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Fiscal Policy and Economic Growth in Bulgaria

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SUMMARY: This paper analyses the impact of fiscal policy on economic activity in Bulgaria and provides a range of estimates for the tax and spending multipliers. We compare the results of linear VAR models with the output from time-varying parameters Bayesian VAR with stochastic volatility. In all model specifications, first-year spending multipliers do not exceed 0.4, implying that there is not much to gain in terms of economic output from demand stimulating fiscal policy in Bulgaria. There is a lot of uncertainty in regards to the size of the tax multipliers, given contrasting results from VARs with different identification techniques, but the overall output effect of tax measures appears to be small and short-lived. The results from the linear models are largely consistent with the output from the time-varying parameters VAR model, which indicates that the size of first-year spending multiplier has doubled during the recent global crisis, but remains no larger than 0.3. These findings support the general view in the literature that fiscal multipliers are higher during periods of economic recession, but they are typically small in small open economies.

Keywords: Fiscal policy, Structural VAR models, Fiscal multipliers, Government spending, Bayesian estimation, Time-varying parameters

JEL Codes: C11, C32, E62

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Introduction

The strand of literature researching the effect of fiscal policy on the economy has gained momentum after the 2007/2008 global financial turmoil. While initially the main question for the policy makers was about the size and appropriate mix of fiscal stimuli to counteract the severe economic downturn, sovereign debt sustainability issues soon moved the focus of the discussion on fiscal consolidation strategies and the quantification of the expected negative effects on output. In both cases, however, the output effects of fiscal policy, as measured by the fiscal multiplier, are in the center of the discussion. Broadly speaking, the fiscal multiplier is used to measure the overall effect of discretionary fiscal policy on economic output. In 2012 the debate on the size of the fiscal multipliers has become even more relevant, as the economic recovery was weaker than expected in most European countries and the euro area fell into recession for a second time.

Despite its high importance and the large number of research papers published in recent years, the discussion regarding the macroeconomic effects of fiscal policy remains a highly controversial one. In fact, there is no theoretical consensus on the size and even the sign of the fiscal multipliers, with neoclassical and new Keynesian macroeconomic models predicting different responses of private consumption, employment and real wages, following a fiscal shock. The numerous studies published since the onset of the global crisis did not manage to provide firm support for either of the theoretical models. On the contrary, the estimates of the size of the fiscal multipliers are now dispersed over an even broader range, which is largely due to the lack of consensus on the most appropriate way of their assessment.

The aim of this paper is to contribute to the analysis and the debate on the macroeconomic effects of fiscal policy by providing a range of estimates for the fiscal multipliers in Bulgaria. For the purpose, we estimate several linear and time-varying parameter vector autoregressive models. Our contribution to the existing body of literature is twofold. First, the paper adds to a small but growing literature on the effects of fiscal policy in Central and Eastern Europe and Bulgaria in particular, by applying methodologies that have been found useful in assessing fiscal multipliers in the more advanced European economies. Second, we contribute to the relatively new and so far limited research effort of employing time-varying parameter VAR models to study the output effects of fiscal policy over time. We consider the application of this methodology to be especially relevant for analyzing fiscal policy in Eastern European economies, where many factors for non-linearity and time-dependent effects of fiscal stimuli have been present in the last 15 years.

The rest of the paper is structured as follows: the next section provides a brief overview of the related literature, including useful definitions and list of the main factors that affect the multipliers' size and their variation over time; Section 3 briefly presents the mostly widely used evaluation methodologies for measuring fiscal multipliers and reviews the different techniques for identification of fiscal policy shocks; Section 4 and Section 5 describe the data and the models that we use in the empirical study; Section 6 presents the results, while Section 7 is dedicated to the concluding remarks and the policy implications of the results.

Overview of related literature

Definition of fiscal multipliers

A brief overview of the related publications points to the conclusion that the fiscal multipliers are found in many different forms in the academic literature and their size varies considerably even if the analyses are focused on a specific economy, region and time span. In this study, along with the common practice, the fiscal multiplier is measured by the ratio of the change in GDP, or other measure of output, to the exogenous change in a fiscal variable that has caused the effect on output. For example, the spending multiplier represents the change of GDP due to a discretionary increase of government spending (fiscal shock). Thus, if the fiscal multiplier is higher or smaller than unity, fiscal expansion would respectively crowd-in or crowd-out some component of aggregate demand and consequently output. Depending on the fiscal variable that is chosen for the assessment, the multiplier could be defined as government consumption multiplier, government investment multiplier, tax multiplier (which can be further broken down to direct or indirect tax multiplier, net tax multiplier etc.), lump-sum transfers multiplier, etc. Also, the definition of the fiscal multipliers may differ according to the period of time considered in the assessment. For instance, the impact multiplier refers to the estimated ratio in the first period (e.g. first quarter) following the fiscal shock, while the cumulative multiplier refers to the ratio of the cumulative changes in the output and the fiscal variable over a specified time horizon (Spilimbergo et al., 2009). Short-, medium- and long-term multipliers are also frequently used notions in the literature. Short-term multipliers usually provide a measure of the output effects up to one year after the fiscal shock has taken place, while the medium-term multipliers are typically calculated for a period between 1 and 3 years.

Determinants of fiscal multipliers

Overall, there is a broad consensus in the academic literature about the main factors that affect the size of the fiscal multipliers. Spilimbergo et al. (2009) have grouped the most relevant of them.

First, fiscal multipliers are considered to be larger when only a small part of the additional income generated by the fiscal stimulus is saved by the private sector or used for imported goods and services (thus limiting the negative effect on output resulting from lower consumption or higher imports). These conditions are particularly valid when: the economy is large or relatively closed (i.e. the marginal propensity to import is relatively small); the structure of the stimulus is such that it does not affect imports and it is mostly based on an increase in government expenditure, rather than a decrease in taxes;[1] the marginal propensity to consume is high and the stimulus is targeted towards credit or liquidity constrained consumers (i.e. hand-to-mouth consumers); following fiscal stimulus the economic agents do not expect future offsetting measures due to short planning horizon or poorly formulated expectations for the future (i.e. non-Ricardian households);[2] the automatic stabilizers are small[3] and the efficiency of public spending is high.

Second, the size of the fiscal multiplier, at least theoretically, depends on the monetary policy response to the fiscal shock (expansion). The traditional argument in the literature follows the Mundell-Fleming proposition, which implies that fiscal multipliers are lower in economies with floating exchange rates regimes. Born et al. (2012) discuss the relevance of the Mundell-Fleming proposition in explaining the size of fiscal multipliers and its empirical validity. The authors conclude that the difference between the size of the spending multipliers in economies under fixed and floating exchange rate are smaller than what the traditional Mundell-Fleming analysis would suggest.

The sustainability of the fiscal stance after the stimulus is another important determinant of the multiplier's size. Excessively high or rapidly rising gov-

[1] The increase in government expenditure usually has a more direct effect on aggregate demand (increase in social transfers in kind, government purchases of goods and services etc.), while the additional income from a tax decrease might be saved by the consumers, thus limiting the second round effects on aggregate demand.

[2] I.e., the economic agents do not expect an increase in taxes in the future as a result of fiscal stimulus today. Therefore, the agents would rather spend the additional income, resulting from the stimulus, rather than increase precautionary savings in anticipation of higher taxation in the future. In the case when the Ricardian equivalence is valid, private saving would offset the effects from the expansionary fiscal policy, especially if the fiscal shock is permanent.

[3] Smaller automatic stabilizers are associated with relatively smaller output elasticity of government revenue and spending. Therefore, the automatic offset effect, resulting from the fiscal stimulus, would be more limited.

ernment debt levels might negatively affect the effectiveness of fiscal policy in stimulating economic output, as demonstrated by Kirchner et al. (2010) and Nickel and Tudyka (2013). Considering the increasing or already high level of public indebtedness, private agents would perceive the present fiscal situation as unsustainable. Therefore, the fiscal stimulus would lead to lower private consumption and higher precautionary savings, as agents expect higher taxes or lower government consumption in the future, as a result of the higher deficit today. Such argument is strongly supported in the literature on expansionary fiscal contractions (Giavazzi and Pagano, 1990)[4] and it is to a large extent supported by the latest developments in the EU.

More recent studies have found that the degree of financial market development of the country could also affect the size of the fiscal multipliers. Limited credit availability would result in higher share of liquidity-constrained households and companies, which would spend the additional income, associated with the fiscal stimulus, in order to smooth their consumption or investment needs.

Time-variation in fiscal multipliers

The assessment of the fiscal multipliers becomes even more complicated, especially in the current economic environment, by the fact that their size (and possibly the sign) varies over time. Indeed, subsample instability has often been observed in the recent empirical studies (e.g. Pereira and Lopes, 2010). Specifically, the size of the fiscal multipliers is found to be dependent on the underlying state of the economy, as argued by Spilimbergo et al (2009), Baum and Koester (2011, 2012) and Auerbach and Gorodnichenko (2010, 2011). In most cases, fiscal multipliers tend to be larger in downturns than in expansions. This asymmetry has important fiscal policy implications, especially regarding the choice between frontloading and back-loading the required fiscal consolidation effort. Nevertheless, there are several sources of the economic-state dependent character of the multipliers that should be considered when choosing the appropriate adjustment strategy.

On the one hand, fiscal multipliers might be larger in periods of economic recessions since the negative output gap allows the monetary authority to accommodate the increase in demand (as a result of expansionary fiscal measures) without having to increase interest rates, which would otherwise

[4] Giavazzi and Pagano (1990) find empirical relevance for expansionary effects of fiscal contraction for the case of Denmark in the 80's where cuts in government spending were associated with an increase in consumption even after controlling for wealth and income, and even in the presence of a substantial increase in current taxes.

offset part of the fiscal stimuli effects. In the opposite case, the monetary authority would not increase the money supply as a response to the increase in output due to the associated inflationary pressure. This, in turn would appreciate the local currency (due to increase in interest rates and capital inflows) and reduce net exports, hence, offsetting the initial fiscal expansion effect on output. Under a fixed exchange rate, however, the fiscal expansion would imply increase in money demand and a corresponding increase in money supply, with no offsetting effect through a decrease in net exports. Moreover, the share of liquidity and/or credit constrained households and companies usually increases in downturns and allows for a much stronger effect of fiscal stimuli on private consumption and output, as greater part of the additional income would be consumed or invested, but not saved. On the contrary, periods of severe recession could trigger high levels of precautionary savings, given the heightened risk of unemployment and lower income. This would decrease the effect of the fiscal stimulus, due to the limited second round effects on private consumption. Similarly, the corporate sector may also postpone or abandon investment projects in view of the uncertainty about the economic outlook.

The size of fiscal multipliers

The variation of the multiplier's size over time is particularly relevant for the catching-up economies of the EU, such as Bulgaria, which have experienced a number of significant structural changes that have undoubtedly influenced the output effects of fiscal policy. These episodes of structural reforms and the short data series pose challenges in quantifying the fiscal multipliers in these countries. To a large extend these are the reasons why the estimates on the fiscal multipliers in catching-up economies are scarce and mostly based on panel data approaches. Overall, the few existing studies suggest that spending and tax multipliers in the new Member States of the EU are very small[5] or at least considerably lower as compared to the estimates for the large economies, such as the USA, Germany, France and UK,[6] which is largely due to the high degree of economic openness in the smaller countries. In terms of magnitude, Spilimbergo et. al (2009) suggests a rule of thumb – 1.5 to 1 for spending multipliers in large countries, 1 to 0.5 for

[5] E.g. Ilzetzki et al. (2010) conclude that fiscal multipliers are lower in small open economies because of the crowding out of net exports. More evidence on Central and Eastern European countries can be found in Lendvai (2007) for Hungary, Benčík (2009) for Slovakia and Mirdala (2009) for Bulgaria, Romania, Poland, Czech Republic, Slovakia and Hungary.

[6] Boussard et al. (2012) provide summary tables of results from VAR model-based expenditure and net taxes multipliers in US, Germany, France, Italy, Spain, UK, Portugal and the Euro area.

medium-sized countries, and 0.5 or less for small open countries. In all cases, tax multipliers are generally found to be lower. The results of the recent study of Muir and Weber (2013) are broadly in line with the approximation of Spilimbergo et. al (2009). The authors find that first-year spending multipliers in Bulgaria are around zero, while the first-year revenue multipliers are in the range of 0.3 – 0.4. Moreover, Muir and Weber (2013) find evidence that that during periods of recession, the first-year responses of output to a positive spending and a revenue shocks are close to 0.3 and -0.5, respectively. During expansions, the responses decrease to 0.2 and -0.4, respectively. These findings add to the empirical evidences, which suggest that active fiscal policy is more effective during downturns, but the effect of fiscal stimuli is generally small in small open economies, such as Bulgaria.

Overview of the estimation techniques

The growing body of research studies on fiscal multiplies utilizes several different approaches for assessing the impact of fiscal stimuli on macroeconomic developments. The most widely used approaches are the empirical estimates based on vector autoregressive (VAR) models and structural model-based evaluations, such as Dynamic Stochastic General Equilibrium (DSGE) models.

An often cited shortcoming of assessments based on simulations with structural models is that the estimated multiplier is largely dependent on their theoretical construction. Particularly, the results are significantly influenced by the forward looking features of the models, the assumptions about the utility function of the individuals, the production function of the firms, the source of nominal rigidities and the monetary policy reaction function (Spilimbergo et al, 2009, Perrotti, 2007, Christiano et al, 2010 and Coenen, 2012 for a review). On the other hand, DSGE models are suitable for assessing fiscal multipliers by instrument (i.e. specific budgetary item) since they are not subject to restrictions in the number of explanatory variables. Overall, fiscal multipliers estimated by DSGE models are found to be lower as compared to empirical models, such as the VAR-based models. In the DSGE setup, the share of liquidity constrained households appears to be the most relevant parameter in influencing the size of the impact spending multipliers, as pointed out by the meta-analysis of Leeper et al. (2011).

The effects of discretionary fiscal policy can be also identified by case studies, based on well documented changes in tax policy or discretionary government spending. The advantage of this approach, followed by Romer and Romer (2010), is that the timing of the announcement of the fiscal measure can be clearly identified. At this point of time the future expectations of the economic agents are formed, which is considered to be the relevant moment for assessing their reaction and the resulting output effect, rather than the moment of the actual implementation of the measure. This methodology offers certain advantages over the more commonly used approaches for identification of discretionary fiscal policy shocks, but it requires long data series with the presence of many such episodes of exogenous fiscal shocks. Data series of this kind, however, are rarely available.

Linear VAR Models

As compared to the DSGE models, VAR-based specifications have the advantage of being unrestricted by a predetermined theoretical construction, but on the other hand, important structural features of the economy might be omitted by the empirical model. Another fundamental difference between the two most widely used techniques concerns the nature of the fiscal shock. In addition to the economic environment, the monetary regime and the other factors outlined in the introduction, the nature and the composition of the fiscal shock significantly influences fiscal multipliers estimates. Typically, the VAR models rely on specific temporary fiscal shocks, while structural models allow for policy evaluations based on both temporary and permanent shocks. Therefore, a comparison between the results of the two techniques is not always appropriate.

In fact, the identification of the presumably exogenous fiscal shocks is a major issue in the VAR models. As demonstrated by Caldera and Camps (2008), different identification schemes of the fiscal shocks can significantly affect the estimates.

The most widely applied identification approaches in the linear VAR-based studies include:

– The *recursive approach*, introduced by Sims (1980) and later applied by Fatás and Mihov (2001), Giuliodori and Beetsma (2004), Alfonso and Sousa (2009) and many others. This approach is based on the recursive Cholesky decomposition of the variance-covariance matrix of the model residuals and requires strong and sometimes arguable assumptions about the contemporaneous relations between the variables in the model specification. The recursive identification scheme is used to evaluate fiscal policy effects in several studies on the new members of the EU (i.e. Mirdala, 2009 and Lendvai, 2007).

– The structural VAR *approach proposed by Blanchard and Perotti* (2002) and further extended in Perotti (2005). Especially in the recent years, this approach is among the most widely applied fiscal shock identification schemes for empirical evaluation of fiscal multipliers. The technique of Blanchard and Perotti (2002) is based on out-of-the-model institutional information on the automatic responses of government spending and taxes to economic activity (budgetary output elasticities) and requires certain assumptions about the period of time, which is needed for the government to implement discretionary fiscal measures in response to output innovations. This approach (henceforth BP approach) is extensively applied in studies on fiscal multipliers in the euro area countries,[7] but it is also dominant in the analysis on the catching-up European economies.[8]

– The *sign-restrictions approach* developed by Uhlig (2005) and applied by Mountford and Uhlig (2005) and Caldara and Kamps (2008). This methodology involves simultaneous identification of business cycle and fiscal policy shocks by imposing sign restriction on the impulse responses. For instance, the business cycle shock is identified by restricting the impulse responses of output and net taxes to be positive for at least four quarters following the shock. The tax shock is identified by restricting the impulse responses of government taxes to be positive for at least four quarters following the shock, etc. The advantage of this technique is that it controls for a frequently observed problem in empirical studies related to a puzzling result of an increase in output as a response to a positive tax shock. At the same time, however, the sign-restrictions approach[9] tends to overestimate the negative response of output after a tax increase, as argued by Caldara and Kamps (2008).

– The *event-study approach* of Ramey and Shapiro (1998), which is used to analyze the output effects resulting from large unexpected increases in government spending (in this case – defence spending). Similar identification techniques have been applied by Perotti (2007), Ramey (2007) and Caldara and Kamps (2008). The application of an event-study technique may provide valuable information on the economic effects of fiscal shocks, but it requires long data series of well-documented exogenous spending shocks, which is rarely available. Therefore, its application is limited primarily to studies based on data for the United States.[10]

– The *long-run restrictions approach*, which imposes restrictions on the responses of the variables in the VAR model, as in Blanchard and Quah (1998).

[7] Caprioli and Momigliano (2011) provide a detailed comparison of studies and estimates on the euro area, Germany, France, Italy, Spain and the UK.

[8] See for instance: Jemec et al (2011) for a study on Slovenia, Cuaresma et al (2011) for a study on five Central and Eastern European economies, Benčík (2009) for a study on Slovakia, Mançellari (2011) for a study on Albania and Muir and Weber (2013) for a study on Bulgaria.

[9] The sign-restrictions approach has been applied by Benčík (2009) for an analysis on the Slovakian economy.

[10] See Caprioli and Momigliano (2011) for a more detailed reference.

The identification strategy imposes a long-run neutrality assumption on some of the variables.[11] Mirdala (2009) follows this approach to analyze the output effects of fiscal policy shocks in the several of the new Member States of the EU, including the Czech Republic, Hungary, Poland, the Slovak republic, Bulgaria and Romania. The results are then compared to the outcome of a VAR model with a recursive identification scheme. The two approaches provide quite similar results for both the tax and the spending multipliers. Yet, to the extent that long-run neutrality assumptions seem to be quite arguable and rarely used in the fiscal policy literature, we refrain from using this methodology in this paper.

Non-linear VAR Models

The VAR models provide valuable information about the output effects of fiscal policy, but the drawbacks and the caveats of the different estimation techniques should be always kept in mind. On the one hand, VAR estimates of fiscal multipliers are highly dependent on the type of identification scheme, which tend to diverge considerably, especially with respect to the output effects of tax changes, as shown by Caldara and Kapms (2008). On the other hand, most of the studies on the output effects of fiscal policy, especially before the recent crisis, are based on linear vector auto-regressions, which ignore the state of the economy and assume that the fiscal multiplier time invariant. As Parker (2011) points out, linear models (including linearized or close-to-linear structural models) provide weighted average estimate between the 'important multiplier', which operates during economic downturn and the 'less relevant' multiplier, which applies during periods of economic expansion. Therefore, since the beginning of the crisis, the non-linear effects of fiscal policy became subject to extensive research. The studies that provide evidence for a relationship between the size of the fiscal multipliers and the underlying state of the economy are also based on several different econometric methodologies, including: threshold VAR models (e.g. Baum and Koester, 2011, for Germany, Baum et al., 2012, for the G7 countries, except Italy, Muir and Weber, 2013, for Bulgaria), time-varying parameter VAR models with stochastic volatility (Kirchner et al., 2010) and Smooth Transition Vector Autoregressive models (Auerbach and Gorodnichenko, 2010 and extended in Auerbach and Gorodnichenko, 2011).

[11] Typically, it is assumed that government spending does not permanently affect tax revenues and vice versa, real output does not have a permanent effect on government expenditures and inflation , inflation does not have a permanent effect on government expenditures and real output and interest rates do not have a permanent effect on any other endogenous variable of the model.

Data Description

For the purpose of this study we have chosen to use quarterly accrual fiscal data (based on ESA 95[12] definition), rather than cash-based data, where longer data series are available. This is strongly justified as it enables us to compare results with other studies on European economies, most of which are based on ESA 95 data.[13] In addition, fiscal data on accrual basis takes into account the payment lags in tax revenue, it offers a better treatment of EU funds related transfers and it accounts for the accumulation of public arrears. All fiscal variables are taken or derived from the quarterly non-financial accounts of the general government (QNFAGG) for the period Q1 1999 – Q3 2011. The fiscal variables have been deflated and log-transformed before being seasonally adjusted with TRAMO-SEATS in EViews.

A key issue in fiscal multipliers studies is the specific definition of tax and expenditure aggregates that are used in the models. In the study of Blanchard and Perotti (2002) the net taxes aggregate is defined as total tax revenues minus social transfers and net interest payable, while the government spending variable is the sum of government consumption and government investment. The argument for not including social transfers in the expenditure aggregate and subtracting them from government revenues is that social transfers have similar redistributional effects as taxes do. This approach is perhaps the most universal one in the fiscal multipliers literature and it is also applied in Jemec et al. (2011) for Slovenia, Cuaresma et al. (2011) for five Central and Eastern European countries and Mirdala (2009) for Bulgaria, Romania, Poland, Czech Republic, Slovakia and Hungary. Alternatively, there are strong arguments for including social payments on the expenditure side as they account for a substantial part of total government spending, especially in Bulgaria, and represent an important instrument for stimulating internal demand. Therefore, we construct two different sets of government tax and expenditure aggregates. The one, which is based on the Blanchard and Perotti (2002) definition, is used in the baseline model, while the alternative one, which includes social payments, is used to check the robustness of the results from the baseline model.

Further details on the data, including the definition of the variables, their sources and treatment are presented in Appendix A.

[12] European System of National and Regional Accounts.

[13] A notable exception is a paper by Caprioli, and Momigliano (2011) for Italy, who rely on cash-based data for government wages and intermediate consumption.

Models Description

Our assessment on the multipliers in Bulgaria is based on two different estimation approaches. First, we estimate linear vector auto-regression models with two different identification schemes. As a starting point we estimate a standard VAR model with recursive identification scheme, similarly to Fatás and Mihov (2001). This specification allow us to compare results with the study of Mirdala (2009), which is based on the same identification scheme and includes estimates for the tax and spending multipliers in Bulgaria. In addition, the results of the recursive VAR is often used as a benchmark, when compared to the output of models with a more sophisticated identification schemes, such as the one of Blanchard and Perotti (2002). The approach of Blanchard and Perotti (2002) is among the most widely used methods in the literature for measuring fiscal multipliers. Applying it for Bulgaria will allow us to compare results with other similar studies on European economies, including the recent study of Muir and Weber (2013) for Bulgaria. For the time being we refrain from estimating models with other identification schemes largely due to data availability constraints or reservations regarding the assumptions they require.

As a second step, we analyse the variation in the size of the spending consumption multiplier in Bulgaria by estimating a time-varying parameter VAR with stochastic volatility. We have chosen this approach for several reasons. First, VAR-based techniques are subject to much less computational challenges than structural models for capturing the non-linear nature of the multiplier's size. Second, among the available techniques, the use of Bayesian methods to estimate time-varying parameter VAR models offers some advantages over sub-sample or rolling-sample estimates as it allows greater flexibility in modelling non-linearity and time heterogeneity (Pereira and Lopes, 2010). This approach allows us to test for non-linear output effects of the fiscal policy in Bulgaria, which might have been caused by structural changes that cannot be easily identified a priori, or they may take the form of processes that last a number of years (Kirchner at al., 2010). The alternative approach of including sub-sample or rolling-window estimation is not appropriate for the purposes of this study mainly due to the short length of the time series. In addition, the gradual nature of some of the structural changes in Bulgaria will not be properly captured by a sub-sample estimation.

The recursive approach

The baseline VAR model in this study uses the recursive identification approach, which is based on the Cholesky decomposition of innovations that allows for the identification of the fiscal policy shocks. The model includes three endogenous variables in real terms: government spending, GDP and net taxes. The definition of government spending and net taxes follows the one used in Blanchard and Perotti (2002). The ordering of the variables in the Cholesky decomposition has strong economic implications and requires that: (a) government spending does not react contemporaneously (in the same quarter) to any of the shocks in the other variables in the VAR model, (b) output responds contemporaneously only to shocks in government spending, (c) taxes respond contemporaneously to shocks in both government spending and output. As exogenous variables we include a constant, a linear time trend and the log-transformed foreign demand for Bulgarian exports. The inclusion of the foreign demand variable is to account for the fact that Bulgaria is a small open economy and external shocks have a strong effect on domestic output. Similar approach has been also applied by Caprioli and Momigliano (2011) for the case of Italy. In their study, however, foreign demand is added to the list of endogenous variables, but due to the short data series in the case of Bulgaria and the large numbers of parameters that has to be estimated, this approach did not provide meaningful results.

In addition to the baseline model, we estimate two extended VAR models, with recursive identification scheme, which are similar to the specifications in the study of Fatás and Mihov (2001). In the first one, we add private consumption and investment, separately, as a fourth exogenous variable. First, the response of private consumption to a government spending and a tax shock is estimated. Then, we follow the same procedure by replacing private consumption with investment. As in Fatás and Mihov (2001) these two variables are ordered second – before aggregate GDP. The second extension of the recursive VAR includes five endogenous (government spending, GDP, inflation, net taxes and interest rates) and three exogenous variables (constant, linear time trend and log-transformed foreign demand for Bulgarian exports). We also check whether the results of the models are robust to the alternative specification of government tax and spending aggregates. The results from the extended recursive VAR models are reported and discussed in the robustness check section in the Appendix.

All the details about the estimation methodology of the VAR models with recursive identification scheme are presented in section B1 in Appendix B.

The approach of Blanchard and Perotti

The approach of Blanchard and Perotti (2002) requires certain assumptions about the tax and transfers system and utilizes supplementary estimates for the budgetary output elasticities (estimated outside the model) in order to identify structural government spending and revenue shocks in the VAR setup. Then, the response of output and its main components to a given exogenous fiscal impulses is estimated. The derivation of the tax revenue elasticity is based on the OECD methodology[14] and as it is generally accepted in the literature we assume a zero elasticity of government spending to GDP. Net transfers are not included in the government spending aggregate, whereas they are netted out from tax revenues. Following Perrotti's argument, an output elasticity of net transfers of -0.2 has been assumed.

In the baseline specification of the structural VAR (SVAR) model we follow the same fiscal variable definitions, as in Blanchard and Perotti (2002). This approach allows for comparison of results with other similar studies and it takes in consideration the plausible assumption that it usually takes more than one quarter for the government to implement changes in social payments in the event of a shock in the other expenditure items. As in the baseline recursive VAR, we estimate the structural VAR model including three endogenous variables - net taxes, government spending and output.

As a robustness check, we also estimate a structural VAR with the alternative definition of the fiscal variables used in Baum and Koester (2011). They define government spending as the sum of compensation of employees, intermediate consumption, public investment, social payments and subsidies, net of unemployment benefits. Such a definition ensures that there are no items in the government spending aggregate that are automatically adjusted to the business cycle. There are two arguments for including social transfers in the expenditure aggregate. First, social payments represent a substantial part of total government expenditures and therefore they are a major instrument for conducting active fiscal policy. Second, we consider that social payments are more effective as compared to tax measures in stimulating economic activity as the associated 'leakages' of the fiscal stimulus, both in terms of increased demand for imports and increase of private savings, are generally more limited, given the hand-to-mouth characteristics of the targeted individuals.

Following the approach of Caprioli and Momigliano (2011) we also estimate the model by replacing aggregate output with private output. Estimating the effects on private GDP in the linear VAR model is often consider to be more economically meaningful given that the main purpose on the analysis is to evaluate the effects on private consumption and investment decisions as a result of a fiscal policy shock. The results from the structural VAR models with the alternative specifications of the variables are reported and discussed in the robustness check section in the Appendix.

[14] Details in Appendix C.

Further details on econometric methodology behind the structural VAR approach of Blanchard and Perotti (2002) are presented in section B2 of Appendix B.

Time-varying parameter VAR model

The time-varying parameter VAR model with stochastic volatility (TVP-VAR) in this study is based on the specification of Blake and Mumtaz (2012).

The TVP-VAR model estimates are also based on quarterly national account data,[15] including real government consumption, real private consumption and real GDP, all seasonally adjusted with TRAMO SEATS. The input data is transformed in first-difference logarithms and then divided by the ratio of the variable of interest to GDP. Thus, we obtain impulse responses, expressed in terms of percentage of GDP. The initial values of the parameters in the model are set using ordinary least squares (OLS) estimates over the full data sample. Due to the volatility of the data series and the need for theoretical consistency in the results we impose sign restrictions to the impulse responses. This translates into an always positive response of private consumption to a government spending shock. Thus, only the size of the response remains unknown.

We have estimated a TVP-VAR with net taxes, private consumption and output, but the results were not theoretically meaningful and therefore they are not reported in the study. This, however, is not surprising, given the contrasting results in the linear VAR models. Generally, the empirical literature is less divided with respect to the size of the spending multipliers, while the estimates for the tax multiplier cover a much broader range. The estimates for the tax multipliers are also found to be much more sensitive to the choice of fiscal shock identification technique. To some extend this is due to the fiscal foresight problem and the inability of the VAR models to properly account for the fact that changes in the tax rates for example, are often anticipated and known ahead of the actual change in the legislation.[16]

Detailed description of the TVP-VAR estimation procedure is provided in section B3 of Appendix B.

[15] The time period of consideration for the TVP-VAR is extended to Q2 2012.

[16] See Caldara and Kamps (2008) and Leeper et al. (2008) for a discussion.

Results

Overall, the impulse responses of the structural VAR are not considerably different from the responses of the baseline VAR with the recursive identification scheme, especially in regards to the spending shocks (Figures D1 and D2 in Appendix D).

As shown in Figure D3 in Appendix D, the impulse response from the tax shock in the baseline VAR is an interesting exception. Specifically, the positive tax shock causes output to initially increase for eight quarters, before its response turns negative. This puzzling outcome is also found in Mirdala (2009) for Bulgaria. A possible explanation could be the fact that historically after a tax cut, government revenues actually increase as tax compliance significantly improves. Most recently, such an effect was observed after the introduction the flat tax rate in 2008. This observation, however, could be one factor for an omitted variable bias.

Nevertheless, the sign of the impact tax multiplier changes in the structural VAR and the effect on output, following a tax increase becomes negative and significant (Figure D4). As pointed out by Caldara and Kamps (2008) there are strongly diverging results as regards the economic effects of tax shocks, depending on the identification approach used in the VAR. In the case of Bulgaria, shocks in net taxes seem to be more persistent as compared to government spending shocks.

More detailed analysis and figures of the different impulse responses from the baseline models are provided in Appendix D.

Time-invariant fiscal multipliers

The estimated impulse response functions do not directly reveal the government spending or tax multiplier because the estimated elasticities must be converted to unit equivalents (e.g. euro equivalents). In order to provide estimates for the absolute change in output, following a unit change in the fiscal variables we transform the original impulse responses of output by first dividing them by the standard deviation of the fiscal shock to normalize the initial impulse to 1% shock in the fiscal variable. Then, we multiply the impulse response by the ratio of the output to the fiscal variable. Since the impulse response functions are for the log-transformed variables, we use the following formula:

$$\frac{\Delta X_{t+k}}{\Delta F_t} = \frac{\Delta \ln X_{t+k}}{\Delta \ln F_k} \cdot \frac{X_{t+k}}{F_t},$$

where k is the moment of time (i.e. the quarter), in which we evaluate the multiplier, X is output and F denotes the fiscal variable (net taxes or government spending).[17]

The next table summarizes the results for the tax and spending multipliers in the two standard 3-variable linear VAR models.

Table 1

CUMULATIVE TAX AND SPENDING MULTIPLIERS – LINEAR VAR MODELS

Cumulative fiscal multipliers – effects on GDP	Quarters			
VAR model with recursive identification:	**1**	**4**	**8**	**12**
Government spending multiplier	0.03	0.17	0.48	0.70
Net taxes multiplier	0.00	0.91	1.48	1.02
SVAR model with BP identification:	**1**	**4**	**8**	**12**
Government spending multiplier	0.01	0.41	0.87	0.92
Net taxes multiplier	-0.30*	0.19	0.43	-0.21

*denotes significance at the 5% level.

The results from both model specifications indicate that the size of the first-year cumulative government spending multiplier is in the range of 0.2 to 0.4. The outcome is broadly consistent with the findings of Muir and Weber (2013) who estimate first-year spending multipliers in Bulgaria to be close to 0.3.[18] The spending multiplier in Bulgaria is also comparable to most of the studies on EU periphery countries and supports the argument that small open economies are usually characterized by small fiscal multipliers. These values are, however, much smaller than the spending multipliers in the USA and the larger (less open) euro area economies, which are usually found to be close to unity, on average.[19] Burriel et al. (2010), for instance, estimate a SVAR model with BP identification scheme and find that the overall spending multiplier of the euro area is 0.87.

[17] The same procedure is applied for evaluating the effects on private consumption or investment in the extended VAR specification with recursive identification, following Fatás and Mihov (2001).

[18] The authors estimate a VAR model based on Blanchard and Perrotti (2002), using monthly cash-based data from 2003 to mid-2012 with industrial production as a proxy for GDP. For the whole sample, both first year spending multipliers and first year revenue multipliers are found to be 0.3. They also estimate the model with quarterly accrual-based data between 1999 and 2011 and find that first year spending multipliers lie around zero and first year revenue multipliers are 0.3. Both, however, are statistically insignificant.

[19] Boussard et al. (2012) provide a summary table of VAR-based estimates of expenditure multipliers in large economies.

Again, there is a lot of uncertainty in regards to the size of the tax multipliers, given contrasting results from VARs with different identification techniques, but the overall output effect of tax measures appears to be small and short-lived.

This outcome is broadly in line with the existing VAR-based studies, significant part of which point to highly diverging tax multipliers, depending on the choice of identification scheme. The estimate for the impact tax multiplier in the BP structural VAR specification (-0.3) is much smaller in magnitude as compared to Burriel et al (2010) for the euro area (-0.79), but somewhat above the estimates of Jemec et al (2011) for Slovenia (-0.08).[20] The results of Muir and Weber (2013) for Bulgaria, based on monthly data, suggest that first-year tax multipliers are in the range of 0.3 - 0.4.[21]

Nevertheless, it should be stressed that the impulse responses in both VAR model specifications turn insignificant already in the second quarter after the shock. This statistical issue is to a large extent related to the short length of the time series. Therefore, all results should be considered with caution.

Details about the statistical properties of the VAR models, including unit root, co-integration and diagnostics tests can found in Appendix F.

Time-varying fiscal multipliers

The output of the TVP-VAR model is largely consistent with the results from linear VAR models, both pointing to a very limited and short-lived effect of fiscal policy shocks on economic activity.

The results in Figure 1 indicate that the first-year cumulative government spending multiplier[22] is considerably larger in the years after the introduction of the currency board (0.3) compared to the period just before the 2008 crisis (0.15). As the global financial meltdown started, the size of the multiplier rapidly increases back to the levels from the beginning of the sample, before shrinking again along with the economic recovery. The effects on private consumption resulting from the government spending shock are larger as compared to the effects on GDP, which implies that other components of GDP have been affected as well. The responses of both variables, however,

[20] Boussard et al. (2012) provide a summary table of VAR-based estimates of net tax multipliers in large economies.

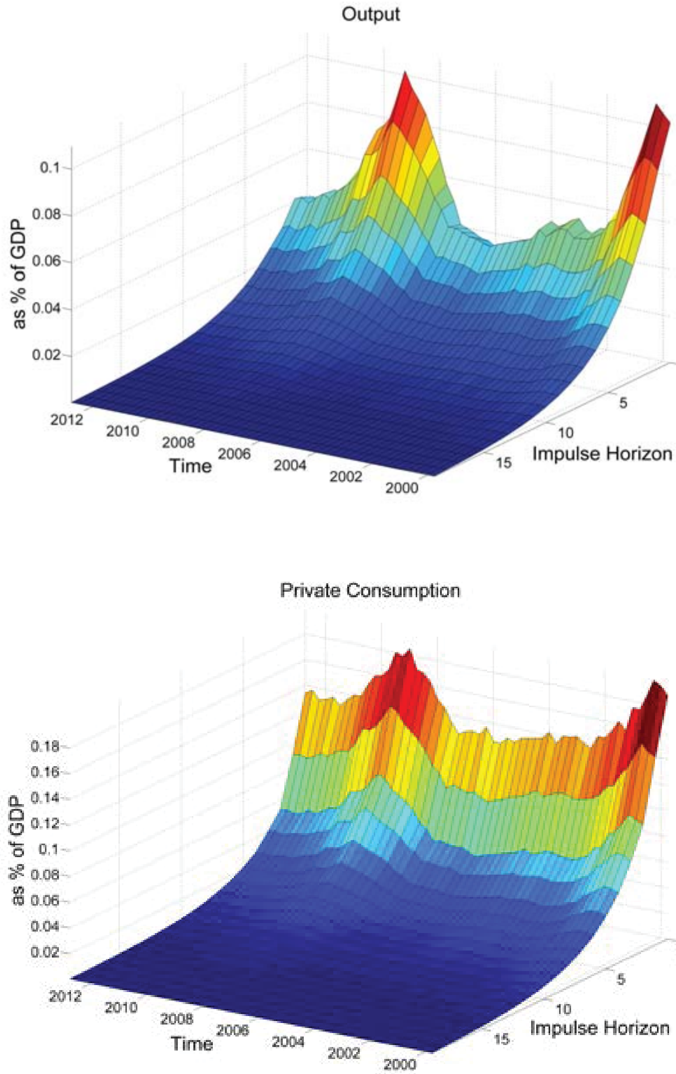
[21] Muir and Weber (2013) report the tax multiplier with a positive sign but this is only due to representation purposes, while the interpretation remains the following: an increase in tax collections decreases economic activity.

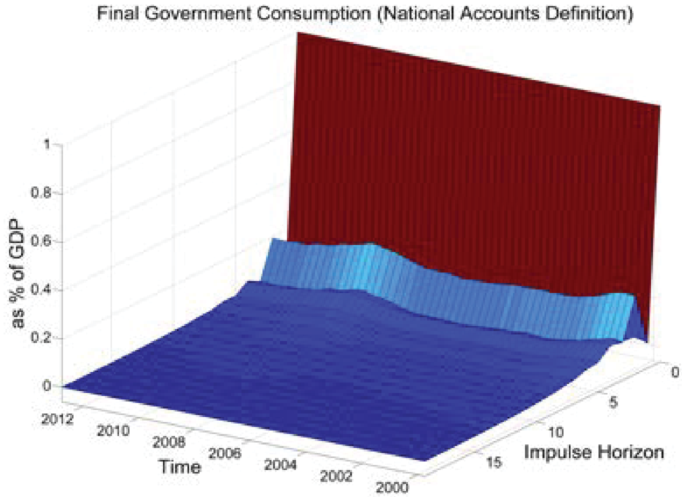
[22] The government spending aggregate used for the estimation of TVP-VAR is the real seasonally-adjusted government consumption.

varied over time in a similar manner in terms of size and duration. The response of government spending itself is rather stable throughout the sample period (both in terms of size and duration), with small increases in the beginning of the sample and during the peak of the global financial crisis.

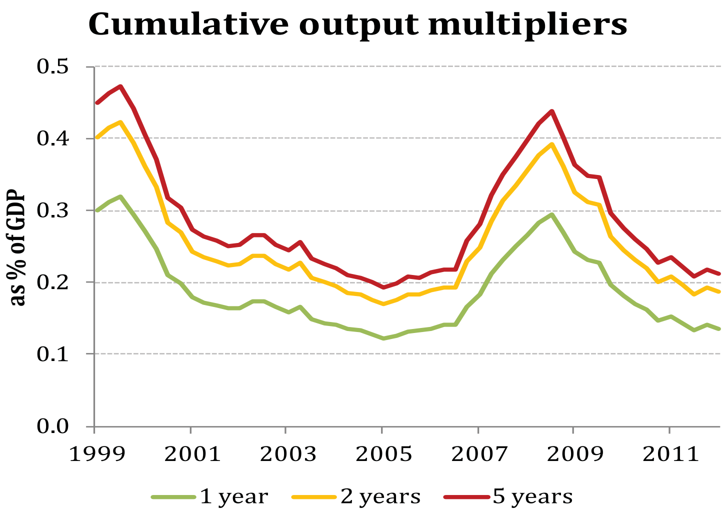
Figure 1

TIME-VARYING IMPULSE RESPONSES





Final Government Consumption (National Accounts Definition)
as % of GDP
1
0.8
0.6
0.4
0.2
0
2012
2010
2008
2006
2004
2002
2000
Time
0
5
10
15
Impulse Horizon



Cumulative output multipliers
as % of GDP
0.5
0.4
0.3
0.2
0.1
0.0
1999
2001
2003
2005
2007
2009
2011
1 year
2 years
5 years

The outcome of the TVP-VAR is in line with the threshold VAR study of Muir and Weber (2013) for Bulgaria, who find that during periods of economic expansion the first-year spending multiplier is around 0.15, while in downturns it increases up to 0.3.

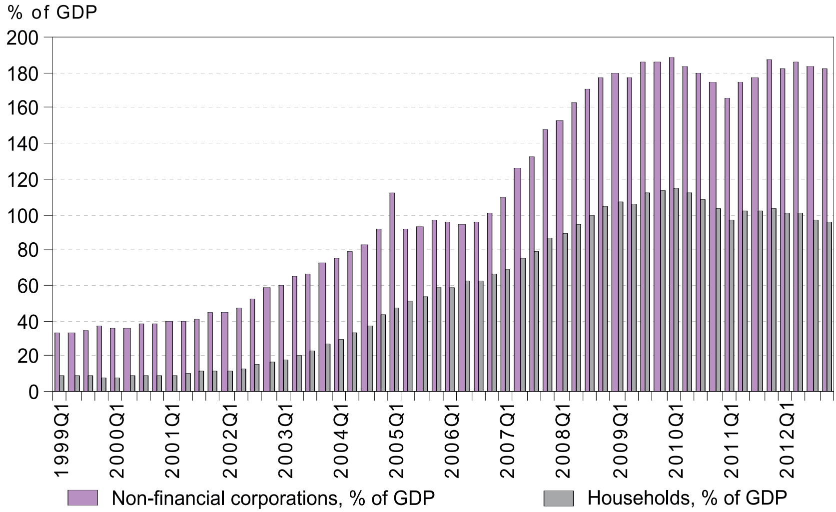
The results of the TVP-VAR suggest that during the years of economic expansion other components of aggregate demand would have been increasingly crowded-out by increases in government consumption. Specifically, the response of private consumption to government spending shocks has become weaker and shorter in duration in the period 1999 – 2007. Correspondingly, the size of the first-year cumulative government consumption multiplier has become nearly two times smaller.

Several factors might explain the dynamics in the size of the fiscal multipliers in the period before the recent economic downturn.

First, in the period 2004 – 2008 the Bulgarian economy experienced high economic growth, coupled with significant deepening of the financial sector. As shown in Figure 2, the competition of foreign-owned financial institutions for expanding their market share led to rapid credit expansion. The external indebtedness of the private sector was also continuously rising due to the good investment opportunities offered by both the financial and non-financial corporations. Naturally, this led to a gradual decrease in the share of liquidity and credit constrained households and companies over the period.

Figure 2

CREDIT TO PRIVATE SECTOR



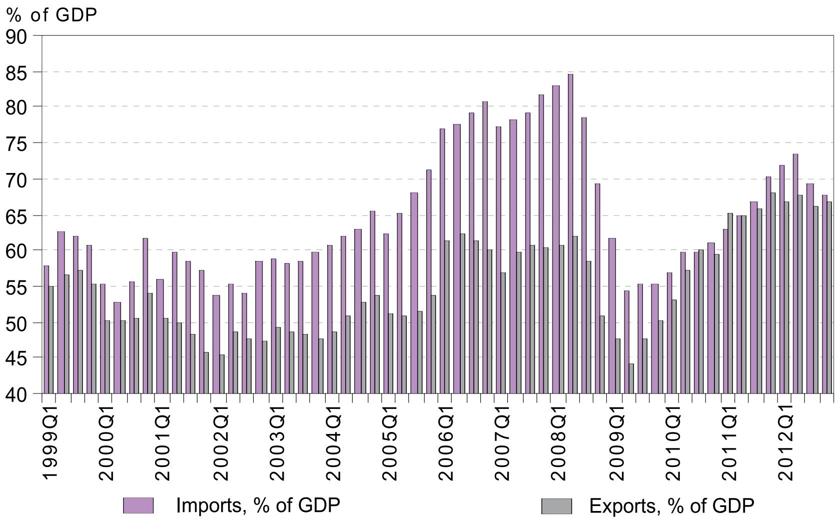
Source: BNB

As Perotti (2005) argues relaxation of credit constraints is among the factors that could explain a decline in the effectiveness of government spending in stimulating economic activity. Kirchner et al. (2010) also provide evidence for the view that households' access to credit is among the most important determinants of the size of fiscal multipliers. In particular, the authors find that an increase in households' credit as percent of GDP leads to lower multipliers.

Second, the process of integration of Bulgaria into the EU single market has significantly increased the openness of the economy (Figures 3 and 4), which has certainly widened the so-called 'import leakage' of the fiscal stimulus. This 'leakage' results from the fact that part of the fiscal stimulus is spend on foreign goods and services. Thus, part of the positive impact on GDP attributable to the stimulus is offset by the increase in imports. Usually, the higher the openness of the economy, the higher this leakage is.

Figure 3

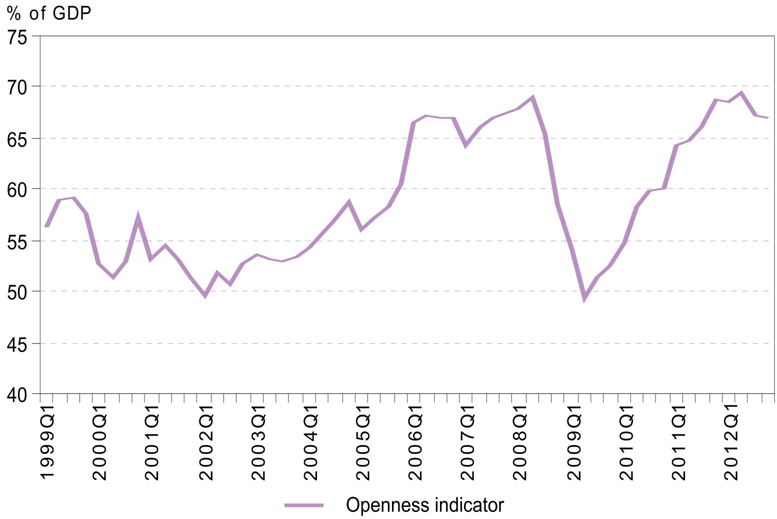
IMPORTS AND EXPORTS, SEASONALLY ADJUSTED



Source: BNB

Figure 4

OPENNESS INDICATOR



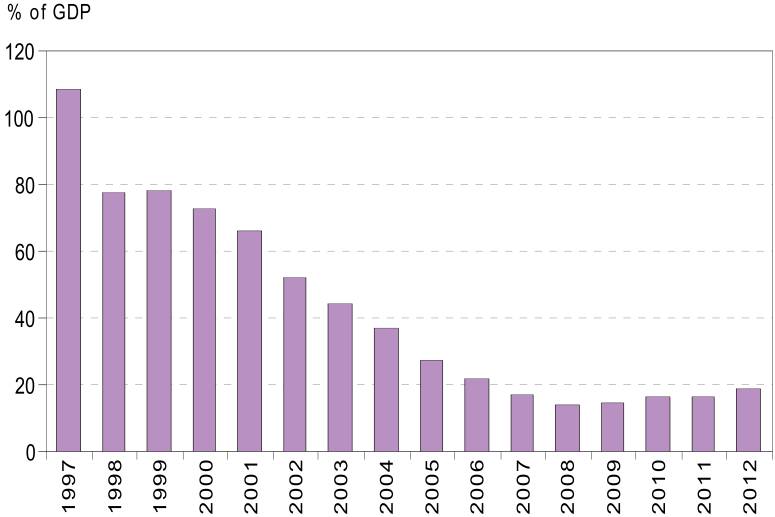
Source: Authors' calculations

Note: Openness is measured by import penetration, that is Imports/(GDP – Exports + Imports)*100. All series are seasonally adjusted. Identical measure is used in Appendix 1 'Fiscal Multipliers in Expansions and Contractions', IMF, Fiscal Monitor – April 2012.

Third, it is generally accepted that the size of the fiscal multiplier is larger if the fiscal position of the country remains sustainable after the stimulus. Therefore, it is reasonable to expect that in the years after the introduction of the currency board arrangement in 1997, the effects of fiscal policy would have been non-Keynesian in nature, as these were years of economic recovery and regaining confidence in the fiscal framework. Moreover, the high level of government debt in the beginning of the sample period would have made expansionary fiscal stimuli intolerable. Nevertheless, government debt sustainability issues were successfully mitigated in the last fifteen years as the debt-to-GDP ratio declined from over 100% in 1997 to below 20% in 2012 (Figure 5), which was largely attributable to the budget surpluses in the years before the recent crisis (Figure 6). As suggested by the literature (e.g. Perotti, 1999) debt sustainability issues are among the important factors in determining the output effect of government spending. Perotti (1999) argues that high debt levels acts as a signal for required future fiscal adjustment, resulting from current increases in government expenditures. The anticipation of the future fiscal tightening (i.e. increase in taxation) would cause a decline in private consumption today, thus offsetting the expansionary impact of government consumption.

Figure 5

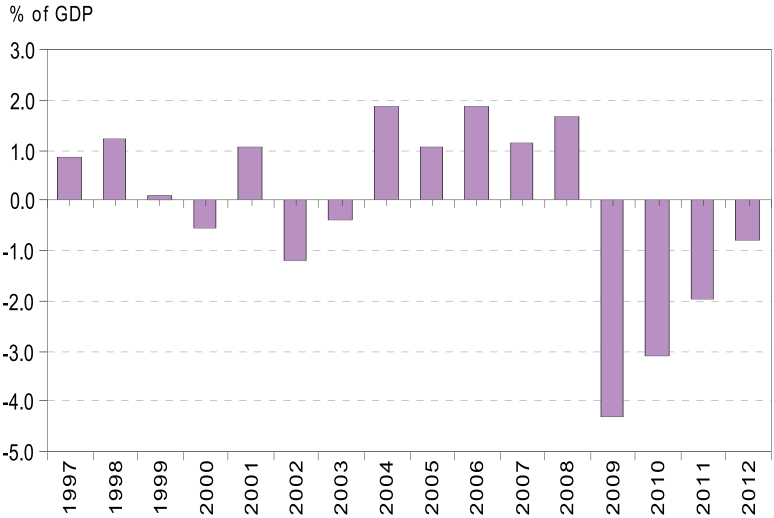
CONSOLIDATED GOVERNMENT DEBT



Source: BNB

Figure 6

GENERAL GOVERNMENT DEFICIT (-) / SURPLUS (+)

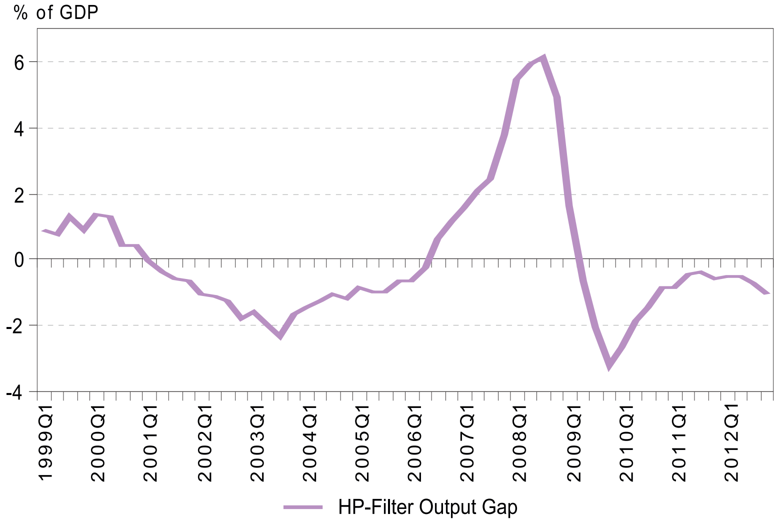


Source: Eurostat

As the global financial crisis started, the output gap rapidly deteriorated (Figure 7), both consumer and corporate credit growth declined (Figure 2) and imports contracted (Figure 3). These developments might explain the fact that the size of the fiscal multipliers has nearly doubled at the peak of the crisis.

Figure 7

OUTPUT GAP



Source: Authors' calculations

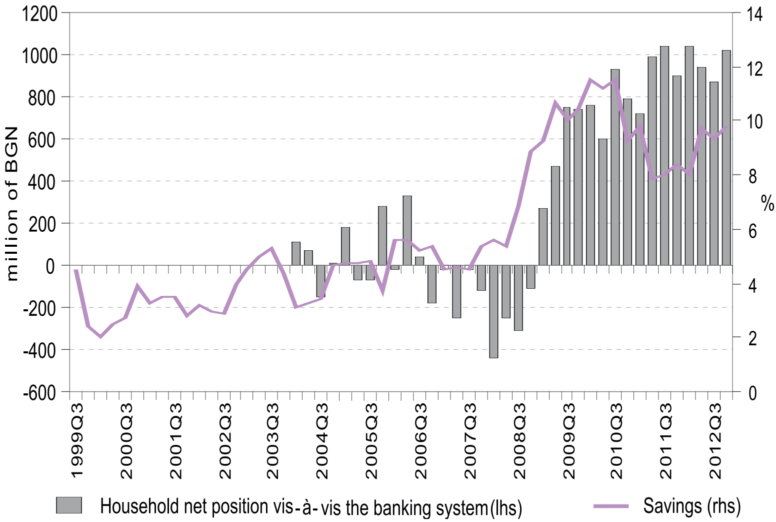
Note: The trend is obtained using the Hodrick-Prescott filter (Lambda = 1600).

As shown by Galí et al. (2007) and Corsetti et al. (2011) a government spending shock can have a larger effect on aggregate consumption to the extent that the financial crisis raises the share of credit-constrained agents. Moreover, the traditional crowing-out argument is also less applicable during periods of recession, given that the economic slowdown usually results in higher degree of firms' excess capacities, which can be brought in use by additional public expenditure.

Despite the observed increase, however, the size of the spending multiplier in Bulgaria remained as low as 0.4 at the peak of the financial crisis. Perhaps, the significant increase in the level of domestic savings during the crisis, induced mainly as a result of precautionary incentives, has been a relevant factor for limiting the increase in the multiplier's size (Figure 8).

Figure 8

HOUSEHOLD PROPENSITY TO SAVE



Sources: NSI Household Budget Survey, BNB

Note: LHS – Quarterly change, seasonally adjusted data, available since 2004; RHS – Share of disposable income, average per household member, seasonally adjusted data.

In the period 2010 – 2011 economic growth stabilized, imports recovered to their pre-crisis levels and public financing sustainability concerns were largely mitigated. Companies managed to improve the utilization of the excess capacities by redirecting the production towards the external market. These developments and the continuous growth of domestic savings have probably been relevant factors for the decline of the fiscal multiplier back to levels as low as 0.2.

Overall, the TVP-VAR model results reveal important information about the changes in the output effects of government consumption shocks in Bulgaria over the last fifteen years. It appears that the effectiveness of spending shocks in stimulating economic activity varies over time according to the underlying state of the economy. This relationship is found to be valid in a number of recent empirical studies, which analyse the links between fiscal multipliers and the state of the economy.[23]

[23] Baum et al. (2012) provide a summary of results from selected studies on fiscal multipliers that employ non-linear approaches.

Conclusions, policy implications and further work

This paper analyses the impact of fiscal policy on real economic activity in Bulgaria and provides a range of estimates for the tax and spending multipliers. We compare the results from linear structural VAR models with recursive identification and structural identification following Blanchard and Perotti (2002) to the estimates from a time-varying parameters Bayesian SVAR, with the aim of investigating changes in the effectiveness of fiscal shocks in Bulgaria over the period 1999 – 2011.

The results of the linear VAR models indicate that the effectiveness of fiscal policy in stimulating economic activity is generally low as first-year spending multipliers do not exceed 0.4. The results regarding the tax multiplies are subject to a lot of uncertainty, as seen by the contrasting results in the estimated VAR models with different identification techniques, but the overall effect of tax measures on economic activity appears to be small and short-lived. These findings are in line with most of the studies on the catching-up EU Member State and support the general view that fiscal multipliers are usually small in small open economies.

The results of the two linear VAR models are broadly confirmed by the output of the TVP-VAR model, both pointing to a very limited effect of government spending shocks on economic activity. However, TVP-VAR model reveals important information regarding the variations of the government consumption multiplier over time. Since the beginning of the sample (1999) the size of the first-year spending multiplier has been gradually decreasing from levels of around 0.3, down to a level of nearly 0.15 in 2007. As the global financial crisis started, the size of the multiplier doubled in less than two years, before decreasing again back to its pre-crisis levels, along with the economic recovery period (2010-2011). These results indicate that the underlying state of the economy appears to be a relevant factor for the non-linear effects of fiscal policy on economic growth in Bulgaria, even though further research is needed to support this view.

In terms of policy implications, the results imply that the effect of discretionary fiscal expansion on real economic activity in Bulgaria seems to be relatively small and short-lived, even during times of economic downturn. Analogously, if required, fiscal contractions are not expected to weigh heavily on economic activity, even in the short-run. Therefore, it is reasonable for the size of the fiscal multipliers to be taken into consideration when policy makers design fiscal consolidation or expansionary strategies. Even though the appropriate pace and effectiveness of a fiscal adjustment depends on a number of other factors, the small size of the fiscal multipliers in Bulgaria imply that frontloaded consolidation would be in most cases preferable than back-loading the adjustment process, given the limited effects on output and the favourable impact on government debt dynamics, interest payments and fiscal sustainability. Back-loading the required fiscal consolidation effort is often motivated by the anticipation of lower multipliers in the future, associated with improvement in the economic outlook. Such a strategy, however, entails certain risks, as fiscal multipliers are unobservable variable and there is a lot of uncertainty about their magnitude. This uncertainty is even further amplified given that the assessment of the multipliers' size is based on forecasts. In addition, back-loading fiscal adjustment requires much larger cumulative consolidation effort in the medium term, which in turn leads to a high level of public debt and correspondingly higher interest expenditure. In addition, the postponement of the consolidation process is usually associated with a significant implementation risks related to the uncertainties about the materialization of the expected economic recovery as well as larger political risks associated with the postponement of the consolidation measures for the next election cycle.

The results are rather inconclusive in regards to the composition of the preferred consolidation strategy, but at least on impact it appears that expenditure restraints would have less negative effect on growth than increase in taxes. Nevertheless, more research is needed to understand the size of the multipliers of the different subcomponents of government expenditure and their dependence of the state of the economy. It plausible to assume that discretionary increase or decrease in certain expenditure items might have larger output effects than others. Extending the research in this direction would provide valuable information about the preferable budget composition over the economic cycle. In addition, exploring the factors behind the dynamics of the fiscal multiplier over time is a natural subsequent step in researching the functioning of the fiscal transmission mechanism in Bulgaria. For these purposes, evaluations based on structural models, such as DSGE models, could provide a valuable input. Data constraints and the significant structural changes in the Bulgarian economy during the last fifteen years are other relevant arguments for further research based on structural model evaluations.

Nevertheless, the findings in this study have important policy implications for the desired fiscal policy over the cycle in the case of Bulgaria. Overall, the results of the empirical models suggest that there is little to gain in terms of economic output from active fiscal policy, even during periods of economic downturn.

In view of the small size of the fiscal multipliers and the limited scope of the monetary policy in Bulgaria to support economic growth, the fiscal policy makers should concentrate on enhancing the quality of the government expenditure structure. Therefore, the fiscal adjustment strategies in the future should be based on cuts in inefficient public expenditure and coupled with the implementation of structural reforms in the ineffective public entities and loss-making state-owned companies, while preserving or even fostering growth-enhancing spending items. Heightening the role of the cost-benefit analysis as an analytical tool for weighing the benefits against the costs of certain legislative or regulatory proposals and larger public investment projects could also increase the efficiency of public spending and the positive effects on economic output.

References

Alfonso, A. and R. M. Sousa (2009), 'The Macroeconomic Effects of Fiscal Policy in Portugal: a Bayesian SVAR Analysis', NIPE WP3/2009. Universidade do Minho.

Alfonso, A. and R. M. Sousa (2009), 'The Macroeconomic Effects of Fiscal Policy', ECB Working Paper Series No. 991

Auerbach Alan. J., and Yuriy Gorodnichenko, (2010), 'Fiscal Multipliers in Recession and Expansion', NBER Working Papers 17447.

Auerbach, Alan, J. and Yuriy Gorodnichenko, (2011), 'Measuring the Output Responses to Fiscal Policy', forthcoming in American Economic Journal: Economic Policy.

Baum, A. and Koester, G. (2011), 'The impact of fiscal policy on economic activity over the business cycle – evidence from a threshold VAR analysis', Deutsche Bundesbank Discussion paper No. 03.2011

Baum A., Poplawski-Ribeiro M., and Weber A. (2012), 'Fiscal Multipliers and the State of the Economy', IMF Working Paper, WP/12/286

Benčík, M. (2009), 'The Analysis of the Effects of Fiscal Policy on Business Cycle – A SVAR Application', NBS Working Paper 2/2009. Národná Banka Slovenska.

Blake A. and Mumtaz H. (2012), 'CCBS Technical Handbook – No.4 Applied Bayesian econometrics for central bankers', Centre for Central Banking Studies, Bank of England, September 2012

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

Blanchard, O. and Quah, D. (1989), 'The Dynamic effects of aggregate Demand and Supply Disturbances', The American economic review , Vol 79, 1989, No.4, pp. 655-673

Blanchard, O. and Perotti R. (2002), 'An Empirical Characterization of the Dynamic Effects of Changes in Government Spending and Taxes on Output', Quarterly Journal of Economics, No. 117, pp. 1329-68.

Born, B., Juessen, F., Müller, G. J. (2012) 'Exchange rate regimes and fiscal multipliers', Journal of Economic Dynamics and Control, Volume 37, Issue 2, February 2013, Pages 446–465

Boussard, Jocelyn, Francisco de Castro and Matteo Salto (2012), 'Fiscal Multipliers and Public Debt Dynamics in Consolidations', European Economy Economic Papers 460 | July 2012

Burriel P., F. de Castro, D. Garrote, E. Gordo, J. Paredes and J. J. Perez (2009), 'Fiscal policy shocks in the euro area and the US: an empirical assessment', Working Paper No. 1133, European Central Bank.

Caldara, D. and C. Kamps (2008), 'What Are the Effects of Fiscal Policy Shocks? A VAR-based Comparative Analysis', ECB, Working Paper, No. 877, March.

Caprioli, F. and Momigliano, S. (2011), 'The effects of Fiscal Shocks with Debt-Stabilizing Budgetary Policies in Italy', Bank of Italy Working Paper No. 839

Castro F. and Hernández de Cos P., (2006), 'The economic effects of exogenous fiscal shocks in Spain: a SVAR approach', Working paper No. 647, European Central Bank.

Coenen G., Erceg C., Freedman C., Furceri D., Kumhof M., Lalonde, R., Laxton D., Linde J., Mourougane A., Muir D., Mursula S., Roberts J., Roeger W., Resende C., Snudden S., Trabandt M. and Veld J., (2012), 'Effects of Fiscal Stimulus in Structural Models', American Economic Journal: Macroeconomics 2012, 4 (1): 22–68.

Corsetti G., Kuester K., and Muller G. J., (2011), 'Pegs, floats and the transmission of fiscal policy', CEPR Discussion paper 8180

Cuaresma J., Eller M. and Mehrotra A., (2011), 'The Economic Transmission of Fiscal Policy Shocks from Western to Eastern Europe', OeNB's Focus on European Economic Integration (FEEI) 2/2011

Fatás, A., and I. Mihov (2001), 'The Effects of Fiscal Policy on Consumption and Employment: Theory and Evidence', CEPR Discussion Paper 2760. London.

Galí, J., J. D. López-Salido, and J. Vallés (2007), 'Understanding the Effects of Government Spending on Consumption,' Journal of the European Economic Association, 5, 227–270

Giavazzi F. and M. Pagano (1990), 'Can Severe Fiscal Contractions be Expansionary: Tales of Two Small European Countries', NBER Macroeconomics Annual, 75-122.

Giordano, R., S. Momigliano, S. Neri and R. Perotti (2007), 'The Effects of Fiscal Policy in Italy: Evidence from a VAR Model', European Journal of Political Economy, No. 23, pp. 707-33.

Giorno C., P. Richardson, D. Roseveare and P. van den Noord, (1995), 'Potential output, output gaps and structural budget balances', OECD Economic Studies No. 24, 1995/1.

Giuliodori M. and R. Beetsma (2004), 'What are the spill-overs from fiscal shocks in Europe? An empirical analysis',. Working Paper No. 325. European Central Bank.

Ilzetzki E., Mendoza E. G. and C. A. Vegh (2010), 'How Big (Small?) are Fiscal Multipliers?', NBER Working Paper No. 16479.

International Monetary Fund, 2012b, World Economic Outlook: Coping with High Debt and Sluggish Growth (Washington: International Monetary Fund, October).

Jemec, N. Kastelec, A. Delakorda, A. (2011), 'How do fiscal shocks affect the macroeconomic dynamics in the Slovenian economy', Working Paper No. 2/2011. Bank of Slovenia

Kirchner, M., J. Cimadomo, and S. Hauptmeier (2010), 'Transmission of fiscal shocks in the euro area: time variation and driving forces', Research Paper 21/2, Tinbergen Institute

Leeper E. M., N. Traum, and T.B. Walker (2011). 'Clearing up the fiscal multiplier morass.' NBER Working Paper 17444.

Leeper, E. M. (2010), 'Monetary Science, Fiscal Alchemy,' NBER Working Paper 16510

Leeper, E. M., T.B. Walker and S.S. Yang (2008). 'Fiscal foresight: analytics and econometrics.' NBER Working Paper 14028.

Lendvai, J. (2007), 'The Impact of Fiscal Policy in Hungary', European Commission, Directorate General for Economic and Financial Affairs. Country Focus IV(11). November.

Mançellari, A. (2011), 'Macroeconomic effects of fiscal policy in Albania: a SVAR approach', Bank of Albania Working Paper 5/2011

Mirdala, Rajmund (2009), 'Effects of Fiscal Policy Shocks in the European Transition Economies', Journal of Applied Research in Finance, Vol. 1, No. 2 (2009): pp. 141-155.

Mountford, A. and H. Uhlig (2009), 'What are the effects of fiscal policy shocks?', Journal of Applied Econometrics, John Wiley & Sons, Ltd., vol. 24(6), pages 960-992.

Mountford, A. and H. Uhlig (2005), 'What Are the Effects of Fiscal Policy Shocks?', A SFB 649 Discussion Paper 2005-039. Humboldt University, Berlin.

Muir D., and Weber A., (2013), 'Fiscal Multipliers in Bulgaria: Low But Still Relevant', IMF Working Paper WP/13/49, February 2013

Nickel, C. and Tudyka, A. (2013), 'Fiscal Stimulus in times of high debt. Reconsidering multipliers and twin deficits', ECB Working Paper Series No 1513, February 2013)

Parker, J. (2011). 'On Measuring the Effects of Fiscal Policy in Recessions,' Journal of Economic Literature, American Economic Association, vol. 49 (3), pages 703-18, September

Pereira, M. and Lopes, A. (2010), 'Time varying fiscal policy in the U.S', Working Papers 201021, Banco de Portugal, Economics and Research Department.

Perotti, R. (1999): 'Fiscal Policy in Good Times and Bad', Quarterly Journal of Economics, 138, 1399–1435.

Perotti, R. (2005), 'Estimating the Effects of Fiscal Policy in OECD Countries', CEPR Discussion Paper 168, Center for Economic Policy Research, London.

Perotti, R. (2007), 'In Search of the Transmission Mechanism of Fiscal Policy', NBER Working Paper No. 13143, NBER Macroeconomics Annual 2007, Volume 22 (2008), University of Chicago Press.

Ramey, V. A. (2007), 'Identifying Government Spending Shocks: It's All in the Timing', University of California, San Diego.

Ramey, V. A., and M.D. Shapiro (1998), 'Costly Capital Reallocation and the Effects of Government Spending', Carnegie-Rochester Conference Series on Public Policy 48 (June): 145-194.

Romer, C. and D.H. Romer (2010), 'The Macroeconomic Effects of Tax Changes: Estimates Based on a New Measure of Fiscal Shocks,' American Economic Review, 100, 763-801.

Rzonca, A. and P. Cizkovicz (2005), 'Non-Keynesian Effects of Fiscal Contraction in New Member States', ECB Working Papers No.519. September 2005.

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

Uhlig, H. (2005), 'What Are the Effects of Monetary Policy on Output? Results from an Agnostic Identification Procedure', Journal of Monetary Economics 52 (2): 381-419.

Appendix A. Details on data

Variables	Code	Description and calculation	Unit	Treatment	Source
Output	Y	GDP at 2005 prices	log millions of domestic currency	Seasonal adjustment	National Statistical Institute - National Accounts data
Private output	YPR	GDP at 2005 prices - Real Government Consumption -Real Government Investment (deflated with the investment deflator)	log millions of domestic currency	Seasonal adjustment	National Statistical Institute - National Accounts data and Quarterly Non-Financial Accounts of the General Govenment
Consumption	CON	Final Consumption of Households and NPISH's at 2005 prices	log millions of domestic currency	Seasonal adjustment	National Statistical - Institute National Accounts data
Investment	INV	Gross Fixed Capital Formation at 2005 prices	log millions of domestic currency	Seasonal adjustment	National Statistical Institute - National Accounts data
Government Consumption	GC	Government Consumption at 2005 prices	log millions of domestic currency	Seasonal adjustment	National Statistical Institute - National Accounts data

Variables	Code	Description and calculation	Unit	Treatment	Source
Government Spending	G1	Compensation of employees (ESA code D.1) + Intermediate consumption (ESA code P.2) + Gross fixed capital formation (ESA code P.51)	log millions of domestic currency	Seasonally adjusted and deflated with the GDP deflator	National Statistical Institute - Quarterly Non-Financial Accounts of the General Govenment
Government Spending (alternative definition)	G2	Compensation of employees (ESA code D.1) + Intermediate consumption (ESA code P.2) + Gross fixed capital formation (ESA code P.51) + Social payments (ESA code D.60) + Subsidies (ESA code D.3) - Unemployment benefits (COFOG 10.5.0)	log millions of domestic currency	Seasonally adjusted and deflated with t he GDP deflator	National Statistical Institute - Quarterly Non-Financial Accounts of the General Govenment
Net Taxes	T1	Indirect taxes (ESA code D.2) + Direct Taxes (ESA code D.5) + Social Security Contributions (ESA code D.611) + Capital taxes (ESA code D.91) - Social payments (ESA code D.60) - Subsidies (ESA code D.3)	log millions of domestic currency	Seasonally adjusted and deflated with the GDP deflator	National Statistical Institute - Quarterly Non-Financial Accounts of the General Govenment
'Net Taxes (alternative definition)'	T2	Indirect taxes (ESA code D.2) + Direct Taxes (ESA code D.5) + Social Security Contributions (ESA code D.611) - Unemployment benefits (COFOG 10.5.0)	log millions of domestic currency	Seasonally adjusted and deflated with the GDP deflator	National Statistical Institute - Quarterly Non-Financial Accounts of the General Govenment
Foreign demand	FD	Index 2005 = 100	log		Authors estimates
Inflation	INFL	Year-on-year change in the core HICP index	%	Seasonal adjustment	National Statistical Institute
Interest rates	INTS	Overnight interbank rate in EUR for the period 1999 -2004 and LEONIA for the period 2005 - 2011	%		Bulgarian National Bank

Appendix B. Details on the econometric methodology

B.1. The recursive approach

The baseline VAR model in our study includes three endogenous variables in real terms: government spending (g), GDP (y) and net taxes (τ). Apart from the endogenous variables, we also include a constant (μ_0), a linear time trend (*t*) and the log-transformed foreign demand (*fd*) for Bulgarian exports as exogenous variables.

The reduced-form VAR model can be expressed in the following way:

$$X_t = \mu_0 + \mu_1 t + \mu_2 fd_t + A(L)\, X_{t-1} + u_t \, , \tag{1}$$

where $X_t = [g_t \; y_t \; \tau_t]$ is a three-dimensional vector of endogenous variables, $A(L)$ is a 4th-order lag polynomial and u_t is a vector of residuals (innovations). As in Blanchard and Perotti (2002) we choose a lag length of four quarters in order to ensure serially uncorrelated residuals.[24] The inclusion of four lags is a common practice in the estimation of models with quarterly data (Caldara and Kamps, 2008).

Notice that in the first extended (4-variable) recursive VAR, the vector of variables would be augmented to: $X_t = [g_t \; y_t \; con_t/inv_t]$, where con_t/inv_t indicates either private consumption or investment. In the second extension of the recursive VAR (5-variable), the vector becomes: $X_t = [g_t \; y_t \; \pi_t \; \tau_t \; intrs_t]$, where π_t is inflation and $intrs_t$ is short-term interest rates.

In order to recover the structural shocks that affect the endogenous variables of the model we use the recursive identification approach, which is based on Cholesky decomposition of the variance-covariance matrix of the model residuals. As the reduced form residuals u_t are usually contemporaneously correlated, it is necessary to transform them into structural shocks. For the purpose we multiply equation (1) by the matrix A_0, which is a diagonal one. Thus, the new (structural) shocks $e_t = A_0 u_t$ are no longer correlated and they can be economically interpreted. The resulting equation is the following:

$$A_0 X_t = A_0\mu_0 + A_0\mu_1 t + A_0\mu_2 fd_t + A_0 A(L) X_{t-1} + Be_t \tag{2}$$

The equation $A_0 u_t = Be_t$ gives us the relation between the reduced-form residuals (u_t), which we observe and the structural shocks (e_t), which we want to identify.

In order to identify the structural model, the parameters in A_0 and B have to be restricted. In the recursive identification approach, the Cholesky de-

[24] Formal tests as the Akaike information criterion (AIC) and other information criteria (FPE, HQ, SC suggest the inclusion of two lags.

composition of the variance-covariance matrix of the VAR residuals defines the matrix as a lower triangular matrix with the contemporaneous influences and unit values on the diagonal. The construction of matrix A_0 has an economic meaning. It implies that some of the structural shocks will not have a contemporaneous impact on some of the endogenous variables. Specifically, the variable ordered last does not affect the variables before it in the current period, while the variable order first affects the other immediately. As shown in equation 3, the off-diagonal elements of matrix B are all zeros, which restrict the structural disturbances (shocks) e_t to be correlated with each other.[25] This assumption implies for instance, that there is no significant correlation between government revenues (net taxes) and government spending.

By construction, the ordering of the variables in the model is very important. In the baseline model the variables are ordered in the following way: government spending (g), GDP (y) and net taxes (τ). Therefore, the equation $A_0 u_t = Be_t$ can be represented in the following matrix form:

$$\begin{bmatrix} 1 & 0 & 0 \\ -\alpha_{yg} & 1 & 0 \\ -\alpha_{\tau g} & -\alpha_{\tau y} & 1 \end{bmatrix} \begin{bmatrix} u_t^g \\ u_t^y \\ u_t^\tau \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} e_t^g \\ e_t^y \\ e_t^\tau \end{bmatrix} \qquad (13)$$

where α_{ij} indicates how variable i responds contemporaneously to a shock in variable j. This specification implies that government spending (g) does not react contemporaneously to shock in the other endogenous variables, because spending is not depended on the economic cycle; GDP (y) does not react contemporaneously to shock in net taxes (τ), but it is contemporaneously affected by the shock in government spending; net tax are contemporaneously affected by both the shocks in government spending and GDP, due to changes in the respective macroeconomic bases. This ordering of the variables assumes that there is no contemporaneous effect of tax changes on output, which is somewhat arguable. Note that these assumptions are valid only for the first period (first quarter) after the shock. Afterwards all variables can free interact with each other.

In the case of the four-variable recursive VAR with private consumption or investment as a fourth variable, the equation above is transformed according to the ordering of the variables. As in Fatás and Mihov (2001), private consumption or investment is ordered second – before aggregate GDP.

[25] In the case of the baseline VAR is a three-dimensional identity matrix. In the extended models, matrix becomes four or five dimensional identity matrix, respectively.

Thus, the equation $A_0 u_t = Be_t$ would consist of four by four matrices and four-variable vectors.

In the second extended VAR model with five variables - government spending, GDP, inflation, net taxes and interest rates, the equation would be represented in the following form:

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ -\alpha_{yg} & 1 & 0 & 0 & 0 \\ -\alpha_{\pi g} & -\alpha_{\pi y} & 1 & 0 & 0 \\ -\alpha_{\tau g} & -\alpha_{\tau y} & -\alpha_{\tau\pi} & 1 & 0 \\ -\alpha_{rg} & -\alpha_{ry} & -\alpha_{r\pi} & -\alpha_{r\tau} & 1 \end{bmatrix} \begin{bmatrix} u_t^g \\ u_t^y \\ u_t^\pi \\ u_t^\tau \\ u_t^r \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} e_t^g \\ e_t^y \\ e_t^\pi \\ e_t^\tau \\ e_t^r \end{bmatrix}$$

The ordering of the variables is the same as in Fatás and Mihov (2001), namely, government spending (g), GDP (y), inflation (π), net taxes (τ) and interest rates (r). The implications of the ordering and the associated economic interpretation are discussed in Fatás and Mihov (2001) and Caldara and Kamps (2008).

B.2. The approach of Blanchard and Perotti

In the application of the approach of Blanchard and Perotti (2002) we start again from the reduced form VAR specification from equation (1),

$$X_t = \mu_0 + \mu_1 t + \mu_2 fd_t + A(L)\, X_{t-1} + u_t ,$$

where $X_t = [\tau_t\ g_t\ y_t]$ is a three-dimensional vector of endogenous variables, which includes net taxes, government spending and output. Again, as in the recursive identification approach, we need to identify matrices A_0 and B, which provide the relation between the reduced-form residuals u_t and the structural disturbances $e_t : A_0 u_t = Be_t$. We follow a four step approach as in Jemec et al. (2011) and Gordano et al. (2007). First, after the reduced form VAR model is estimated, we decompose the reduced-form residuals of taxes u_t^τ ut and government spending u_t^g in the following way:

$$u_t^\tau = \alpha_{\tau y} u_t^y + \beta_{\tau g} e_t^g + e_t^\tau \tag{4}$$

$$u_t^g = \alpha_{gy} u_t^y + \beta_{gt} e_t^\tau + e_t^g \tag{5}$$

The coefficients $\alpha_{\tau y}$ and α_{gy} are elements of the matrix A_0 and represent the response (both automatic and discretionary) of taxes and government spending to a shock in the economic activity. The coefficients $\beta_{\tau g}$ and β_{gt} capture how the structural shock in government spending affects contemporaneously taxes and vice versa.

Following the approach of Blanchard and Perotti (2002), in the second step of the procedure we estimate the cyclically adjusted reduced-form residuals:

$$u_t^{\tau,CA} = u_t^{\tau} - \alpha_{\tau y} u_t^{y} = \beta_{\tau g} e_t^{g} + e_t^{\tau} \tag{6}$$

$$u_t^{gCA} = u_t^{\tau} - \alpha_{gy} u_t^{y} = \beta_{gt} e_t^{\tau} + e_t^{g} \tag{7}$$

**CA – cyclically-adjusted*

This is done by assuming that $\alpha_{\tau y}$ and α_{gy} capture only the automatic response of taxes and government spending to a shock in output. The reasoning is that it usually takes more than one quarter for the government to respond with discretionary measures to disturbances in the economic activity. Afterwards, institutional information is used to estimate the tax and spending elasticities to GDP. The details regarding the methodology for the derivation of the tax revenue elasticity is provided in Appendix C. As it is generally accepted in the literature we assume a zero elasticity of government spending to GDP: ($\alpha_{gy} = 0$). Another key assumption, made by Blanchard and Perotti (2002) is that taxes do not respond contemporaneously to changes in government spending as it takes at least one quarter to adopt and practically implement changes in the tax codes. So, in this case spending decisions come first. Therefore, $\beta_{g\tau} = 0$ and the structural disturbance e_t^g can be identified directly from equation (7). The outcome is then used to estimate equation (6) by applying ordinary least squares (OLS) method. Finding the estimates for $\beta_{\tau g}$ represents the third step of the procedure.

In the last stage, we use the estimates for the cyclically-adjusted reduced form tax and spending residuals as instrumental variables to estimate the following equation:

$$u_t^{y} = \alpha_{y\tau} u_t^{\tau} + \alpha_{yg} u_t^{g} + e_t^{y} \tag{8}$$

This step completes the estimation of all parameters in the A_0 and B matrices in the BP identification strategy, which can be written in matrix form in the following way:

$$\begin{bmatrix} 1 & 0 & -\alpha_{\tau y} \\ -\alpha_{yg} & 1 & -\alpha_{gy} \\ -\alpha_{y\tau} & -\alpha_{yg} & 1 \end{bmatrix} \begin{bmatrix} u_t^{\tau} \\ u_t^{g} \\ u_t^{y} \end{bmatrix} = \begin{bmatrix} 1 & \beta_{\tau g} & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} e_t^{\tau} \\ e_t^{g} \\ e_t^{y} \end{bmatrix}, \tag{9}$$

After the A_0 and B matrices have been identified, we estimate the structural disturbances and compute the impulse response functions for the dynamic effect of the three structural shocks on taxes, government spending and output.

As noted by Caldara and Kamps (2008), the major difference between the recursive identification scheme and the approach of Blanchard and Perotii (2002) is that the A_0 matrix is not diagonal and the exogenous elasticities of taxes and spending to output, estimated outside the model, are present as coefficient to the right-side of the main diagonal. Moreover, *B* is no more an identity matrix. This approach is more appropriate when estimating the effects of a tax shock. While the recursive approach implies a zero restriction on the contemporaneous effect of taxes on output, in the approach of Blanchard and Perotti (2002) these effects can be freely estimated. As shown in Table 1 in Section 6, in the BP specification of the VAR the sign of the impact tax multiplier becomes negative.

B.3. Time-varying parameter VAR model with stochastic volatility

The time-varying VAR model with stochastic volatility is based on the model of Blake and Mumtaz (2012).

For the purpose of our analysis we assume the following model:

$$Y_t = c_t + \sum_{j=1}^{P} B_{j,t}\, Y_{t-j} + \upsilon_t, VAR(\upsilon_t) = R_t \tag{10}$$

$$\begin{gathered} \beta_t = \{c_t\,,\ B_{1,t} \dots .\ B_{P\,,t}\} \\ \beta_t = \beta_{t-1} + e_t\,, VAR(e_t) = Q \end{gathered} \tag{11}$$

The covariance matrix of the error term ν_t, denoted R_t, has time-varying elements. For simplicity we consider that the structure of R_t is as follows:

$$R_t = A_t^{-1} H_t A_t^{-1}, \tag{12}$$

Given that we use a three-variable model the lower triangular matrix A_t with elements $a_{ij,t}$ and the diagonal matrix H_t with diagonal elements can be written as:

$$A_t = \begin{bmatrix} 1 & 0 & 0 \\ a_{12,t} & 1 & 0 \\ a_{13,t} & a_{23,t} & 1 \end{bmatrix}, H_t = \begin{bmatrix} h_{1,t} & 0 & 0 \\ 0 & h_{2,t} & 0 \\ 0 & 0 & h_{3,t} \end{bmatrix}, \tag{13}$$

where the transition equations for the elements $\alpha_{ij,t}$ and $h_{i,t}$ are defined as:

$$\begin{aligned} a_{ij,t} &= a_{ij,t-1} + V_t, VAR(V_t) = D \qquad \text{for } i = 1 \dots 3 \\ \ln h_{i,t} &= \ln h_{i,t-1} + z_{i,t}\,, VAR(z_{i,t}) = g_i \end{aligned} \tag{14}$$

Appendix C. Details on the derivation of tax revenue elasticity

In line with the OECD approach, the net tax elasticity is a weighted average of the elasticities of four tax categories (personal income tax, corporate income tax, indirect taxes and social security contributions) and net transfers (taken with a minus sign). More formally:

$$\alpha_{\tau y} = \sum_i \varepsilon_{\tau_i} \varepsilon_{\beta_i, y} \frac{\tau_i}{\tau}$$

where $\varepsilon_{\tau i}$ is the elasticity of tax category *i* to the respective macro tax base, $\varepsilon\beta_{i,y}$ is the elasticity of the tax base to GDP and $\frac{\tau_i}{\tau}$ is the share of respective tax category in the tax aggregate. The latter variable is positive for the four tax categories and negative for net transfers (unemployment benefits in the alternative specification). The elasticities of the various categories to the respective tax bases are calibrated on the basis of the tax legislation and are summarized in Table C1. For all categories, the elasticity is equal or close to 1 as the Bulgarian tax system is proportional with flat direct tax rates. It should be mentioned that for personal income tax we assume a higher elasticity until 2008, when the tax was progressive and afterwards when a flat tax rate with no minimum non-taxable income was introduced. Since only data for aggregate direct taxes is available at the quarterly frequency, we have used quarterly cash-data profiles to interpolate the annual data for personal income tax and other direct taxes. Corporate income tax receivables are estimated as a residual variable.

Table C1

BUDGETARY ELASTICITIES RELATIVE TO CORRESPONDING MACROECONOMIC BASES

Budget item	Macroeconomic base	Budgetary elasticity
Direct taxes on households	Average compensation per employee	1.2 up to 2007, 1.0 afterwards
	Employment	1.0
Social security contributions	Average compensation per employee	1.0
	Employment	1.0
Direct taxes on companies	Operating surplus	1.05
Indirect taxes	Private consumption	1.0
Net transfers	GDP	-0.2

The elasticity of different tax bases with respect to output has been evaluated econometrically by using error-correction specifications. The next table summarizes these elasticities together with the information on the average share of the different tax categories in aggregate net taxes.

Table C2

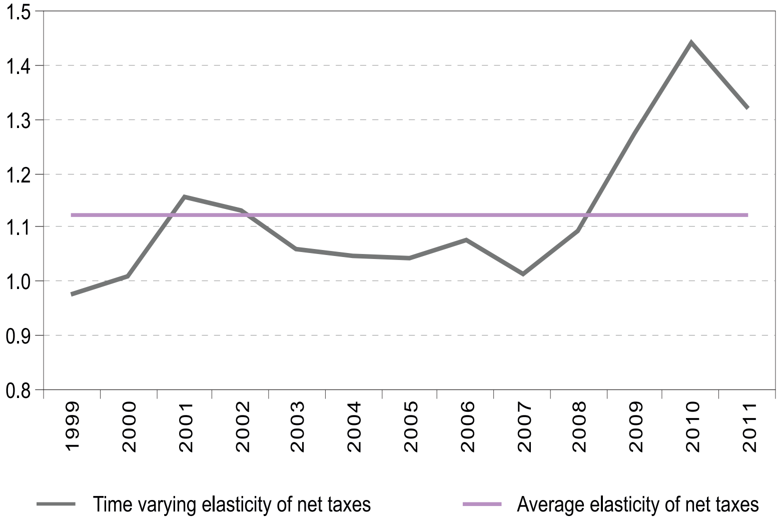
DERIVATION OF THE NET TAX ELASTICITY

	Elasticity with respect to GDP	Average share in net taxes 1999-2011	Weighted elasticity
Corporate income tax	0.82	0.17	0.14
Personal income tax*	0.27	0.20	0.05
Indirect taxes	1.03	0.92	0.95
Social Security Contributions	0.27	0.55	0.15
Elasticity of tax revenues			**1.29**
Net transfers	-0.2	0.85	-0.17
Elasticity net taxes			**1.12**

Our estimate is somewhat lower than the average elasticity, estimated by Burriel et al (2009) for the EU (1.54) and slightly higher than the one, estimated by Jemec and Delakorda (2011) for Slovenia (0.87). If we apply the alternative definition for net taxes (current taxes minus unemployment benefits), applied by Baum and Koester (2011), our elasticity estimate is 0.87, which is also lower than the identical estimate for Germany (1.02). However, what we observe from the data is that the net tax elasticity is changing over time (Figure C1). This can be attributed to the impact of the economic cycle as well as to the gradual movement from a more progressive to a more proportional tax system and to the constantly increasing share of indirect taxes. The time-variation of the tax elasticity is another argument to take an advantage of a time-varying parameter VAR model.

Figure C1

TIME VARYING ELASTICITY OF NET TAXES



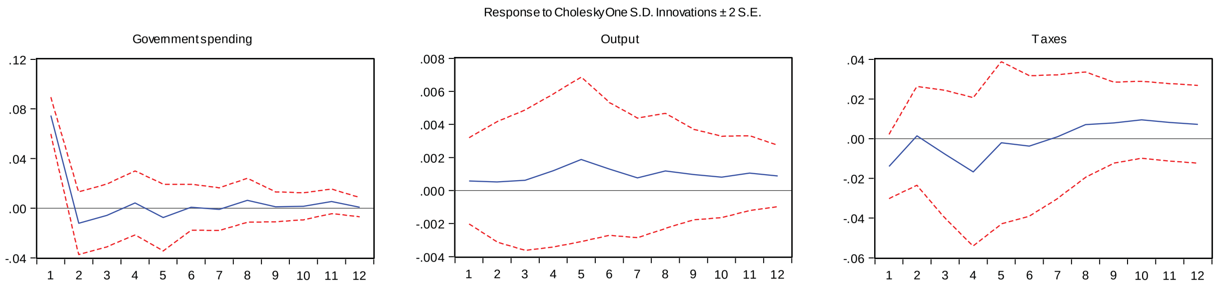
Appendix D. Impulse responses from the baseline VAR models

D.1. Government Spending Shock

In our baseline three-variable VAR with recursive identification, output follows a hump-shaped response after a spending shock – it increases gradually until it peaks in the 5th quarter, following the expenditure shocks. The output responses are positive for all quarters after the shock, but they are not significant. The expenditure shock itself is very short-lasting and it dies away already in the second quarter. After the spending shock taxes initially decrease and then gradually increase. Again, the effect is not significantly different from zero after the first period.

Figure D1

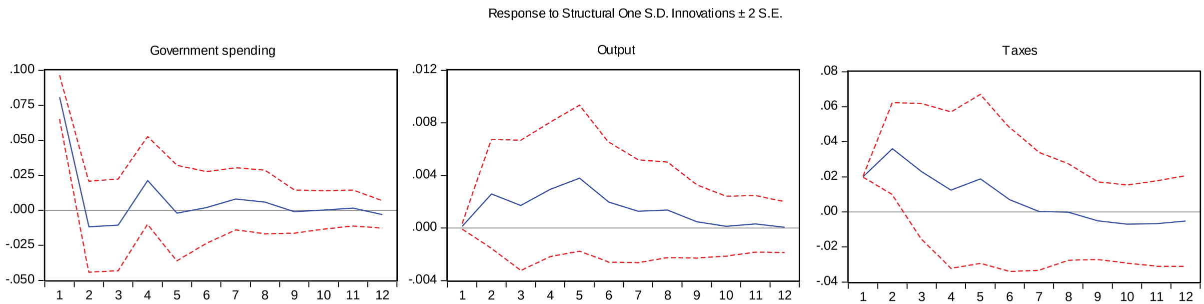
IMPULSE RESPONSES TO GOVERNMENT SPENDING SHOCK IN THE BASELINE VAR WITH RECURSIVE IDENTIFICATION



The results from a VAR with BP identification are not considerably different from the outcome of the model with the recursive identification scheme. Again, we observe a hump-shaped response of output, following an expenditure shock. The impact multiplier, however, is not significantly different from zero. The response of output peaks in the fifth quarter and dies away afterwards. The impulse responses are always positive, but not significantly different from zero. The expenditure shock is very short-lasting and becomes insignificantly different from zero after the first quarter. As compared to the recursive VAR, the response of taxes in the BP VAR is more pronounced. It is positive until the end of the second year after the shock has taken place, but it is significant for the first two quarters only.

Figure D2

IMPULSE RESPONSES TO GOVERNMENT SPENDING SHOCK IN SVAR WITH BP IDENTIFICATION

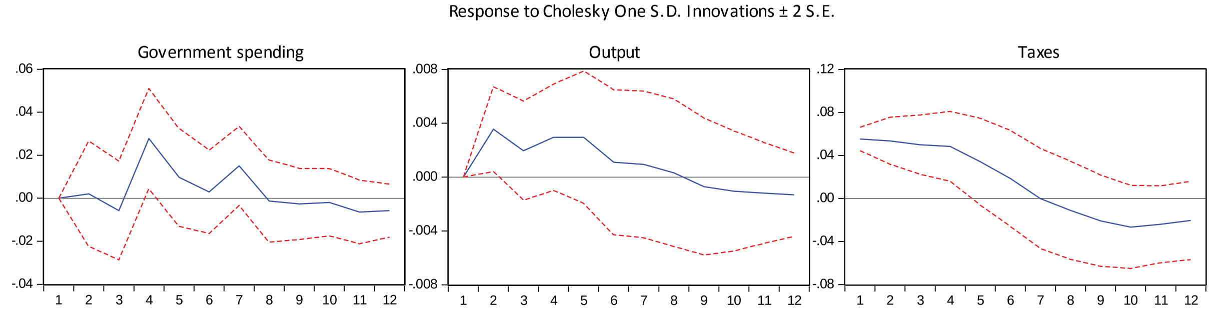


D.2. Tax Shock

The baseline VAR model provides an interesting result. The tax shock causes output to initially increase for eight quarters, before its response turns negative. Again, the impulse response is not significantly different from zero after the second quarter. Overall, shocks in net taxes seem to be more persistent as compared to spending shocks. The duration of the tax shock is around two years and the response is significantly positive for the first four quarters. Following a tax increase, government spending does seem to react positively and substantially. To some extent this is due to the restrictions imposed by the recursive specification. The response of spending peaks in the fourth quarter and dies away afterwards.

Figure D3

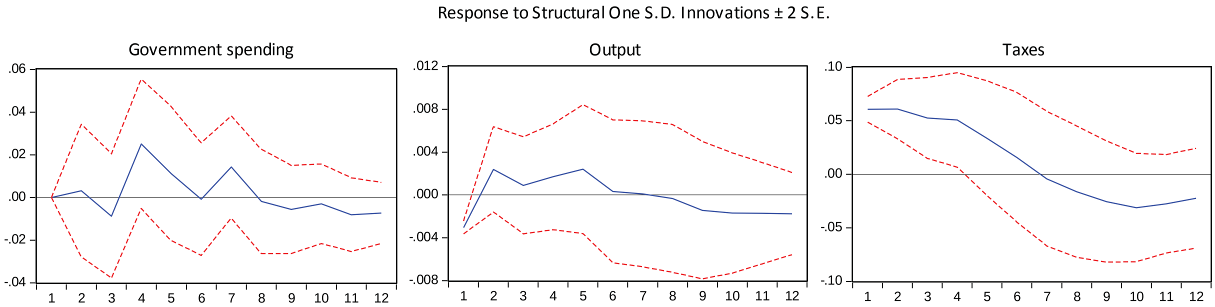
IMPULSE RESPONSES TO GOVERNMENT TAX SHOCK IN THE BASELINE VAR WITH RECURSIVE IDENTIFICATION



In the VAR model with BP identification, the sign of the impact tax multiplier changes and the effect on output, following a tax increase, becomes negative and significant. The output response becomes insignificant already in the second quarter, it remains positive for three quarters before it turns negative. The response of government spending after a tax shock is very similar to the baseline model. It takes three quarters before government expenditure increases following a tax increase and the response peaks in the fifth quarter. Afterwards, the response slowly dies away. This model also confirms the fact that tax shocks are usually more persistent than shocks in government spending.

Figure D4

IMPULSE RESPONSES TO GOVERNMENT TAX SHOCK IN THE VAR WITH BP IDENTIFICATION



Appendix E. Robustness check

E.1. Effects on Private Consumption and Investment

The results from the extended recursive VAR model with private consumption or investment as fourth variable show that the responses of the other endogenous variables do not change significantly after the tax or the spending shock. Private consumption reacts positively to a government spending shock in the first period and its response turns negative afterwards (Figure E1). The effect on investment is much stronger and always positive, but becomes significant in the 3rd quarter after the shock (Figure E2). Both consumption and investment react in a similar way to a tax shock with a temporary increase in the first two quarters. Overall, it appears that these results are more in support of the Real Business Cycle models, which predicts a drop in private consumption as a result of expansionary fiscal policy. Nevertheless, the statistical significance of the results from the VAR model do not allow for any strong conclusions.

Figure E1

IMPULSE RESPONSE OF CONSUMPTION AFTER GOVERNMENT SPENDING AND A TAX SHOCK IN VAR WITH RECURSIVE IDENTIFICATION

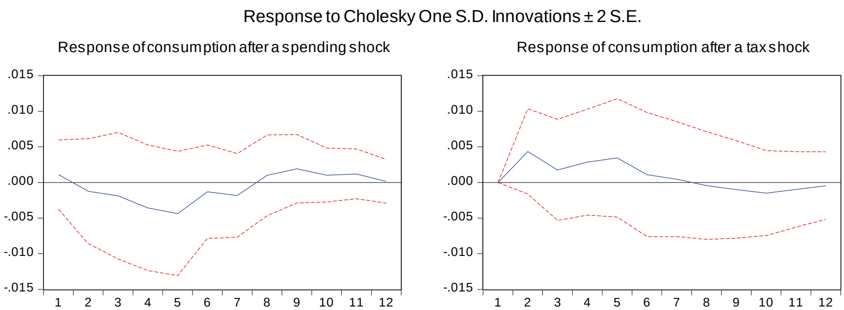
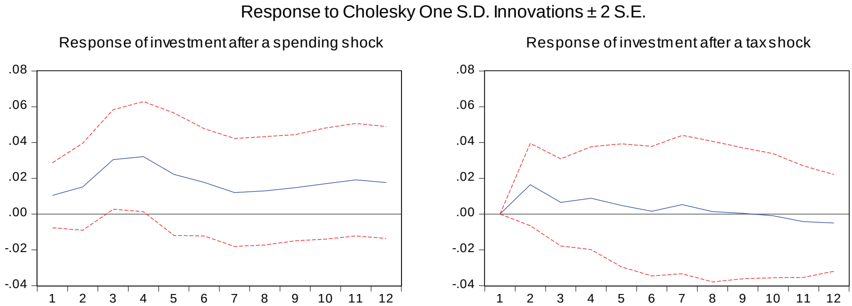


Figure E2

IMPULSE RESPONSE OF INVESTMENT AFTER GOVERNMENT SPENDING AND A TAX SHOCK IN VAR WITH RECURSIVE IDENTIFICATION



E.2. Alternative specification of government spending and net taxes

To check the robustness of the linear VAR model results as we opt for a different classification of expenditures and net taxes. As stated in the data description section of the paper, there are strong arguments for including social payments on the expenditure side as these account for a substantial part of total government spending in Bulgaria and represent an important instrument for stimulating internal demand.

We estimate two separate models with an alternative specification of government spending and net taxes - one five-variable VAR with recursive identification scheme and one three-variable structural VAR with BP specification. In the case of the structural VAR, the use of the different net tax aggregate requires re-estimation of the net tax elasticity, which is somewhat lower with the alternative specification.

The outcome (Figures E3, E4, E5 and E6) shows that the effects of a spending and a tax shock on output are not considerably different as compared to the results of the baseline models. Regarding the recursive VAR, the only significant response that we observe in respect to inflation and interest rate is the impact rise of interest rates after a spending shock (Figure E3). In fact, the reduced VAR residuals are normally distributed only when the alternative definition for government spending and net taxes is used.

Figure E3

EXTENDED FIVE-VARIABLE VAR WITH RECURSIVE IDENTIFICATION – RESPONSES AFTER GOVERNMENT SPENDING SHOCK

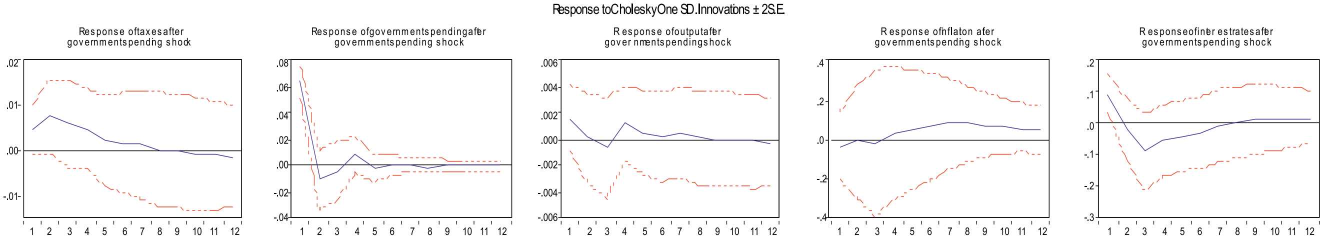


Figure E4

EXTENDED FIVE-VARIABLE VAR WITH RECURSIVE IDENTIFICATION – RESPONSES AFTER GOVERNMENT TAX SHOCK

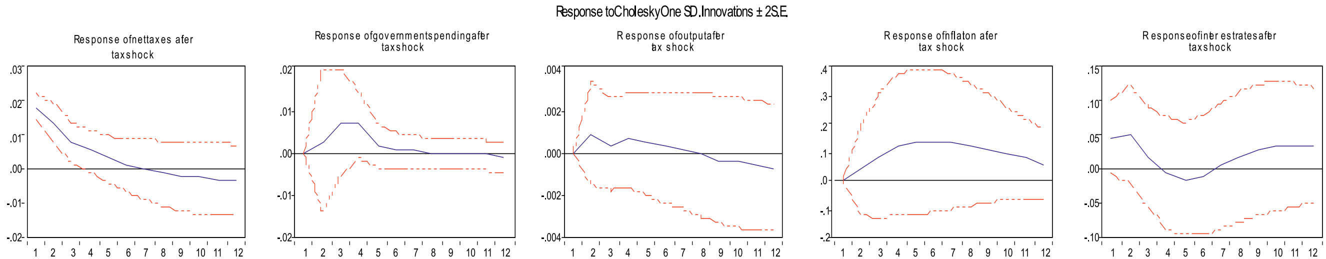


Figure E5

SVAR WITH ALTERNATIVE DEFINITION OF GOVERNMENT SPENDING AND TAXES – RESPONSES AFTER GOVERNMENT TAX SHOCK

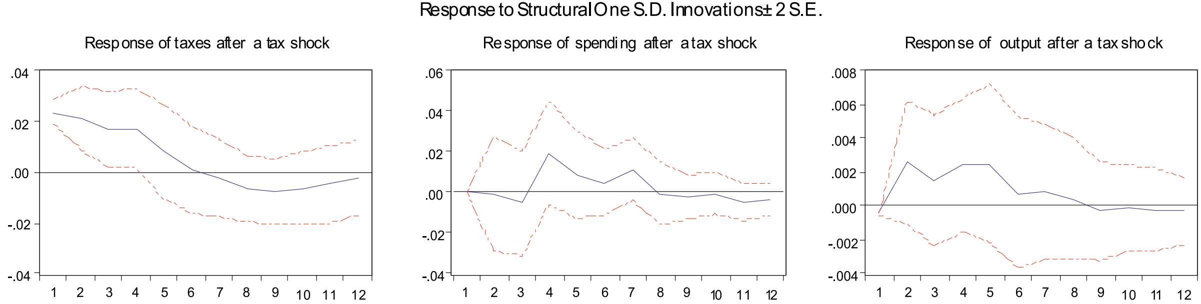
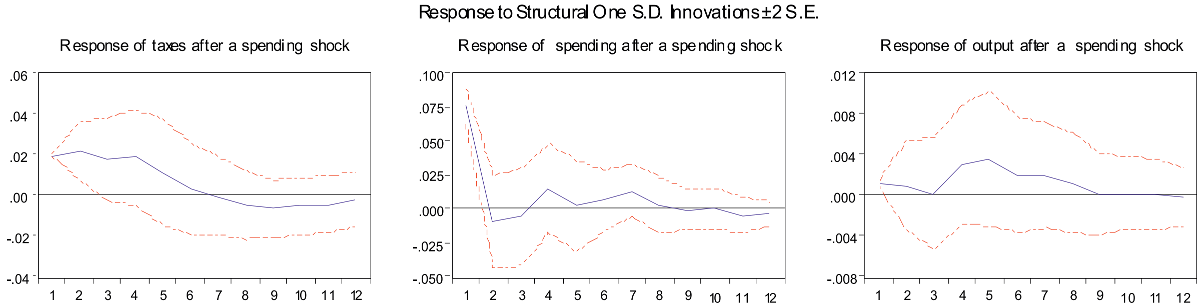


Figure E6

SVAR WITH ALTERNATIVE DEFINITION OF GOVERNMENT SPENDING AND TAXES – RESPONSES AFTER GOVERNMENT SPENDING SHOCK



E.3. Replacing aggregate GDP with private GDP

Following the approach of Caprioli and Momigliano (2011) we re-estimate the structural VAR model with BP identification by replacing aggregate output with private GDP.

The impulse responses show that the sign of the output reaction do not change and we only get a positive and significant spending multiplier in the first two quarters (Figure F1). As in the original specification of the model, the tax multiplier is negative and significant only in the first quarter after the shock has taken place (Figure F2).

Figure F1

SVAR WITH PRIVATE OUTPUT – RESPONSES AFTER GOVERNMENT SPENDING SHOCK

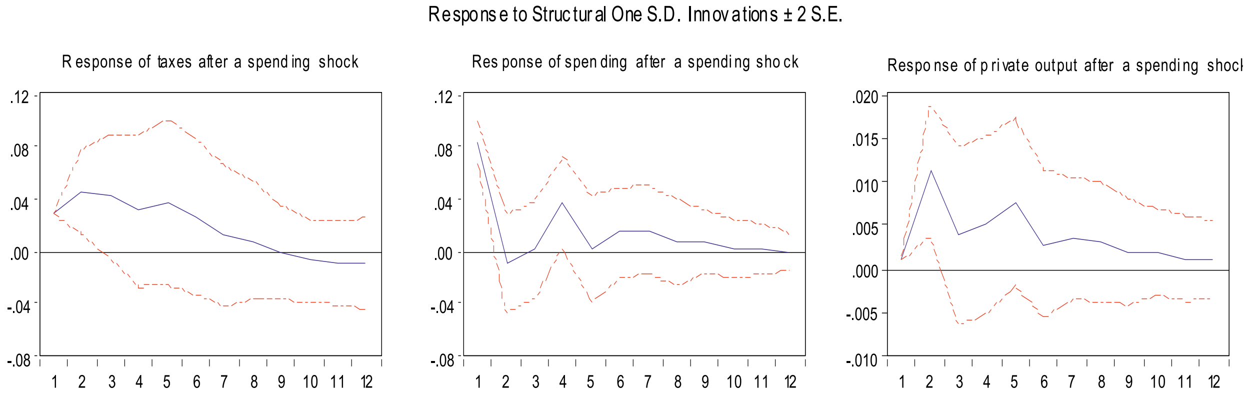
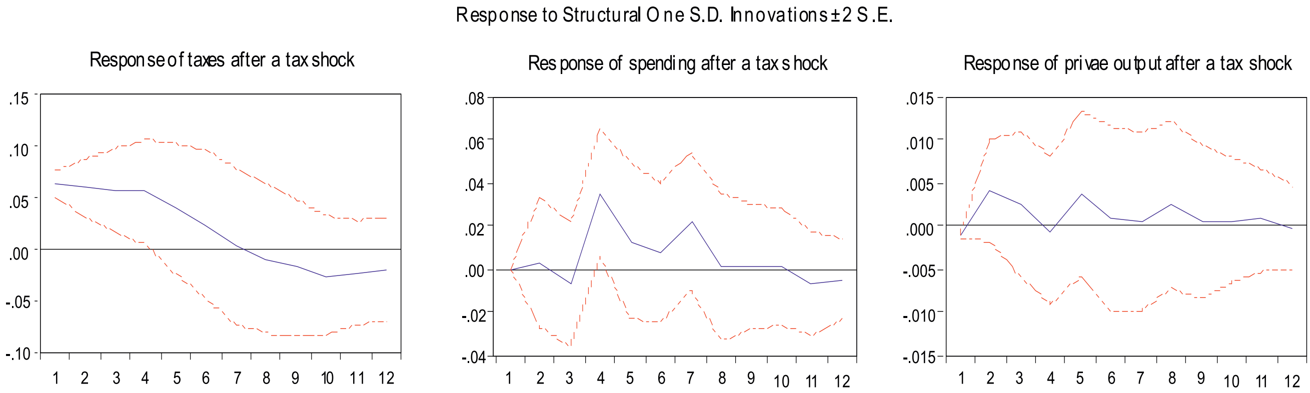


Figure F2

SVAR WITH PRIVATE OUTPUT – RESPONSES AFTER GOVERNMENT TAX SHOCK



Appendix F. Supplementary figures and tables

Figure F3

STABILITY OF VAR SPECIFICATION

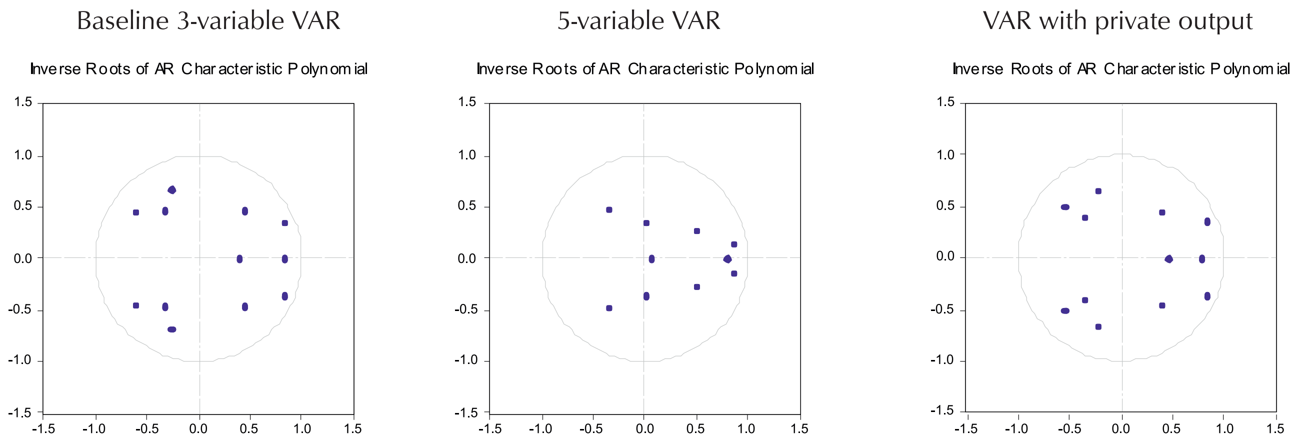


Table F4

UNIT-ROOT TESTS

H0: Variable has a Unit Root	ADF Test t-statistics		Phillips Perron Test t-statistics	
	Level	First diff.	Level	First diff.
Output	-1.55	-3.66**	-1.28	-6.44**
Private output	-1.31	-8.54**	-1.36	-8.48**
Consumption	-2.77	-3.51*	-2.45	-6.41**
Investment	-1.36	-8.67**	-1.36	-8.49**
Government spending	-1.17	-10.31**	-1.62	-16.66**
Net taxes	-2.45	-4.19**	-2.12	-7.17**
Gov. spending - alt. def.	-1.23	-10.56**	-1.42	-14.49**
Net taxes - alt. def.	-2.02	-3.54**	-2.76	-5.71**
Core Inflation	-1.74	-3.09*	-1.89	-4.71**
Interest rate	-2.17	-3.59**	-1.51	-3.66**

* Statistically significant at 5% level.

** Statistically significant at 1% level.

Table F5

CO-INTEGRATION TEST FOR BASELINE VAR SPECIFICATION – THREE VARIABLES

Unrestricted Co-integration Rank Test (Trace)			
Hypothesized No. of CE(s)	**Eigenvalue**	**Trace Statistic**	**Prob.****
None *	0.534	52.230	0.005
At most 1	0.152	11.800	0.826
At most 2	0.056	3.041	0.872

Johansen trace test. Indicates 1 co-integrating eqn(s) at the 0.05 level

** Denotes rejection of the hypothesis at the 0.05 level.*

** *MacKinnon-Haug*-Michelis (1999) p-values

Table F6

DIAGNOSTIC TESTS OF THE BASELINE VAR SPECIFICATION

Diagnostic Tests	Baseline 3-variable VAR P-value	Extended 5-variable VAR P-value	Extended VAR with private GDP P-value
Normality: Cholesky (Lutkepohl) - J.Bera[1]	0.317	0.326	0.701
Normality: Residual Corr. (Doornik-Hansen) - J.Bera[1]	0.194	0.027	0.673
Heteroskedasticity Test[2]	0.528	0.012	0.269
Serial Correlation LM Tests[3]			
Lag 1	0.471	0.414	0.191
Lag 2	0.271	0.263	0.401
Lag 3	0.683	0.602	0.401
Lag 4	0.304	0.015	0.211

[1] Null Hypothesis: residuals are multivariate normal.

[2] Null Hypothesis: no heteroskedasticity.

[3] Null Hypothesis: no serial correlation at lag order h.

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