Assessing the Impact of Fiscal Measures on the Czech Economy

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Abstract

We build a satellite DSGE model to investigate the transmission of fiscal policy to the real economy in the Czech Republic. Our model shares features of the Czech National Bank's current g3 forecasting model (Andrle, Hlédik, Kameník, and Vlček, 2009), but contains a more comprehensive fiscal sector. Crucial fiscal parameters, related mainly to the specified fiscal rule, are estimated using Bayesian techniques. We calculate a set of fiscal multipliers for individual revenue and expenditure items of the government budget. We find that the largest real GDP fiscal multipliers in the first year are associated with government investment (0.8), social security contributions paid by employers (0.5) and government consumption (0.5).

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1. Introduction

Fiscal policy has received considerable attention since the global economic and financial crisis began in 2008. This attention has also fallen on central banks, since fiscal measures often significantly affect economic activity (real GDP, inflation) and consequently monetary policy interest rates need to be set appropriately. Governments frequently introduce several fiscal measures at once, in so-called fiscal packages, which consist of various measures on both the expenditure and revenue sides of the government budget. Depending on the model used, fiscal measures might not be easily implemented into the model to produce macroeconomic forecasts fully consistent with the fiscal policy settings. This applies also to the practice in the Czech National Bank (CNB).

The CNB's core g3 model, developed and described in Andrle et al. (2009), currently lacks sufficient detail with respect to the fiscal sector. Hence, the objective of this paper is to address this deficiency by building a satellite DSGE model with an extended fiscal sector. To concentrate mainly on fiscal policy variables, we proceed with some simplification of the g3 model; to be more specific, stochastic trends are omitted from the model, but on the other hand we enrich the model with several important fiscal channels. First, we introduce into our model so-called "rule-of-thumb" households, in the manner of Galí, López-Salido, and Vallés (2007). These households do not accumulate any savings and consume all their disposable income. Second, we allow government consumption and government capital to be productive; in other words, government consumption brings some utility to households and government capital contributes to firms' production. These two productive features are often neglected in the mainstream DSGE literature, although the possibility of productive government consumption and government capital has been discussed in the past (Bailey, 1971; Barro, 1981; Baxter and King, 1993). Third, our model contains an extensive set of fiscal instruments, namely, four instruments on the expenditure side (government consumption, government investment, unemployment benefits, and other social benefits) and five instruments on the revenue side (a consumption tax, a wage tax, a capital tax, social security contributions paid by employers, and a lump-sum tax). Fourth, we extend our model to include unemployment, in a tractable way proposed by Galí (2011), which helps to partly endogenize unemployment benefits. Fifth, we specify the government's fiscal rule with feedback coefficients for domestic output and debt, as found, for example, in Leeper, Plante, and Traum (2010), and estimate its coefficients for Czech data using Bayesian techniques.

Given the absence of a consensus in the literature regarding the precise value of the fiscal multipliers,[1] one of our objectives is to provide the CNB with the values of the fiscal multipliers for the Czech economy. Our DSGE model with its extended fiscal sector allows us to produce a rich set of multipliers, by several fiscal instrument categories, and also to assess the robustness of the multipliers to the underlying model assumptions. Recent estimates of fiscal multipliers for the Czech economy based on the structural VAR approach (Valenta, 2011) indicate an output fiscal multiplier of between 0.3 and 0.6 in the first year after a shock to government spending. The real GDP fiscal multipliers implied by our DSGE model attain their largest values in the first year in the case of government investment (0.8), social security contributions paid by employers (0.5) and government consumption (0.5). These are followed by the fiscal multipliers for the consumption tax (0.4), the wage tax and lump-sum taxes (roughly 0.3) and other social benefits (0.2). Unemployment benefits and the capital tax have negligible fiscal multipliers. Our results suggest that the most costly, in terms of the real GDP loss in the first year, are fiscal consolidations based on cuts in government investment and increases in social security contributions paid by employers, followed by cuts in government consumption.

[1] Histograms of fiscal multipliers, obtained from many studies, are reported by Gechert and Will (2012).

Comparing our estimates of fiscal multipliers with the results reported in a meta analysis by Gechert and Will (2012) based on the examination of 89 studies suggests that the rather low values of the fiscal multipliers for the Czech economy could be attributed to its high import intensity of GDP. Furthermore, in what follows our DSGE-based fiscal multipliers should be viewed as lower bound estimates compared to those produced by macroeconometric models, single equation approaches or VARs. Nevertheless, our sensitivity checks demonstrate that the higher is the share of "rule-of-thumb" households, the higher are the values of fiscal multipliers, which corresponds to the evidence from the meta analysis.

For practical purposes, using our proposed DSGE model we evaluate the partial impact of selected fiscal measures on the Czech economy (that is, not accounting for all supply-side effects and assuming that fiscal shocks are of a temporary nature and the economy starts from its equilibrium). We find that the selected fiscal consolidation measures, related to the ongoing process of fiscal consolidation in the Czech Republic, might slow real GDP growth down by 0.8, 1.4, and 1.9 percentage points in 2013, 2014, and 2015, respectively, as compared to the baseline with unchanged fiscal policy.

The paper is structured as follows. Section 2 reviews relevant literature, Section 3 outlines our satellite DSGE model with the extended fiscal sector, and Section 4 provides estimates of fiscal multipliers and several robustness checks, and quantifies the impact of the selected fiscal measures on the Czech economy. The last section summarizes our findings and outlines suggestions for future research.

2. Related Literature Review

Generally, the empirical literature provides a variety of estimates of fiscal multipliers. (These are often based on (S)VAR techniques, but Dynamic Stochastic General Equilibrium (DSGE) model estimates have gained in prominence recently.) For example, for the euro area, Ratto, Roeger, and in 't Veld (2006) estimate the value of the government spending multiplier on output to be 0.6 over the first year. Using US data, Galí et al. (2007) find the government spending multiplier for output to be 0.8 at the beginning, rising to 1.7 after two years, in line with previous estimates by Baxter and King (1993). Blanchard and Perotti (2002), using the SVAR methodology, estimate the government spending multiplier for output at around 0.8–0.9. Some studies give puzzling results. For example, de Castro and de Cos (2006), using Spanish data, report the expected positive effect of government spending on output in the short run, but a negative relationship in the medium and long run. A recent meta regression analysis of around 90 studies by Gechert and Will (2012) shows that the values of fiscal multipliers are rather dependent on the chosen modeling approach and its settings; nonetheless, the underlying studies suggest that the average fiscal multiplier is less than one.

There is a growing number of models which examine the interactions of monetary and fiscal policies using the DSGE approach. A number of comprehensive models have been built, for instance the IMF's Global Integrated and Fiscal Model (see Kumhof et al., 2010), the European Commission's QUEST III model (Ratto, Roeger, and in 't Veld, 2009) or the Czech Ministry of Finance's HUBERT model (Štork, Závacká, and Vávra, 2009). The New Area-Wide Model (NAWM) of the euro area, elaborated by the European Central Bank, is another state-of-the-art framework, enabling, inter alia, interactions between fiscal and monetary policies.[2] The NAWM model was recently extended by Coenen, Straub, and Trabandt (2012b) to include a richer specification of the fiscal sector, and identified a significant role of discretionary fiscal policies for real GDP growth during the Great Recession. An interesting comparison of structural models, in terms of fiscal policy effectiveness, was performed by Coenen et al.

[2] See Christoffel, Coenen, and Warne (2008) for the description of the NAWM and related references therein.

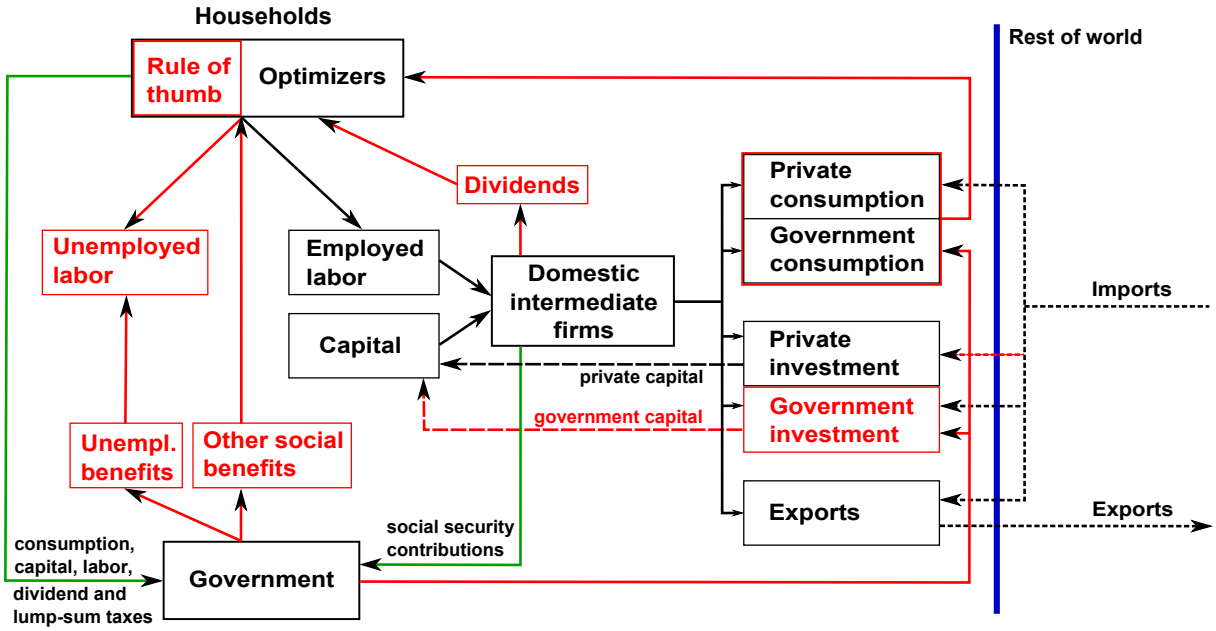
(2012a). These authors found considerable agreement across models on both the absolute and relative sizes of different types of fiscal multipliers.

Regarding the Czech Republic, there are several studies dealing with fiscal policy. Barrell et al. (2004) examine the impacts of economic policies in several EU countries, including the Czech Republic, for which they estimate a fiscal multiplier of 0.4. A somewhat higher fiscal multiplier of 0.6 is obtained by Hřebíček, Král, and Říkovský (2005) using both regression analysis and structural simulation. Recently, Prušvic (2010) determines the government expenditure multiplier at 0.5, in line with previous estimates. An attempt to examine the cyclical effects of fiscal policy employing the structural vector error correction (SVEC) model is made by Radkovský and Štiková (2008). While the authors manage to specify and estimate the SVEC representation, its impulse responses look rather inconclusive. There is ongoing work on modeling the fiscal sector in the Ministry of Finance HUBERT model (Štork and Závacká, 2010). At the current stage this model suffers from some drawbacks, i.e., there is no capital, a shock to government consumption leads to an unrealistic deflationary response, and the incorporated fiscal rule is rather simple, reacting to government expenditure only. An extensive set of various fiscal multipliers for the Czech Republic is provided by Klyuev and Snudden (2011), where the authors calibrate the IMF's GIMF model for the Czech data. These multipliers are used by Ambriško et al. (2012) to quantify the impacts of Czech fiscal policy on real GDP in the period 2001–2011. Their results also indicate little evidence of countercyclical fiscal policy in the Czech Republic. The latest empirical evidence on the effects of fiscal policy on the Czech economy is provided by Valenta (2011) and Franta (2012). These studies explore VAR-based identification approaches and apply classical (Valenta, 2011) and Bayesian (Franta, 2012) estimation techniques. According to Valenta (2011), the output fiscal multiplier is estimated in the range of 0.3–0.6 in the first year following a shock to government spending.

3. Structural DSGE Model

Our structural model is built along the lines of the models by Andrle et al. (2009), Coenen et al. (2012b), Galí (2011), and Galí et al. (2007). The small open economy is populated by two types of representative households, the first type called optimizers or Ricardian households, who can save, and the second type called "rule-of-thumb" consumers or non-Ricardian households, who cannot save and consume all their disposable income. The households consume a final consumption good, which is made from private consumption and government consumption goods. So, we allow government consumption to be productive, i.e., it yields utility to the households. The members of households monopolistically supply a differentiated unit of labor to an employment agency, and wage setting follows Calvo contracts. Besides private capital, there is government (public) capital, which freely enters intermediate domestic goods production. Government expenditures are divided into government consumption, government investment, unemployment benefits, and other social benefits. Government revenues come from consumption, labor, capital, dividend and lump-sum taxes, and social security contributions paid by employers. The government balances its budget by issuing bonds or by adjusting taxes. In the fiscal rules, fiscal instruments (taxes or expenditures) react to the deviations of government debt, output or government consumption from their respective targets. The central bank operates under an inflation targeting regime and follows a standard Taylor interest rate rule. The features of the model are shown in Figure 3.1, where black parts overlap with the g3 model, red parts represent the fiscal sector, and green parts depict tax revenues. For a full exposition of the model, used data and the estimation results see Ambriško et al. (2013).

Figure 3.1: The Scheme of the Model



Note: Black parts show overlap with the g3 model, red parts represent the fiscal sector, and green parts depict tax revenues.

4. The Results

In this section we present the fiscal multiplier values implied by our structural DSGE model, then we use our model to evaluate the impact of the selected fiscal measures on the economy, and finally we comment on the role of unemployment benefits in our model.

4.1 Fiscal Multipliers

The model's implied fiscal multipliers are listed in Tables A.1–A.7 in the Appendix. The fiscal multipliers are calculated according to Uhlig (2010), so these are net-present-value multipliers accumulated over time, discounted by the steady state real interest rate. We list fiscal multipliers with effects on real GDP for individual revenue and expenditure items of the government budget. The fiscal multipliers are calculated for the case of a temporary, one-year fiscal stimulus and for the case of a longer-lasting 10-year fiscal stimulus. The unexpected shocks to the fiscal instruments are set so that the *ex-ante* worsening of the government budget balance in the first year equals 1% of nominal GDP, and the value of the corresponding fiscal instrument is kept constant during the affected period. Moreover, the estimated fiscal rule is initially turned off for two years (keeping unaffected fiscal instruments at their steady states) so as to isolate the effects of affected fiscal instruments. Otherwise, keeping the fiscal rule turned on from the beginning could result in our results being somewhat blurred by co-movements of fiscal instruments as defined in the fiscal rule. We treat the estimated fiscal rule as a good approximation of the fiscal policy settings in the long run, hence we decided to turn off the fiscal rule at the beginning of the simulations. This also means that the fiscal stimuli in the first two years are fully debt financed. The role of alternative assumptions, concerning the model or the simulations, is demonstrated later in the robustness of the results.

Regarding the effect of a temporary fiscal stimulus on real GDP (see Table A.1), the largest effects after the first year occur with government investment, with the fiscal multiplier reaching roughly 0.8. Next,

social security contributions paid by employers and government consumption have a fiscal multiplier of 0.5, followed by the consumption tax with a corresponding fiscal multiplier of 0.4. The fiscal multipliers for the wage tax and lump-sum taxes attain values of roughly 0.3. Other social benefits have fiscal multiplier of approximately 0.2. Negligible fiscal multipliers are recorded for unemployment benefits and the capital tax. All the values of the fiscal multipliers with effects on real GDP are below 1.

Our values of the overall expenditure multipliers are not far from the CNB estimates of around 0.6 reported in Hřebíček, Král, and Říkovský (2005), which are obtained from empirical estimates using regression analysis and structural simulation. On the other hand, our fiscal multiplier values are somewhat higher than the ones estimated by Klyuev and Snudden (2011) for the Czech Republic using the GIMF model. For instance, the one-year temporary fiscal multiplier for government investment is twice as large in our case (0.8) compared to their estimate (0.4). On the revenue side, our one-year fiscal multipliers for the consumption tax (0.4) and the wage tax (0.3) are roughly 3–4 times higher than the estimates based on the GIMF model. Nevertheless, our temporary fiscal multipliers for government consumption and the capital tax are quite similar to those reported by Klyuev and Snudden (2011). Also, according to our model the capital tax has a negligible fiscal multiplier. In the study by Klyuev and Snudden (2011), the capital tax has the lowest multiplier: 0.03 (see p. 17). This is within the range found by Coenen et al. (2012b) for the USA (0.01–0.11) and for the euro area (0.03–0.06).

The fiscal multipliers for a 10-year fiscal stimulus have similar values in the short run as in the case of a temporary, one-year fiscal stimulus. In the long run, the fiscal multipliers for the 10-year fiscal stimulus are somewhat lower, and for government investment and lump-sum taxes the long-run effect on real GDP is slightly negative. Lower fiscal multiplier values for permanent stimuli is confirmed by several other structural models (Coenen et al., 2012a).

The long-run effects of a temporary fiscal stimulus on real GDP (see the last column in the tables) suggest that it is desirable to support the domestic economy mainly by increasing other social benefits or government consumption, and further by decreasing taxes associated with wages (the wage tax and social security contributions paid by employers). For a longer-lasting fiscal stimulus, the highest effects on real GDP are recorded for taxes associated with wages and government consumption. Conversely, as regards an appropriate, growth-friendly fiscal consolidation strategy, cuts in unemployment benefits and hikes in capital taxes seem desirable given the low values of the fiscal multipliers in all horizons for these fiscal instruments. However, the scope for cutting unemployment benefits is very limited, since their share in GDP is rather small in the Czech Republic. These long-run suggestions should be taken with care, since they are more or less prone to the specification of the fiscal rule, as will be demonstrated in the robustness of the results.

4.1.1 Robustness

To investigate the robustness of the results, we calculate several alternative fiscal multipliers. We inspect how the fiscal multipliers change with: (i) a larger share of rule-of-thumb households, (ii) a simplified type of fiscal rule, (iii) a different elasticity of labor supply, (iv) passive monetary policy, and (v) anticipated shocks.

The share of rule-of-thumb households matters for the size of fiscal multipliers, as can be seen from Table A.3 in the Appendix. Additionally to the 25% share of rule-of-thumb households in the baseline, the share of 50% is considered here. Generally, with a higher share of rule-of-thumb households the fiscal multipliers take higher values, in line with evidence from other literature summarized in the meta analysis of 89 studies by Gechert and Will (2012). Lower variation in fiscal multipliers is visible for social security contributions paid by employers. This can be explained by the fact that this kind of tax

is incurred by firms and does not directly affect employees' net labor income. Generally, all the fiscal multipliers behave according to economic intuition; that is, the higher is the share of rule-of-thumb households in the economy, the stronger are the demand effects generated by consumers in response to fiscal stimuli.

Next, we checked the robustness of the fiscal multipliers with respect to the specification of the fiscal rule when the model contains only a simple calibrated fiscal rule, as adopted from Galí et al. (2007), with corresponding results in Table A.4. With a simple fiscal rule the model's implied fiscal multipliers in the short run are very similar to those obtained with a more comprehensive estimated fiscal rule. This is due to the fact that the fiscal rule is switched off for the initial two years by assumption. So, again, the highest temporary one-year fiscal multipliers are found for government investment, social security contributions paid by employers, and government consumption. As to the cumulative long-run gains in the case of a one-year fiscal stimulus, the situation changes. Here, the largest effects are attained for lump-sum taxes and taxes associated with wages (social security contributions paid by employers and the wage tax). The relevance of lump-sum taxes in this case is the result of the fiscal rule used, as only lump-sum taxes can adjust in response to rising government debt and government consumption, in contrast to the comprehensive estimated fiscal rule, where all fiscal instruments can adjust to variations in government debt and intermediate production.

Originally, in the g3 model the utility function is linear in labor supply, implying an infinitely elastic supply of labor. By contrast, in our model we estimated the inverse of the Frisch elasticity of labor supply ϕ_n at a value of roughly 3. Therefore, we check the sensitivity of this parameter on the values of the fiscal multipliers. Alternatively, we set the value of parameter $\phi_n = 1$. For this case, we list the fiscal multipliers in Table A.5. On inspecting the results, we see that the fiscal multipliers have increased. This is due to a greater willingness of households to supply labor to firms, which want to cover the higher demand generated by the fiscal stimuli. The ordering of the first three fiscal instruments, in terms of GDP growth contribution, has changed slightly. In the short run it is the same, the most significant are government investment, social security contributions paid by employers and government consumption, but in the long run government consumption is followed by the wage tax and other social benefits.

Furthermore, the fiscal multipliers change when monetary policy is passive, which means that monetary policy does not follow the Taylor rule, i.e., the central bank does not raise interest rates in response to rising inflation. We simulate the effects of fiscal stimuli with temporarily passive monetary policy, when the interest rate is kept constant for two years at its steady state level and thereafter adjusts according to the model's Taylor rule. This simulation is different from the situation where interest rates hit the zero lower bound; nonetheless, the direction of real effects might be similar. The fiscal multipliers with passive monetary policy are reported in Table A.6. Many of the fiscal multipliers have increased, with the highest one-year multipliers being attained by government investment, government consumption, and the consumption tax. The increase in the fiscal multipliers when monetary policy is passive is due to the fact that the monetary conditions are looser in the first two years compared to the baseline. The results for social security contributions paid by employers are puzzling, as the fiscal multipliers have decreased compared to the baseline.

As a last robustness check, fiscal multipliers with anticipated shocks are calculated in Table A.7. The majority of the fiscal multipliers have decreased compared to the baseline. One exception concerns social security contributions paid by employers in the short run. The highest one-year fiscal multipliers are recorded by social security contributions paid by employers (0.7), government investment (0.6), and government consumption (0.4). The lower real GDP effects might be explained by the fact that households fully expect the tax cuts or expenditure increases to be temporary and choose rather to smooth

their consumption profiles. Another explanation might be that all the fiscal instruments have substantial backward-looking elements by definition.

4.2 The Impact of Selected Fiscal Measures

Having built and estimated our model, we try to illustrate its use with a real-world example from the Czech economy. In April 2012, the Czech government announced a new fiscal consolidation package of various measures for 2013–2015. We focus on selected, already approved measures from this consolidation package, with further details provided in Table A.8 in the Appendix. Obviously, it is interesting to quantify the macroeconomic effects of such consolidation measures on the Czech economy.

Firstly, in order to simulate the effects of the selected fiscal measures, we mapped these measures onto the models' fiscal instruments. Afterwards, the estimated impacts of the individual measures on the government budget balance, expressed in percent of nominal GDP, were transformed into desired deviations of the relevant fiscal revenues/expenditures using the steady state value of the model's nominal GDP. Adjusting the paths of the affected fiscal revenues/expenditures for the calculated deviations, it is possible to simulate the macroeconomic effects of the fiscal measures considered. The remaining unaffected fiscal instruments (unemployment benefits and lump-sum transfers) were kept at their steady state levels for two years; thereafter, the estimated fiscal rule is switched on, serving as a good approximation of the fiscal policy settings in the long run.

The results given by our model show that the selected consolidation measures might imply a tightening of real GDP growth by 0.8, 1.4, and 1.9 percentage points in the respective years compared to the baseline scenario with unchanged fiscal policy. Given the size of the consolidation measures selected, the implicit fiscal multiplier of the simulated measures is roughly 0.6. To make our simulation more realistic, we arbitrarily increase the share of "rule-of-thumb" households to 50%, so as to reflect the idea that during the downturns there are more households who are unable to save. In this case, the selected consolidation measures would depress real GDP growth by 1.3, 2.1, and 3.0 percentage points, with the average implicit fiscal multiplier increasing slightly above 1. Moreover, to mimic the current state of the economy when interest rates have virtually hit the zero lower bound, in another simulation we set monetary policy as passive for three years (e.g. the central bank does not react to deviations in the inflation). In this setting, the impacts to real GDP growth would increase to 1.3, 2.3, and 3.3 percentage points, associated with the average implicit multiplier as of 1.1. Calculated impacts should be taken with caution, since there is a further simplification which stems from the fact that the fiscal shocks in our model are treated as temporary (i.e., as having only temporary effects which do not affect the steady state of the model), whereas some of the above-mentioned fiscal measures might be valid permanently, thus pushing the economy toward a new equilibrium.

4.3 Unemployment benefits

Not many models involve unemployment benefits in their structure, so we look how they operate in our fiscal model. An increase in unemployment benefits leads to a positive demand effect, inducing the firms to hire additional labor, and consequently reflected in lower unemployment rate. One can argue that this behavior is not very realistic, because it implies that we can solve high unemployment in the economy by the stimulation of unemployment benefits. This might be an artefact stemming from the way we introduced unemployment in our model, so it would be interesting to investigate the effect of unemployment benefits on real GDP in the models incorporating searching/matching frictions.

Our calculated values of real GDP multipliers for unemployment benefits are relatively low. Thus unemployment benefits seem to be as a good candidate how to consolidate public budgets; however, as

was already noted, this is not very suitable for the Czech republic as their share on GDP is relatively low, which limits the scope for possible savings in government's budget. Nonetheless, the picture can be different for other countries with more sizeable shares of unemployment benefits on GDP, also possibly implying different (higher) values of multipliers for unemployment benefits.

5. Conclusion

In this paper we presented a satellite DSGE model for the Czech Republic to study the effects of fiscal policy on the economy. Our DSGE model shares key features of the CNB's core g3 model, developed by Andrle et al. (2009), and contains a comprehensive fiscal block. The most distinctive fiscal features of our DSGE model are due to the inclusion of "rule-of-thumb" consumers, detailed specification of the revenue and expenditure fiscal instruments, productive government spending, productive government capital, unemployment dynamics, and the estimated fiscal rule.

The real GDP fiscal multipliers from our DSGE model suggest that the largest multipliers after the first year of a temporary fiscal stimulus are associated with government investment (0.8), social security contributions paid by employers (0.5) and government consumption (0.5), followed by the consumption tax (0.4), the wage tax and lump-sum taxes (both roughly 0.3), then by other social benefits (0.2), and lastly by unemployment benefits and the capital tax (close to zero). Thus, our results imply that the strongest effects, in terms of real GDP, are associated with an increase in government investment and a decrease in social security contributions paid by employers and an increase in government consumption; or, to put it differently, fiscal consolidations based on cuts in government investment, increases in social security contributions paid by employers or cuts in government consumption would be associated with substantial real GDP losses, at least in the short to medium run. Conversely, a less costly way to consolidate public finance is to raise capital taxes, because of their low impact on GDP growth.

For practical purposes, we used our model to perform a partial evaluation of the effects on the real economy of selected consolidation measures related to the ongoing process of fiscal consolidation in the Czech Republic. Conditional on the model's set of simplifying assumptions (inter alia, limited supply-side aspects and the assumption of temporary fiscal shocks) we found considerable impacts on real GDP dynamics, specifically impacts of 0.8, 1.4, and 1.9 percentage points in 2013, 2014, and 2015, as compared to the baseline with unchanged fiscal policy. These can further increase, if a higher share of "rule-of-thumb" households and/or passive monetary policy is considered.

This paper could be extended in several directions. The robustness of our results could be further checked in terms of the underlying model mechanisms and assumptions. For example, what is the role of complementarity/substitutability between private and government consumption/capital in the measured values of fiscal multipliers? And what is the size of the fiscal multipliers if the zero lower bound on nominal interest rates is reached? One could also further refine the fiscal sector; for instance, it is possible to further elaborate government labor services and model them explicitly as a production input. Another possible extension would be to build a DSGE-VAR model, that is, to simulate the priors from our DSGE model and use them afterwards in the estimation of the Bayesian VAR model.

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Appendix A

Table A.1: Fiscal Multipliers: One-Year Stimulus on Real GDP

	Quarters				Peak	Long-run
	1	4	8	16		
Expenditures (+):						
Government consumption	0.49	0.49	0.50	0.51	0.58	0.58
Government investment	0.73	0.84	0.99	0.85	0.99	0.23
Unemployment benefits	0.03	0.03	0.04	0.03	0.04	0.04
Other social benefits	0.21	0.24	0.29	0.31	0.60	0.60
Taxes (-):						
Consumption tax	0.27	0.35	0.42	0.30	0.42	0.19
Wage tax	0.23	0.33	0.43	0.37	0.43	0.40
Social contributions employers	0.22	0.51	0.54	0.30	0.57	0.36
Capital tax	0.00	0.00	0.00	0.00	0.00	0.00
Lump-sum tax	0.21	0.25	0.28	0.19	0.28	0.19

Note: These are cumulative net-present-value fiscal multipliers calculated as the discounted cumulative change in real GDP over the discounted cumulative change in the corresponding fiscal instrument in real terms. The *ex-ante* fiscal stimulus lasts for one year and is calibrated so that the budget balance worsens by 1% of nominal GDP in the first year.

Table A.2: Fiscal Multipliers: 10-year Stimulus on Real GDP

	Quarters				Peak	Long-run
	1	4	8	16		
Expenditures (+):						
Government consumption	0.49	0.49	0.50	0.42	0.50	0.31
Government investment	0.73	0.84	0.94	0.64	0.94	-0.22
Unemployment benefits	0.03	0.03	0.03	0.01	0.03	0.00
Other social benefits	0.21	0.24	0.27	0.09	0.27	0.01
Taxes (-):						
Consumption tax	0.27	0.35	0.41	0.25	0.41	0.11
Wage tax	0.23	0.33	0.41	0.35	0.43	0.43
Social contributions employers	0.22	0.51	0.54	0.30	0.56	0.33
Capital tax	0.00	0.00	0.00	0.00	0.01	0.01
Lump-sum tax	0.21	0.25	0.27	0.09	0.27	-0.02

Note: The *ex-ante* fiscal stimulus lasts for 10 years and is set so that the budget balance worsens by 1% of nominal GDP in the first year.

Table A.3: Fiscal Multipliers: One-Year Stimulus on Real GDP, Rule-of-Thumb Households 50%

	Quarters				Peak	Long-run
	1	4	8	16		
Expenditures (+):						
Government consumption	0.66	0.65	0.67	0.67	0.81	0.81
Government investment	0.82	1.00	1.26	1.08	1.26	0.56
Unemployment benefits	0.05	0.06	0.08	0.06	0.08	0.07
Other social benefits	0.43	0.45	0.50	0.54	0.92	0.92
Taxes (-):						
Consumption tax	0.50	0.57	0.63	0.43	0.63	0.29
Wage tax	0.42	0.50	0.59	0.47	0.59	0.47
Social contributions employers	0.23	0.55	0.63	0.34	0.64	0.39
Capital tax	0.00	0.00	0.01	0.00	0.01	0.00
Lump-sum tax	0.43	0.44	0.46	0.33	0.46	0.28

Note: See Table A.1 for a detailed description.

Table A.4: Fiscal Multipliers: One-Year Stimulus on Real GDP, Simple Fiscal Rule

	Quarters				Peak	Long-run
	1	4	8	16		
Expenditures (+):						
Government consumption	0.46	0.44	0.46	0.36	0.46	0.33
Government investment	0.70	0.77	0.94	0.83	0.94	0.25
Unemployment benefits	0.02	0.03	0.04	0.03	0.04	0.04
Other social benefits	0.19	0.20	0.26	0.19	0.26	0.22
Taxes (-):						
Consumption tax	0.23	0.28	0.35	0.26	0.35	0.16
Wage tax	0.21	0.29	0.39	0.37	0.39	0.39
Social contributions employers	0.22	0.49	0.54	0.32	0.56	0.37
Capital tax	0.00	0.00	0.00	0.00	0.00	0.00
Lump-sum tax	0.20	0.22	0.45	1.25	1.29	0.93

Note: See Table A.1 for a detailed description.

Table A.5: Fiscal Multipliers: One-Year Stimulus on Real GDP, $\phi_n = 1$

	Quarters				Peak	Long-run
	1	4	8	16		
Expenditures (+):						
Government consumption	0.94	0.99	1.11	1.19	1.31	1.31
Government investment	1.36	1.59	1.94	1.76	1.96	0.66
Unemployment benefits	0.05	0.05	0.08	0.06	0.08	0.06
Other social benefits	0.38	0.44	0.55	0.58	1.02	1.02
Taxes (-):						
Consumption tax	0.51	0.70	0.88	0.70	0.88	0.49
Wage tax	0.46	0.70	0.99	1.03	1.12	1.12
Social contributions employers	0.46	1.10	1.27	0.80	1.29	0.94
Capital tax	0.00	0.00	0.01	0.00	0.01	0.00
Lump-sum tax	0.39	0.46	0.54	0.33	0.54	0.25

Note: See Table A.1 for a detailed description.

Table A.6: Fiscal Multipliers: One-Year Stimulus on Real GDP, Passive Monetary Policy

	Quarters				Peak	Long-run
	1	4	8	16		
Expenditures (+):						
Government consumption	0.50	0.53	0.59	0.59	0.65	0.65
Government investment	0.74	0.87	1.07	0.94	1.08	0.31
Unemployment benefits	0.03	0.03	0.05	0.04	0.05	0.04
Other social benefits	0.21	0.25	0.32	0.36	0.64	0.64
Taxes (-):						
Consumption tax	0.27	0.38	0.48	0.36	0.48	0.24
Wage tax	0.24	0.36	0.47	0.41	0.48	0.43
Social contributions employers	0.12	0.20	0.19	0.10	0.23	0.23
Capital tax	0.00	0.00	0.00	0.00	0.00	0.00
Lump-sum tax	0.22	0.27	0.33	0.24	0.33	0.22

Note: See Table A.1 for a detailed description.

Table A.7: Fiscal Multipliers: One-Year Stimulus on Real GDP, Anticipated Shocks

	Quarters				Peak	Long-run
	1	4	8	16		
Expenditures (+):						
Government consumption	0.45	0.41	0.41	0.39	0.45	0.44
Government investment	0.60	0.57	0.64	0.50	0.64	-0.20
Unemployment benefits	0.02	0.01	0.02	0.00	0.02	0.00
Other social benefits	0.15	0.12	0.11	0.07	0.15	0.15
Taxes (-):						
Consumption tax	0.18	0.16	0.22	0.15	0.22	0.06
Wage tax	0.17	0.19	0.28	0.26	0.30	0.30
Social contributions employers	0.36	0.65	0.57	0.29	0.67	0.34
Capital tax	0.00	0.00	0.00	0.00	0.00	0.00
Lump-sum tax	0.14	0.09	0.10	0.01	0.14	0.00

Note: See Table A.1 for a detailed description.

Table A.8: Selected Fiscal Consolidation Measures

Consolidation measures (in % of GDP)	2013	2014	2015	Model's instruments
Direct taxes				
7% additional solidarity personal income tax	0.0	0.1	0.1	τ^W
Abolition of basic allowance for working pensioners	0.1	0.1	0.1	τ^W
Reduction of flat-expense deductions for self-employed	0.1	0.1	0.1	τ^W
Increase of withholding tax against tax havens, abolition of health insurance ceiling	0.1	0.1	0.1	τ^W, τ^S
Indirect taxes				
1 pp increase in VAT	0.5	0.5	0.4	τ^C
Abolition of selected excise exemptions	0.0	0.1	0.1	τ^C
Other taxes				
1 pp increase in real estate tax	0.1	0.1	0.1	τ^K
Sales of emission permits	0.1	0.1	0.1	τ^K
Revenue measures	0.9	1.0	0.9	
Expenditure				
Freezing of wages for state employees	-0.1	-0.3	-0.4	G
Savings in state administration	0.0	-0.3	-0.6	G
Lower subsidies	-0.1	-0.1	-0.1	I^g
Lower indexation of pensions, cancelation of some social benefits	-0.3	-0.4	-0.5	OB
Expenditure measures	-0.5	-1.1	-1.6	
Total impact on government budget balance	1.4	2.0	2.6	

Note: Impacts of consolidation measures accumulate over time.
Source: Ministry of Finance of the Czech Republic and CNB estimates.