagan et al. (2001). The MCM is a multiple behavioural equations model with an embedded theoretical structure. The model has a backward-looking setup. All the caveats concerning this class of models, most notably their vulnerability to the Lucas critique, apply here. However, from a practical perspective, the model is a useful benchmark or complement to the theoretically sounder DSGE frameworks.

In neoclassical settings, to which the model converges in the long run, the optimal level of supply in an economy is the one consistent with profit maximization by firms. On top of this long-run core, the model is supplemented by the New Keynesian notion of diverging short-run dynamic of demand.

The evolution of variables is consistent with optimizing choices by agents subject to realistic budget constraints. The budget constraints of the government, households and private firms are modelled in fine detail, as they play an important role in the assessment of fiscal policy strategies. The long-run supply relationships are inherently embedded through theory, while short-term demand dynamics is based on actual data and estimated behavioural equations. Therefore, the predictions of the model are valid insofar as past relationships continue to hold in the future and under alternative policies. Expectation formation is assumed to be adaptive (i.e. backward-looking).

The short-run dynamics of supply and demand is associated with nominal rigidities and capital market imperfections. Prices are central for achieving the equilibrium between supply and demand side via adjustment according to the demands of firms and households.

The long-term equilibrium is consistent with a stable government revenue and expenditure growth path, i.e. for achieving target debt/deficit in the long-run the model includes fiscal rules for different tax and expenditure items that also enable to provide a realistic account of the fiscal adjustment as usually implemented by policy makers in Slovakia.

The model is generally linear but aims to account for important nonlinearities associated with fiscal policy by considering risk premia on public debt. Unlike traditional MCM type models the



supply side is affected by different government policies through potential labour and capital adjustment.

The structure of paper is as follows: Following a brief literature review on fiscal multipliers and an overview of our main results, section 2 discusses the main building blocks of the model, the solution of the model is elaborated in section 3. The policy experiments and the key results are presented in the simulation exercises in section 4.

1.1. Fiscal multipliers

The key results from the paper deal with the real economy consequences of fiscal adjustment. Here, the results are linked to the existing literature on fiscal multipliers. Spilimbergo et al. (2009) provide an excellent overview of the general literature, including earlier results. A more general overview can be found in Gechert and Will (2012), recently Gechert et al. (2015).

In models that come closest to the one in this paper, the implied multipliers have generally been found to be quite large (see Ambrisko et al., 2012, Krusper and Pellenyi, 2010, Gechert and Will, 2012). The MCM-style semi-structural models of WIFO, OeNB and IHS³ find fiscal multipliers above one for government spending after one year (1.1 in the OeNB model, 1.17 of WIFO-Macromod, and 1.5 in the IHS model)⁴. This is also the case of ECB (MCM) estimates of government expenditure multiplier on a one-year horizon (Henry et al., 2004), the OECD-Interlink estimates at 1.2 (Dalsgaard et al., 2001) and the IMF-MULTIMOD model at 1.5 (Hunt, Laxton, 2003). See [Table 1](#) for a short summary.

Table 1: Fiscal multipliers – short overview (referring to 1-year multipliers)

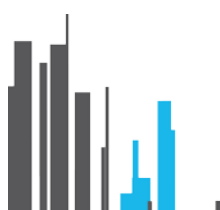
Econometric model (MCM-type)		DSGE-type	
Spending	Revenues	Spending	Revenues
1.1 (Fenz et al., 2004)	0.3 (Henry et al., 2004)	1.16 (Baksa et al., 2010)	0.5-0.8 (Baksa et al., 2010)
1.17 (Baumgartner et al., 2004)	0.5 (Dalsgaard et al., 1998)	0-0.4 (Ambrisko et al., 2012)	0-0.3 (Ambrisko et al., 2012)
1.5 (Hofer, Kunst, 2004)		0-0.5 (Klyuev, Snudden, 2011)	0-0.2 (Klyuev, Snudden, 2011)
1.1 (Henry et al., 2004)		VAR-type	
1.5 (Hunt, Laxton, 2003)		0.4-0.6 (Valenta, 2011)	-0.1-0.3 (Valenta, 2011)
1.2 (Dalsgaard et al., 1998)		0.4 (Bencik, 2009)	0.15 (Pecsyova, 2013)
		0.4 (Pecsyova, 2013)	

As far as specific tax versus spending multipliers are concerned, the literature tends to suggest the multipliers for taxes are smaller.⁵ For example, the MCM and Interlink studies show low multipliers for the personal income tax (0.3 and 0.5, consequently). Lower tax multipliers are also reported in Gechert and Will (2012) and Gechert et al. (2015) based on their meta-analysis, and also in Nickel and Tudyka (2013).

³ WIFO – Austrian Institute of Economic Research, OeNB – Oesterreichische Nationalbank, IHS – Institute for Advanced Studies.

⁴ See Baumgartner et al. (2004), Fenz et al. (2004), and Hofer, Kunst (2004).

⁵ The reason might be that different monetary policy normally accompanies spending cuts than tax hike, as argued in Davig, Leeper (2009).



It has been argued that fiscal multipliers can be larger in times of crises (Blanchard and Leigh, 2013, Boussard et al., 2012, Auerbach and Gorodnichenko, 2012 or Gechert et al., 2015). One reason might be the presence of the zero lower bound (e.g. Christiano et al. 2011), or higher level of debt to GDP ratio with possible non-linear effects (Nickel and Tudyka, 2013, Ilzetzki et al., 2011, Bi et al., 2012). However, Owyang et al. (2013) have provided evidence against state-dependency in multipliers.

Openness is generally found to reduce the magnitude of fiscal multipliers (OECD, 2010, Ilzetzki et al., 2011, Spilimbergo et al., 2009). Experience for economies similar to Slovakia suggest multipliers below one for taxes in **Hungary** (Baksa et al., 2010): for personal income tax (maximum of 0.8 during first year), social security contributions (0.5) and indirect taxes (0.46). In the case of government purchase of goods the authors report multipliers above 1 (1.16). For the **Czech Republic** Ambrisko et al. (2012) report also low multipliers from DSGE models individually for various expenditures and revenues (from 0 to 0.4). Similarly, Klyuev and Snudden (2011) report a value between 0 and 0.5. VAR models with various identification schemes show no significant results (Franta, 2012) or low multipliers in the range of 0.3-0.6 (Valenta, 2011).

For **Slovakia**, Bencik (2009) reports a 0.4 impact multiplier in a SVAR analysis with Blanchard-Perotti-style restrictions (Blanchard and Perotti, 2002) and sign restrictions. More recently, Pecsyoova (2013) estimates a 1-year cumulative multiplier for revenues and expenditures in the range of 0.2-0.4 (SVAR analysis with Blanchard-Perotti short-run restrictions).

1.2. Main results

The main results can be summarized as follows. In line with the literature, the fiscal multipliers on the government spending side are found to be large, exceeding one for spending on investment, compensations (both through wages and labour), and goods and services. The effects of tax changes on the real economy are found to be weaker. Corporate income tax, social security contributions of employees tend to have the most pronounced effect on the real economy, followed by personal income tax. The policy implication here is that a growth-friendly fiscal consolidation strategy should avoid placing too much weight on these budgetary items.

Due to larger expenditure multipliers the consolidation strategies for reducing debt-to-GDP ratio suggest more weights on taxes with prices effects, such as excise tax and value added tax. The expenditure side consolidation through public wages, social contributions of employers and capital investments seem to put too much burden on the economy to be an effective way for returning the debt-target to desired level.



2. The model

The present model follows the structure of medium-scale econometric models of the type akin to the ECB multi-country model (Relovsky and Siroka, 2009 for Slovakia). It includes three main blocks: supply, demand and price block. It extends the model of the National Bank of Slovakia to include detailed government, household and firm budgets.

The inclusion of the fiscal block affects the supply side by allowing the impact of government policies on labour and capital in the long-run, while tracking in detail the flow of resources between households, private firms and government budget. The long-run supply relationships are inherently embedded through theory, while short-term demand dynamics is based on actual data and estimated behavioural equations. The evolution of supply and demand in the short run is associated with nominal rigidities and capital market imperfections. Prices are central for achieving the equilibrium between supply and demand side via adapting the prices and wages according to the demands of firms and households. However, also fiscal targets need to be set for anchoring long-run position of investment (savings) and labour.

2.1. Supply side

The long-run core of the macroeconomic model is derived from the optimal behaviour of a neoclassical agent solving a maximisation problem of a monopolistic firm. The agent aims to maximise the difference between the market value of its production and its costs. At the level of the national economy an average firm is assumed to face a static profit (Π) maximisation problem:

$$\max_{L,K} \Pi(Y) = PY \cdot Y - CI_CE_PH_N \cdot L - (r + \delta + \lambda + \tau) \cdot K \cdot PI \quad (1)$$

Where Y is real aggregate output, PY the general price – deflator of GDP, PI – general price of investments, $CI_CE_PH_N$ – nominal compensation per employee, L total employment, r real interest rate, δ depreciation rate, λ risk premium, τ the tax rate on profits and K the real capital stock. The production function is assumed to be of the Cobb-Douglas type:

$$Y_POT = TFP \cdot K^\beta \cdot L_POT^{1-\beta} \quad (2)$$

With β as K/L constant elasticity ratio, and TFP as total factor productivity set in the model exogenously.

The long-run equilibrium is defined through two central equations derived from first order conditions of (1) with respect to labour and capital:

$$CI_CE_PH_N/PY = (1 - \beta) \cdot (Y_POT/L_POT) \text{ or } PY = CI_CE_PH_N/(1 - \beta) \cdot (Y/L) \quad (3a, 3b)$$

$$(r + \delta + \lambda + \tau) = \beta \cdot Y/K \quad (4)$$



In the static steady state the real compensations per employee (3a) – later referred to as ($CI_CE_PH_STAR$) are set at the level of potential labour productivity. The general price of production (PY), in the long-run referred to as (PY_STAR), is evolving together with nominal unit labour costs (3b). Desired level of capital for the given potential output occurs when satisfying the condition in (4), the price of investment (PI) and output (PY) from (1) are assumed to grow at the same pace in the long-run.

Government policy is assumed to feed back onto the **capital stock** through the risk premium reflecting the debt to GDP ratio and through changes in capital tax. **Potential labour** is affected by labour taxes and social contributions rates which have an influence on labour supply incentives.

2.1.1 Capital stock

The costs of capital include the real interest rate (calculated as exogenous nominal interest rate divided by GDP deflator⁶), exogenous depreciation rate on accumulated capital, an endogenous risk premium on investments levied on government bonds and tax on capital represented by a proxy of effective tax rate on profits. The level of equilibrium cost of capital⁷ directly emanating from the relationship in (4) implies the tax on profits must be already reflected also in other components (interest rate, risk premium). Higher profit tax requires more investment to sustain the growth of capital stock, therefore will have negative effect on private resources in the long-run.

Slovak sovereign bonds are allowed to carry a risk premium. Historical risk premia are backed out from equation (4). The interest rate on Slovakia's sovereign bonds is the weighted rate on ten-year government bonds according to the definition of Maastricht Treaty EMU convergence criterion series harmonised long-term interest rates.

The risk premium development is based on a simple estimated model that links it to other observables. Pooled regression across countries and time is used to model government yield spreads (defined as long-term interest rate minus return on German bunds) of Visegrad 4 countries over a period between 2003-2014.⁸

Simple plots of risk premia against potential explanatory variables reveal a non-linear relationship (see [Figure 1](#)), highlighted also in Haugh et al. (2009), Corsetti et al. (2013) or Orr et al. (1995).

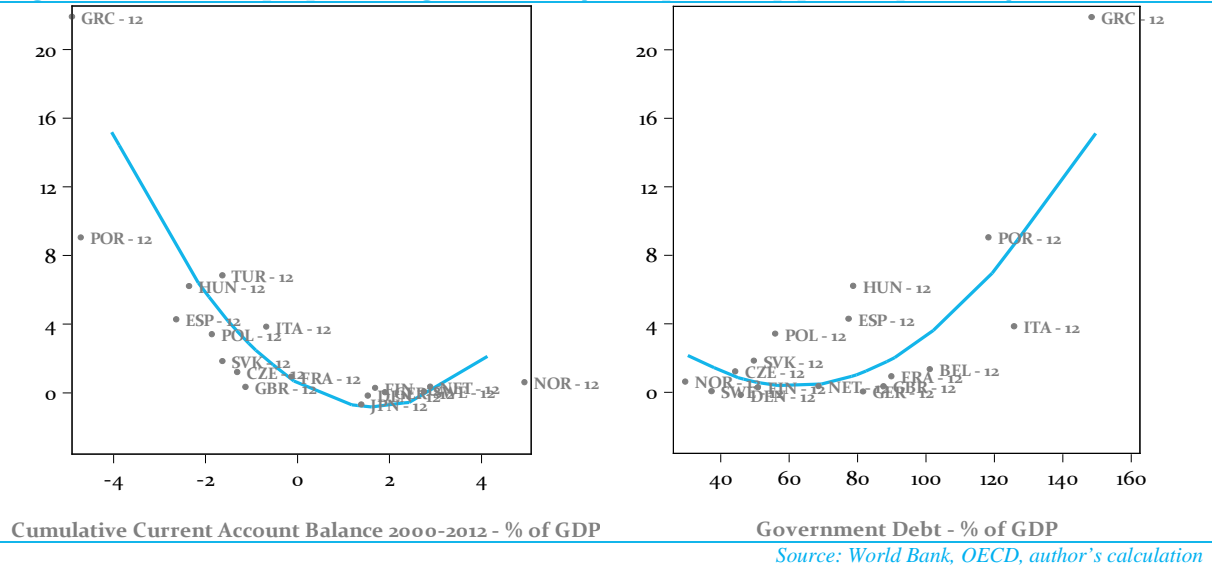
⁶ The National Bank of Slovakia does not determine the interest rates since entering into the euro area in 2009.

⁷ The time series of capital stock and potential GDP are the estimates of National Bank of Slovakia.

⁸ The approaches of Corsetti et al., (2013), Haugh et al. (2009), Aizenman et al. (2011) and Kocsis and Nagy (2011) are the closest related to the analysis. The Visegrad 4 countries comprise the Czech Republic, Hungary, Poland and Slovakia.



Figure 1: Non-linear properties – government yield spread in p.p. vs. explanatory variables⁹



From the possible explanatory variables, only the government debt-to-GDP ratio and the current account balance (ratio to GDP) proved to be statistically significant– see [Box 1](#) in [Appendix 1](#). The first variable shows significant effect in squared form, confirming the presence of non-linearity in the relationship. Both explanatory (lagged) variables are used as instruments to account for the possible simultaneous causality bias.

2.1.2 Labour dynamics

In line with the ESA definition of employment, the long-run level of potential employment (5) is consistent with the non-accelerating inflation rate of unemployment (NAIRU) with labour force (LF) adjusted for the labour operating outside Slovak borders.

$$L_{POT} = (LF - L_{ABROAD})(1 - NAIRU) \quad (5)$$

The growth of potential employment is assumed to converge to the one of the euro area (as well as exogenously set growth rate of working age population), for forecasting exercises one can use more realistic forecasts of working age population taking into account current demographic projections.

To give account of labour response to government policies the labour force is allowed to adjust according to the movements of net wage (6), i.e. after deduction of income tax (R_TAXPIT) and social contributions paid by employees (R_SCW).

$$lf_t = (1 + f_{lss}) * lf_{t-1} + c_{lf1} \Delta(r_{taxpit}_t) * lf_{t-1} + c_{lf2} \Delta(r_{scw}_t) * lf_{t-1} + \varepsilon_t^{lf} \quad (6)$$

⁹ Fitted regression line from panel regression with government yield spread as dependent variable.



Since public employment is determined by policy makers, only **private employment** (**L_FIRMS**) is modelled, defined as sum of private employees and self-employed persons according to the ESA methodology. The dynamics of private employment follows the desired level of employment in the economy (**L_STAR**) defined as inverted production function (in 7 with logs) with current level of real GDP (**Y**) in an error correction fashion (behavioural equations see [Appendix 3](#)).

$$\log(L_STAR_t) = \frac{1}{1 - \beta} [\log(Y_t) - \log(TFP_t) - \beta \log(K_{t-1})] \quad (7)$$

Some of the short-term dynamics is explained also by adjustment to the previous level of potential employment.

In the long-run the real compensations of employees (**CI_CE_PH**) grow in accordance with the real productivity in economy. However, in the presence of labour market frictions, unemployment arises, and the wages are negotiated by labour and trade unions. In the short-run, these relations are represented by the general wage Phillips curve (vertical in the long-run). Since public wages are given by government policy, only **private gross real wages** (**WREAL**) are modelled. The gross wages are defined according to the ESA methodology as the difference between total compensations and approximately the amount of social contributions paid by employers for its employees. The short-run behaviour equation of Phillips curve (8) captures the employee-employer wage bargaining by an error correction mechanism between private consumption (**PC**) and output deflator (**PY**), i.e. between wages demanded of households at the level of prices for domestic goods and services and wages offered to households according to unit labour costs. The wage growth reflects also the difference between current unemployment rate (**UR_ESA**) and the **NAIRU** rate (i.e. the strength of labour unions to bargain higher wages in case of large unemployment gap). The real wages are flexible towards the adjustment to labour productivity of private firms – value added of firms (**VA**) divided by private employment (**L_FIRMS**) – however, the adjustment with respect to the total economy labour productivity (**LPROD**) involves a time lag of one quarter. The government policy affects directly the behaviour of private employers when considering the rate of social contributions paid from gross wages of their employees (**R_SCF**). The real wages also react to the fluctuations of the actual compensations (**CI_CE_PH**) around such in the steady state (**CI_CE_PH_STAR**).

$$\begin{aligned} \Delta \log(WREAL_t) = & \theta \Delta \log\left(\frac{VA_t}{L_FIRMS_t}\right) + (1 - \theta) \Delta \log(LPROD_{t-1}) + \omega \Delta \log \frac{PC_t}{PY_t} + \rho (UR_{ESA} - NAIRU) + \\ & + \sigma \Delta (R_{SCF}) + \zeta \Delta (R_{SCW}) + \mu \log\left(\frac{CI_CE_PH}{CI_CE_PH_STAR}\right) + \varepsilon \end{aligned} \quad (8)$$

The parameter θ is estimated on actual data, however, the dynamic homogeneity condition requires that in the long run wages adjust to the labour productivity at the economy level (**LPROD**), and thus is constrained to one. The parameter ω represents the importance of wage negotiation process based on changes in consumption prices and production prices, while the parameter μ the correction term of adjusting to the long-run level of compensations on the aggregate economy level (both estimated on historical data). The unemployment gap parameter (ρ), i.e. the firms' bargaining power, is calibrated. Also labour demand reaction is considered in addition to labour supply effects (i.e. the substitution effect). The firms react both to changes in



social contributions paid by employers and employees (parameters σ and ζ). The first effect is the reaction to a change in actual unit labour costs, the second effect reflects the bargaining process with employees as a reaction to change of their net wages. The parameters calibrated according to regression estimates¹⁰ are in the range of similar studies, presented e.g. in the meta-analysis of González and Melguizo (2013), who give evidence of 0.65 elasticity of wages to taxation.

Economic incidence of wage taxation is therefore divided in the model into three effects: in the long-term the increase of compensations is borne ultimately by consumers, following the higher producing costs (**PY_STAR**). In the short-term, wage taxation reduces the firm's profits and finally, some of the burden is moved towards reduction of wages (detailed consequences of social contributions shock analysis in section 4.2).

The central price equation for short-term fluctuations of GDP deflator (**PY**) allows the model to converge to the equilibrium (with stable fiscal deficit and debt). Domestic prices evolve with inertia and adaptive expectations with regards to the development of import prices (**PM** – imports of energy commodities). In the long-run, the steady state path is captured by price movement towards closing of the output gap (**Y_GAP**), also with an error correction mechanism adapting the actual production prices in the economy towards the level of potential unit labour costs (**PY_STAR**). The unit labour costs equal the steady state costs, if and only if, the output gap is closed, i.e. the potential labour and output equal the actual ones.

Reflecting the last variable in the production function (2) – total factor productivity (**TFP**) – its growth is set exogenously. The real convergence of Slovak economy follows via the closure of total factor productivity growth difference between the euro area and Slovakia (present in export equation). The **TFP** growth enters the potential output equation, the level of convergence is thus also observed in the average labour productivity in the economy. Competitive prices on import and export are assumed to converge to the steady state of euro area GDP deflator growth.

2.2. Demand side and prices

Short-term dynamics is modelled through error-correction relationships reflecting the expenditure approach to GDP.

The consumer behaviour of households depends upon their permanent income. Consumption is thus a function of both human and physical wealth. The households are assumed to be the sole owner of all assets in the economy, which includes capital stock, government debt and net foreign assets. The households' optimizing behaviour also implies an intertemporal and an intra-temporal choice between consumption and leisure. The short-term development of household consumption (**Coo**) depends on the previous change of consumption (due to habit formation) and also on the actual change of their disposable income (**DISP_Y**), reflecting some degree of

¹⁰ The estimation follows two-stage process given the endogeneity of the explanatory variable (i.e. the wage per employee and the total volume of wages in the effective social contributions effective rates computation). In the first step the contributions volume is explained through wage-base development (allowed only with a contemporaneous effect). In the second step the residuals enter the wage equation, i.e. the unexplained part implies the actual changes of effective social contributions rates.



non-Ricardian behaviour. Changes in real purchasing power feed through into consumption via the private consumption deflator. In line with Euler equation dynamics the decisions about consumption are also affected by the change in the real interest rate.

In the long run, investments (**I**) must converge to the steady state given by equilibrium equation (4), in which the real GDP to capital ratio is equal to the price of capital. The decisions about investment depend on the changes in the real interest rate, the change in the profits of firms as well as government investment. The inclusion of the profit in the investment equation allows linking investment to the state of the private sector and also accounts for crowding out of investment by changes in the corporate income tax.

Government expenditures (**G**) encompass final consumption expenditures, such as the expenditures on wages of government employees and their social contributions, and on goods and services provided for public.

Exports of goods and services (**X**), which make up about three quarters of Slovak GDP are linked to the World Demand Indicator – (**WDR** – elasticity of one in the long-run) and converge towards the euro area rate of growth.

Imports (**M**) are largely dependent on planned exports (due to import intensive production), and modelled through domestic demand indicator as well as relative prices with foreign countries.

The private consumption deflator (**PC**) level is designed to follow the harmonised inflation index (**HICP**) composed of energy (**HEG**) and non-energy prices (**HEX**). The effective excise tax rate (**R_TAXEXC**) is reflected in levels in the long-run energy price equation (**HEG_STAR**), while in difference entering the short-run equation (**HEG**). Main impact on energy prices is divided between production prices (**PY**) and oil prices (**P_OIL**). Other domestic prices on the market evolve according to the general price level in the economy (**PY**), but some impact is expected to have been caused by the taxes, specifically the level of effective value added tax (**R_TAXVAT**) entering the long-run non-energy selling prices (**HEX_STAR**) and in difference also the short-run equation (**HEX**). Non-energy prices are absorbing an effect of current business cycle state of the economy (**Y_GAP**) and also competition prices (**CMD**) measuring the relative price level between Slovak import and foreign weighted export prices.

Given the open economy character of Slovak economy the domestic prices of investments (**PI**) are assumed to have more ties with foreign prices (import deflator **PM**), contrary to prices of government expenditures (**PG**), which are connected more to private consumption prices (**PC**). Both are expected to converge in the long-run to the movement of general price in the economy (**PY**). Import prices (**PM**) are weighted according to the level of competition prices on the import side (**CMD**), oil prices (**P_OIL**) measured in euro and domestic production prices level (**PY**). Export prices (**PX**), on the other side, are weighted average of domestic production prices (**PY**) and exporters' competition prices (**CXD**), computed as the export-shares weighted average of fourteen trade partners' export prices of Slovakia in same currency (both **CMD** and **CXD** time series are compiled by CBR).



2.3. The household budget identity

The household budget equation is constructed following the scheme of the National Accounts – Generation and use of income in sector of households. All budget items are recorded in levels (mil. EUR).

Each item of the **revenue side** (see Table 2 below) is linked to a specific macroeconomic variable in our forecasting exercise. The basic income of households – super-gross *compensations* from employment contracts (**H_RCOMP**) – is linked to the development of nominal wages in the economy and employment growth (i.e. the nominal wage base). The net income from work abroad is added to these compensations – **BOP_NFNL** (from Balance of Payments statistics).¹¹ *Mixed income* (**H_RGMI**) is computed as a rate of margin of private firms – **MARG** (value added less employers’ social contributions and brutto wages) and is directly transferred from the budget of firms to households¹². Revenues from ownership of assets – **H_RPPROP** (*property income*) are modelled as a ratio of nominal value added of firms, while social transfers (**H_RSOC**), such as pensions, are linked to nominal GDP growth. *Other transfers* (**H_ROTH**) evolve according to the household expenditures, i.e. this income is dependent on outgoing payments, such as private insurance.

On the **expenditure side** social contributions (**H_EXSOC**) are levied on income from employment (wages), taking into account also the portion flowing into private pension funds management companies (**H_EXSOCPRIV**). Gross wages are taxed by the personal income tax (**H_EXCURT**) and the income from property on the revenue side is taxed by the property tax (**H_EXPROP**). Effective tax rates are used throughout. Other transfers include various payments such as life and non-life insurance, and are linked to the evolution of nominal GDP (**H_EXOTH**). The social contributions, comprising both contributions of wage receivers (**SCW**) and employers (**SCF**), are transferred to the general government budget, in the form of health and social contributions (**G_RHEAL**, **G_RSOC**).

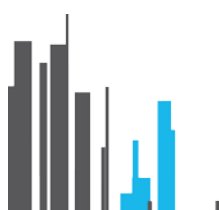
Table 2: Budget of households

Household Revenues		Household Expenditures	
Item	Base/Growth Rate	Item	Base/Growth Rate
Compensations	<i>Wage base, current account</i>	Property exp.	<i>Property income of hous.</i>
Mixed Income	<i>Value added of firms</i>	Taxes on income	<i>Brutto wage (effective rate)</i>
Property Income	<i>Value added of firms</i>	Social contributions	<i>Brutto wage (effective rate)</i>
Social transfers	<i>Nominal GDP</i>	Other transfers	<i>Value added</i>
Other transfers	<i>Household expenditure transf.</i>		
	+ Σ		- Σ
= Nominal disposable income			

Source: author

¹¹ Therefore, unlike in the traditional MCM type models, such income does not feature in the real wealth of households. This feature is directly taken from the National Accounts – Generation and use of income in sector of households, which includes additionally the foreign income relative to GDP computation based on income approach.

¹² To restrict the price illusions and non-standard price behavior of the model, the rate of income flowing from firms to households in form of mixed income is based on real variables.



2.4. The budget identity of firms

Constructing the representative firm's budget constraint is necessary for us to be able to compute tax bases for various taxes and contributions (Table 3), and to differentiate between total GDP in the economy (Y) and market GDP (Y_{MARKET}), i.e. excluding government. The market GDP is calculated as GDP minus the amount of wages of government employees ($WAGEGOV$) including contributions of their employers (following Brillet, 2006). After deducting the indirect taxes (G_{RTAXVAT} and G_{RTAXEXC}) we obtain the value added (VA) in real terms, each tax deflated by private consumption deflator adjusted for the changes of effective VAT tax rate and excise tax rate in the prices of 2005 (current base year for calculation of real GDP).

The operating margin ($MARG$) of the private firms emerges after subtracting the super-gross wages paid by the employers (i.e. wages plus contributions, $WAGEFIRMS$ and the contribution rate R_{SCF}), and by adding subsidies from government ($G_{\text{EXCAPSUBS}}$). We obtain the net profit ($PROFIT$) after deducting various types of taxes (corporate income tax, withholding tax, and other taxes) some of which is then transferred to the households as gross mixed income (H_{RGMI}). The part of the profit that stays with the firm is used for investments and re-payment of loans from banks (NIF).

Table 3: Budget of firms

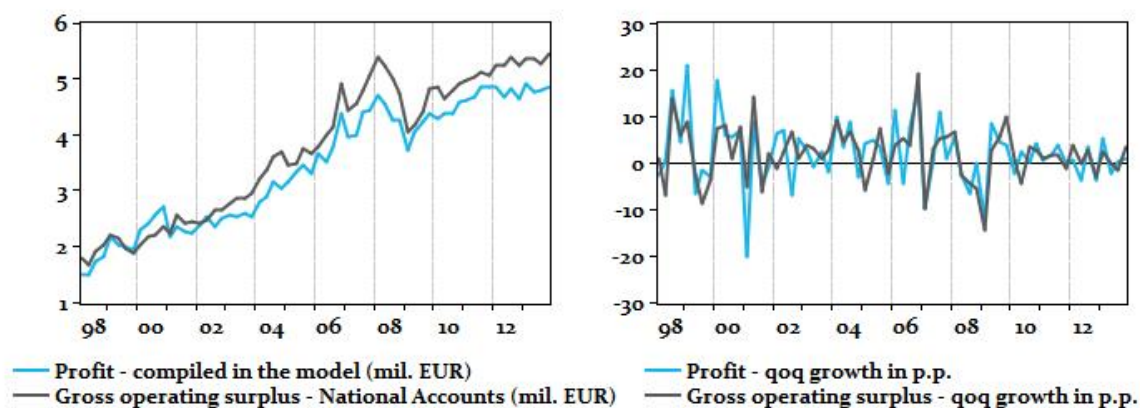
Firm Revenues		Firm Expenditures	
Item	Computation	Item	Computation
Market GDP	= GDP - government comp.		
Value added	= GDP - indirect taxes		
Margin =	= Value added - expen.	Paid wages	Total wages
		Paid contributions	Effective contribution rate
Profit =		Mixed income	Value added (effective rate)
		Net interests (loans)	Rate of GDP
		Corporate tax	Profit (effective rate)
		Withholding tax	Deposits and GDP (effect. rate)
		Other taxes	GDP (effective rate)

Source: author

Although artificial, the compiled resulting time series of profit covers well the development of gross operating surplus from National Accounting (GDP income approach) – Figure 2.



Figure 2: Profit of firms from model and actual gross operating surplus



Source: NBS, author's calculations

2.5. The government budget constraint

The government flow budget constraint includes a detailed division of public expenditures and revenues (see Table 4). In the model, each element is linked to its source. More specifically, the tax revenues are linked to their tax bases (income of households, firms), social transfers to gross wages of households and the expenditures evolve according to the development of economy. Taxes and expenditures are endogenously determined in the model, and the table below lists all the basic links through which changes in tax and expenditure policies feed back into the model.

On the **expenditure side**, the government wage bill evolves as a function of the number of government employees (L_{GOV}) and their average wage ($WGOV$), both following the development in private sector. The accounting entry for social contributions on these wages (G_{EXINS}) appears on both sides of the budget to preserve the total value of expenditures and revenues. Pensions ($G_{EXCURSOCTRAN}$) and other transfers ($G_{EXCUROTH}$) are set to follow nominal variables. Government spending on goods and services and natural transfers (G_{EXGOOD} and $G_{EGOODNSOC}$) are linked to nominal GDP. Debt service (G_{EXI}) depends upon the level of current debt deviation from target. We also consider an exogenous shock which stands for the increase in the risk premium on government bonds in the euro area ($LAMBDA - \lambda$). The risk premium feeds fully into the debt service and copies the current term-structure of government bonds. Government investments follow firm behaviour through a link to the firms' value added (both capital subsidies and fixed capital formation – $G_{EXCAPSUBS}$, $G_{EXCAPINV}$). Looking ahead, the dynamics of different spending items is modelled via simple rules as explained later below.

The revenue side consists of payments from taxpayers, contributors of social and health insurance and administrative fees from all agents in the economy. Personal income tax ($G_{RTAXPIT}$) is levied on income of households from employment (gross wages, $WAGE$). Household income is burdened also by property tax ($G_{RTAXPROP}$) and social contributions distinguished to come from wage earners (SCW) and employers (SCF). Both are in the form of social and health insurance contributions (G_{RSOC} , G_{RHEAL}). The personal income tax and

contributions are imposed on gross wages in private as well as government sector. Other income is levied from private firm sector, such as the withholding tax revenues (*G_RTAXWH*), corporate income tax revenues (*G_RTAXCIT*) and other taxes (*G_RTAXOTH*). The development of non-tax revenues is linked to the nominal GDP growth. [Table 4](#) presents the different kinds of taxes considered in the model and their respective payers.

To ensure the model has a long-term solution, the government surplus is targeted at a certain level consistent with a long-run debt target.

Table 4: Budget of the government

	Source/Base	Short-run reflection	Long-run reflection
Revenues			
Personal income tax	Wage base, mixed inc.	Households	Savings, labour force
Corporate income tax	Profit	Firms (profit), hous. (mixed inc.)	Investment, savings
Withholding tax	Deposits, GDP	Firms (profit), hous. (mixed inc.)	Investment, savings
Taxes on property	Value added of firms	Households	Investment, savings
Value added tax	Final consumption	Consumption prices	Consumption deflator
Excise tax	Private consumption	Consumption prices	Consumption deflator
Other taxes	GDP in current prices	Firms (profit), hous. (mixed inc.)	Investment, savings
Social contr. (employees)	Wage base	Households	Savings
Social contr. (employers)	Wage base	Firms	Investment
Other nontax revenues	GDP in current prices	Budget balance only	Savings (public)
Market production	Value added of firms	Government consumption	Savings (public)
Expenditures			
Wages	Private wage base	Government consumption	Savings (public)
Social contributions	Social Security	Gov. consumption, revenues	Savings (public)
Goods and services	GDP in current prices	Government consumption	Savings (public)
Natural transfers	GDP in current prices	Government consumption	Savings (public)
Pensions	GDP in current prices	Households	Savings (priv., public)
Other expenditures	GDP in current prices	Budget balance only	Savings (public)
Interest costs	Risk premium	Households	Savings, capital stock
Investment	Value added of firms	Investment	Capital stock
Subsidies	Value added of firms	Firm's margin	Savings (private)
Σ			
Deficit			

Source: author



2.6. Fiscal rules

Fiscal rules ensure that the model converges to a long-run equilibrium. The definition of the rules introduces key fiscal targets defined in terms of the ratio of government debt to GDP, ratio of government deficit to GDP. The rules involve a feedback from any deviations from these targets as well as a feedback from the output gap.

The rules are somewhat non-standard (following Vetlov, Warmedinger, 2006, p. 31). Rather than being simple reaction functions as commonly assumed in the literature, the rules here aim to reproduce real-world decision making, and allow a flexible allocation of the burden of adjustment across individual budgetary items. Intuitively, the process involves three steps. First, the consolidation need on a particular budgetary item (as a percentage of GDP) is identified. For example, the government may want to reduce debt from a present level towards the target by a few percentages of GDP. In the second step, the speed of consolidation is chosen. This will imply a desired effective rate of tax or expenditure for the next period. The difference between next period's desired effective rate and the previous period's effective rate. This is calculated in the third step. The process is iterative over time. In every period, the known base (from the previous period) is used to calculate the effective rate. It is thus assumed that the base itself is unaffected by fiscal adjustment. Of course, the base is endogenous, and the general equilibrium effects of the fiscal adjustment will have an influence on the base too. In the next period, the same formula applies, and the base gets gradually updated. Because of such an adjustment, it might in reality take somewhat longer to reach the target than initially planned. This step-wise procedure is captured in the equations below.

$$v_{it} = [w_{debt} \cdot s \cdot (cur_{debt} - tar_{debt}) + w_{def} \cdot s \cdot (tar_{def} - cur_{def}) + w_{gap} \cdot s \cdot (y_{gap_{t-1}})] \cdot y_{n_t} \quad (9)$$

$$c_{ti_debt} = \frac{v_{it} w_{debt}}{base_{t-1}}; c_{ti_def} = \frac{v_{it} w_{def}}{base_{t-1}}; c_{ti_gap} = \frac{v_{it} w_{gap}}{base_{t-1}} \quad (10)$$

$$d(rate) = c_{ti_debt} + c_{ti_def} + c_{ti_gap} \quad (11)$$

The variable v_{it} refers to the consolidation need of a fiscal variable i at time t , given the chosen speed¹³ s and weights w_{debt} , $w_{deficit}$, w_{gap} in the reaction function. The variable y_{n_t} stands for nominal GDP. The terms in brackets in (9) are the current deviations from targeted debt, deficit and the state of the output gap. In (10) the c_{ti} represents the change of the rate for the time t of the fiscal rule variable i only to see the contribution of each consolidation reference (deficit, debt or gap). In (11) the implied changes in the effective rate from all three feedback variables can be added together to give the desired change in the effective rate. A key element of the process is the choice of the consolidation variable, i.e. the revenue or spending item(s) on which the burden of consolidation will fall. The fiscal adjustment is allowed for following items:¹⁴

¹³ The speed of consolidation has no impact on fiscal multipliers, while having effect only on how fast the fiscal targets are reached. During the convergence of the model to the equilibrium state it is set to 2 quarters, i.e. the differential between target and current deficit/debt is being expected to be consolidated during half a year.

¹⁴ Non-tax revenues were excluded from the fiscal rule: non-tax revenues tend to closely follow the growth of GDP. Current expenditures of public administration are excluded because their dynamic closely follows the evolution of pensions. Paid interests are following risk premium on government bonds on the markets and the additional amount regarded as renegotiated debt is not considered as a fiscal rule.



Revenue side:

Personal income tax (rate R_TAXPIT), corporate income tax (R_TAXCIT), withholding tax (R_TAXWH), property tax ($R_TAXPROP$), value added tax (R_TAXVAT), excise tax (R_TAXEXC), social security contributions – wage earners (R_SCW), social security contributions – employers (R_SCF).

Expenditure side:

Wages of administration – number of government employees (L_GOV), wages of administration – average wage of employees ($WGOV$), expenditures on goods and services (G_EXGOOD), capital expenditures ($G_EXCAPINV$), capital transfers to firms in form of subsidies ($G_EXCAPSUBS$).

3. Solution of the model

The first part of the model consists of equations set-up according to the theory, which means the variables contained are chosen strictly according to theory and the parameters are then estimated or calibrated. This concerns primarily the production function. The remainder of the model is estimated on data following mainly the MCM type models for Italy (Angelini et al., 2006) and for Germany (Vetlov and Warmedinger, 2006). Together the model is estimated with 388 endogenous and 57 exogenous variables, counting the fiscal reaction variables as well. The long-run equilibrium is modelled via 13 error correction models. The full list of variables is presented in [Appendix 2](#) and the equations are listed in [Appendix 3](#) and [Appendix 4](#). The model is solved via deterministic dynamic simulation via Newton algorithm (EViews – Quantitative Micro Software 2007).

3.1. Calibration and estimation

As mentioned earlier, certain parts of the model are calibrated. Most notably, the production function parameters as well as some convergence parameters of the Slovak economy to the euro area.

In order to enable the model to converge to equilibrium, assumptions must be made about the steady-state properties of the external environment. These are listed in [Table 5](#) below.

Table 5: Chosen steady states and steady state growths per quarter – in percentage points

Production Function		External Environment		Convergence Parameters		Other	
Beta	0.57	USD/EUR rate	1.1	CMD, CXD to F_PY_{stst}	3 years	K_priv	84.8
Delta	0.7	F_L	0.01	F_Y to F_Y_{stst}	3 years		
R	1	p_oil, F_PY	0.5	F_L to F_L_{stst}	3 years		
RN	1.5			F_M to F_M_{stst}	3 years		
NAIRU	0.09			WDR to WDR_{stst}	20 years		
TFP	0.29			P_OIL to P_OIL_{stst}	3 years		
TFP to TFP_{stst}	2 years			USDEUR to $USDEUR_{stst}$	3 years		
WAP to WAP_{stst}	5 years						
NAIRU to $NAIRU_{stst}$	5 years						
Delta to $DELTA_{stst}$	3 years						
RN to RN_{stst}	3 years						

Source: author



Table 5 shows the duration of convergence of exogenous variables from their currently observed level to the steady state level (with subscript “stst”), i.e. the total factor productivity (TFP), working age population (WAP), NAIRU, depreciation rate (DELTA), nominal interest rate (RN), competition prices (CMD, CXD) and foreign prices (F_PY), foreign GDP (F_Y), employment (F_L) and imports (F_M), the world demand indicator (WDR – compiled by CBR), prices of oil (P_OIL) and the USD/EUR exchange rate. The USD/EUR exchange rate is set to 1.1, Slovakia – being a euro area economy – takes monetary policy as given, thus, the levels of basic interest rates are set exogenously (nominal interest rate RN at 1.0, with steady state growth of prices 0.5 per quarter). This also means there is no monetary response to the fiscal experiments analysed.

The parameters of the production function are used from the former National Bank of Slovakia model – such as depreciation rate (DELTA), beta capital/labour share ratio, or NAIRU rate (set as an exogenous anchor). Share of private capital (K_PRIV) is set to follow average of latest observations. The growth rate of total factor productivity was chosen to bring an approximately 2.8 % steady state growth of potential real GDP (year over year).

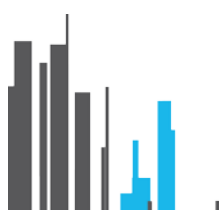
The tax (income) elasticity of labour supply is calibrated at minus one, which is a conservative value when compared with Chetty et al. (2011) with elasticities well above one but realistic according to Fiorito and Zanella (2008).¹⁵

Error correction models¹⁶ are used to estimate the equations containing the long-term targets for demand and prices variables as well as the short-term dynamics. Cointegration check in the estimated relations makes sure the gap between actual and long-term path of related variables is closed. A two-step approach is used. First, the theoretical skeleton comprising the static long-term relationships is built, and subsequently, the short-term dynamic relationships between variables and the error correction term are estimated (Engle and Granger, 1987). Long-term targets (suffix _STAR in Appendix 3) follow the standard definitions in this type of model. Keeping in mind the trade-off between smooth convergence and purity of econometric estimates, the definitions of long-run targets is kept as simple as possible (no lagged dependent variable can be used). In this case the sufficient condition is cointegration of dependent and explanatory variables (single equation Engle-Granger cointegration test reported in Appendix 3). As a consequence the data do not often offer satisfactory test statistics in estimated equations, however, this can be tolerated if the structure of the whole model is well defined.

The model is estimated on quarterly data. The data are collected from the National Bank of Slovakia, Statistical Office of the Slovak Republic, Ministry of Finance of SR, OECD, IMF, World Bank and Eurostat. The sample begins in the first quarter of 1998 and ends in the third quarter of 2014. All the National Accounts data are based on the new version of ESA2010, published in detail in December 2014. The public administration data are based on consolidated database of the National Bank of Slovakia for modelling purposes. When needed, the inconsistencies

¹⁵ Micro-econometric studies refer to much lower elasticities. In the context of Slovakia, Siebertova et al., 2014 find an elasticity of -0.25. The consequence of such a calibration would be to cut fiscal multipliers of personal income tax and social contributions paid by employees by roughly one quarter.

¹⁶ All equations are estimated separately. Simultaneous estimation of the supply block following Fenz and Spitzer (2004) was rejected based on unsatisfactory estimates of error correction parameters (positive values).



between public expenditures and revenues of the consolidated database and the ESA methodology are handled by residuals gradually converging to zero (variables in [Appendix 2](#) with the prefix “RES_”). The database contains aggregate composite indicators compiled by CBR, such as world demand indicator ([WDR](#)), competition prices on the export and import side ([CXD](#), [CMD](#)).

3.2. Ensuring the convergence of the model

The estimated parameters of the ECM behavioural equations are reported in [Appendix 4](#). In some cases the error correction term or parameters are calibrated given that the original estimates were not statistically significant (e.g. Phillips curve in real compensation equation and deflator GDP short-run equation). In some cases the estimated parameters were restricted to satisfy the dynamic homogeneity condition ensuring the convergence of the model, which must apply for all equations. It means that the steady state long-term growth of dependent variable must equal the sum of parameters multiplied by the long-term growth of the explanatory variables (see Benkovskis and Stikuts, 2006, Fenz and Spitzer, 2004, or Boissay and Villette, 2005).

To converge from the current state, i.e. state of non-equilibrium with variables far from their long-term targets, fiscal rules must be turned on to ensure a stable government deficit to GDP ratio. Stable debt service costs and consequently also a stable risk premium allow the capital stock to converge to the desired level.

The choice of instrument variables for the fiscal rule varies in standard models (for an overview of 16 econometric eurozone central bank models, see Fagan and Morgan, 2005). In the context of our model, there are 8 different revenue and 5 expenditure categories available to support long-run fiscal targets. Some of them cannot be used if we want to preserve some key ratios characterizing the steady state of the economy such as the investment-to-GDP ratio.

Considering the above, the consolidation mix was chosen in line with Cournede et al. (2013) and the weight attached to each instrument is shown in [Table 6](#).

Table 6: Consolidation weights

Used weights			Original weights – OECD (2013)	
<i>Subsidies</i>	0.8	0.12	<i>Subsidies</i>	0.5
<i>Excise taxes</i>	1.0	0.15	<i>Environmental taxes</i>	0.7
<i>Property tax</i>	1.0	0.15	<i>Other property taxes</i>	0.7
<i>Property tax</i>	1.3	0.19	<i>Immobile prop. taxes</i>	1.0
<i>Goods and services</i>	1.3	0.19	<i>Goods and services</i>	1.0
<i>Personal income tax</i>	0	0	<i>Personal income tax</i>	1.8
<i>Corporate income tax</i>	0	0	<i>Corporate income tax</i>	0.2
<i>Value added tax</i>	1.4	0.20	<i>Consumption taxes</i>	0.9
Σ	6.8	1	<i>(% of potential GDP)</i>	6.8

Source: OECD, author's calculations

It turns out that the requirement of equilibrium convergence places a bound on the levels of debt and the associated risk premia that can be analysed in the model. Fortunately, the range that the model supports involves the interval that is relevant for the study of the Slovak



economy. As explained, the model of risk premium is based on estimates from a pooled regression (see [Appendix 1](#)). [Table 7](#) lists the steady state values for the risk premium associated with different levels of target public debt. Given high values of target steady state debt the risk premium shoots up rapidly. Once the target debt reaches 70% of GDP, the model does not converge.

Table 7: Risk premium vs debt level

Model for Visegrad Group	
Target debt	Risk premium
0.20	0.013
0.30	0.015
0.40	0.018
0.50	0.022
0.60	0.027
0.70	<i>does not converge</i>

Source: author's calculations

4. Simulations

The basic functioning of the model is presented by a supply, demand and price shocks in the equilibrium state of the economy consistent with a 40-percent debt-to-GDP ratio.

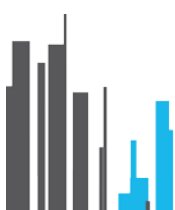
It is important to note that the fiscal rule is turned off during the first 2 years of simulation¹⁷ in order to observe an undisturbed impact of the shocks on the economy (including fiscal shocks later). After that the consolidation pack is switched on again delivering the debt target in the long run.

The rule allows for a response to three variables: deviations from target debt, deficit and output gap. There may be situations when the debt stabilization and macroeconomic stabilization objectives clash.

In our simulations, countercyclical considerations are ignored, and so the fiscal instruments do not respond to the output gap. We justify this choice on the following grounds that the policy makers have neither stable or informative estimates of the output gap, as also stated in Kucserova and Odor (2014). At the same time, responding to both deficit and debt improves the stability properties of the model.

After the basic dynamics of the model is shown, the consequences of permanent adjustment in different revenue and spending items are studied. In each case, the size of the adjustment is a fiscal tightening worth 1 percent of GDP in the first two quarters. This exercise is consistent with different long-run steady states in terms of debt-to-GDP ratio.

¹⁷ The models described in Fagan, Morgan, 2005 (e.g. Belgium, Germany, Ireland, Spain) switch off the fiscal rule completely during the simulation of shocks. However, other line of models analysing fiscal multipliers, such as Klyuev, Snudden (2011), discuss also the cases of active fiscal instruments during the simulation of shocks.



The fiscal multiplier is calculated as the ratio of the change in GDP in constant prices relative to the baseline (superscript *b*) and to the change in government revenue/expenditure relative to GDP in constant prices (see Uhlig, 2010):

$$(\Delta Y_t - \Delta Y_t^b) / \Delta G_t, \text{ where} \quad \Delta G_t = \frac{G_t}{Y_t} - \frac{G_t^b}{Y_t^b} \quad (12, 13)$$

and for the cumulative implied fiscal multiplier,

$$\frac{\sum_{t=0}^N (\Delta Y_t - \Delta Y_t^b)}{\sum_{t=0}^N \Delta G_t} \quad (14)$$

4.1. The basic dynamics of the model

We study the basic properties of the model by looking at the consequences of three types of shocks:

1. A supply shock – a one-off increase in total factor productivity growth by 1 percentage point compared to baseline
2. A demand shock – an isolated one-quarter fall in world demand growth by 1 percentage point relatively to baseline
3. A price (cost-push) shock – permanent decrease in oil prices (Brent) by 20 %.

4.1.1. Supply shock – total factor productivity

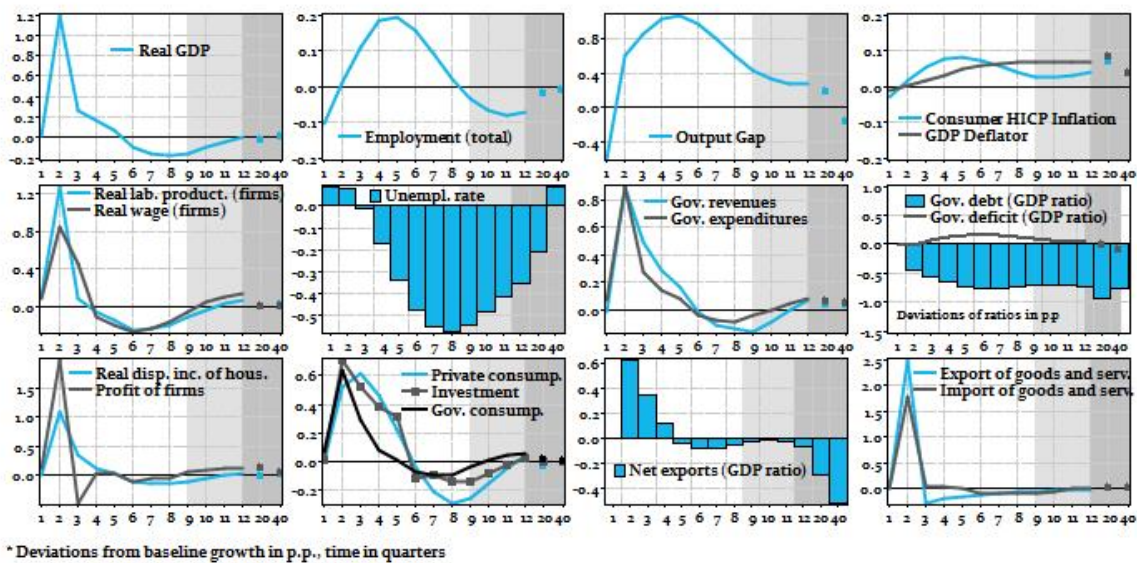
The positive supply shock accelerates the real growth immediately having positive impact on firms' profits, disposable income of households and revenues of government budget – [Figure 3](#). Despite being merely a real shock the output gap is getting positive. One reason is the absence of monetary policy, which would dampen the pickup of consumption and excessive investment through an increased interest rate.

One year after the shock the prices are on the rise due to stronger domestic demand and sticky wages, composing of higher contributions from investment (high profits, investment accelerator), private consumption (disposable income also takes in mixed income from the firms, but with wages growth roughly in line with productivity) and also government consumption utilising the improving condition of budget. The rising demand brings new opportunities in the labour market resulting in a drop of unemployment rate at 0.4 percentage point at the end of second year. At this time the government debt has improved about 0.7 percentage point of GDP, net exports contribute 0.4 p.p. to GDP growth compared to baseline due to higher exports. The main contribution to exports is the total productivity differential between domestic and foreign economy. The exogenous character of foreign economy development brings the ratio of net exports down later on, because of higher domestic export prices relatively to foreign prices, which are assumed to grow at constant rate.



After the second year the fiscal policy makers regain the control over the budget (fiscal rule is activated). The rule that gives equal weight to deficit and debt deviations from their targets immediately adjusts the taxes (lower revenues) and boosts expenditures both trying to reverse the debt back to 40% of GDP. However, the output gap begins to shrink very slowly although wages and consumption are back to their baseline growth levels. Given the more positive impact of taxes and expenditures on the economy after the second year the gap closes very slowly and the aimed equilibrium is delayed for several years.

Figure 3: Positive supply shock – total factor productivity



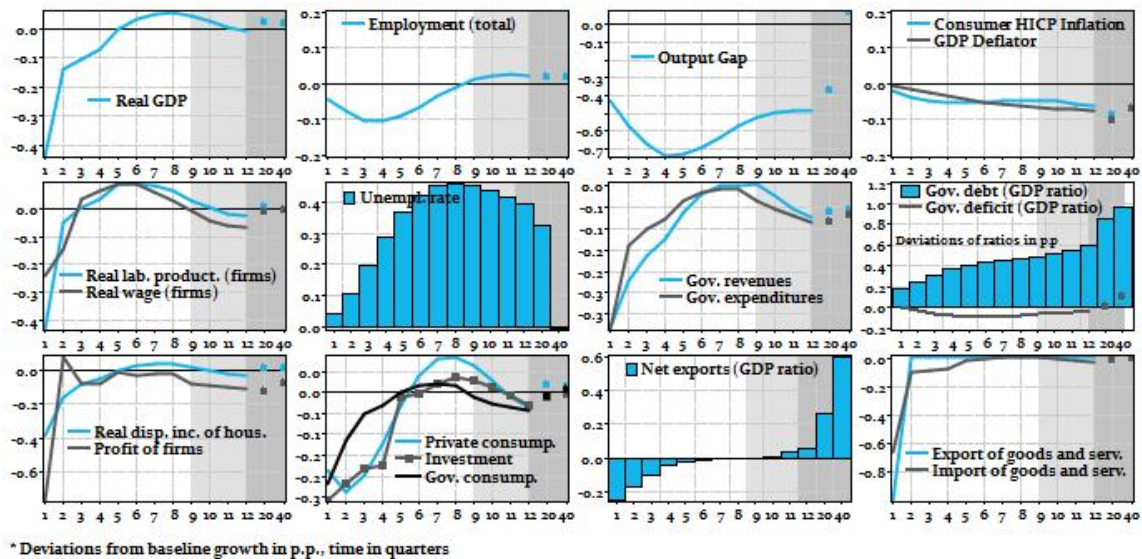
Source: author's calculation

4.1.2. Demand shock – world demand

In case of a one-off 1 percentage point fall in foreign demand¹⁸ (exclusively entering the export equation) the impact is observed immediately – Figure 4. Taking into consideration the high ratio of exports to GDP (over 80%) and unit elasticity between exports and foreign demand, the fall in GDP is milder. This result is driven also by imports, which took some impact from weaker domestic demand. Unemployment rises by more than 0.3 percentage point and the government debt given lower revenues than expenditures rises about 0.5 p.p. over the target, two years after the shock. The fiscal rule is activated at the point of recovered GDP growth (but still in negative gap position and 0.1 lower prices growth). This means consolidation through raising taxes and cutting expenditures given the high ratio of debt.

¹⁸ The fall is modelled as 1-percent slow-down of growth from quarter to quarter, i.e. 1% reduction in level.

Figure 4: Negative foreign demand shock



Source: author's calculation

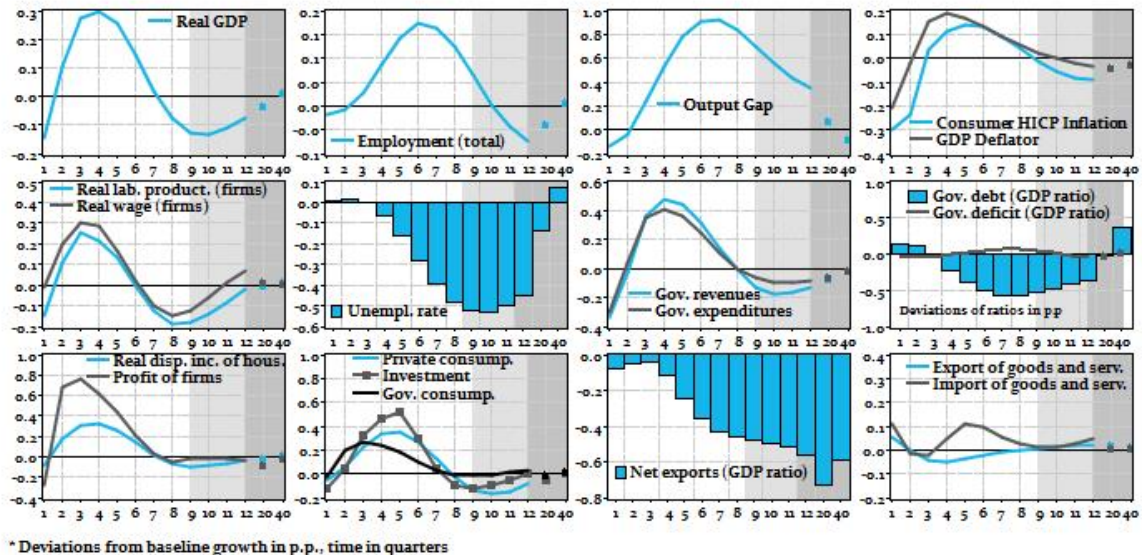
Both expenditures and revenues adjust their position, but given relatively high multipliers (elaborated later in the paper), the growth path of GDP and wages slows down a bit. The profits are very weak, therefore, there are no available sources for new investment. The convergence towards equilibrium is slowly underway despite slowing down of the economy caused by cutting expenditures and raising taxes in a negative output gap.

4.1.3. Price shock – oil prices

Figure 5 shows the impact of a permanent decrease of oil prices (20% quarter on quarter). The prices adjust quickly, but output reacts only with a lag. The immediate impact of the oil shock on prices is about 0.3 percentage points, the maximum impact on real GDP is observed in the end of the first year after shock (0.3 p.p. compared to baseline). At the start, the government budget loses revenues due to nominal decline in the economy. Soon, after two quarters, the situation reverses and both expenditures and revenues pick up higher growth rates. Government debt begins to dissolve after one year when positive effects of the oil shock are materialized.

The positive effects are mostly the result of higher consumption (both private and government) given the increase in real wages. With some lag, also employment improves and unemployment drops 0.5 p.p. as a result of higher profits of firms.

Figure 5: Oil price shock



Source: author's calculation

4.2. Consequences of revenue-side policy shocks

We first study the consequences of a permanent increase in the VAT and social contributions rates. Then, we calculate implied multipliers from exercises involving a permanent adjustment in various revenue and spending items. The economy is assumed to be in its long-run steady state consistent with a debt-to GDP ratio of 40 percent and the size of the fiscal adjustment is calibrated to amount to an improvement of 1 percent of GDP in the budget balance over two quarters.¹⁹ The fiscal rules are switched off during the first two years in the exercises and then switched on but kept switched off when calculating fiscal multipliers.

4.2.1. Consequences of a permanent VAT rate rise

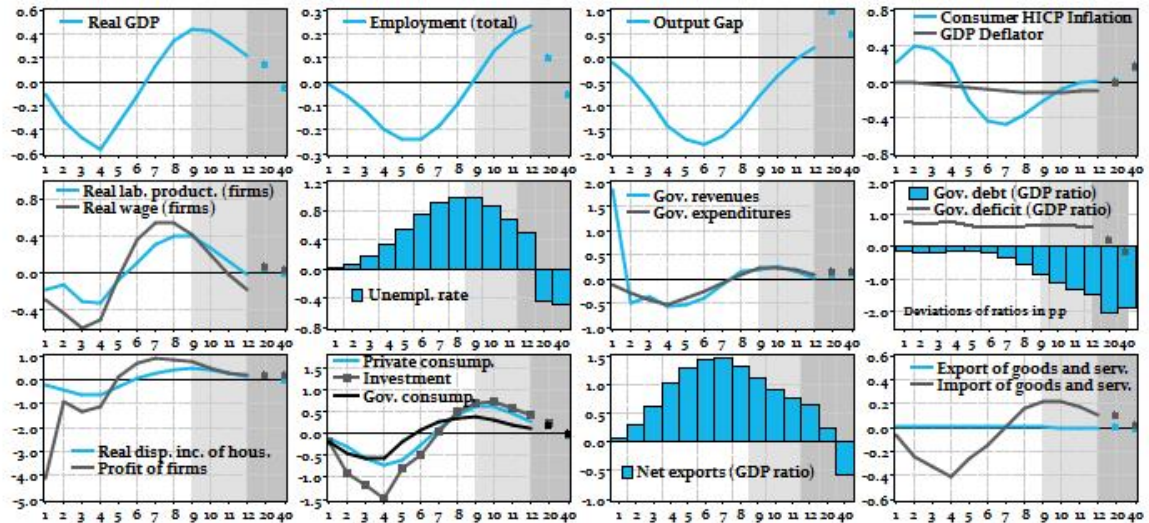
The dynamics of key variables is shown in Figure 6. The increase of the VAT rate triggers higher consumer price inflation (maximum of 0.4 in the first year against the baseline), which causes a drop in the real income of households and the domestic consumption, bringing down the real GDP growth by 0.5 p.p. below the baseline. The increase in prices is, however, short-lived, as contracted demand and the associated negative output gap keep prices on leash after an initial spike in inflation. Net exports also improve as domestic demand contracts, which is caused by a more rapid fall in imports than in exports. The real economy variables such as the output and real wages, overshoot in the medium run the growth on the background of favourable relative price development. Unemployment rises towards 1.0 percentage points against the baseline.

After two years of the shock effect the government decides to get back to its target. Given its favourable budget position (nearly 1 percentage point below target debt-to-GDP ratio) it loosens

¹⁹ Given that the model is essentially linear, exercises involving different initial conditions yielded very similar results.

the expenditures and decelerates revenues. This slowly brings the deficit down towards the baseline.

Figure 6: Value added tax – permanent increase of tax rate



* Deviations from baseline growth in p.p., time in quarters

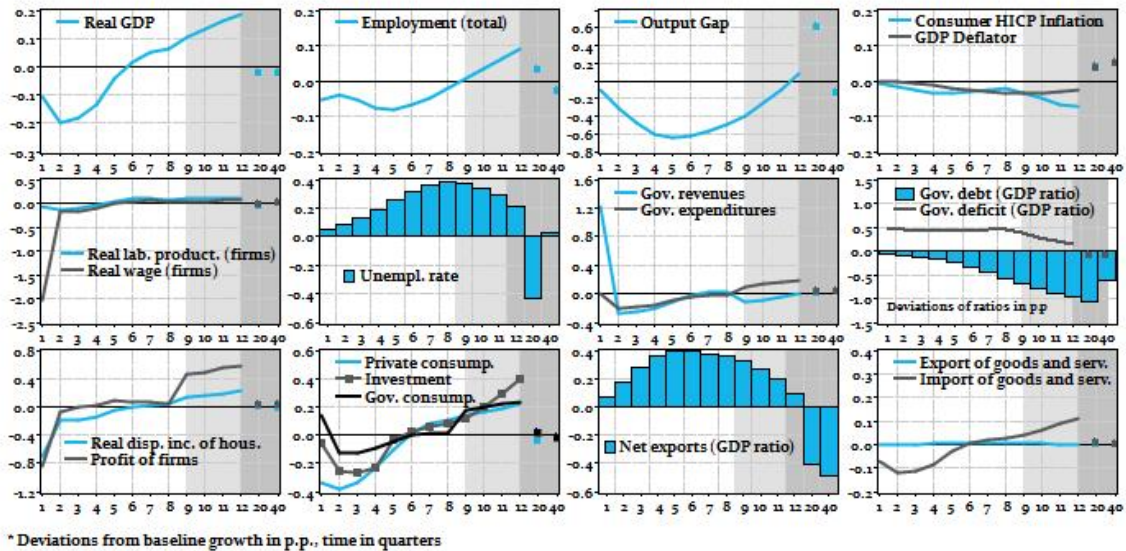
Source: author's calculations

4.2.2. Consequences of a permanent rise of the employers' social contribution rate

The model distinguishes between contributions deducted from gross wages of employees and those paid in addition by employers. The amount of contributions by employers is taken from the margin of firms (market value added less indirect taxes). After raising the effective contribution rate by the state the firms drop the real wages immediately (2.0 p.p.) – Figure 7. The rate at which firms reduce the wages is not sufficient to cover the higher labour costs, therefore, the result is the reduction of profits by approximately 1.0 p.p. The aggregate domestic demand falls with negative contributions of investment and private consumption – mainly due to drop of disposable income (wage base) and profits. The higher social contributions revenues ensure a gradual improvement of budget position with the negative deficit improving about 0.5 points of GDP quarterly from the starting point. This is because the higher wage costs are shared between firms (lower profits) and households in the short-run (compensations). In the long-run the costs are reflected by firms into general higher prices level.

Subsequently, the gap position starts to improve as the government tries to erase the incurred gap by raising expenditures and cutting revenues.

Figure 7: Social contributions rate – employers

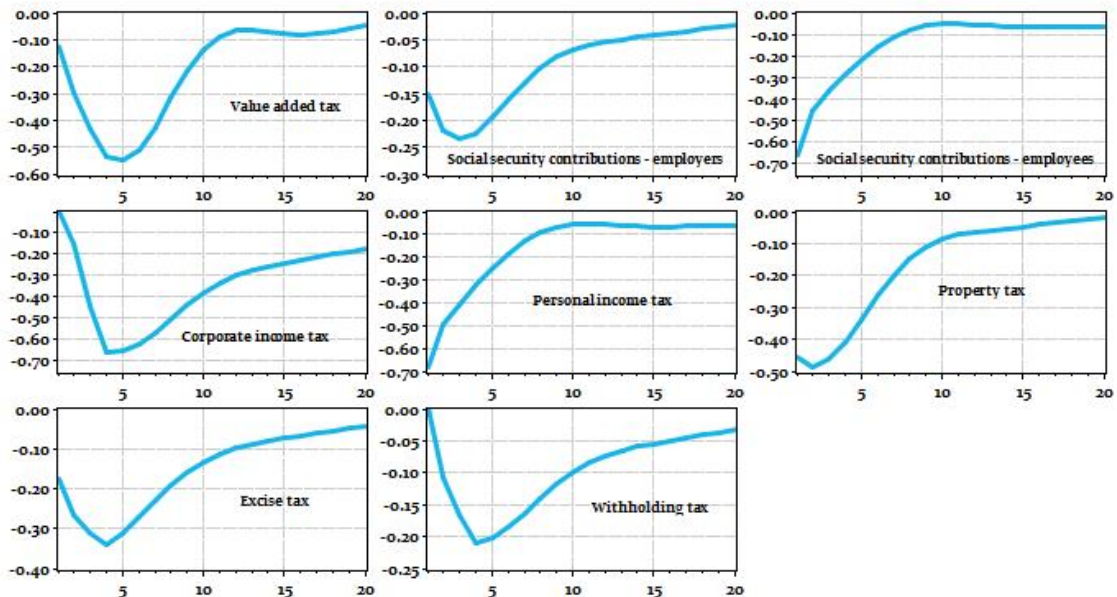


Source: author's calculations

4.2.3. Revenue multipliers

We summarize the real economy impact of revenue measures using fiscal multipliers defined above. The multipliers associated with budget revenues adjustment are somewhat higher than those referred to in literature (Section 1.1 – Table 1). One reason is that we have a much more detailed definition of ties between households and government budgets. The indirect taxes – Figure 8 – have smaller impact on the economy (value added tax 0.5 and excise tax 0.3). They are entering prices of private consumption, and thus are paid indirectly by households when purchasing goods and services on the market. Likewise, also the social contributions paid employers, if borne by firms together with households, result in a 0.3 multiplier (also fast adjustment of firms' labour productivity). On the other hand, social contributions paid by wage earners and personal income tax (0.7 during the impact) are the worse option for consolidation in the short and medium term. Together with the property tax (impact almost 0.5) they directly reduce the disposable income of households and reduce the contribution of private consumption to GDP growth. The worst option is however the corporate income tax with a negative short-term impact of almost 0.7 and lasting impact in long-term (0.2), diminishing profits and consequently investments. While the household budget stays more or less untouched by raising withholding tax (also considering the missing banking sector in the model), the corporate tax is present also in the price of capital, therefore lowers the potential output in the long-run. Detailed impact of each tax is presented in figures in Appendix 5.

Figure 8: Summary of government revenues multipliers



Source: author's calculations

4.3. Consequences of expenditure-side policy shocks

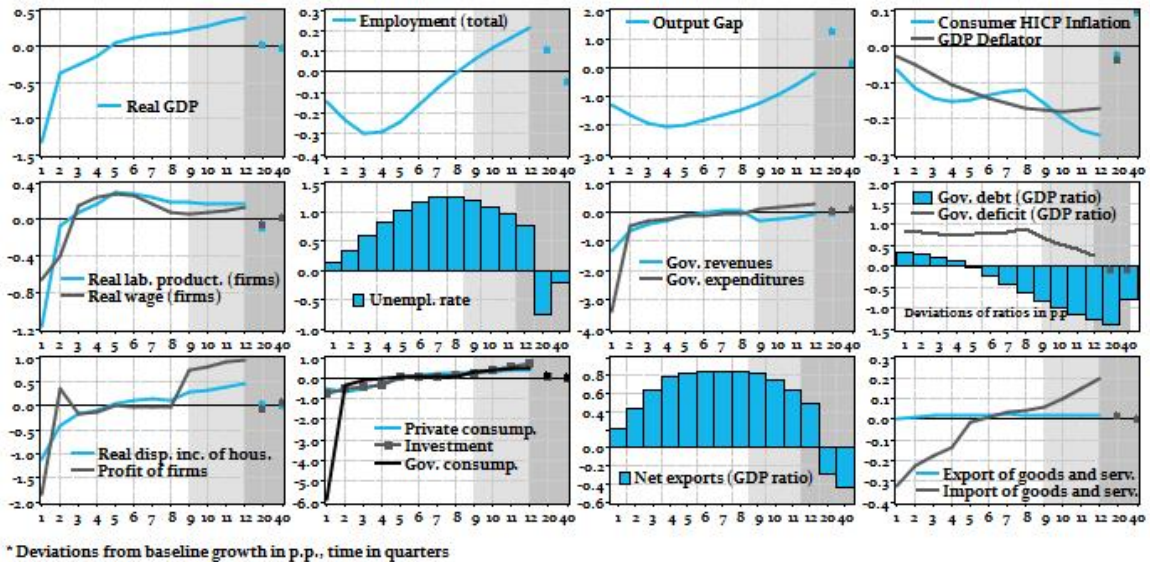
We conduct exercises on the spending side similar to those we have just analysed for various revenue items. Again, we study the consequences of an improvement in the budget position through a reduction in expenditures expected to have an impact of 1 percent of GDP over two quarters. The economy is in its steady state consistent with a debt-to GDP ratio of 40 percent. The fiscal rules are switched off during the first two years, after that the deficit and debt fiscal rule is switched on.

4.3.1. Consequences of a goods and services spending cut

The impact on the economy implied by goods and expenditures cut is presented in Figure 9. We observe a drop in GDP by 1.4 p.p. in the first quarter, employment by more than 0.3 p.p. and prices by 0.1 p.p. The negative impact is highlighted by drop of government revenues over 1.0 percentage points over the baseline. This is caused by the reaction of firms by dropping the real wages, consequently, the real disposable income of households falls as well. The shock reveals a connection between government consumption and market production of firms, which is visible in the missing contracts due to fall of profits by over 1.5 p.p. to the baseline. Two years after the shock employment recovers, but due to frozen economy caused by weakened domestic demand the profits stay depressed and lagged unemployment rate peaks over 1.0 p.p. compared to baseline. The improvement of budget is not strong, and exhibits only 0.7 points of debt-to-GDP ratio in the eighth quarter. After switching on the fiscal rule the government expenditures recover together with profits, investments and private consumption. With model on its path

back to the equilibrium state the gap turns over in the third year into slightly positive values, but soon is dropping again.

Figure 9: Goods and services expenditures – consolidation of budget



Source: author's calculations

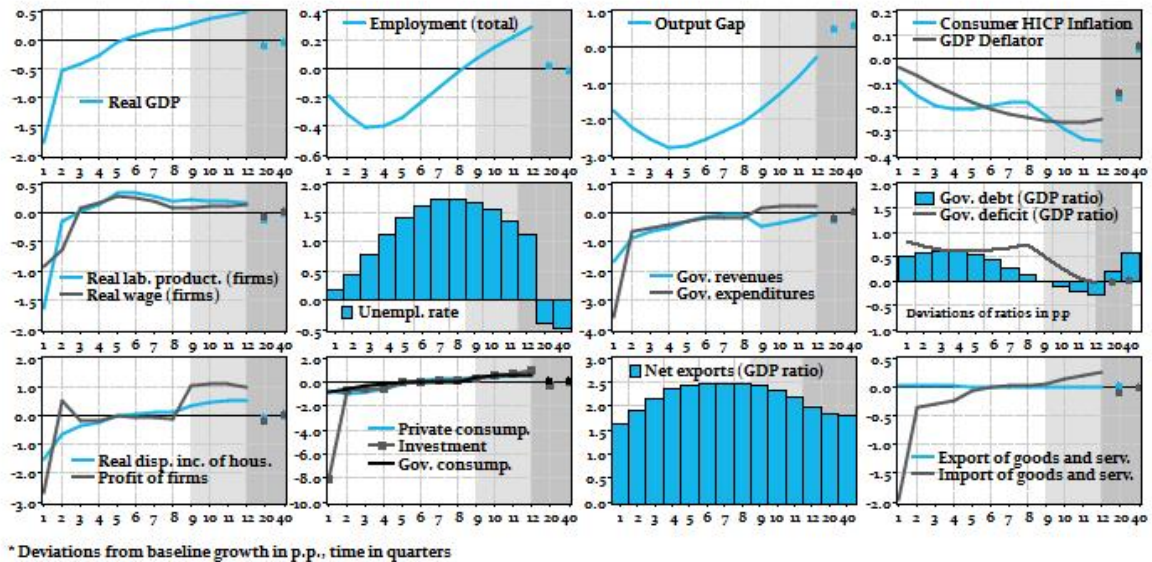
4.3.2. Consequences of a government investment cut

The government is following its consolidation plans by cutting government fixed capital formation by expected 1% of GDP (Figure 10). As being a part of total investments, investment are the main contributor to GDP fall in the first quarter of the simulation. The fall of investments is strengthened by a decline in profits, due to connection of public and private production (fall of market GDP). Private firms are forced to deploy some of employees (0.2 p.p. against the baseline) and decrease the wages (0.8 against the baseline). Therefore, due to lower wage base and cut in mixed income, the private consumption is dragged down during the first year.

Unfavourable environment during the first two years is caused by missing profits (as a main source of investments) and also due to the investment accelerator (GDP in investment equation). Some of the government revenues are attached to wage bases (personal income tax, social contributions), and except the missing revenues from corporate income tax, also a shortfall of value added tax revenues is observed (missing investments). Last but not least, cumulatively, one can observe the fall of potential product by 0.5% after the first two years.

The result of the shock before switching on government fiscal policy is a stagnant economy with negative output gap and inflation growth below baseline, and no actual improvement of public debt (on the target). The fiscal rule leads the government to raise government expenditures and cut taxes. This lifts profits and subsequently investment, leading unemployment back towards the natural rate, while prices and debt reach their equilibrium level.

Figure 10: Government investment cut



Source: author's calculations

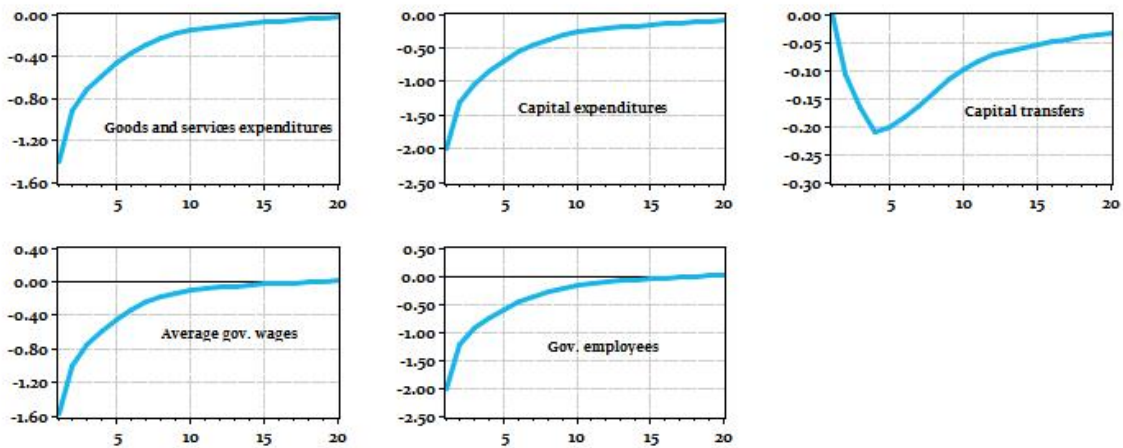
4.3.3. Expenditure multipliers

The multiplier effects of expenditures we obtain from our simulation are in line with the literature (Table 1 – Section 1.1) – referred to be in the range of 1.1 – 1.5. In the experiments currently provided by the model the range is 1.4-2.0, except the capital transfers to firms and individuals (all Figure 11). The **capital transfers** are entering the budget of firms, and therefore contribute to the level of profits, however, they do not enter directly the investment equation, i.e. they are transformed into private investments with help of the profits. The shortage of government capital transfers however worsens the economy mostly in the long-run. Their share on total government expenditures is however very low. Impact of expenditure side consolidation measures is recorded in figures in Appendix 5.

Cutting **wages of government employees** (compensations) has in principle the same effect as government intermediate consumptions cuts. While on the one hand both are components of the “G” government final consumption aggregate of GDP according to the expenditure approach, on the other hand, there is no forward-looking behaviour to reverse this impact. In case the government wages are cut, the multiplier is two tenths percentage higher on impact (1.6) than in case of goods and expenditures (1.4). The difference is much greater impact on real disposable income of households and employment (some firms lost sales on the market due to lower private demand).

The impact of **reducing government employment** is much worse. In the equilibrium, saving 1% of GDP in public expenditures is equivalent to cut in employment in the public sector of 20%. The unemployment rate is higher in the beginning of the shock something around 4 p.p. The government expenditures fall over 3 p.p. against the baseline, while causing also revenues shortage by 2.0 p.p. Lower denominator causes worsening of debt-to-GDP ratio during the first year before improvement.

Figure 11: Summary of government expenditures multipliers



Source: author's calculations

5. Conclusions

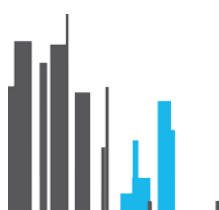
The CBR uses a medium scale econometric model of the Slovak economy for short-term and mid-term forecasting exercises. The model also allows the investigation of the short-term consequences of alternative fiscal policy measures which can be summarized in an implied fiscal multiplier measure.

We have found that fiscal adjustment on the spending side has the most pronounced effect on the real economy, such as changes in government expenditures on capital expenditures, public employees' wages, and goods and services. On the revenue side, corporate income tax is found to be particularly harmful for growth in the long-run, social security contributions of employees and personal income tax in the short-run.



References

- Aizenman, J., Hutchinson, M. and Y. Jinjark (2011). What is the Risk of European Sovereign Defaults? Fiscal Space, CDS Spreads and Market Pricing of Risk. NBER Working Paper No. 17407.
- Ambrisko, R., Babecky, J., Rysanek, J. and V. Valenta (2012). Assessing the Impact of Fiscal Measures on the Czech Economy. CNB Working Paper Series 15/2012, Czech National Bank, December 2012.
- Angelini, E., Boissay, F. and M. Ciccarelli (2006). The Dutch Block of the ESCB Multi-Country Model. ECB Working paper No. 646, June 2006, European Central Bank.
- Auerbach, A. and Y. Gorodnichenko (2012). Measuring the Output Responses to Fiscal Policy. American Economic Journal – Economic Policy, Vol. 4, pp. 1–27.
- Baksa, D., Benk, S. and Z. M. Jakab (2010). Does „The“ Fiscal Multiplier Exist? Fiscal and Monetary Reactions, Credibility and Fiscal Multipliers in Hungary. Office of the Fiscal Council.
- Baumgartner, J., Breuss, F. and S. Kaniowski (2004). WIFO-Macromod – An Econometric Model of the Austrian Economy, pp. 61-86. In: Macroeconomic Models and Forecasts for Austria, Proceedings of OeNB Workshops No. 5, November 2004, Oesterreichische Nationalbank.
- Bencik, M. (2009). The Analysis of Effects of Fiscal Policy on Business Cycle – A SVAR Application. NBS Working Paper 2/2009, National Bank of Slovakia.
- Benkovskis, K. and D. Stikuts (2006). Latvia’s Macroeconomic Model. Working Paper 2/2006, Latvijas Banka, ISBN 9984-676-82-X.
- Bi, H., Leeper, E. M. and C. B. Leith (2012). Uncertain Fiscal Consolidations. NBER Working Paper 17844, National Bureau of Economic Research, February 2012.
- Blanchard, O. and D. Leigh (2013). Growth Forecast Errors and Fiscal Multipliers. IMF Working Paper WP/13/1, January 2013, IMF.
- Blanchard, O. and R. Perotti (2002). An Empirical Characterization of the Dynamic Effects of changes in Government Spending and Taxes on Output. Quarterly Journal of Economics, 117 (4), pp. 1329-1368.
- Boissay, F. and J. P. Villetelle (2005). The French Block of the ESCB Multi-Country Model. ECB Working Paper No. 456, March 2005, European Central Bank.
- Boussard, J., Castro, de F. and M. Salto (2012). Fiscal Multipliers and Public Debt Dynamics in Consolidations. Economic Papers 460, European Commission, July 2012.



Brillet, J. (2006). Structural Econometric Modelling: Methodology and Tools with Applications under Eviews. Available online at: <http://www.eviews.com/StructModel/structmodel.pdf>.

Chetty, R., Guren, A., Manoli, D. and A. Weber (2011). Are Micro and Macro Labor Supply Elasticities Consistent? A Review of Evidence on the Intensive and Extensive Margins. *American Economic Review*, 101(3), pp. 471-475.

Christiano, L., Eichenbaum, M. and S. Rebelo (2011). When Is the Government Spending Multiplier Large? *Journal of Political Economy*, Vol. 119, pp. 78-121.

Corsetti, G., Kuester, K., Meier, A. and G. J. Mueller (2013). Sovereign Risk, Fiscal Policy, and Macroeconomic Stability. *The Economic Journal*, Volume 123, Issue 566, pp. 99-132, February 2013.

Dalsgaard, T., Andre, C. and P. Richardson (2001). Standard Shocks in the OECD Interlink Model. OECD Economics Department Working Papers No. 306, OECD Economics Department.

Davig, T. and E. M. Leeper (2011). Monetary-fiscal policy interactions and fiscal stimulus. *European Economic Review*, Elsevier, 55(2), pp. 211-227.

Engle, R. F. and C. W. J. Granger (1987). Cointegration and Error Correction: Representation, Estimation and Testing. *Econometrica*, 55, pp. 251-76.

Fagan, G., Henry, G., and R. Maestre (2001). An area-wide model (AWM) for the euro area. ECB Working Paper No. 42, January 2001, European Central Bank.

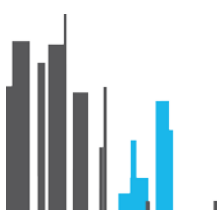
Fagan, G. and J. Morgan (eds.) (2005). *Econometric Models of the Euro-area Central Banks*, Edward Elgar.

Fenz, G. and M. Spitzer (2004). AQM The Austrian Quarterly Model of the Oesterreichische Nationalbank, pp. 11-60. In: *Macroeconomic Models and Forecasts for Austria*, Proceedings of OeNB Workshops No. 5, November 2004, Oesterreichische Nationalbank.

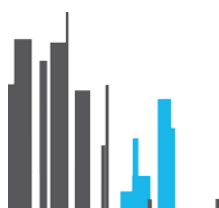
Fiorito, R. and G. Zanella (2008). Labor Supply Elasticities: Can Micro Be Misleading for Macro? *Quaderni del Dipartimento di Economia Politica*, Università Degli Studi di Siena, n. 547.

Franta, M. (2012). Macroeconomic Effects of Fiscal Policy in the Czech Republic: Evidence Based on Various Identification Approaches in a VAR Framework. CNB Working paper series 13/2012, Czech National Bank.

Gechert, S. and H. Will (2012). Fiscal Multipliers: A Meta Regression Analysis. IMK Working Paper 97-2012, Macroeconomic Policy Institute, Dusseldorf, July, 2012.



- Gechert, S., Hallett, A. H. and A. Rannenberg (2015). Fiscal Multipliers in Downturns and the Effects of Eurozone consolidation. CEPR Policy Insight No. 79, Centre for Economic Policy Research, February 2015.
- Haugh, D., P. Ollivaud and D. Turner (2009). What Drives Sovereign Risk Premiums?: An Analysis of Recent Evidence from the Euro Area. OECD Economics Department Working Papers, No. 718, OECD Publishing. <http://dx.doi.org/10.1787/222675756166>.
- Henry, J., Hernandez, P. de Cos and S. Momigliano (2004). The Short-Term Impact of Government Budgets on Prices: Evidence from Macroeconomic Models. ECB Working Paper Series, No. 396, October 2004, ECB.
- Hofer, H. and R. M. Kunst (2004). The Macroeconometric Model LIMA, pp. 87-116. In: Macroeconomic Models and Forecasts for Austria, Proceedings of OeNB Workshops No. 5, November 2004, Oesterreichische Nationalbank.
- Hunt, B. and D. Laxton (2003). Some Simulation Properties of the Major Euro Area Economies in MULTIMOD. IMF Working Paper WP/03/31, February 2003, IMF.
- Ilzetki, E., Mendoza E. G. and C. A. Vegh (2011). How Big (Small?) are Fiscal Multipliers? IMF Working Paper WP/11/52, March 2011, IMF.
- Klyuev, V. and S. Snudden (2011). Effects of Fiscal Consolidation in the Czech Republic. IMF Working Papers 11/65, International Monetary Fund.
- Kocsis Z. and D. Nagy (2011). Variance decomposition of sovereign CDS spreads. MNB Bulletin, October 2011.
- Krusper, B. and G. Pellenyi (2010). Impacts of fiscal adjustments in Western European countries on the Hungarian economy. MNB Bulletin Vol. 5 Issue 4, Magyar Nemzeti Bank, December 2010, pp. 17-23.
- Nickel, Ch. and A. Tudyka (2013). Fiscal Stimulus in Times of High Debt (Reconsidering multipliers and twin deficits). ECB Working paper Series No. 1513/February 2013, European Central Bank.
- Odor, L. and J. J. Kucserova (2014). Finding Yeti: More robust estimates of output gap in Slovakia. Working Paper No. 2/2014, Council for Budget Responsibility, National Bank of Slovakia.
- OECD, Economic Outlook, Chapter 4 – Fiscal Consolidation: Requirements, Timing, Instruments and Institutional Arrangements, Volume 2010/2, OECD, 2010, pp. 219-265
- Orr, A., Edey, M. and M. Kennedy (1995). Real Long-Term Interest Rates: the Evidence from Pooled-Time-Series. OECD Economic Studies No. 25.



Owyang M. T., Ramey V. A. and S. Zubairy (2013). Are Government Spending Multipliers Greater During Periods of Slack? Evidence from 20th Century Historical Data. Working Papers 2013-004, Federal Reserve Bank of St. Louis, January 2013.

Pecsyova, M. (2013). Estimated Impact of Fiscal Consolidation on GDP Growth in the SR. BIATEC Volume 21 (4), National Bank of Slovakia, 2013.

Relovsky, B. and J. Siroka (2009). A structural model of the Slovak economy, Banking Journal BIATEC, Volume 17/2009, No. 7, p. 8-12.

Siebertova, Z., Senaj, M., Svarda, N. and J. Valachyova (2014). To Work or Not to Work? Estimates of Labour Supply Elasticities. Working Paper No. 1/2014, Council for Budget Responsibility, National Bank of Slovakia.

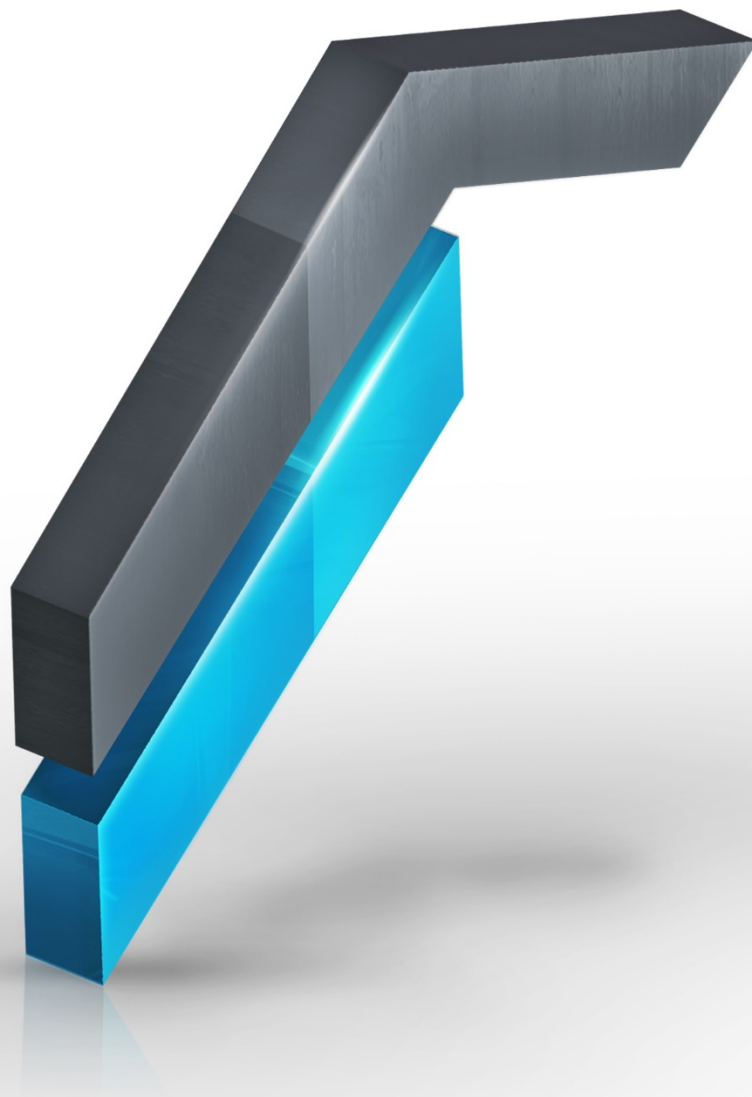
Spilimbergo, A., Symansky, S. and M. Schindler (2009). Fiscal Multipliers. IMF Staff Position Note, SPN 09/11, May 2009, IMF.

Uhlig, H. (2010). Some Fiscal Calculus. American Economic Review, 100 (2): pages 30-34.

VALENTA, V. (2011). Interactions between fiscal policy and real economy in the Czech Republic: A quantitative analysis. (Doctoral dissertation, University of Economics, Prague).

Vetlov, I. and T. Warmedinger (2006). The German Block of the ESCB Multi-Country Model. ECB Working paper No. 654, July 2006, European Central Bank.





**Council for Budget
Responsibility**

Imricha Karvaša 1
Bratislava 1
813 25
Slovakia



www.rozpoctovarada.sk