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DUAL REGIME FISCAL MULTIPLIERS IN CONVERGING ECONOMIES - A SIMPLIFIED STVAR APPROACH

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Dual regime fiscal multipliers in converging economies - a simplified STVAR approach

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Abstract

This paper assesses fiscal policy effects over the business cycle in V4 countries using a simplified smooth transition VAR (STVAR) model. The estimated parameters imply a presence of two different regimes associated with recessions and expansions, leading to different impulse-response functions. Transformation of these functions to fiscal multipliers confirms a different nature of long run effects. In expansions, the fiscal multipliers peak below unity and diminish to zero. In recession, the multipliers grow faster than in expansion and stay well above unity.

JEL clasification: E62, H62
Key words: V4 countries, fiscal multiplier, STVAR

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1. INTRODUCTION

Experience with fiscal consolidation efforts in recent years has renewed discussions on the mechanics guiding fiscal policy effects on the economy. Keynesian theory provides the story suggesting that fiscal policy works via increasing demand and eliminating the gap between aggregate supply and demand. Recently, this view has been challenged by the emphasis on inter-temporal smoothing of consumption by households. It led to the revival of Ricardian equivalence and assumption of consumption smoothing. This implies that the long run effect of fiscal policy may converge to zero and even become negative. During the recent financial crisis, some authors (for example Blanchard and Leigh 2013) argue in favor of the higher effects of fiscal multipliers either by claiming that the previous results are underestimated or that the fiscal multiplier has changed since the Great Moderation period.

Auerbach and Gorodnichenko (2010, 2012) explore the state dependency of fiscal policy effects and their spillovers through international trade using data for OECD countries. They develop a smooth transition VAR methodology, an extension to smooth transition autoregressive models. The former paper assumes that the closed economy model is sufficiently described by government spending, taxes and GDP, whereas the latter paper allows for leakage of the aggregate demand via imports and exports that are themselves aggregates of country-to-country flows, so that the original STVAR model is significantly enriched. This leads to cross-country effects of fiscal shocks.

The V4 countries (i.e. the Czech Republic, Hungary, Poland and Slovakia) are still subject to the convergence process towards the advanced European economies. This process forms preconditions for presence of shocks both from supply and demand side and for reliance on contribution of foreign demand to economic growth. Depth of financial markets does also trace behind their more advanced peers, so the process of financial deepening is still taking place. As a result, the interest rate channel plays less prominent role in conducting monetary policy. On the contrary, the exchange rate has been frequently used to anchor the inflation development. The high weight of exchange rate in the real economy is a natural consequence of being very open to trade. This avenue also works the other way around - accumulated problems in the real economy may cause abrupt changes of in the exchange rate. This realignment of the exchange rate eliminates any disequilibria that caused it, but may lead to bouts of inflation and/or recession due to decreased domestic demand. The role of fiscal policy in these countries is comparatively significant, although it is generally diminishing in the convergence process. Such working of convergence process is more or less common among all transition countries.

Auerbach and Gorodnichenko included the V4 countries in their sample, but, because of their special features, these countries may be outliers and the results may not hold for them. The aim of this paper is to estimate the effects of fiscal policy for these countries separately in order to eliminate this uncertainty. Useful feature of the STVAR methodology is that it allows for somewhat modified relationships as outlined above. Ideally, we would use the methodology of Auerbach and Gorodnichenko (2012b), but the model is too complex for our dataset. Moreover, the cross-country spillovers would be reflected incompletely, because strong shocks driving V4 countries are coming from the original EU members that are not part of our dataset. Thus, we use the methodology of Auerbach and Gorodnichenko (2012a) by extending the model in such a way that it captures the special characteristics of selected countries, including full volume of foreign trade. The paper is organized as follows: we review the literature in part 2, take a look at the data in part 3, present the model and estimation in part 4, present the results and discuss limitations of our estimates in part 5 and conclude.

2. LITERATURE REVIEW

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, have become very popular in the literature recently. DSGE models are usually solved for the general equilibrium of the economy, using the Walrasian notion that supply and demand equate (although they may differ from the steady state in the short run), whereas in VAR models, this assumption is absent. As the discrepancy between aggregate supply and demand may be crucial for the efficiency of fiscal policy, we focus on VAR models in this paper.

In World Economic Outlook (2012), Blanchard and Leigh from the IMF suggested that fiscal multipliers were probably underestimated, which led to excessive fiscal consolidation in many countries. By regressing forecast errors of economic growth on forecast errors of fiscal consolidation in a cross-country setup they have argued that fiscal multipliers may have changed during the recent crisis. European Commission (2012) expressed a differing view, noting that the multipliers were not underestimated severely and that the inclusion of government bond spreads changed the results. Blanchard and Leigh (2013) re-casted their exercise and stressed that only variables known to forecasters in the forecast process should be included in the regression. This topic necessitates more complex modeling techniques, as the parameters are per definition not assumed constant. There is a growing body of literature focusing on fiscal policy effects under different circumstances: (i) the business cycle; (ii) zero lower bound on the interest rates; or (iii) in the presence of a special feature of the economy (high debt to GDP ratio, high openness etc.). These papers use often a large multi-country database and rely on panel VAR models.

We divide the presented literature into three groups: (i) papers using data from developed countries, assuming parameter stability with the aim to quantify the impact of fiscal policy or choosing between neoclassical and Keynesian reaction to fiscal policy shocks; (ii) papers using data from transition economies, assuming parameter stability with the aim to quantify the impact of fiscal policy; and (iii) papers allowing for a varying reaction depending on various conditions.

Fatás and Mihov (2001) and Blanchard and Perotti (2001) belong to the first group of papers. Their implicit goal is to determine, whether the reaction of the domestic economy to fiscal policy is more in line with Keynesian or RBC theory. They use data for the US from the period before the Great Moderation and estimate structural VARs, as these aren't imposing any structure and let the data speak. Their results are mixed, the former authors reject the RBC notion that public spending crowds out private demand and favor Keynesian theory, noting that private consumption rises with public spending and the multiplier is greater than one. The latter authors come to the conclusion that private consumption drops as a reaction to tax shock and increases as a reaction to spending shock (consistent with the Keynesian theory). The investment, however, drops after both types of fiscal shocks, which seems to be more consistent with the neoclassical theory.

Other studies use structural models to evaluate fiscal multipliers. Coenen et al (2012) study the fiscal stimulus in the framework of several models for the US and euro area, most of them being DSGE models. They find that the cumulative European multipliers are around unity for government consumption lasting 2 years conditional on no monetary accommodation. However, the cumulative multipliers range from 1 to 3, depending on a particular model, in the case of monetary accommodation. The multipliers are somewhat higher for the government investment as it has a positive supply effect. In general, the simulation results in this study reflect the neoclassical nature of the models used. Barell et al. (2012) simulate fiscal policy in many countries by means of NiGEM, a multicountry econometric model. Although the consumption function in the model is not derived from maximization of an intertemporal utility function, and thus, not leading to Ricardian equivalence, lower government spending crowds out components of GDP. This leads to multipliers below one for most countries. The results of the presented studies are thus quite mixed, but contrary to VARs that are more or less agnostic, the structural models impose implicit constraints that can influence the results.

The second group consists of studies, devoted especially to quantifying multipliers or other measures of the impact of fiscal policy on GDP in the post-socialist countries (large macroeconomic models were used for the evaluation of economic policy, including fiscal policy). Čolláková et al. (2013) evaluate the multipliers with a structural VAR. A one-percent-of-GDP cut in government spending restricts GDP, approximately by 0.4 p.p. above the initial level in the long-run. Jemec et al (2011) analyze the Slovenian economy in a similar way. The resulting multipliers are positive for spending and negative for taxes in the short run, but are not significantly different from zero in the long run.

Ambriško et al. (2012) quantify the fiscal multipliers for the Czech Republic with a DSGE model. The model contains a wide variety of government expenditures and revenues, households that do not save (they thus behave more in line with the Keynesian theory) and explicit modeling of unemployment rate and associated benefits. The fiscal policy is determined by an estimated fiscal rule. Government investment has the highest multiplier, equal to 0.4 in the first year, spending only 0.2, as the former increases capacity. The multipliers for V4 countries are lower, perhaps due to convergence process and wide variety of supply and demand shocks, that increase the noise in the business cycle.

As the models with dual regimes of fiscal policy have more parameters and require more observations, the papers in the third group use large cross-country datasets (e. g. for OECD countries). The simplest way to allow for different effects of fiscal policy is to introduce indicator variables (or their interactions with dependent variables) or split the sample of a panel VAR model. Born et al. and Nickel and Tudyka (2013) apply the former approach, Ilzetzki et al. (2010) and Corsetti et al. (2012) the later one. The multiplier is higher under predeterminted exchange rate regime than under floating, higher in closed countries than in open countries, higher in countries with low debt then with high debt and higher in countries with high income (0.66) than with low income. Hebous and Zimmerman (2012) construct a global VAR for the original euro area countries. A common fiscal shock is defined by introducing simultaneous shocks to all countries. The effect of a common shock on output is greater than a domestic shock for most of the countries, although it lasts shorter. The size of the fiscal multiplier, when the monetary policy is constrained by zero lower bound, has been studied with structural models in Hall (2009) and Christiano, Eichenbaum and Rebello (2011) with the result that the multiplier is well above one in such situations. The assumption that parameters of a VAR change abruptly depending on an indicator variable can be formalized within a threshold VAR (TVAR). Afonzo, Baxa and Slavík (2011) use threshold VAR methodology for evaluating the fiscal policy as a function of financial stress for several developed countries. They find that fiscal multipliers are positive and non-linear, that financial stress lowers GDP growth and worsens fiscal position and that multipliers are greater in current crisis.

Rather than splitting the sample, weights for distinct sets of parameters can be introduced in the model, allowing for a smooth behavior of the system. Auerbach and Gorodnichenko (2012a) study the effect of fiscal policy in OECD countries (including V4) in a panel setup. They estimate a smooth transition VAR (STVAR) model, where the vector of dependent variables (government spending, taxes, GDP; all in log levels) is a function of its lagged values with two sets of parameters, one for recessions and one for expansions. It has the advantage of estimating two sets of parameters without splitting the sample. They find that the multipliers reach up to 0.5 during expansions and are negative in the long run, whereas they peak at around 2.5 in recessions and flatten at 2.3 in the long run. This is more consistent with traditional Keynesian theory rather than New Keynesian one. In a newer paper, the authors study the effect of spillovers of fiscal policy of the trading partners of a particular country on its GDP. Their approach assumes that fiscal shocks in a country are propagated by exports from a country rather than by imports into a country, what seems to be the case of Slovakia. As a further step, they are introducing two sets of parameters, like in their previous paper. The results confirm highly positive multipliers from spillovers in recession and negative in expansion. Apart from the former, they let the parameters vary according to the exchange rate regime. Resulting multipliers are higher for floating exchange rates.

In general, considerably rich evidence in papers presented in this section lead to the conclusion that the effects of fiscal policy depend significantly on many aspects of the state of the economy. However, the use of a big dataset of many countries with common, relatively simple model that fits all leads to an implicit assumption that the special features of countries can be neglected. V4 countries are to some extent specific among the OECD countries, due to their very high openness to trade and ongoing convergence process. Some of the presented papers include data for V4 countries in their sample, but it is unclear, how important these countries are for the general results and more importantly, whether the results hold for V4 countries alone. This paper is an experiment to detect the state dependency of reactions to fiscal shocks in this group of countries that have many common features.

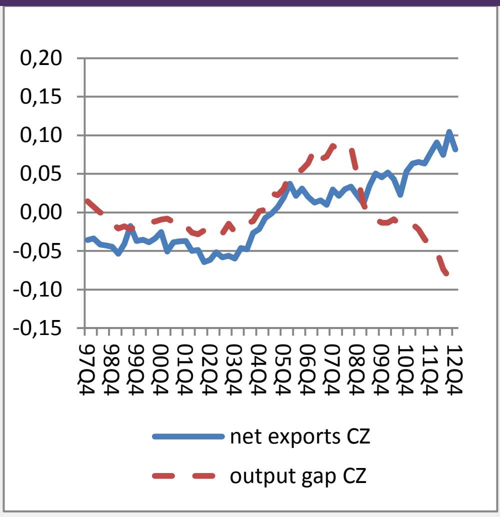
3. DATA

We have used mostly national accounts statistics (GDP, exports, imports and general government consumption), nominal exchange rates and CPI indices for the V4 countries and the euro area for computing the real exchange rates. National accounts data were seasonally adjusted by X11 method using rolling window.

The output gap was computed by subtracting a linear trend from the seasonally adjusted GDP data expressed in logs. We explored the possibility of using an HP filter, but a considerable part of the variability linked to policy shocks (for example expansionary policy in Slovakia before 1998) would be captured by trend rather than by cyclical component.

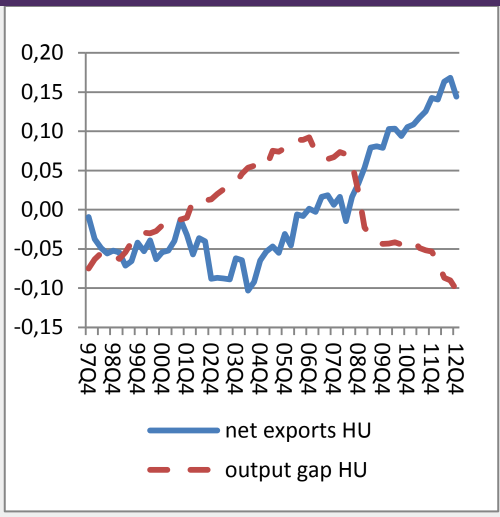
There were permanent shifts in the ratio of government spending to GDP, corresponding to various consolidation measures and the resulting series were in some sense heterogenous. Thus, government spending was used as differences to logarithms.

Figure 1a Net exports and output gap (Czech Republic)



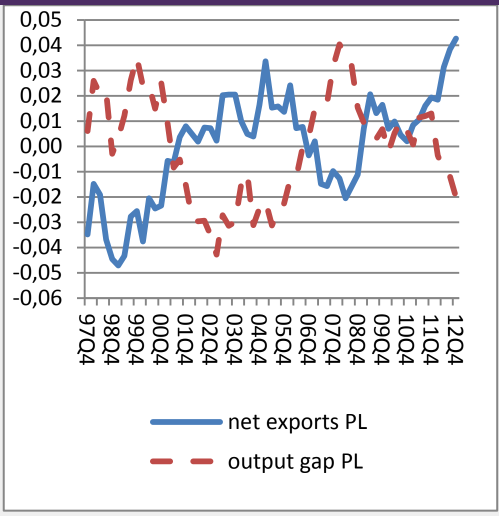
Source: own computations
Note: Net exports are defined as a fraction of GDP

Figure 1b Net exports and output gap (Hungary)



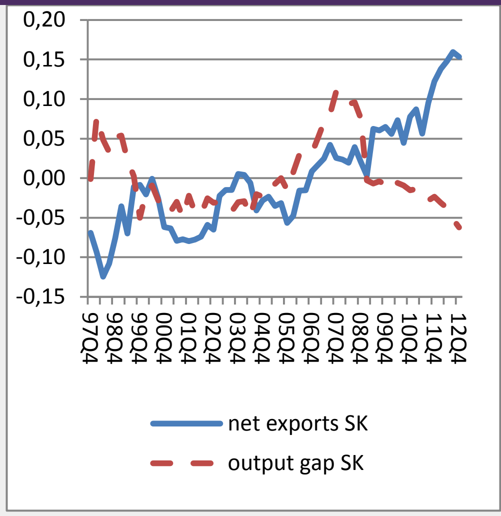
Source: own computations
Note: Net exports are defined as a fraction of GDP

Figure 1c
(Poland)



Source: own computations
Note: Net exports are defined as a fraction of GDP

Figure 1d
(Slovakia)



Source: own computations
Note: Net exports are defined as a fraction of GDP

The nominal exchange rate was defined as a number of units of domestic currency per one euro, thus it increases when domestic currency depreciates. We first calculate the log real interest rate as

$$RER = \log \frac{1}{NER} \frac{P}{P^*} \qquad (1)$$

where P* is the consumer price index in the euro area. We subsequently extract linear trend from the series and use the deviations from this trend for estimation purposes.

Net exports, output gap, and the real exchange rate are assumed to be stationary. The argument behind this assumption is that these series are reverting to their respective trend values and their cyclical components are reverting to zero. They may be however highly autocorrelated.

4. THE MODEL

VAR models are an agnostic description of the dynamics in the vector of dependent variables. Contrary to structural econometric models, they do not impose any overidentifying restrictions. Such restrictions are often rejected by data, due to a bias in the true relations between variables. To retain this advantage, but still allowing the model responses to depend on the state of the economy, we could possibly have split the sample according to a certain criterion (e.g. presence of a recession) in two subsamples and estimate two separate models (see Iltzetzki 2010). Alternatively, TVAR methodology allows for abrupt changes in parameters only, similarly as splitting the sample. However, if a minor change causes the separation criterion to switch between true and false, behavior of dependent variables would change abruptly (e.g. if the output gap drops below zero). To allow for richer dynamics of the parameters, we could use the time varying parameters approach, but our number of parameters is insufficient for that.

To allow for gradual rather than abrupt transition between the two regimes Auerbach and Gorodnichenko (2012a) adopted the assumption that the dependent vector behaves according to a mixture of two VARs (one for expansion and one for recession) with their weights being continuous functions of the lagged output gap. Changes in output gap amend both the weights and the behavior of the system allowing for smooth transition from one regime (parameterized VAR) to another. If the output gap is equal to zero, both weights are equal. The derivative of the weights with respect to output gap at zero determines the speed of the transition. If the speed is high, the model has similar dynamics as the model used by Iltzetzki (2010). The more the speed approaches zero, the less does the output gap determine behavior of dependent variables. In such case, a simple VAR would be appropriate. In case the derivative is significantly different from zero, but not too distant, the system evolves rather smoothly, also when the output gap intersects with zero.

This system is described following Auerbach and Gorodnichenko (2012a)

$$X_t = [1 - F(z_{t-1})]\prod_E(L)X + F(z_{t-1})\prod_R(L)X + u_t \qquad (2)$$

where the weights *F* follow logistic function of a recession indicator *z*. The resulting non-linear system is then transformed into a series of linear equations (using the weights derivatives with respect to output gap), from which the optimum is selected.

Vector of dependent variables X consists of net exports, government spending, output gap and real exchange rate. We exploit the possibility to define new variables for known value of weight $F(z_{t-1})$:

$$[1 - F(z_{t-1})]\mathrm{X} = \mathrm{X}_E \qquad (3)$$

and

$$\mathrm{F}(\mathrm{z}_{t-1})\mathrm{X} = \mathrm{X}_R \qquad (4)$$

so that

$$[1 - F(z_{t-1})]\prod_E(L)X + F(z_{t-1})\prod_R(L)X = \prod_E(L)X_E + \prod_R(L)X_R\ . \qquad (5)$$

This substitution yields a linear version of (1) for a given weight $F(z_{t-1})$. The weight itself is a logistic function of output gap z_t with a parameter γ[2]:

$$F(z_t) = \frac{1}{1 - \exp(\gamma z_t)}\ . \qquad (6)$$

The parameter γ expresses qualitative behavior of the model. The following three distinct situations are possible:

γ≈0 weights are close to 0.5 and the model collapses to a simple VAR.

[2] Note that this is a recession indicator; it rises above 0.5, when γ_t is less than zero.

γ>0 weights move continuously in the interval (0.05, 0.95) according to the output gap. There are two regimes and the system transits smoothly between states dominated by expansion or recession. The system is always a convex combination of the two polar cases that do not exist separately.

γ>>0 weights are either zero or one, so that the weights *de facto* select observations and group them into two separate estimators. Two distinct regimes are present; switching abruptly. The polar cases of expansion and recession alternatively drive the system. The dynamics of the model is similar to that of Iltzetzki (2010).

The model allows for smooth transition between regimes, as noted by Auerbach and Gorodnichenko, but it encompasses simpler hypotheses as well.

Contrary to Auerbach and Gorodnichenko, we assume that the covariance matrix of u_t is constant, since the residuals in our model do not depend on the weights F(.) explicitly:

$$Var(u_t) = \sum \quad (7)$$

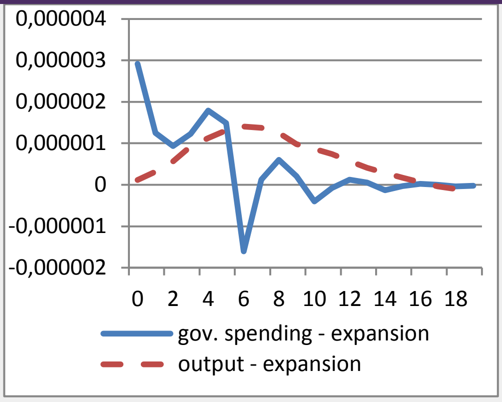
We have transformed the non-linear model into a group of linear models, among which the optimal model was found using one-dimensional grid search across *γ*. In every step of the grid search, we defined the value of *γ*, computed the weights *F(.)* and the weighted variables and estimated the model. The dependent vector is a linear function of the weighted variables so that pooled weighted least squares could be used. Every model consists of four separately estimated equations. We evaluated the combined fit of the model for every value of *γ* and have chosen the maximizing value of γ and parameters of the corresponding linear estimates as the optimum estimator of the parameters of our model.

We then arranged parts of the resulting equations into models (for expansion and recession) with explicitly expressed shocks analogous to residuals. We computed the heuristic impulse-response functions as the reactions of the system to transitory shocks. As these functions correspond to the IRF from the reduced form VAR, we identified the VAR with the Cholesky decomposition and transformed the IRFs by multiplying them with the transformation matrix computed from the covariance matrix of the errors from the estimation, assuming for simplicity that the transformation matrix is the same in the two regimes. We ordered the variables as follows: net exports, government spending, output gap and real exchange rate. Finally, we transformed the structural heuristic impulse-response functions into fiscal multipliers. Detailed description of the estimation procedure is in the Appendix.

5. THE RESULTS

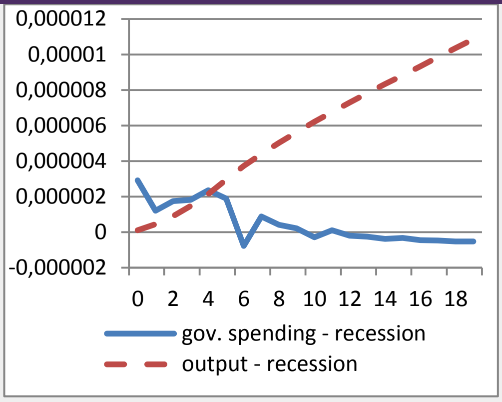
The combined R^2 is constant for small *γ* and then takes a U-shape. Very high values of *γ* imply practically binary weights resulting in two distinct regimes switching abruptly, rather than smoothly transiting in the form of convex combination with smooth weights. There is an abrupt change in behavior when the actual output drops below the potential output, so that the efficiency of the fiscal policy changes already in small recessions.

Figure 2a Structural heuristic IRF functions (expansion)



Source: own computations
Note: The horizontal axis depicts quarters
.

Figure 2b Structural heuristic IRF functions (recession)



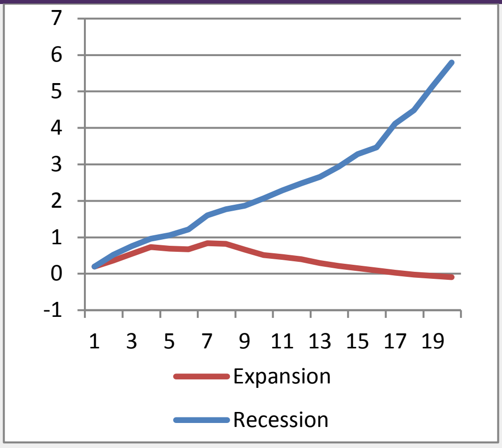
Source: own computations
Note: The horizontal axis depicts quarters

Figures 2a and 2b depict the structural impulse response function for a government spending shock lasting 6 quarters. These shocks are based on simulating the increase by 10^{-4} in the dependent variables and eliminating their correlation, as described in the annex, step 8. For government spending, there is little difference, i.e. spending overshoots shortly to the downside and then there is a residual increase converging to zero.

Much more interesting results are obtained for the output gap. While in expansion it is gradually increasing to peak at six quarters to return to zero in longer-term, in recession it does not fade out and rises even as government spending returns to its pre-shock value. Although steadily rising output is partly result of non-stationary nature of the estimated model, it is evident that the effect of government spending remains positive while the government spending reaction to the temporary shock fades out. Furthermore, we find that the slope attached to the reactions of output in recession is steeper than the one in expansion.

Figure 3 shows the fiscal multiplier computed according to the heuristic impulse response specification (see annex 11a and 11b). The multipliers are similar in nature to the structural heuristic IRF. In expansion, the multiplier grows from 0.2 to the maximum of 0.84 after 6 quarters, followed by gradual decline to zero. On the contrary, in a recession the multiplier continuously rises across time, reaching 1.0 after 4 quarters to even speed up later on, exceeding 5.0 in 5 years. Even if we discard the last year as not fully reliable due to non-stationarity of the model, we still get a message consistent with Auerbach and Gorodnichenko (2012a), namely that multipliers may be well above 2 in recession, while converging to zero in expansion.

Figure 3 Fiscal multipliers for V4 in expansion and recession



Source: own computations
Note: Quarters are on horizontal axis

In order to pursue the main goal of the study to analyze V4 countries separately rather than in a bigger and more heterogeneous group of countries, we had to make certain compromises.

In all V4 countries, the convergence process is still ongoing. As a result, output is often subject to large economic policy and market shocks. This translates into heterogeneous nature of the business cycle and output gaps. We tried to offset this by including the net exports and real exchange rate in our model (widening its information set), since these factors often accumulate disequilibria and cause disruptions when the accumulation stops.

A drawback of our model is caused by using the output gap both as a control variable (in weights) and dependent variable. The problem arises from the construction of variables X_E and X_R. The output gap was an autocorrelated but mean reverting series originally. In our The estimation with a high value of γ effectively split the series into two truncated series and changed its nature, because it introduced a regime change associated precisely with observations completing the mean reversion. This increased the autocorrelation of output gap and as a result, instead of a stable model, we worked with two models, of which at least one was unstable (potentially leading to explosive cumulative IRFs). We thus conjecture that the instability is an artifact of our estimation procedure and the output gaps are highly autocorrelated but stationary. We tried to alleviate this using the output gap in weights and difference of log output in endogenous vector, but the resulting model did not fit our hypothesis and had to be rejected. Similarly, we could not use the GDP growth rate as a control variable, because there were too few observations with negative GDP growth rate. Other variables, such as debt to GDP ratio differed between countries and we would mix up country effects and control variable effects if we used them. We are aware that our approach is not perfect, but it is the best compromise we were able to achieve.

Our choice of the functional form of government spending is not in line with other variables that are in the gap form. We have tried using the ratio of government spending to output in the endogenous vector, but the resulting model was not interpretable from the economic point of view. Therefore, our results are not robust and need to be interpreted with possible margin of error.

We have computed a separate model for every country originally, but the results had very large variability and were negatively affected by a low number of observations. The results were very sensitive to changes in specification as well. Therefore, the decision to use a pooled estimator was made.

The financial crisis, beginning in 2009, led to a sharp and relatively sustained drop of output in several European countries. A question may arise, whether the detected state dependence of fiscal policy does not simply reflect the change in the business cycle since 2009. This is not likely, as the V4 countries recovered from the recession quite fast (Poland even wasn't in a recession). The growth of potential output may have decreased since 2009, but the output surpassed pre-crisis level and continues growing. From a technical perspective, truncating the sample before the crisis would lead to a relatively large loss of observations, especially in the recession regime, and the problems of our model would get more pronounced.

Despite these drawbacks, we consider worthwhile to analyze V4 countries, as this diminishes the likelihood that the multipliers are constant and their state-dependence was detected only due to pooling V4 countries with other countries, not sharing their structural characteristics. Due to the limitations, however, results would benefit from further cross-checking when new data becomes available or by applying different method to detect state dependency of fiscal multipliers in studied countries. It is encouraging that our estimates of fiscal multipliers in expansion and recession are broadly comparable with those of Auerbach and Gorodnichenko. Our results support the assertion that the V4 countries are not outliers in the OECD dataset, when this dataset is used for fiscal policy evaluation.

6. CONCLUSION

Current challenging economic environment being in place, there is renewed interest in quantifying the effects of fiscal policy under non-standard circumstances. As Ilzetzki (2010) and Auerbach and Gorodnichenko (2012a) show for large multi-country datasets, fiscal multipliers indeed depend on the phase of the business cycle – being higher in recessions than in expansions.

The V4 countries are transition countries, i.e. still subject to the convergence process. They are highly open and export driven economies. Because of less developed financial markets, interest rate plays less important role then the exchange rate in monetary policy conduct compared to the advanced economies.

In order to capture the specifics of fiscal policy effects in converging economies we have used a simplified STVAR approach, based on Auerbach and Gorodnichenko, to explore the fiscal multiplier for V4 countries. Compared to the cited paper, we extended the model to capture special country characteristics. The dependent variable vector includes net exports, government spending, output gap and real exchange rate. We allow for two separate regimes for expansions and recessions as well as their convex combination.

We confirm the existence of two regimes, although we find transition between the regimes being abrupt rather than smooth in our system. The heuristic impulse-response functions of output to fiscal shock differ significantly in expansion and recession. Transforming these impulse-response functions into scenarios, we have computed fiscal multipliers. We find that in expansion, the multipliers peak below unity and decrease gradually to zero, while in recession, the multiplier grows faster than in expansion and keeps rising steadily also in longer-term (to well above 2.0).

Due to atypical nature of the business cycle in these countries and limited number of observations, certain compromises had to be taken. When having observed more completed business cycles and with growing number of available observations in future, we will be able to improve the model further to make more specific conclusions.

LITERATURE

Afonso A., Baxa, J., Slavík, M.:. "Fiscal developments and financial stress: a threshold VAR analysis," Working Papers Department of Economics 2011/11, ISEG - School of Economics and Management, Department of Economics, University of Lisbon, 2011

Ambriško, R. et al.: Assessing the Impact of Fiscal Measures on the Czech Economy, Working paper 15, ČNB, Praha, 2012

Auerbach, A. J. and Gorodnichenko, Y.: Measuring the Output Responses to Fiscal Policy, American Economic Journal: Economic Policy, American Economic Association, vol. 4(2), pages 1-27, May 2012a.

Auerbach, A. and Gorodnichenko, Y.: Output Spillovers from Fiscal Policy, NBER, Cambridge, 2012b

Barrell, R., Holland, D. and Hurst, I.: Fiscal Consolidation, Part 2. Fiscal Multipliers And Fiscal Consolidations, Working Paper No. 933 OECD Economics Department, 2012

Benčík, M.: "Analyzing the Path of Slovakia towards Monetary union by means of a Multi-equation gap model", in: Mathematical Methods in Economics, 23-th international conference, University of Hradec Králové, Hradec Králové, 14. – 16. September 2005

Blanchard, O. and Leigh, D.: Growth Forecast Errors and Fiscal Multipliers, IMF Working Paper WP/13/1, IMF 2013

Blanchard, O. and Perotti, R.: An empirical characterization of the dynamic effects of changes in government spending and taxes on output, MIT and NBER, 2001

Born, B., Jueßen, F. and Müller, G. J.: Exchange rate regimes and fiscal multipliers, without indication of the publisher and place of publishing, 2012

Christiano, L., Eichenbaum M. and Rebelo, S.: When Is the Government Spending Multiplier Large? Journal of Political Economy, 119(1), 2011, pp. 78–121.

Coenen, G. Erceg, Ch., J., Freedman, Ch., Furceri, D., Kumhof, M., Lalonde, R., Laxton, D., Lindé, J., Mourougane, A., Muir, D., Mursula, S., Roberts, J., Roeger, W., de Resende, C., Snudden, S., Trabandt, M., in't Veld, J.: Effects of fiscal stimulus in structural models, American Economic Journal: Macroeconomics, Vol. 4, No. 1, January 2012, pp. 22-68.

Corsetti, G., Meier, A. and Müller, G. J.: What Determines Government Spending Multipliers?, IMF Working paper WP/12/150, IMF, 2012

Čolláková, V., Machlica, G., Melioris, L., Pécsyová, M., Šrámková, L.: Ako veľmi bolí konsolidácia, Analýza vplyvu fiškálnej politiky na rast HDP na Slovensku, IFP MF SR, Bratislava, 2013

Fatás, A. and Mihov, I.: The Effects of Fiscal Policy on Consumption and Employment: Theory and Evidence, INSEAD and CEPR, 2001

Forecast errors and multiplier uncertainty, Box 1.5 in autumn 2012 forecast, European Commission , http://ec.europa.eu/economy_finance/eu/forecasts/2012_autumn/box_af12_-_multipliers_en.pdf

Hall, R. E.: By How Much Does GDP Rise if the Government Buys More Output? NBER Working Paper 15496, NBER, Cambridge, 2009

Hebous, S. and Zimmerman, T.: Estimating the Effects of Coordinated Fiscal Actions in the Euro Area, CESifo, 2012

Ilzetzki, E., Mendoza E. G., and Végh C. A., 2010. "How Big (Small?) are Fiscal Multipliers?" NBER Working Papers 16479

Jemec, N., Kastelec, A. S. and Delakorda, A.: How do Fiscal Shock Affect the Macroeconomic Dynamics in Slovenian Economy, Banka Slovenije, Ljubljana, 2011

Nickel C. and Tudyka A.: Fiscal Stimulus in Times of High Debt, Reconsidering Multipliers and Twin deficits, ECB Working Paper Nr. 1513, ECB, Frankfurt am Main, 2013

World Economic Outlook, October 2012, Coping with High Debt and Sluggish Growth, IMF, 2012

ANNEX: DETAILS OF THE ESTIMATION

We programmed a macro in E-views for carrying out the following calculations. Accessing the impact of fiscal policy consists of several steps; some of them are repeated in a cycle. Before the main calculations, we transformed the data from database as described in part about data. Further steps follow:

1. We defined scalars γ_{max} and $RSQWA_{max}$ and set their values to zero

We should explore values from zero to plus infinity for γ ideally. The model, however, is subject to perfect multicolinearity for γ = 0. On the other hand, it is evident from the logistic function that for sufficiently large γ, weights become binary (except for output gap equal exactly zero). Thus, we have chosen a sufficiently small value as a starting point and sufficiently large value ensuring that the weights are binary (except for a few observations) as the cutoff. The values of γ were computed according to the formula:

$$\gamma_i = 2^{-7} \times 2^{0.1i} \qquad \text{for } i = 1 \text{ to } 200 \qquad (8)$$

We thus repeated the steps 2 to 4 in 200 iterations for different γ.

2. We computed weight from γ and output gap according to (6) and variables X_E and X_R according to (3) and (4), using the whole vector X.
3. We regressed net exports on lagged values of X_E and X_R (lags 1 to 4) and kept the coefficient of determination. The fixed effects and cross-section specific weights were used in the pooled weighted least squares estimator.[3] The estimation sample was from the first quarter 1999 to fourth quarter 2012 for all four countries. We repeated the same for government spending, output gap and the real exchange rate.
4. We computed the weighted coefficient of determination from the coefficients of determination for the four equations: [4]

$$RSQ_{WA} = 0.1 * RSQ_{NX} + 0.5 * RSQ_{LYGAP} + 0.3 * RSQ_{DG} + 0.1 * RSQ_{RER} \qquad (9)$$

If $RSQ_{VA} > RSQWA_{max}$, then set equal $RSQWA_{max}$ to RSQ_{VA} and γ_{max} to γ.

5. After completing the cycle, we set γ to γ_{max} and repeated steps 2 and 3. The resulting regressions contain the parameters Π_E and Π_R associated with variables X_E and X_R.
6. Further computations depended on the value of γ_{max}.
a) If γ_{max} is at the minimal value of γ, the weights are practically constant at 0.5, there is only one regime. The equation (1) becomes an average of two identical VARs. The parameters can be derived from the coefficients of X_E and X_R as

[3] We assumed least squares appropriate, because it is a generalization of a reduced form VAR. We did not use dynamic panel techniques, because there are no lagged dependent variables of the right hand side formally. We used the weighted estimator in order to eliminate the heteroskedasticity connected with different variances of variables for various countries.

[4] The weights are based on perceived importance of the corresponding dependent variables for the fiscal policy evaluation. We wanted the highest weight associated with the output gap equation, so that the less important variables (net exports and exchange rate) do not, for example, cause γ_{max} to be small, when based on the equation for output gap, γ_{max} should be large.

$0.5\prod_E(L) + 0.5\prod_R(L)$ or a usual VAR can be estimated alternatively[5]. The impulse-response function of this VAR can be computed in normal way. The possibility of two regimes did not help to explain the variation in the endogenous vector X.

b) If γ_{max} is significantly different from zero (RSQ_{VA} is different from its value for smallest γ)[6], the parameters $\prod_E$ and $\prod_R$ are used to construct separate VAR models for expansion and recession.

7. As the models are not defined as VARs in E-views, we computed heuristic impulse-response function as follows: We added to both model a diagonal matrix of shocks S so that $X=\prod_E(L)X+S$ for expansion and $X=\prod_R(L)X+S$ for recession.
8. For both models, we computed a basic scenario with S=0 and a a scenario for every equation where the element of S corresponding to the equation in question was increased by 0.0001 for six quarters.[7] The simulations ran for 20 quarters
9. For every quarter of the simulation, we defined the heuristic impulse response function as the difference between the scenario with non-zero shock and the base scenario (with all shock equal to zero). Both for expansion and recession, for each dependent variable, there are four heuristic impulse responses corresponding to four variables of the VAR.
10. We arrange the heuristic IRFs from the model for expansion into a 4x4 matrix (with rows corresponding to dependent variables and columns corresponding to shocks)

$$H_E = \begin{bmatrix} \Delta NX/\Delta S_{NX} & \Delta NX/\Delta S_{DG} & \Delta NX/\Delta S_{LYGAP} & \Delta NX/\Delta S_{RER} \\ \Delta DG/\Delta S_{NX} & \Delta DG/\Delta S_{DG} & \Delta DG/\Delta S_{LYGAP} & \Delta DG/\Delta S_{RER} \\ \Delta LYGAP/\Delta S_{NX} & \Delta LYGAP/\Delta S_{DG} & \Delta LYGAP/\Delta S_{LYGAP} & \Delta LYGAP/\Delta S_{RER} \\ \Delta RER/\Delta S_{NX} & \Delta RER/\Delta S_{DG} & \Delta RER/\Delta S_{LYGAP} & \Delta RER/\Delta S_{RER} \end{bmatrix} \quad (10)$$

We arranged the heuristic IRFs from model for recession in an analogous matrix H_R. We computed the structural heuristic IRF as $H_{SE} = H_E C_\Sigma$ and $H_{SR} = H_R C_\Sigma$, where C_Σ is the Cholesky decomposition of Σ. This was done for 20 quarters the heuristic IRF were defined for (time indices are omitted form (9) for simplicity).
11. From the matrices H_{SE} and H_{SR}, that have structure analogous to H_E and H_R, we took the elements $\Delta LYGAP/\Delta S_{DG}$ and $\Delta DG/\Delta S_{DG}$ and reconstructed the path of government spending under shock in expansion and recession (in Excel). We assumed that the potential output is insensitive to fiscal policy so that the changes in output can be computed by multiplying the structural heurisitic IRF $\Delta LYGAP/\Delta S_{DG}$ with the actual output. Finally, we define the multipliers for lag t as

$$m_{Et} = \frac{(\Delta LYGAP/\Delta S^E_{DGt})Y_{At}}{G_{EGt} - G_{At}} \quad (11a)$$

[5] The parameter γ cannot be equal to zero in our computations since this would cause perfect multicolinearity. In fact, for small values of γ, the estimates of the parameters still suffer because of severe multicolinearity and the coefficient of determination is constant if γ is smaller than a certain threshold. In these cases, estimating a VAR with constant parameters is the safest path, since the parameters from step 3 may be in absolute value greater than 50 or 100.

[6] This is our case.

[7] The models - especially the one for recession - are not stable (see the part about limitation for further elaboration). Therefore, we did not use permanent shocks. The shocks lasting just one period had little impact on the dependent variable. We have chosen the six quarters duration hoping to get results that are well interpretable from the practical point of view.

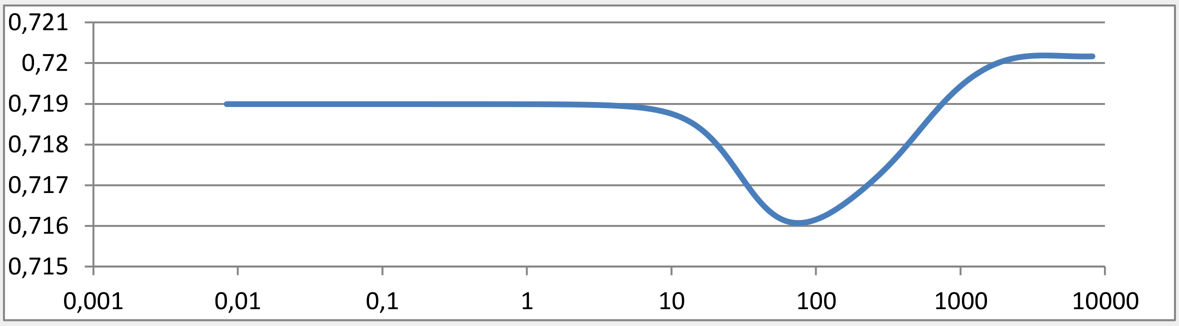
and

$$m_{Et} = \frac{(\Delta LYGAP/\Delta S^{R}_{DGt})Y_{At}}{G_{EGt}-G_{At}},\qquad (11b)$$

where the first factor in the numerators are structural heuristic IRFs for expansion and recession, Y_{At} actual output, G_{EGt} and G_{RGt} government spending under shock in expansion G_{RGt} and G_{RGt} in recession) and G_{At} are its actual values.

The weighted coefficient of determination RSQ_{VA} and parameter γ were stored in matrices during the computations. The evolution of RSQ_{VA} with rising values of γ is shown in Figure 4. It shows that the combined fit of the model decreases with rising γ, then rises, peaks and decreases. This is an indication that the optimal γ excludes smooth transition and leads to abruptly changing behavior of the system.

Figure 4. Weighted average of R-sqared as a function of parameter γ



Note: The parameter γ is on the horizontal axes (logaritmic scale), the weighted R-sqauared is on vertical axis.
Source: own computations.