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FISCAL MULTIPLIERS IN SLOVAK ECONOMY DSGE SIMULATION

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NBS Working Paper

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Abstract

In order to calculate fiscal multipliers for Slovakia, I used a small open DSGE model of Slovakia constructed by Zeman and Senaj (2009), augmented by more sophisticated fiscal sector that comprises of government expenditure components – consumption, investment and social transfers to liquidity constrained households as well as government revenue components – personal income tax, employer social contributions, VAT tax and lump-sum tax.

The Slovak government has laid out a plan of public finance consolidation for the period from 2013 to 2017 in order to meet the Fiscal Compact criteria. According to fiscal multipliers calculated in this paper the consolidation will cause an aggregate loss of 2.5 % of GDP during this period.

JEL classification: E 32, E 62, H 20, H 50
Key words: Fiscal multipliers, expenditure and revenue components, DSGE simulations

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1. INTRODUCTION

In the aftermath of the euro area crisis caused mainly by sovereign debt problems in some periphery countries a Fiscal Compact has been introduced. This agreement stipulates an implementation of rigorous fiscal rules in all euro area countries, namely balanced structural budget and a debt brake at 60% of GDP. As most countries do not meet these requirements, they will have to adopt fiscal and other macroeconomic policies that would, in medium term, guarantee fulfilling those criteria. Slovakia belongs to a group of countries that have to consolidate their public finances. The consolidation is naturally painful as it is accompanied by a GDP growth slowdown. It is therefore important for the policy makers to know both short-run as well as long-run effects of various consolidation instruments on economic activity.

Fiscal policy has traditionally been evaluated within a framework of large-scale macroeconomic models. However, these models have been subject to the Lucas critique. Therefore, new kinds of models, such as VAR and DSGE in particular, have become very popular in the literature recently. DSGE models can assess and evaluate various policy instruments in both the short and the long run, can compare effects of temporary and permanent changes and can analyze interactions of fiscal and monetary policies.

There is a large number of papers estimating fiscal multipliers in DSGE models. To mention just few, Furceri and Mourougane (2010), in their OECD study examine the effects of fiscal policy on output and debt sustainability by developing a DSGE fiscal model calibrated using euro area data and OECD tax and benefits database. The study also tests robustness of its results to a wide range of structural parameters. Stähler and Thomas (2011), simulate fiscal consolidation in Spain within the euro area in a two-country DSGE model with comprehensive fiscal and labor blocks. They find that public investment cuts are the least desirable way of performing consolidation and that a shift of direct to indirect tax financing of government expenditures can improve Spain's competitiveness. Baksa et al. (2010), calculate

fiscal multipliers in Hungary with a small open DSGE model estimated on Hungarian data. They find large differences between the multipliers of different types of fiscal expansions and also that multipliers can be largely modified depending on the future ways of financing the expansion i.e. depending on different fiscal rules. Ambrisko et al. (2012), study the effects of fiscal policy on the Czech economy with a small open DSGE model whose crucial fiscal parameters are Bayesian estimated. Using estimated multipliers they quantify the effects of the Czech Republic's 2012 consolidation fiscal package on the economy.

Čolláková et al. (2014), estimate fiscal multipliers for Slovakia with a structural VAR model as well as with QUEST model.[2] They find that consolidation performed through tax increases is less painful in the short run while it is more damaging for the economy in the long. The consolidation carried out with expenditure instruments has high negative effects on economic activity in the short run and stays negative in the case of public investment but turns to positive in the case of government consumption.

The main objectives of this paper are estimating fiscal multipliers for various fiscal instruments, comparing their values in two regimes – autonomous monetary policy and monetary union and quantifying the cost of a 2013-17 consolidation package undertaken by the Slovak government. For this purpose we augment a small open DSGE model developed by Zeman and Senaj (2009) by more sophisticated fiscal sector that comprises of government expenditure components – consumption, investment and social transfers to liquidity constrained households, as well as government revenue components – personal income tax, employer social contributions, VAT tax and lump-sum tax.

This paper has the following structure. In section 2 we summarize the structure of the original DSGE model and describe in detail augmented fiscal sector including calibration of its parameters. Section 3 describes simulation design and compares

[2] QUEST is a DSGE model developed by the European Commission and calibrated with Slovak data.

multipliers of all fiscal instruments in the sort and long run. Section 4 evaluates the costs of 2013-17 planned consolidation of the Slovak government. Section 5 summarizes the main results and concludes.

2. THE MODEL

The model used in our study is an augmented version of the small open DSGE model described in detail in Zeman and Senaj (2009).[3] First we summarize the main features of that model.

2.1. ORIGINAL MODEL

Production

There are two sectors of production – intermediate goods and final goods.

Inputs for intermediate goods are labor, capital and oil. Intermediate goods are tradable and can be used either domestically for producing final goods or can be exported abroad. Producers in this sector produce differentiated good. There is imperfect competition in this sector and hence producers have market power in setting price of goods used domestically.

Final goods are produced of intermediate goods either domestic or imported and of oil and are either consumed privately, publicly or invested. There is perfect competition in final good production sector. Final good is non-tradable.

Households

There are two types of households – Ricardians and Non-Ricardians. The former ones make each period decisions about current consumption, investment in physical capital, holdings of financial assets and hours worked in such a way as to maximize their lifetime utility. The latter ones do not borrow or save but instead spend all their current labor income. There is an imperfect competition in the labor market that

[3] QUEST is a DSGE model developed by the European Commission and calibrated with Slovak data.

[3] http://www.nbs.sk/_img/Documents/PUBLIK/WP_3-2009%20DSGE%20Slovakia.pdf

gives market power to workers in wage setting. In order to improve dynamics of the model we assume habit formation in consumption and capital adjustment costs implying costly transformation of investment into capital.

Price setting

There is staggered price setting á la Calvo for the prices of domestic and imported intermediate goods as well as for the price of labor (wages). Firms (workers) cannot change their price unless they receive a random "price-change signal". If they do not receive this signal the price is automatically adjusted, partially to previous period inflation and partially to steady state inflation.

Trade

Only intermediate goods can be traded. Domestic firms export a fraction of intermediate goods abroad. Prices of exported intermediate goods can differ from prices of intermediate goods sold domestically (pricing to market). Imported intermediate goods cannot be consumed directly. Importing firms have market power in setting price of imports. Hence exchange rate pass-through is incomplete and the law of one price does not necessarily hold in short term.

Financial market

Domestic agents can insure against shocks by holding a portfolio of domestic bonds and foreign assets. To avoid of excessive accumulation of net foreign assets in domestic economy in the model, their price increase with their level. The more is domestic country indebted (higher level of net foreign assets), the costlier for its citizens is to borrow further.

Monetary and fiscal policy

Monetary authority reacts to deviations of inflation, output and exchange rate from their steady state values by setting nominal interest rate (Taylor rule).

Fiscal sector is very simple. Exogenous government expenditure is balanced with lump-sum taxes each period and hence government deficit and debt are zero in equilibrium. There are no other taxes and transfers.

2.2. AUGMENTED FISCAL SECTOR

In order to estimate multipliers of various fiscal instruments the simple structure of the fiscal sector need to be extended. Government collects revenue – gr_t in the form of an income tax – tax_w_t, employer social contributions – tax_n_t, VAT tax – tax_c_t and lump-sum tax – tls_t to finance its expenditures – ge_t. A fraction of the expenditures is consumed by the government – gc_t and the rest is returned to the economy in the form of public investment – ig_t and transfers[4] to the non-optimizing (non-Ricardian) households tr_t.

$$gr_t = (tax\_w_t + tax\_n_t)w_t h_t + tax\_c_t c_t + tls_t$$

$$ge_t = gc_t + ig_t + \lambda tr_t$$

where λ is a fraction of non-Ricardian households. We assume tax rates – $\mathrm{tax\_w}$, tax_n and tax_c being constant and all expenditure instruments being exogenous AR(1) processes.

Hence primary deficit – pd_t is given by

$$pd_t = ge_t - gr_t$$

Taking into account interest payments with the gross interest rate R on the existing stock of debt b_t, debt evolves as following

$$b_t = \frac{R_t b_{t-1}}{a_t \Pi_t} + pd_t$$

The term $a_t \Pi_t$ adjusts for inflation and technological progress as all model variables are expressed in real terms.

Public investment increases the stock of government capital which is Cobb-Douglas aggregated with the stock of private capital to form the total capital in the economy.

[4] Government transfers include social and healthcare contributions.

We consider two fiscal rules that stabilize debt in the long run.

In the first case, stabilization is achieved by a lump-sum tax that is paid by households. This taxation is non-distortionary as it does not affect saving and labor supply decisions. Hence it should have only marginal impact on the magnitude of fiscal multipliers.

$$tls_t = \overline{tls} + \tau^b \left(\frac{b_t}{y_t} - b^T \right)$$

where b^T is a long run target of debt relative to GDP.

To test robustness of fiscal multipliers with respect to the fiscal rule, we also use an income tax as a stabilizing instrument. We assume that income tax rate is endogenous

$$tax\_w_t = \overline{tax_w} + \tau^b \left(\frac{b_t}{y_t} - b^T \right) + e\_tax\_w_t$$

As this variable distorts the economy more, it would likely have more harmful impact on output and fiscal multipliers will be probably larger.

2.3. CALIBRATION

Calibration of parameters of the original model is explained in Zeman and Senaj (2009). In this subsection we describe calibration of augmented fiscal sector.

The share of government capital in the capital composite equals 3% and both types of capital depreciate at an annualized rate of 6%.

For the steady state ratios we use values of the 2013 vintage from ESA 95-based fiscal data. From that data we set steady state values for government purchases, public investment and government transfers such that their ratios relative to steady state value of GDP are close to their actual counterparts. On the revenue side average implicit tax rates for VAT, income tax, and employer social contributions are

calculated such that revenue from a given tax is divided by its corresponding base; which for VAT is private consumption and for other two wage base. Parameter b^T was set such that the resulting steady state ratio of public debt to GDP equals 50%. Steady state targeted values are listed in Table 1.

Table 1: Steady state values

target	symbol	values
government purchases to GDP	gc/y	17.2
public investment to GDP	ig/y	2.6
government transfers to GDP	tr/y	18.9
VAT rate	tax_c	13.6
income tax rate	tax_w	21.3
employer contributions rate	tax_n	40.0
public debt to annualized GDP	b/y	50.0
budget deficit5 to GDP	bd/y	2.8

Persistence coefficients of fiscal instruments on the expenditure side were estimated from ESA 95 fiscal series and persistence of all tax instruments were set to zero. The feedback coefficient of fiscal rule measuring responsiveness of corresponding instruments (lump-sum and income tax, respectively) to deviations of the debt ratio to GDP from its long-run average was set to 0.4. This value is used by Furceri et al. (2010) in their OECD study and falls in the range 0.2 – 0.5 estimated by Gali et al. (2007) on US data. Values of the parameters are listed in Table 2.

[5] Budget deficit is the sum of primary deficit and interest payments.

Table 2: Parameter values		
parameter	**symbol**	**values**
Persistence of government purchases	ρ_{gc}	0.9
Persistence of public investment	ρ_{ig}	0.9
Persistence of government transfers	ρ_{tr}	0.9
Persistence of all tax instruments	ρ_{tax}	0
Feedback coefficient	τ^{b}	0.4

3. MAIN RESULTS

In this section we present our main findings about multipliers but first we provide a definition of a fiscal multiplier and describe the simulation design.

3.1. SIMULATION DESIGN

There are various definitions of a fiscal multiplier in the literature. We follow Spilimbergo et al. (2009), and define fiscal multiplier as a net present value, i.e., the discounted sum of output changes until each horizon divided by the sum of discounted budget deficit changes until the same horizon, with steady state real interest rate being discount factor. As this study concerns fiscal consolidation, i.e. the reduction of budget deficit and debt, we consider negative shocks on instruments spending side and positive shocks on tax instruments on revenue side.[6] A negative government spending shock reduces corresponding variable by 1% of its steady state value and a positive tax shock increases corresponding tax rate by 1 percentage point. Shocks are assumed to be permanent and for simplicity, the model is at steady state before shocks' impact.

In the first set of simulations, each instrument at a time is disturbed while all others are kept at their steady state values except lump-sum tax that responds to guarantee a return of debt to its long-run target. Checking for robustness we run the

[6] If the underlying model is linear or linearized, impacts of mutually opposite shocks are symmetrical

second set of simulations where we repeat the same exercise but now with income tax instrument playing the stabilizing role.

As the original model was calibrated with data taken before the adoption of euro in Slovakia, monetary policy is assumed to be autonomous. Hence monetary policy may (and very likely does) interacts with fiscal policy. It may mitigate the impact of fiscal tightening by monetary loosening. To assess a magnitude of this interaction, in the next set of simulations we try to eliminate active Taylor rule and mimic a situation of Slovakia being in the monetary union. To achieve this we run simulations with such a path of exogenous monetary shocks that keep interest rate constant (exogenous).

3.2. FISCAL MULTIPLIERS

Table 3 shows multipliers of fiscal instruments in the process of budget and debt consolidation when each instrument at a time is permanently reduced on an expenditure side and increased on a revenue side, respectively and long-run debt sustainability is achieved by non-distorting lump-sum taxation. While in the case of stimulating an economy larger multiplier is more desirable as one unit of stimulus provides higher boost to GDP, in the case of consolidation it is just opposite; the smaller the multiplier is the lower negative effect of one unit of budget reduction it has on GDP.

As a general observation, instruments on the expenditure side has larger negative effect at first stages of consolidation and this negative impact is diminishing with time while consolidation through revenue instruments is not so harmful to GDP at the beginning but becomes more damaging in later stages.

Table 3 shows that raising social contributions paid by employers have the worst effect on GDP in the long-run, followed by a reduction of public investment; both multipliers are larger than 1.

Table 3: Multipliers – stabilization by lump-sum tax

	4q	8q	12q	16q	100q
government consumption	0,55	0,47	0,44	0,44	0,89
government investment	0,57	0,50	0,48	0,49	1,20
government transfers	0,59	0,45	0,37	0,33	0,41
employer contributions	0,26	0,45	0,53	0,58	2,09
wage tax	0,17	0,18	0,20	0,22	0,92
VAT tax	0,40	0,44	0,45	0,47	0,99

To check robustness of fiscal multipliers with respect to fiscal rule, we substitute non distortionary lump-sum tax with income tax. Income tax rate now changes endogenously in a way to guarantee sustainable long-run debt. Table 4 indicates that results are qualitatively similar in the short run but very different in the long run. Because the lump-sum taxation is not distortionary, the impact of fiscal instruments in the long run is qualitatively similar to the impact in the short run only its magnitude is bigger. Long run effects of fiscal instruments under the income tax stabilization regime can be seen as a combination of the permanent change in the corresponding fiscal instrument and the permanent reduction in the income tax rate implied by fiscal rule. The last column of table 4 indicates that the latter effect dominates in all instruments. Hence consolidation under the income tax fiscal rule turns to become beneficial for the economy in the long run. The second to last column of table 4 denotes the number of quarters after which consolidation becomes expansionary for a particular fiscal instrument.

Table 4: Multipliers - stabilization by income tax

	4q	8q	12q	16q	qtrs	100q
government consumption	0,57	0,47	0,38	0,28	(29)	-0,56
government investment	0,58	0,50	0,43	0,36	(37)	-0,39
government transfers	0,61	0,44	0,29	0,15	(21)	-0,77
employer contributions	0,30	0,67	0,84	0,89	(61)	-0,48
wage tax	0,17	0,13	0,08	0,02	(18)	-0,67
VAT tax	0,45	0,50	0,49	0,44	(51)	-0,22

Government transfers appear to be the best instrument of consolidation in the long run.

Now we want to check a role monetary policy plays in these calculations. In the current model setting of active monetary policy the interest rate reacts to inflation and output gap. As fiscal consolidation conducted in previous simulations reduces economic activity and usually inflation too, the Taylor rule dictates to lower the interest rate. So there is a conjecture that restrictive fiscal policy is counterbalanced by expansionary monetary policy and consequently fiscal multipliers are smaller than they would have been, had monetary policy been passive. This is the case of Slovakia. As a member of the euro area since 2009 it adopts the interest rate that does not necessarily reflect its domestic economic situation. Table 5 lists fiscal multipliers calculated under the condition of passive monetary policy with income tax stabilization.

Table 5: Multipliers - passive monetary policy

	4q	8q	12q	16q	100q
government consumption	0,63	0,62	0,61	0,59	0,47
government investment	0,65	0,66	0,67	0,68	0,66
government transfers	0,69	0,63	0,57	0,52	0,32
employer contributions	0,34	0,79	1,04	1,13	-0,39
wage tax	0,18	0,17	0,14	0,10	-0,17
VAT tax	0,52	0,67	0,76	0,82	0,97

We can observe that all multipliers are larger at the impact and as the time horizon increases, the difference widens further. Only consolidation through employer contributions and income tax rates turn to be beneficial in the long run, though with smaller effect. Hence conducting fiscal consolidation in the euro area is more painful than it would have been under the autonomous monetary policy.

4. COST OF FISCAL CONSOLIDATION 2013-17

We can illustrate a use of estimated fiscal multipliers in practice. Slovak government has pledged to consolidate its public finance in order to stabilize public debt in accordance with the EU regulations contained in the Stability and Growth Pact and the Fiscal Compact. In April 2014 it has announced a new fiscal consolidation package for years 2014-17.[7] Summary of measures from this package and also from 2013 consolidation package is listed in Table 6. The overall magnitude of these measures amounts to 3% of cumulative 2013-17 nominal GDP.

Table 6: Consolidation 2013-17 (1.scenario)

	2013	2014	2015	2016	2017	total
mil €	506.00	748.00	407.00	188.00	444.00	2 293.00
% GDP	0.70	1.00	0.52	0.23	0.52	2.97

Source: Stability program for the Slovak Republic

To quantify macroeconomic effect of this consolidation we use the estimated multipliers from Table 5, calculate cumulative impact of each fiscal instrument and finally add them together[8]. Results are listed in Table 7.

[7] Details of this package are described in a document: Program stability Slovenskej republiky na roky 2014 až 2017
http://www.finance.gov.sk/Components/CategoryDocuments/s_LoadDocument.aspx?categoryId=120&documentId=11715

[8] Although fiscal multipliers are valid for changes in real variables and fiscal package is expressed in nominal terms we do not deflate nominal variables because of very low inflation environment

Table 7: Cumulative effect of 2013-17 consolidation					
	2013	2014	2015	2016	2017
% GDP	-0.17	-1.07	-1.77	-2.09	-2.49

According to our calculations, the planned consolidation package for years 2013-2017 will depress economic activity by 2.5 percentage points of cumulative GDP compared to the baseline model with unchanged fiscal policy.

5. CONCLUSION

In this article we augmented a small DSGE model of the Slovak economy with more sophisticated fiscal sector in order to assess the impact of various fiscal instruments on the economic performance during a fiscal consolidation. The set of instruments comprises of consumption and income taxes and employer social contribution on the revenue side as well as government consumption, public investment and social contributions on the expenditure side. In general, consolidation through expenditure instruments is more damaging initially but this negative effect dissipates with time; the least desirable way of consolidating on the expenditure side in the long run is cutting public investment. Proceeding on the revenue side is different; immediate effect of increasing taxes is mild but is getting more harmful with time, notably in the case of increasing employer social contributions. The picture looks similar whether lump-sum or income tax is used as a stabilizing instrument in the short run. In the long run though, the situation is qualitatively different. Consolidation under the lump-sum tax fiscal rule negatively affects the economy also in the long run while under the income tax rule consolidation slows the economy initially but turns out to be beneficial in the long run. We also show that consolidation is less painful in an environment of autonomous monetary policy where negative impact of restrictive fiscal policy can be counterbalanced by active monetary policy.

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persisting during the given period (price deflator of domestic demand has been constant over 2013-15 period).

Finally we estimate the negative impact of the 2013-17 consolidation package that the Slovak government pledged to stick with; the cumulative cost will be around 2.5 % of aggregate GDP.

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