The use of SVAR analysis in determining the effects of fiscal shocks in Croatia

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Abstract

In this paper we use multivariate Blanchard-Perotti SVAR methodology to analyze disaggregated short-term effects of fiscal policy on economic activity, inflation and short-term interest rates. The results suggest that the effects of government expenditure shocks and the shock of government revenues are relatively the highest on interest rates and the lowest on inflation. A tax shock in the short term increases the inflation rate and also decreases the short-term interest rate, and after one year stabilization occurs at the initial level, while spending shock leads to a reverse effect. The effects of fiscal policies on the proxy variable of output, i.e. industrial production, are less economically intuitive, because the shock of expenditure decreases and revenue shock permanently increases industrial production. The empirical result shows that a tax shock has a permanent effect on future taxes; while future levels of government spending are not related to current expenditure shocks. Interactions between the components of fiscal policy are also examined and it is concluded that a tax shock increases expenditures permanently, while an expenditure shock does not significantly affect government revenues, which is consistent with the tendency of growth in public debt. Furthermore, it was found that government revenue and expenditure shocks do not have a mirror effect, which justifies disaggregated analysis of fiscal policy shocks.

Keywords: SVAR model, fiscal shocks, government revenue, government spending

1 INTRODUCTION

A renewed emphasis on the impact of fiscal policy shocks on economic activity has recently been observed in countries of the European Monetary Union, where fiscal policy emerges as the most important instrument for economic policy. That is the reason why right at the beginning of this century the number of papers related to the effects of state revenue and expenditure shocks increased remarkably.

In this paper the dynamic effects of fiscal policy shocks on economic activity, price levels and short-term interest rates in Croatia will be examined.[1] The econometric methodology used in this research is a structural vector autoregressive (SVAR) model, whose application to fiscal shocks began with Blanchard and Perotti (1999). This paper investigated fiscal effects in United States, but it was soon followed by studies about European countries, such as Heppke-Falk, Tenhofen and Wolf (2006) for the case of Germany, de Castro and de Cos (2006) for Spain, Giordano et al. (2008) for Italy, etc.

Conclusions about the effects of government spending shocks and tax shocks on economic activity differ for various countries and various methodological approaches (Caldara and Kamps, 2008). Also the set of included variables differs among models in various papers. In our research the same set of variables as in Perotti (2002) is used.

[1] The definition of the shock is given in the Blanchard-Perotti specification.

According to Perotti (2002) this is "the minimal set of macroeconomic variables necessary for the study of the dynamic effects of fiscal policy changes."

So far, the macroeconomic consequences of fiscal policy shocks for the case of Croatia have been examined in two studies (Benazić, 2006; and Rukelj, 2009) using a related, structural VEC methodology with some different variables, but the Blanchard-Perotti approach has hitherto not been employed, nor have the responses of inflation and the interest rate to fiscal policy shocks been examined. This paper aims at addressing these issues within the SVAR framework used in Perotti (2002). The results of shocks on economic activity, price levels and short-term interest rates will be shown and analyzed. The short-term and medium-term effects will be compared for all variables used in our model. Fiscal shocks are disaggregated into two components: revenue and expenditure shocks, so the differences between the effects of these shocks, the mutual influence and the intensity and duration will be examined. In addition, the results of the structural VAR model will be compared with those obtained by a recursive VAR model.

Hence, this paper aims to examine the implications of the use of disaggregated fiscal policy instruments and to investigate the strength of fiscal policy in terms of business cycle smoothing. The empirical research will provide answers to the fundamental questions of this paper, referring to the direction, intensity and duration of disaggregated macroeconomic consequences of fiscal shocks.

Our paper is organized as follows. The next section reviews the literature about fiscal shocks, including the main conclusions. Section three briefly explains the econometric methodology used, as well as the identification of both models: the structural and the recursive VAR model. Section four describes the data used in our models. Section five presents the main results in terms of impulse response functions and variance decomposition analysis, as well as robustness tests. Section seven concludes.

2 LITERATURE REVIEW

Besides the already mentioned research related to Europe and the United States; fiscal SVAR models have also been applied to other countries. Here is just a brief list of these papers: Perotti (2002), and de Arcangelis and Lamartine (2003) for OECD countries in general; Lozano and Rodriquez (2008) for Colombia; de Plesis, Smith and Struzenegger (2007) for South Africa. In all these papers, SVAR models are used for simulating fiscal shocks, but they partially differ in the variables used. The original model of Blanchard and Perotti (1999) takes only three variables: government spending, net taxes and real GDP. In Perotti (2002) this model is extended by adding short-term interest rates and price levels.

Apart from the baseline SVAR approach described above, the empirical studies in this literature distinguish four additional approaches chosen to identify fiscal policy shocks: (1) Bayesian structural VAR models (Afonso and Sousa, 2009a; 2009b), (2) the Mountford-Uhlig sign restriction approach (Mountford and Uhlig, 2005), (3) the fiscal dummy approach developed by Ramey and Shapiro (1998), and (4) the recursive approach where the Cholesky decomposition is used as in Fatas and Mihov (2001a, 2001b), and Favero (2002). Caldara and Kamps (2006, 2008) compare these approaches and conclude that the results for the recursive approach (with proper order of the variables in the model) and the conventional structural VAR approach are almost identical, while the most significant difference arises from the fiscal dummy approach. In addition to these five approaches for simulations of fiscal shocks, structural vector error correction models are also used, such as Krušec (2003) for the case of the European Monetary Union members, and Benazić (2006) and Rukelj (2009) for the case of Croatia. On the other side Gali, Lopez-Salidoz and Valles (2007) have developed a micro-based neo-Keynesian model, which is used for simulating fiscal shocks.

As already mentioned, the results from all these papers partly differ from country to country and there are no unambiguous responses of macroeconomic variables to fiscal shocks. Regarding the aggregate investments, it can be concluded that neoclassical results predominate, i.e. the authors conclude that an increase in government expenditure leads at least in some part to the effect of crowding-out investment. For the case of economic activity, Perotti (2002) concludes that there is only a slight influence of government expenditure shocks on economic activity in the case of five OECD countries. The results of Heppke-Falk, Tenhofen and Wolf (2006) for the case of Germany are in the short run almost identical, noting that this positive effect in the long run turns negative. De Arcangelis and Lamartina (2003), and Perotti (2002) demonstrate a statistically significant positive effect of government expenditure on economic activity in the short run. As noted above, the intensity and duration of the macroeconomic consequences of expenditure shocks are not the same in all countries, but in general we can conclude that they are positive in the short run, while the long-run effects are significantly different.[2] The effects of tax shocks on economic activity are mostly negative, while in the short run there are significant deviations from this rule. For example in Lozano and Rodriquez (2008), and Heppke-Falk, Tenhofen and Wolf (2006) positive responses of GDP on tax shocks are shown. This positive effect in De Castro and de Cos (2006) for the case of Spain lasts for two quarters only, while the effect in the mid- and long-run is negative according to the Keynesian theory. Such a result is comparable to the result from the New Keynesian model in Gali, Lopez-Salidoz and Valles (2007) where the decline of the employment rate is shown as well. The effects of fiscal shocks on the inflation rate are very different and there is not single conclusion valid for all countries, so it will be interesting to see the results for Croatia in this paper.

[2] Comparative analysis and results are given in Kamps and Caldara (2006, 2008).

From previous research on the impact of fiscal shocks on the Croatian economy it is worth noting that Benazić (2006) concludes that an increase in budget revenues leads to a slowdown in economic activity, while the increase in government expenditure leads to an increase in GDP. He also concludes that the long-term effect of the tax shocks is much stronger than the expenditure shock effect. But, as already noted, the author uses a SVEC model, while in this paper a structural VAR model will be used. The only recent paper for the case of Croatia closely related to the topic of our research is Rukelj (2009), where the interaction of monetary and fiscal policy is examined (also using SVECM) and where the following variables are used: an index of economic activity (the weighted sum of various indicators of economic activity), money supply and government expenditures. The author concludes that expansionary economic policy really does lead to economic expansion and that these effects are valid in the long run, but it is also noted that the results are not significant enough. In addition, it is shown that fiscal and monetary policies move in opposite directions, i.e. that these policies are substitutes. These results will be compared with the results from our SVAR model, where monetary policy is not included, but on the other hand the distinction of government revenues and expenditures is made, while additional variables (interest rate and inflation) are included in the model, as also proposed in Rukelj (2009).

A paper about cyclically adjusted budget balances in Croatia (Švaljek, Vizek and Mervar, 2009) concludes that in the last few years fiscal policy was pro-cyclic and expansive, but the economic effects of fiscal policy are not examined. Results from this paper about the elasticities of some taxes with respect to its tax bases are used for the identification of our SVAR model. Sopek (2009) examines the effects of the financial crisis on the public debt and concludes that up to 2013 the public debt will remain within the Maastricht criterion of 60% of GDP.

This paper, then, aims to address issues found in previous papers related to this topic for the case of Croatia but with a slightly modified model specification and econometric method. As already noted, this will be done using a five-variable SVAR model, which is the common practice for presenting such shocks.

3 METHODOLOGY

This section will briefly explain the applied econometric method, Blanchard-Perotti identifying presumptions, the method of the computation of the exogenous elasticities needed for the model, the data used in the analysis, and the VAR model, which estimates impulse function with a recursive procedure. The purpose of the comparison of the two methods of identification is a comparison of the results of the benchmark SVAR and results obtained with other methodologies.

3.1 STRUCTURAL VECTOR AUTOREGRESSION

Models of structural vector autoregressions (SVAR) use the restrictions imposed by economic theory to identify the system, i.e. from a reduced form of shocks to obtain an economic interpretative function of the impulse response. Having in mind that SVAR methodology is not often used in empirical research in Croatia, the model used in this study, based on the identification proposed in Blanchard and Perotti (1999), will be briefly displayed.

Since the early eighties VAR models have become a standard tool for empirical analysis by macroeconomists. They are easy to use, they are often more successful in predictions than complex simultaneous models (Bahovec and Erjavec, 2009) and they are *a priori* non-restrictive, i.e. they do not require "incredible identification restrictions" (the often used phrase of Sims (Enders, 2003)).

For starters let us consider the structural form VAR model of order p (Bahovec and Erjavec, 2009)[3]:

$$AZ_t = A_0 + C(L)Z_{t-1} + e_t \tag{1}$$

where Z_t is k dimensional vector of endogenous variables at time t, Z_{t-1} is k dimensional vector of lagged endogenous variables, e_t is k dimensional vector of structural innovations, where $e_t \sim (0, \Sigma_e)$, A_0 is k dimensional vector of constants, A is $k \times k$ matrix of structural coefficients and $C(L)$ is the polynomial shift operator L of order p. According to Gottschalk (2001) there is an infinite set of different values of matrix A and $C(L)$ for given data, parameters that are impossible to obtain without additional restrictions because different structural forms give the same reduced-form VAR model[4]. Therefore, without identifying restrictions it is impossible to draw conclusions about the true state (structural model) from the reduced form VAR. The methodology applied in this paper necessarily entails economic theory-based identifying restrictions. The structural form VAR model can be written in reduced form as:

$$Z_t = v + D(L)Z_{t-1} + u_t \tag{2}$$

where $v = A^{-1}A_0$, $D(L) = A^{-1}C(L)$ and $u_t = A^{-1}e_t$, i.e. those reduced-form innovations (shocks) that have no direct economic interpretation, $u_t \sim (0, \Sigma_u)$. The reduced form VAR can be estimated by a standard OLS (Ordinary Least Squares) method because such an estimator is asymptotically unbiased and efficient (Enders, 2003). As already mentioned, it is impossible to obtain the structural from the reduced form and therefore the impulse response function (IRF), i.e. the dynamic responses of endogenous variables to a unit shock of some of the variables in the system, has no meaningful economic interpretation, since reduced-form innovations u_t have no direct economic context as they are linear combinations of structural innovations. Also, knowing that $\Sigma_u \neq I_K$ (unit matrix of order k), i.e. u_{kt} are often correlated in time t, additionally complicates the interpretation of the reduced form of shocks (Bahovec and Erjavec, 2009). To obtain the structural from

[3] Notation from Bahovec and Erjavec (2009) has been changed to be consistent with Lütkepohl (2005), and McCoy (1997).

[4] See example in Gottschalk (2001).

a reduced form, it is necessary to impose exogenous (nonsample) constraints. Elements of matrix A are known if the instantaneous relation between structural and reduced innovations is known, while, knowing that $e_t = Au_t$, it is possible to obtain information about the structural innovations. This model is known as the A model (Lütkepohl, 2005). It is important to emphasize that restrictions on the relationship among the parameters are valid only for the initial period, and later the effect is transmitted through the VAR depending on specification. Also, assuming that the u_t is the linear combination $e_t \sim (0, I_K)$ it is possible to orthogonalize the variance and covariance matrix of reduced shocks Σ_u, so $u_t = Be_t$, a $\Sigma_u = B\,\Sigma_e\,B'$. Since the matrix of variance and covariance of structural innovations is a unit matrix, i.e. e_{kt} are uncorrelated, in time t it is possible to find a matrix B for which $\Sigma_u = BB'$. This model is known as the B model (Lütkepohl, 2005). The problem is that there is no "best" orthogonalization capable of uniquely decomposing the matrix of variance and covariance of the reduced forms of an innovation (Bahovec and Erjavec, 2009).

Standard decomposition, which yields interpretive impulse response functions, is known as Choleski factorization, in which $\Sigma_u = GG'$, where G is a lower triangular matrix (all values above the main diagonal are zero). It is obvious that the order of endogenous variables in the VAR model is important because it implicitly determines the connection between the innovations[5]. This is precisely the main objection to this factorization, because, although it is considered non-theoretical, it assumes a connection between innovations that is hardly in line with economic theory (Keating, 1992). There are k! possible line-ups of endogenous variables (McCoy, 1997), and ranking is irrelevant if there is no correlation between the reduced form of variables (Enders, 2003). The SVAR methodology used in this paper, as in all of the works that explore the effects of fiscal policy, is the AB model in which $Au_t = Be_t$, and which requires $2k^2 - 1/2k\,(k+1)$ constraints for the system to be just-identified (Lütkepohl, 2005). From this explanation of the above-mentioned models it is clear that SVAR methodology is in fact shock analysis.

It is useful to present the correlation between shock analysis and standard AR representation, which explains Gottschalk (2001). The starting point is the equation (1), i.e. the structural VAR form in which $e_t \sim (0, I_K)$. If from each side of the equation (1) the conditional expectation of vector of the endogenous variables is subtracted, where as a condition is assumed that all information about endogenous variables are known up to time t, i.e. $E_{t-1}Z_t$, the left side will be Au_t because it is, according to equation (2), the difference of Z_t and $D(L)Z_{t-1}$ (term that summarizes data on Z_t at time t-1), if one ignores the vector of constants. On the right side of the equation (1) the expression $C(L)Z_{t-1}$ is eliminated, because it contains only variables that are known to time t-1, so only the vector of structural innovation e_t is left, if the vector of constants is ignored again. With this distinction between the

[5] See example in Bahovec and Erjavec (2009).

expected and unexpected changes in the endogenous variables, we get the A SVAR from the structural form VAR model, but equally we could get the B and AB model.

3.2 SPECIFICATION OF BLANCHARD-PEROTTI IDENTIFICATION METHODOLOGY

This section will briefly explain SVAR methodology and the identification method needed for obtaining economic interpretative impulse response functions. Thus, the reduced form VAR model of equation (2) is estimated where $Z_t = [g, \gamma, \pi, p, r]'$ is the vector of endogenous variables, which includes logarithms of seasonally adjusted budgetary central government expenditures g, logarithms of the seasonally adjusted base index of industrial production (base = 2005) y as a proxy of output, the first difference of logarithms of the consumer price index π, logarithms of seasonally adjusted budgetary central government revenues p and the overnight interest rate on the money market r. The Akaike information criterion and the LM test suggest that the optimal lag order p is 5 shifts. After the reduced form of VAR is estimated with the OLS estimation method, as already mentioned, it is necessary to assume the exogenous coefficients in order to obtain structural innovations (those that have an economic interpretation) from the reduced innovations. Blanchard and Perotti (1999) developed the methodology of structural identification based on the institutional features of the tax system. The main idea is that if you take high frequency data (the mentioned authors use quarterly data), the systematic discretionary fiscal policy response will be slow due to data collection, and the slow implementation of discretionary measures. As in our model we use monthly data, the above argument is further accentuated. Although the structural VARs are predominantly used in the analysis of monetary policy, the discrete character of the collection and publication of fiscal variables, as opposed to the continuous character of the publication of the monetary variables, makes the analysis of fiscal policies even more suitable for this method of identification. According to Perotti (2002), reduced innovations of government spending (u_t^g) and tax revenues (u_t^p) are considered to be a linear combination of three components: (1) the automatic responses of government spending and tax revenues to output (u_t^y), inflation (u_t^π) and interest rates (u_t^r) innovations; (2) the systematic discretionary response of economic policy on output, inflation and interest rates innovations; (3) random discretionary shocks, i.e. structural forms of innovations of government spending (e_t^g) and tax revenues (e_t^p). Thus, the reduced forms of innovation of government spending and tax revenues can be formally written as:

$$u_t^g = \alpha_y^g u_t^y + \alpha_\pi^g u_t^\pi + \alpha_r^g u_t^r + \beta_p^g e_t^p + \beta_g^g e_t^g \tag{3}$$

$$u_t^p = \alpha_y^p u_t^y + \alpha_\pi^p u_t^\pi + \alpha_r^p u_t^r + \beta_g^p e_t^g + \beta_p^p e_t^p \tag{4}$$

The initial assumption that the government cannot react to shocks of other variables in the same quarter or month is essential, because coefficients α_k^j reflect only the automatic response of government spending and tax revenue on output change, inflation and interest rates, while β_k^j show the current effect of k-th structural shock to the j-th variable. As e_t^p and e_t^g are associated through reduced form of innovation, they cannot be obtained by OLS (Heppke-Falk, Tenhofen and Wolff, 2006). Reduced forms of innovations in government spending and tax revenue can be displayed in the form of cyclically adjusted reduced innovation:

$$u_t^{g,CA} = u_t^g - \left(\alpha_y^g u_t^y + \alpha_\pi^g u_t^\pi + \alpha_r^g u_t^r\right) = \beta_p^g e_t^p + \beta_g^g e_t^g \qquad (5)$$

$$u_t^{p,CA} = u_t^p - \left(\alpha_y^p u_t^y + \alpha_\pi^p u_t^\pi + \alpha_r^p u_t^r\right) = \beta_g^p e_t^g + \beta_p^p e_t^p \qquad (6)$$

The next step in the identification process is to make a decision with respect to the relative ordering of fiscal variables. If it is assumed that decisions related to government spending are made prior to decisions related to tax revenues, then $\beta_g^p = 0$, and if we assume the opposite then $\beta_g^p = 0$. Although Perotti (2002) argues that neither of the alternatives has any theoretical or empirical basis, still it is more plausible to assume that decisions on government spending dictate decisions on tax revenues, so we assume that the $\beta_g^p = 0$. Although the above assumption is made in Perotti (2002), Heppke-Falk, Tenhofen and Wolff (2006), Caldara and Kamps (2006), de Castro and de Cos (2006) as well as in Lozano and Rodriquez (2008), the opposite assumption will also be tested.

Under the initial assumption that the $\beta_p^g = 0$, cyclically adjusted reduced shocks are:

$$u_t^{g,CA} = \beta_g^g e_t^g \qquad (7)$$

$$u_t^{p,CA} = \beta_g^p e_t^g + \beta_p^p e_t^p \qquad (8)$$

Other equations of reduced form innovations are estimated using instrumental variables, where e_t is used as instrument, since it is orthogonal (Heppke-Falk, Tenhofen and Wolff, 2006). Also, the mentioned procedure can be found in Perotti (2002), and other equations of reduced form innovations are:

$$u_t^y = \alpha_g^y u_t^g + \alpha_p^y u_t^p + \beta_y^y e_t^y \qquad (9)$$

$$u_t^\pi = \alpha_g^\pi u_t^g + \alpha_y^\pi u_t^y + \alpha_p^\pi u_t^p + \beta_\pi^\pi e_t^\pi \qquad (10)$$

$$u_t^r = \alpha_g^r u_t^g + \alpha_y^r u_t^y + \alpha_\pi^r u_t^\pi + \alpha_p^r u_t^p + \beta_r^r e_t^r \qquad (11)$$

As already mentioned, the SVAR model used in the analysis of fiscal shocks is called the AB model (Lütkepohl, 2005), with the following appearance:

$$Au_t = Be_t \qquad (12)$$

so it is possible to construct A and B matrices:

$$\begin{bmatrix} 1 & 0 & 0.5 & 0 & 0 \\ -\alpha_g^y & 1 & 0 & -\alpha_p^y & 0 \\ -\alpha_g^\pi & -\alpha_y^\pi & 1 & -\alpha_p^\pi & 0 \\ 0 & -0.951 & -0.892 & 1 & 0 \\ -\alpha_g^r & -\alpha_y^r & -\alpha_\pi^r & -\alpha_p^r & 1 \end{bmatrix} \begin{bmatrix} u_t^g \\ u_t^y \\ u_t^\pi \\ u_t^p \\ u_t^r \end{bmatrix} = \begin{bmatrix} \beta_g^g & 0 & 0 & 0 & 0 \\ 0 & \beta_y^y & 0 & 0 & 0 \\ 0 & 0 & \beta_\pi^\pi & 0 & 0 \\ \beta_g^p & 0 & 0 & \beta_p^p & 0 \\ 0 & 0 & 0 & 0 & \beta_r^r \end{bmatrix} \begin{bmatrix} e_t^g \\ e_t^y \\ e_t^\pi \\ e_t^p \\ e_t^r \end{bmatrix} \quad (13)$$

To make the system just-identified, $2k^2 - 1/2k\ (k + 1)$, i.e. 35 constraints (k is the number of endogenous variables) should be imposed in total in both matrices. Matrix B has 19 coefficients that are equal to zero, and the main diagonal of matrix A provides another 5 restrictions. All coefficients associated with the equation of reduced innovation in government spending are set to zero, except for the impact of inflation on government spending, which is assumed to be -0.5, because the expenditures for wages of public employees, who constitute a significant share of government spending, are not indexed to inflation in the same period. This relationship of inflation and government spending is taken from Caldara and Kamps (2006), Lozano and Rodriquez (2008), and Štikova (2006). All other coefficients associated with reduced innovation in government spending are zero, because government spending is entirely under the control of economic policy, which can not react in the same period and the effect is not automatic because it is a variable whose dynamics is solely influenced by government decisions. These arguments give 4 additional restrictions. Furthermore, the assumption that overnight interest rates-reduced innovation does not affect any one of the remaining four reduced innovations provides 3 more restrictions. As the impact of government expenditure on tax revenues can be modelled in a matrix B with structural innovations, the relationship in matrix A is assumed to be zero. Also, it is assumed that the reduced form innovation of inflation is not affected during the same period by the reduced form of output, which gives 2 more restrictions. The remaining two restrictions necessary for the system to be just-identified are obtained by calculating the impact of reduced innovation of output on reduced innovations of tax (exogenous elasticity 0.95) and the impact of reduced innovation of inflation on reduced innovation of taxes (exogenous elasticity 0.89), using a methodology that will be explained below. Such a methodology for exact SVAR identification was also used in Lozano and Rodriquez (2008), Štikova (2006), and Caldara and Kamps (2008).

It is necessary to point out some facts regarding the nature of the fiscal shocks whose effects we are observing. Shocks e_t^p and e_t^g represent a one-time increase in revenues or expenditures by one standard deviation compared to the average of the period. Perotti (2002) points out that although one can argue that due to the nature of the budget process there is only one fiscal shock per year, in practice the fiscal authorities with numerous revisions and changes in tax policy often change the course of fiscal policy. Bernanke and Mihov (1996), while discussing monetary shocks, stress the importance of some technical facts. Since the fiscal shock cannot be viewed in the context of the variables in the model (except for the fiscal variables, output, inflation and short-term interest rate), the shock of fiscal variables cannot be interpreted through the initial movement of these variables. The authors mentioned explain the causes of shocks[6]: (1) the fiscal authorities have imperfect information about the current state of the economy, (2) changes in the relative weights that fiscal authorities place on various budget spending. The first cause is explicitly assumed in the model identification, while the second one is explained by the fact that the process of making decisions about government spending is largely influenced by the struggle of various interest or social groups for greater government spending, so the weights the state puts on various forms of spending are constantly changing.

3.3 EXOGENOUS ELASTICITIES

In order to calculate the required exogenous elasticities, we have used the method developed in Blanchard and Perotti (1999), Perotti (2002), Caldara and Kamps (2006, 2008) as well as in de Castro and de Cos (2006), and Lozano and Rodriquez (2008). The elasticity of government revenue to GDP is composed of the elasticity of each tax category to their tax base, and the elasticity of each tax base to GDP. The elasticities from Švaljek, Vizek and Mervar (2009)[7], which are calculated according to Bouthevillian et al. (2001) are used as elasticities of each tax category to their tax base, while we calculate the other elasticities ourselves according to the same methodology using quarterly data from the monthly report of the Ministry of Finance and the Croatian Bureau of Statistics for the period from 2001 till the last quarter of 2009. Consumption, which is available only on a quarterly basis, is used as a base for some taxes. That is the reason why we are working with quarterly data for calculation of the elasticities.

Common output elasticity of budget revenues was calculated using the following formula:

$$\alpha_y^p = \sum_{i=1}^{n} \varepsilon_{B_i}^{p_i} \times \varepsilon_y^{B_i} \times \frac{T_i}{T} \tag{14}$$

where $\varepsilon_{B_i}^{p_i}$ is the elasticity of each tax category to its tax base, $\varepsilon_{y_i}^{B_i}$ the elasticity of each tax base to GDP, while T_i/T is the weight of type i tax in the sum of taxes, $T = \Sigma_{i=1}^{n} T_i$.

In our case the five largest central government budgetary revenues are used: income taxes, profit taxes, social contributions, value added taxes and excises. The base of income taxes and social contributions is aggregate wages, the base of

[6] Customized, as the authors present the causes of monetary shocks.

[7] Following de Castro and de Cos (2006) short term elasticities which are based on econometric estimation are used.

profit tax is gross operating surplus,[8] while the base of indirect taxes is private consumption. As noted above, $T = \Sigma_{i=1}^{n} T_i$ is the sum of five revenues, so T_i/T is a simple weight of each revenue, which we multiply with the output elasticity to each base and the base elasticity to the corresponding revenue, in order to obtain a single elasticity α_y^p. These shares were obtained from the average share of individual taxes as well as in Heppke-Falk, Tenhofen and Wolf (2006), while the values $\varepsilon_{B_i}^{p_i}$ and $\varepsilon_y^{B_i}$ are calculated according to the methodology described in Lozano and Rodriques (2008). In table 1 the calculations of all elasticities are shown, where the output elasticity of taxes equals 0.95. Comparing our results with the results of other papers, we see that our elasticity almost matches the elasticity obtained in the work Heppke-Falk, Tenhofen and Wolf (2006) for the case of Germany (also about 0.95), while that in Perotti (2002) is 0.92. For Spain, an elasticity of 0.62 is calculated (de Castro and de Cos, 2006), for the USA 1.85, UK 0.76, Australia 0.81 and 1.86 for Canada (Perotti, 2002). We conclude that the results for Croatia do not significantly differ from those in other countries.

TABLE 1
The elasticity of government revenue in relation to output

Revenue	$\varepsilon_{B_i}^{p_i}$	$\varepsilon_y^{B_i}$	$\varepsilon_y^{p_i} = \varepsilon_y^{B_i} \times \varepsilon_{B_i}^{p_i}$	T_i/T
Income tax	2.32	0.88	2.05	0.07
Profit tax	2.12	1.03	2.20	0.12
Value added tax	1.13	0.79	0.89	0.35
Excises	0.50	0.79	0.40	0.11
Social contributions	0.62	0.80	0.50	0.35
$\alpha_y^p = \sum_{i=1}^{n} \varepsilon_{B_i}^{p_i} \times \varepsilon_y^{B_i} \times \frac{T_i}{T}$			**0.95**	

Note: Values rounded upwards to two decimal places.
Source: Authors' calculations, and Švaljek, Vizek and Mervar (2009).

We have calculated not only the output elasticity but also the inflation elasticity, according to the above methodology, with certain modifications. Although there are significant differences among the methodologies used to calculate the elasticity of budget revenue to inflation, we are using the algorithm developed in Perotti (2002), and de Castro and de Cos (2006). Due to the proportionality of the price level with indirect taxes, these authors assumed that the elasticity of profit taxes in relation to inflation, as well as the elasticity of indirect taxes in relation to inflation amounts to 0. Other values are calculated as in the case of output. This

[8] Gross operating surpluss is calculated according the same methodology as in Švaljek, Vizek and Mervar (2009) (the total wages are subtracted from the GDP).

means that we calculate the corresponding base elasticity of social contributions and income taxes, and insert them into the following equation:

$$\alpha_{\pi}^{p} = \sum_{i=1}^{n} \varepsilon_{B_i}^{p_i} \times \varepsilon_{y}^{B_i} \times \frac{T_i}{T} \quad (15)$$

Again using the interim results from Švaljek, Vizek and Mervar (2009), according to our own calculation of the remaining components ($\varepsilon_{\pi}^{B_i} = 2.35$ where B_i are aggregate wages) and previously calculated values of weights, a price elasticity α_{π}^{p} of 0.89 is obtained. Comparing this elasticity with those from previous papers again leads to the conclusion that our result does not deviate from those values.[9]

The price elasticity of government expenditures is set to -0.5, according to Perotti (2002), as well as described in Kamps and Caldara (2006 and 2008), and Lozano and Rodriquez (2008). According to Perotti (2002), this value must be set between 0 and -1; opts for -0.5 without any of the calculation used in the case of other elasticities. The author justifies this choice by the fact that one part (the non-wage component) of government expenditure is inelastic to prices, and the elasticity of the other part is equal to -1 (this part of expenditures is indexed in relation to CPI such as wages in the public sector).

3.4 SPECIFICATION OF RECURSIVE METHOD

Structural innovations can be obtained from reduced innovations using Cholesky factorization. This factorization assumes that the B matrix is a unit matrix, while A is a lower triangular matrix (all elements above the main diagonal are zero), which assumes $\Sigma_u = A^{-1}\Sigma_e (A^{-1})'$ (Lütkepohl, 2005). The order of variables in the vector of endogenous variables is important, because altering the order implicitly changes the relationship structure of innovations. As the 5 dimensional model has 120 different orders of endogenous variables, the question about choosing the optimal order arises. In practice, the first variable should be that whose future periods' variance is best explained by its own structural innovations (which can be seen in variance decomposition), but the problem is that every order implies a different variance decomposition, and therefore requires a significant effort to determine the optimal order (Bahovec and Erjavec, 2009). Therefore, it is common to place the variables by the timeline of their occurrence, i.e. variables that are thought to occur first are placed first in the vector of endogenous variables. The order of the variables in Cholesky factorization is taken from Caldara and Kamps (2008), as follows:

[9] The elasticities from the mentioned papers are between 0.78 and 1.25 according to Perotti (2002:43), and de Castro and de Cos (2006:15).

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ -\alpha_g^y & 1 & 0 & 0 & 0 \\ -\alpha_g^\pi & -\alpha_y^\pi & 1 & 0 & 0 \\ -\alpha_g^p & -\alpha_y^p & -\alpha_\pi^p & 1 & 0 \\ -\alpha_g^r & -\alpha_y^r & -\alpha_\pi^r & -\alpha_p^r & 1 \end{bmatrix} \begin{bmatrix} u_t^g \\ u_t^y \\ u_t^\pi \\ u_t^p \\ u_t^r \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} e_t^g \\ e_t^y \\ e_t^\pi \\ e_t^p \\ e_t^r \end{bmatrix} \tag{16}$$

Such over-identifying factorization assumes that a reduced government spending shock is not linked to any other shock in the model in the same month and also that the reduced shock of industrial production affects only the government spending shock in the same month, and so on. It is important to emphasize the fact that this factorization defines the relationships between reduced shocks only in the first period (month), while later every shock can be affected by any other shock. Also, it is obvious that the endogenous variables are ordered in the same way as in the SVAR model, and since the A matrices of SVAR and recursive VAR models do not substantially differ, some zero restrictions (especially related to a reduced government spending shock) can be justified with the same arguments as in SVAR, which provides the factorization a theoretical context. The results obtained by the recursive method are presented in the appendix and a comment on them in the empirical results section.

4 DATA

As already noted, in this SVAR model the following data will be used: central government budgetary revenues and expenditures (or abbreviated: budget revenues and expenditures)[10] on a monthly basis (Ministry of Finance, 2010); the base index (base = 2005) of industrial production (CBS, 2010); inflation and short-term interest rate (CNB, 2010). All data except interest rate are expressed in a logarithmic scale, and inflation is calculated by differentiating the logarithm of the Consumer Price Index (CPI). Monthly data from 01/2001 until 12/2009 are used for the model. The start date is the date from which data for industrial production index are available.

Despite the fact that we are estimating a model for a relatively short period of just nine years, we can conclude that 108 observations are technically sufficient to estimate a VAR model, as in Heppke-Falk, Tenhofen and Wolf (2006) where a series of 120 quarterly observations is used. This is also a reason for using monthly data as opposed to the usual use of quarterly data in analyses of this kind, because in Croatia no quarterly dataset is available for sufficiently long time series. Hence, the use of a series of less than 50 quarterly observations would lead to a reduction in degrees of freedom and the inability to provide robustness tests. The rule of using high frequency data (quarterly or monthly in contrast to yearly)

[10] Budgetary central government revenues and expenditures are used (despite the varying scope of the budge of the central government out of the observed period) instead of the more consistent revenues and expenditures of the consolidated general government. Due to lack of observations this dataset cannot be used in our five-variable model (available quarterly data from 2004).

to eliminate the impact of discretionary fiscal policy (Blanchard and Perotti, 1999; and Perotti, 2002) also confirms our decision to use monthly data. However, in reaching conclusions it should be taken into account that results in the form of impulse response functions for output actually show industrial production, the dynamics of which are not equivalent to the dynamics of GDP. Another shortcoming is the impossibility of simulating fiscal shocks to GDP components, i.e. showing responses of investment and private consumption to fiscal shocks because these data are published in quarterly frequency.

The appendix presents the original and seasonally adjusted series of budget revenue and expenditures on a monthly basis expressed in a logarithmic scale (LNPRI and LNRAS stands for original and LNPRI_SA LNRAS_SA for seasonally adjusted values). Seasonal adjustment is performed using the U.S. Census Bureau X12-ARIMA method with the program package Eviews 5.0. It is important to emphasize that these are nominal variables, as is usual in describing the impact of fiscal shocks on real variables. Viewing the appendix it is possible to compare the seasonality of revenues and expenditures and conclude that budget revenues show significantly stronger seasonal fluctuations than budget expenditures do. Despite these minor seasonal fluctuations, we also use seasonally adjusted time series for budgetary expenditures, which is consistent with the standard literature. The other variables are also shown in the appendix. It should be noted that due to very strong seasonal fluctuations the index of industrial production is also seasonally adjusted by the same method, while seasonal adjustment is not applied to interest rate or inflation.

Monthly consumer price base-index is taken from the Croatian National Bank (base = 2005), and inflation is derived according the previously described manner. The short-term interest rate on interbank demand deposit trading is used as the reference interest rate, and it is measured as a weighted monthly average (also downloaded from the database of the Croatian National Bank).

Unit root test is also performed (table A1) from which it can be concluded that at the 5% significance level only the interest rate is stationary in levels, while the other variables contain unit roots in levels and are stationary only in first differences. At 1% significance all variables contain unit roots in levels and are stationary in first differences. Despite the fact that the variables contain unit roots, variables in levels will be used in this analysis, which is common practice in such studies (Perotti, 2002; de Castro and de Cos, 2006; and Heppke-Falk, Tenhofen and Wolf, 2006) because of our primary interest in the dynamics, rather than parameter estimation.

5 EMPIRICAL RESULTS

The impulse response functions, the matrices with the estimated parameters and the variance decomposition are given in the appendix. All results were obtained by using Eviews 5.0 software. In table A2 matrices A and B are shown, while in table A3 the variance decomposition of the baseline model can be seen.

In figure A6 and figure A9 impulse response functions for both methods used (recursive and structural) are shown. Dashed lines represent the intervals of two standard deviations, while the solid lines represent the impulse function.

While interpreting the fiscal variable shocks one should have in mind that shocks from government expenditures or revenues are not caused by any of the other variables in the model, because the structural shocks are derived from residuals of the VAR equation.

The effect of expenditure shock on industrial production (see figure A6), which we use as a proxy variable of output, unlike previous research into effects of fiscal policy in Croatia (Rukelj, 2009; and Benavides, 2006), was negative in the short term. The mentioned effect vanishes within two years and throughout the entire period the effect is in the performance range of ± 0.5 units of measurement of variable. A possible explanation of this unconventional direction of influence may be the predominant effect of the crowding out of private investment as against the output effect. An additional problem is the unavoidable choice of industrial production as the only sufficiently long monthly series that serves as an approximation of economic activity. Despite the unexpected result, similar conclusions are found in Heppke-Falk, Tenhofen and Wolf (2006), and Lozano and Rodriguez (2008). In de Castro and de Cos (2006) positive short-term turns into a negative long-term effect.

Revenue shock on industrial production has a negative effect in the first three months after which it turns into a positive, but volatile effect. After 10 months the effect stabilizes and does not vanish, which is probably connected with the fact that the tax shock has a permanent impact on the taxes because a change in tax rates has a lasting effect on the amount of tax revenue. Such a lasting positive reaction of economic activity was obtained in Falk, Tenhofen and Wolf (2006), and Lozano and Rodriguez (2008). De Castro and de Cos (2006) also present a short-term positive effect, which in the long run turns into a negative effect; while in Štikova (2006) government revenue shocks have no impact on GDP.

Both fiscal shocks have a minimal effect on inflation (within 0.007 units of measurement of variable) that vanishes within a year. The initial two-month expenditure shock effect on inflation is positive when it turns to the negative effect which prevails until the eighth month, which is consistent with the textbook knowledge of the economic policy of stable exchange rate (see Gartner, 2006; Mankiw, 2007; etc.). A tax shock raises inflation the first six months and then it stabilizes in spite of the presence of the permanent effect of taxes. This is because the shock is implemented in the inflationary expectations after one year. In other studies based on SVAR methodology the short-term effect of fiscal shocks on inflation is volatile and in the long term also negligible.

Fiscal shocks have the greatest impact on the interest rate (0.5 units of measurement of variables). Directions of effects are in line with the conclusions of textbook knowledge on a stable exchange rate (see Gartner, 2006; Mankiw, 2007; etc.). Interest rates react negatively to the tax shock, and return to the initial level after a year. An expenditure shock lowers the interest rate within two months and again raises it above the initial level at which it is maintained for a year. This conclusion is consistent with Falk, Tenhofen and Wolf (2006).

As noted above, the tax shock has a lasting and positive impact on taxes, which is apparent even after a few years. The effect of an expenditure shock on revenues, after the initial volatility, disappears after 12 months. This effect is in line with the growing public debt, because if taxes are not sufficiently responsive to increase in government expenditure, the needed funds will be debt-financed.

Expenditures are quickly stabilized after the initial shock of expenditures, from which it is evident that, unlike the impact of revenue shocks on revenues, future levels of government spending do not depend on independent expenditures shocks. A tax shock has a positive long term impact on the level of government expenditures, which is very intuitive, because permanently higher taxes (the effect of revenue shock to total revenues is constant) allow greater government spending in the future.

Decomposition of the variance is a standard VAR tool that shows what proportion in the variance of the next period certain shocks have, i.e. it breaks down the proportion of the variability of each variable on the part of the variability that resulted from the shock of the variable and the variability that is the result of shocks in other variables (Bahovec and Erjavec, 2009). In table A3 the variance decomposition for the basic SVAR model for a period of one month to two years is shown. The results of variance decomposition for government expenditures, industrial production, inflation and interest rates show that after a month the variables themselves explain more than 90% of the variance of their forecasting errors. Industrial production explains 11.56% of forecasting error variance of budget revenues after a month, which confirms the dependence of revenues on economic activity. The proportion by which the variance share of forecasting error is explained by the actual variables decreases rapidly; this is especially pronounced with variable government expenditures. The same conclusion is evident from the impulse response function, where the effect of expenditure shock on expenditures disappears rapidly, unlike other functions displayed.

In figure A9 the impulse response functions obtained by Cholesky factorization are given. Most of the impulse response function is similar, with certain exceptions, to the functions obtained by SVAR methodology. For example, the impact of revenue shocks on inflation obtained by Cholesky factorization shows greater variability and has a different short-term effect. In the SVAR model an increase in inflation is instantaneous, while in the recursive model inflation rises after a few months. Also, the difference in short-term effects between SVAR methodology and recursive approach is apparent while observing the effects of expenditure shocks on revenues and revenue shock on expenditures.

6 ROBUSTNESS CHECK

The first stability condition, which indicates that all roots of the characteristic polynomial are inside the unit circle, is satisfied, so the defined VAR model is stable.[11]

An additional stability and robustness check is the comparison of the SVAR model with the VAR model, which uses the Cholesky decomposition. The order of variables was previously mentioned, and the number of lags is again five according to the Akaike information criterion and LM test. The impulse response functions for the recursive approach can be seen in figure A9 and have been described above.

The most common method for checking the robustness of SVAR models is the breakpoint test, where the series is divided into two parts. In this case, the series is divided into two equal samples where the first subsample covers the period from 01/2001 to 06/2005 and the second subsample from 07/2005 to 12/2009. Impulse response functions for two models according to these two series are given in figures A7 and A8. The same method of identification as for the whole series is used, and the number of lags is also chosen according to the lag length criterion tests. Both indicators (Akaike info criterion and LM test) suggest three lags for the second model. For the first model the Akaike information criterion suggests five, while the LM test suggests three lags. Since it is a relatively short series, but also because of the lag selection in the second series, we have decided also to use three lags in the model for the first sample. In addition, the lag exclusion test shows that the fourth shift is not significant, which further confirms our selection decision.

The purpose of dividing the series into two parts is to investigate the similarity between the responses of variables to shocks in each sample. The impulse response function differs most significantly for the case of the reaction of industrial production to an expenditure shock. In contrast to the model for the first sample where the effect is slightly positive, in the second sample this effect is negative, as well as for the total sample. These results may occur due to several factors. There is a possibility of an impact of structural changes in the observed period, which may lead to differences in the results. One reason may be the wrong selection of variables, i.e. in the case of industrial production; however, also the wrong specification of model could be the reason. The latter is possible, but the fact that for all other variables a clearly consistent response to fiscal shocks in both models is visible leads us to the opposite conclusion.

[11] The graph is given in figure A10.

In addition to this breakpoint test, several tests to examine the robustness of our model and the credibility of the results are conducted. Such tests are related to the selection of coefficient values which are not obtained by computation. The first test is the examination of the sensitivity of the model results to the change of the parameter α_{π}^{g} (price elasticity of budget expenditures). Earlier it was explained why the value -0.5 is chosen according to Perotti (2002), but it is also said that this value should be somewhere between -1 and 0. Both extreme cases are examined and the results remain unchanged. The remaining parameter that is not obtained by computation, or is selected because of special assumptions is the parameter β_{p}^{g}. It was assumed that this parameter has to equal 0, which means that one believes that expenditure decisions are prior to tax decisions. An alternative to this case is that β_{p}^{g} is estimated in the usual manner (by OLS), and that β_{p}^{g} is set to zero, which means that one believes that expenditure decisions will follow tax decisions. As in the previous case, the change of this parameter do not change the result significantly, which further confirms our model specification and the robustness of our SVAR model.

7 CONCLUSIONS

In this paper we have used the Blanchard-Perotti method for the identification of a structural vector autoregressive model in a disaggregated analysis of the macroeconomic effects of fiscal policy shocks for the case of Croatia. Unlike the usual quarterly frequency, monthly data are used in our analysis which also provides the theoretical assumptions required for model to be just-identified. For this reason in addition to zero restrictions, estimated exogenous elasticities of budget revenues to economic activity and inflation are included in our model. These procedures were necessary to get structural innovations from the reduced form VAR model residuals, and also to get the associated economic interpretive impulse response functions. The robustness of the model and the model specification is confirmed by dividing the sample into two parts as well as by other robustness checks. The sensitivity of the model to the change of the arbitrarily chosen coefficient of inflation innovation impact on government spending was also tested, which is an additional confirmation of the accurate model specification.

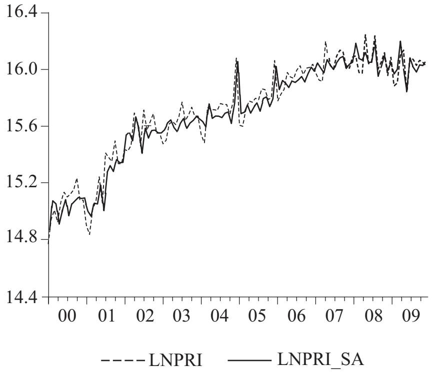
According to the impulse response functions we can conclude that: (1) the interest rate shows the relatively strongest response to fiscal shocks, while inflation shows the weakest response, (2) the effect of budget revenue shock on budget revenue is permanent, while the effect of budget expenditures on budget expenditure shock is instantaneous, from which we can draw intuitive conclusions about the cross-impacts of expenditures to revenues, and vice versa, (3) the effect of spending shocks on revenues is instantaneous, which confirms the hypothesis about the tendency of the growth in public debt, (4) the impact of fiscal shocks on inflation and interest rates is mostly economic intuitive. Revenue shock in the short term increases the rate of inflation and also reduces the short-term interest rate, while after one year stabilization occurs at the initial level. An expenditure shock decreases inflation in the short run, while in the medium run, inflation increases above the initial level, while the interest rate acts in the opposite direction. Such conclusions about inflation and the interest rate could be explained by economic theory only if one assumes that the reaction of output is intuitive as well, but as the effects on industrial production are not as common (the tax shock leads to an increase in industrial production, while the expenditure shock reduces industrial production), it can be assumed that the index of industrial production is an inadequate proxy variable of output. The assumption of a wrong proxy variable selection may not be the only reason for such an unexpected result, because some papers using direct GDP as the variable for economic activity also deal with similar unexpected results, (5) furthermore, government revenue and expenditure shocks, if implemented by the same volume in different directions do not yield the same results, i.e. fiscal expansions and contractions do not show a mirror effect on the impulse response functions.

We believe that the contribution of this paper is in its study of the consequences of fiscal policy on inflation and the interest rate, and separately observing the effects of fiscal policy instruments, as well as testing their mutual influence.

The applied methodology and conclusions of our paper can serve as a benchmark for comparison with the results of future research about the effects of fiscal policy using other methods, such as the fiscal dummy approach, Bayesian structural VAR models, or even theoretically dynamic stochastic general equilibrium models. One possibility for an extension of our model is the inclusion of additional variables in the existing SVAR model. Besides that, the question about the right selection of a proxy variable for economic activity is still not answered. One possible solution is the implementation of a complex composite index of economic activity that in addition to industrial production includes a variety of other variables in order better to approximate the movement of overall economic activity. Only when a long enough sample of national accounts is available, it will be possible to examine the effects of fiscal shocks on GDP and the components of GDP (private consumption and aggregate investment).

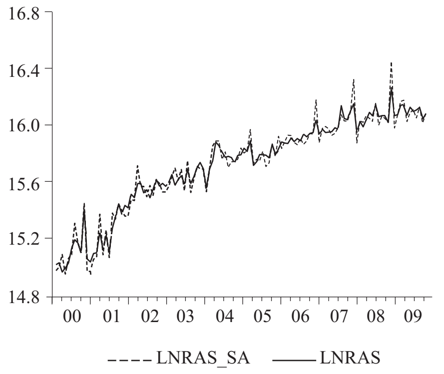
APPENDIX

FIGURE A1
The original and seasonally adjusted values of the budgetary central government revenues expressed in logarithms



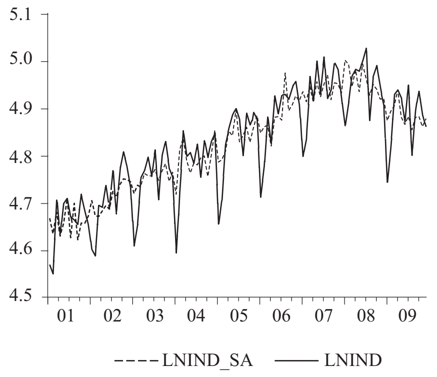
Source: Ministry of Finance.

FIGURE A2
The original and seasonally adjusted values of the budgetary central government expenditures expressed in logarithms



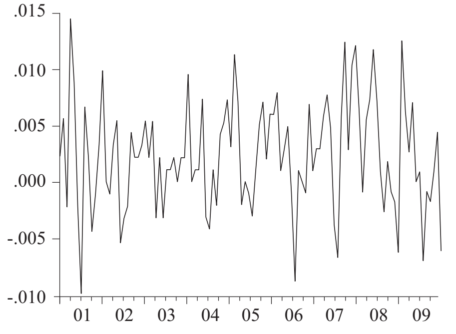
Source: Ministry of Finance.

FIGURE A3
The original and seasonally adjusted base index (base = 2005) of industrial production expressed in logarithms



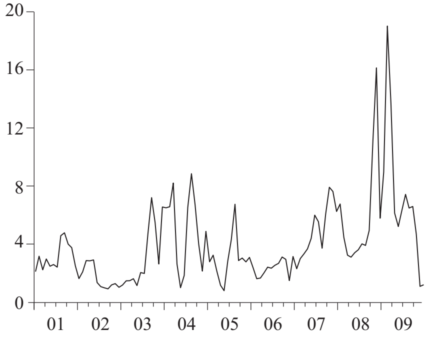
Source: Croatian Bureau of Statistics.

FIGURE A4
Monthly inflation (differenced logarithms of the CPI)



Source: Croatian National Bank.

Figure A5
The short-term interest rate on interbank demand deposit trading



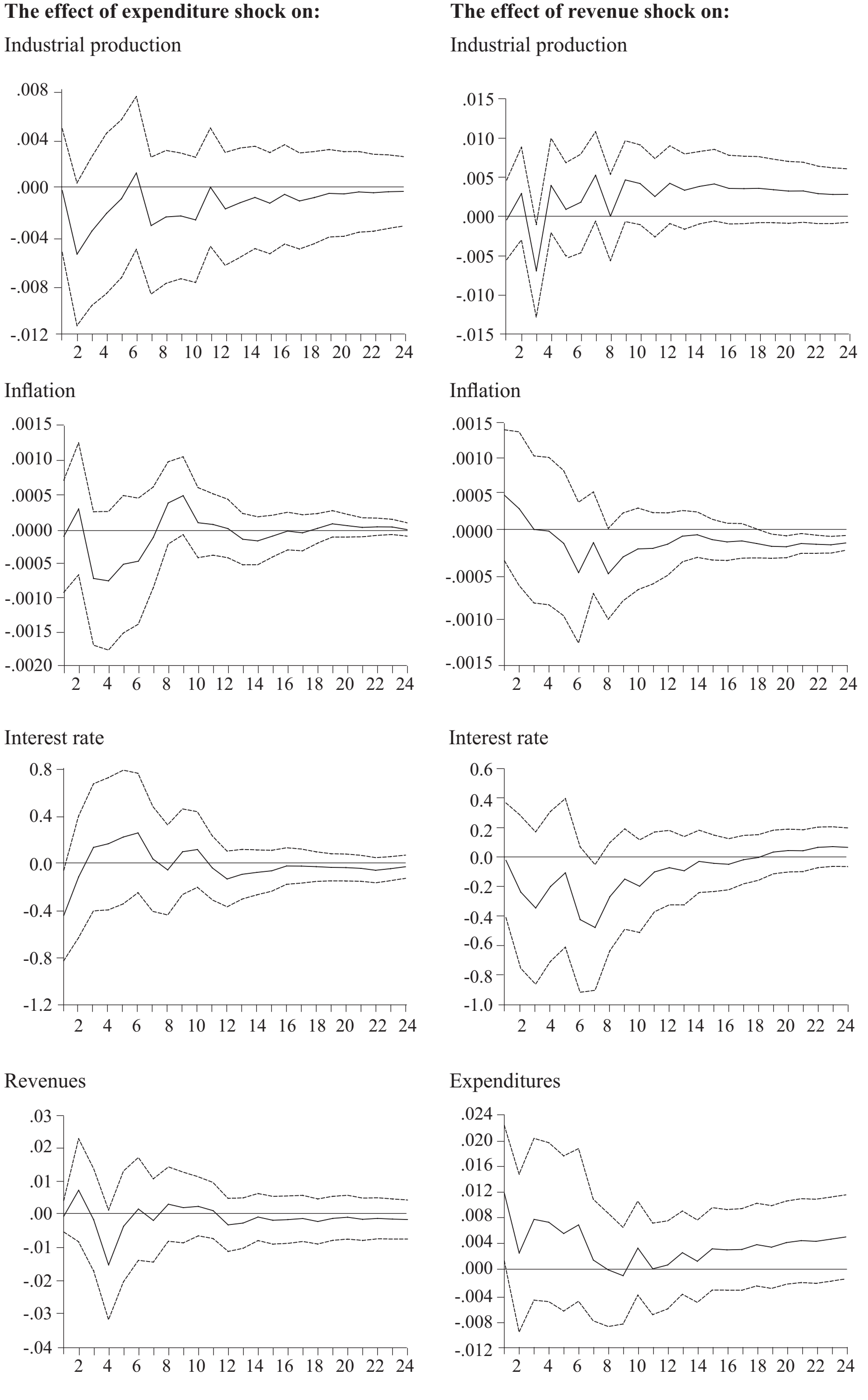
Source: Croatian National Bank.

Table A1
The results of Augmented Dickey-Fuller test

Variables	Level			First difference		
	none	const.	trend+const.	none	const.	trend+const.
LNCPI	3.95	-0.80	-2.27	-7.14*	-8.54*	-8.52*
LNIND_SA	1.97	-2.01	0.367	-12.40*	-12.57*	-8.95*
LNPRI_SA	2.28	-1.26	-1.29	-15.87*	-16.33*	-16.34*
LNRAS_SA	1.70	-1.11	-2.75	-19.33*	-11.01*	-10.98*
KTA	-2.01**	-3.06**	-3.21	-12.88*	-12.85*	-12.80*

*Note: The optimal number of lags according to Schwarz information criteria (Maxlag = 12), where * and ** represent rejection of the null hypothesis at significance level of 1% and 5% for critical values of -2.586 and -1.943 without constant and trend, -3.491 and - 2.888 with constant and without trend, and -4.048 and -3.453 with a constant and trend.*

Figure A6
The impulse response functions for the fiscal shocks of one standard deviation of the baseline SVAR model (solid lines represent the function, the dashed lines represent two standard deviations, the ordinate shows the level phenomena expressed in units of measurement of variables, and the abscissa shows time expressed in months)



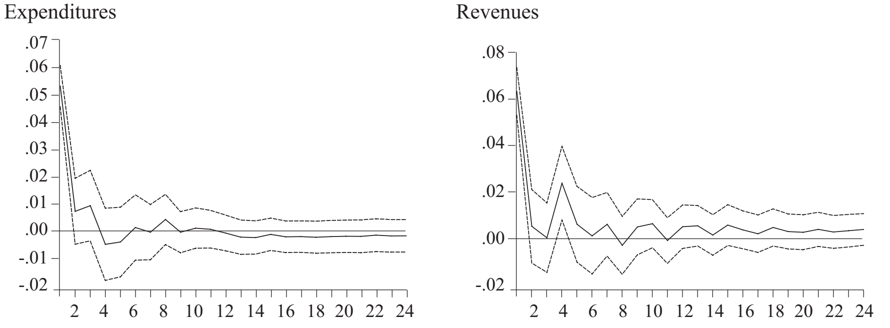
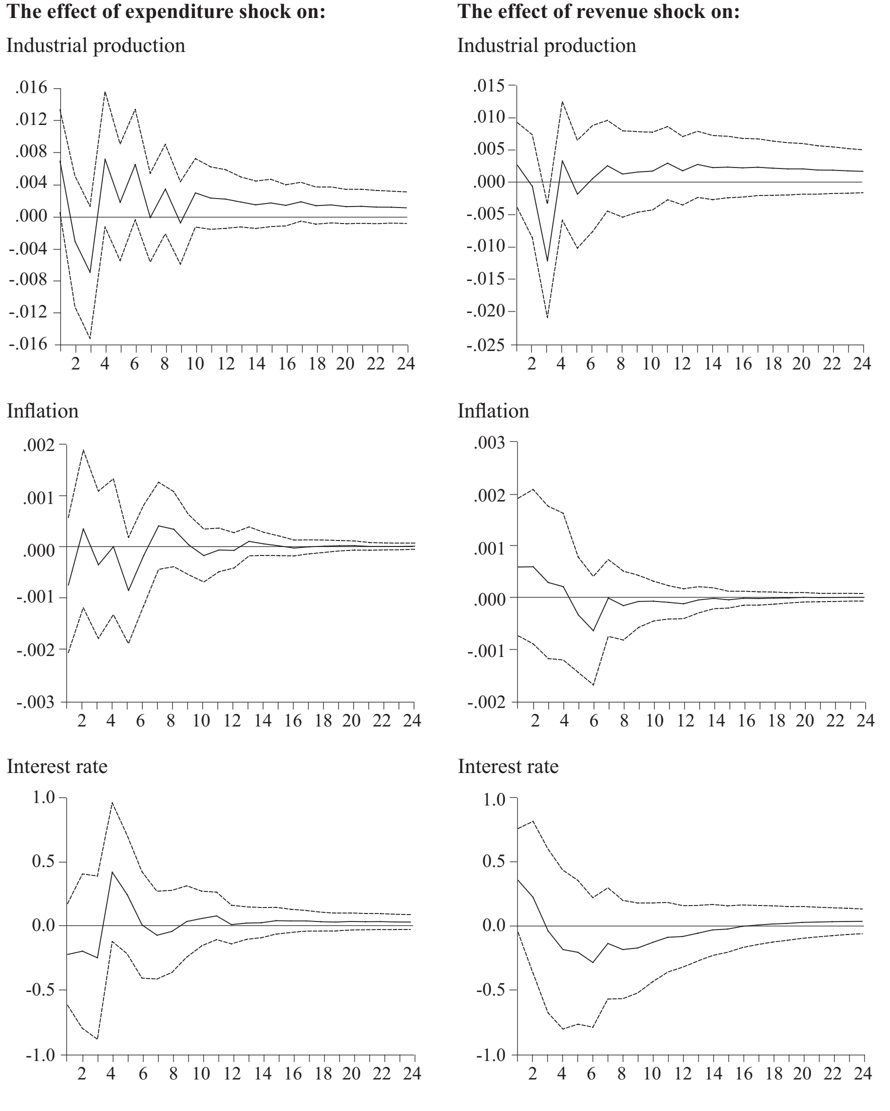


Figure A7
Impulse response functions of the SVAR model for the first subsample (01/2001-06/2005)



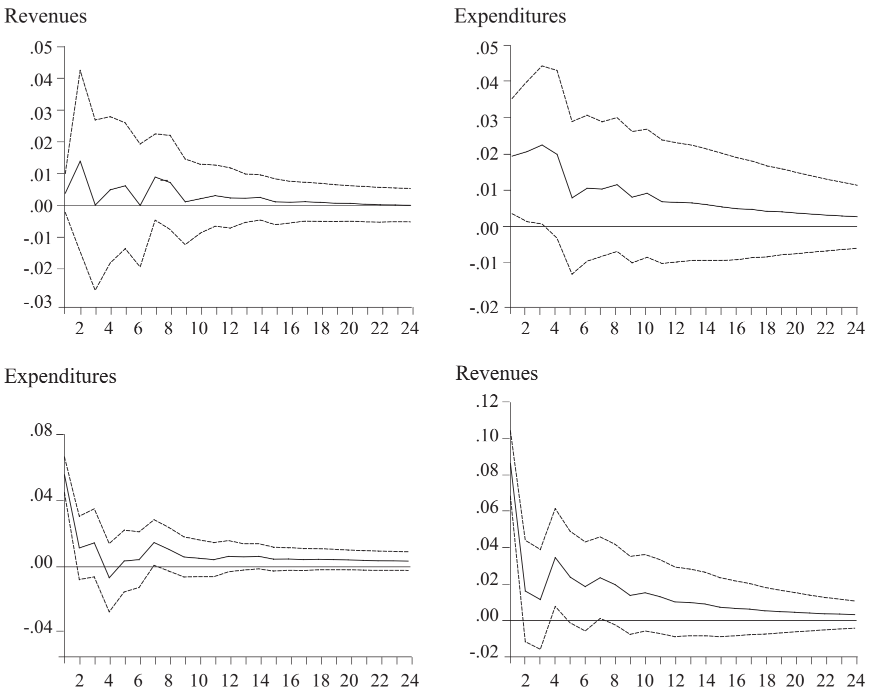
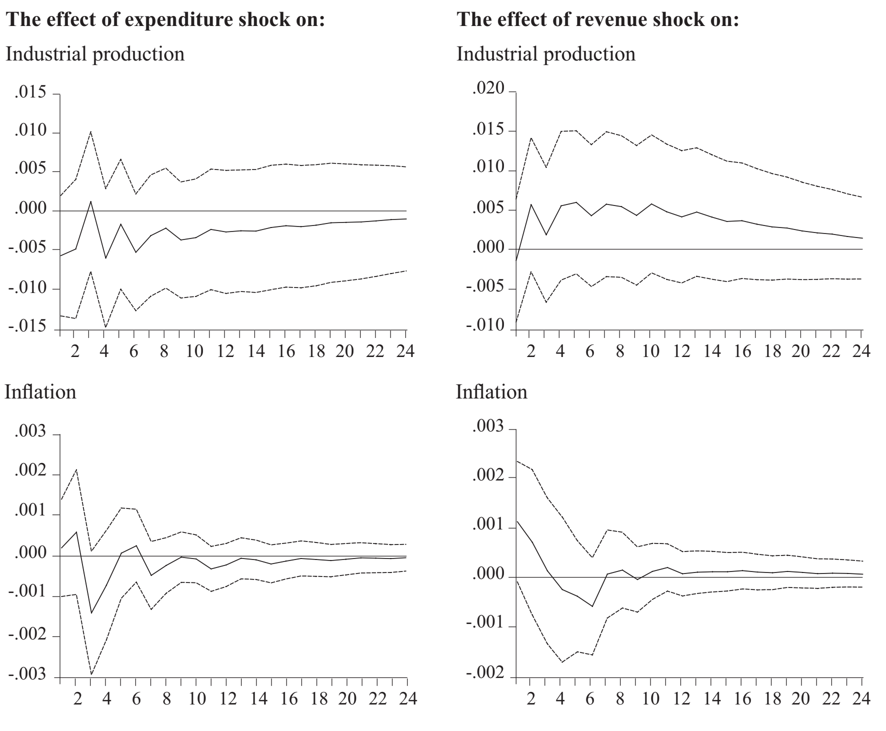


Figure A8

Impulse response functions of the SVAR model for the second subsample (07/2005-12/2009)



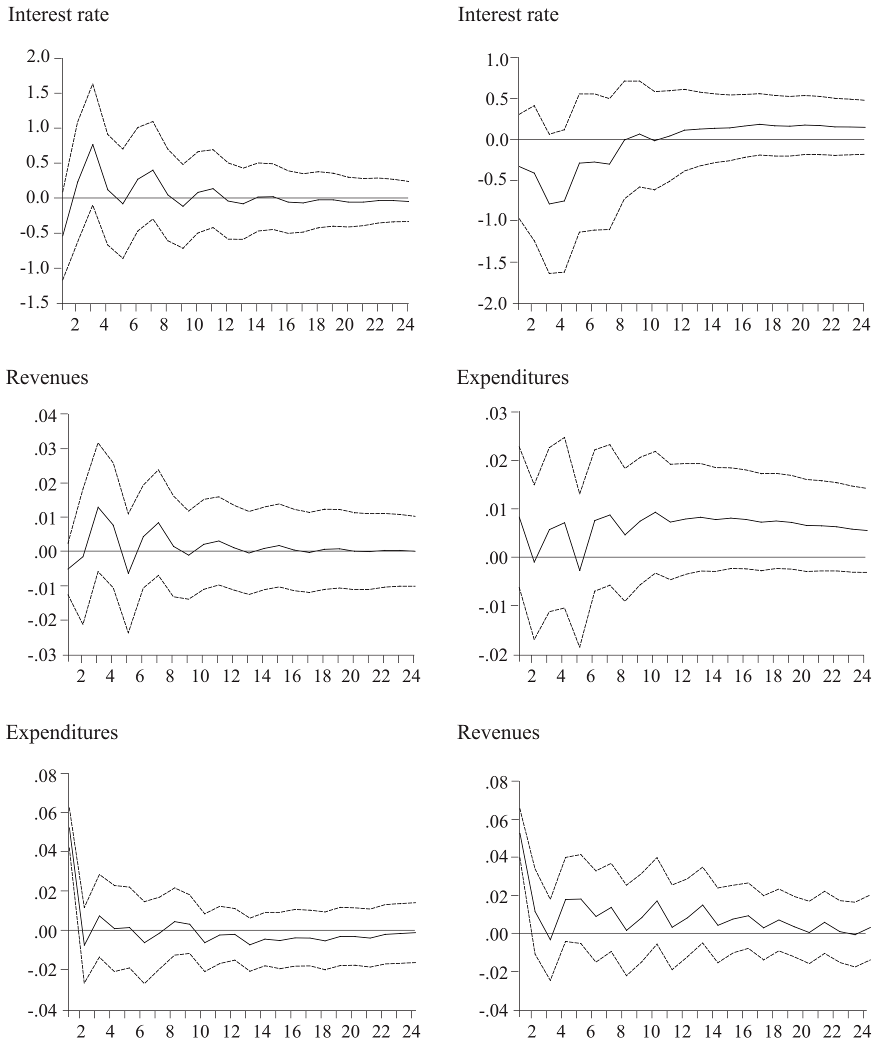
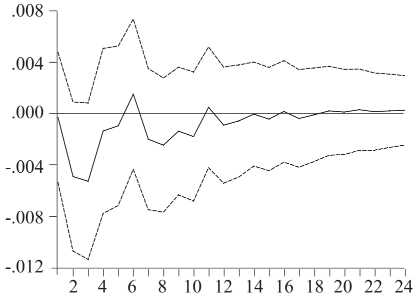

Interest rate
Interest rate
Revenues
Expenditures
Expenditures
Revenues

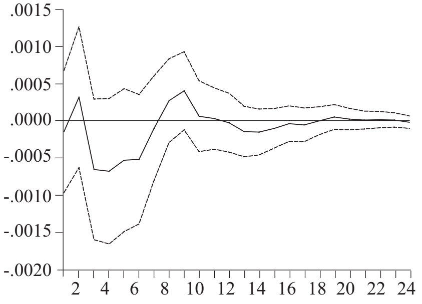
FIGURE A9
Impulse response functions of the recursive model

The effect of expenditure shock on:

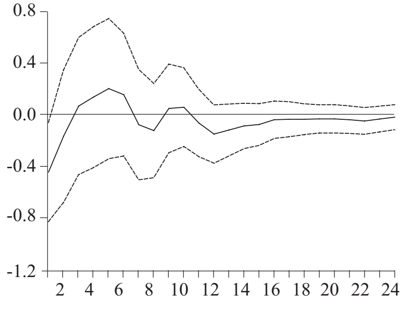
Industrial production



Inflation

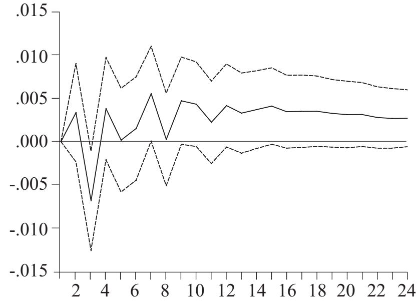


Interest rate

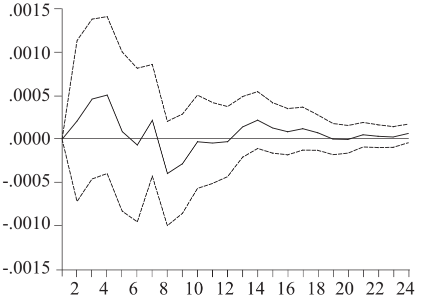


The effect of revenue shock on:

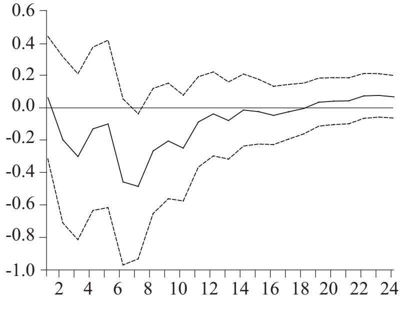
Industrial production



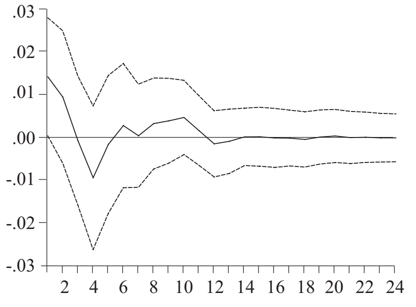
Inflation



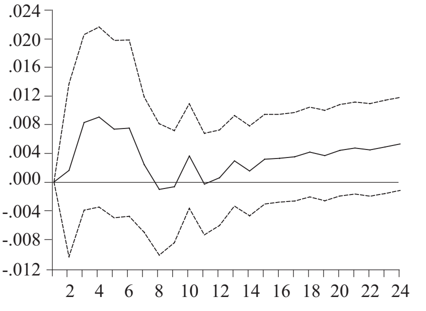
Interest rate



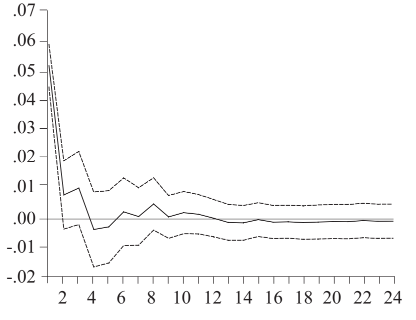
Revenues



Expenditures



Expenditures



Revenues

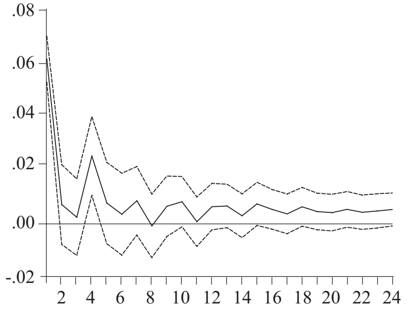


Table A2
Variance decomposition of the SVAR model

Expenditures

Months	S.E	e^g	e^y	e^π	e^p	e^r
1	0.0542	99.85	0.001	0.142	0.003	0.000
6	0.0679	68.14	7.701	7.997	4.049	12.11
12	0.0747	56.87	19.29	7.444	3.587	12.79
18	0.0805	49.09	28.58	6.621	4.053	11.46
24	0.0864	42.74	33.58	5.950	5.286	12.43

Industrial production

Months	S.E	e^g	e^y	e^π	e^p	e^r
1	0.025	0.028	99.92	0.000	0.045	0.000
6	0.034	4.433	76.93	6.831	5.989	5.811
12	0.041	3.978	67.69	5.448	9.909	12.96
18	0.045	3.406	63.74	4.694	12.24	15.91
24	0.047	3.172	62.21	4.360	13.66	16.59

Inflation

Months	S.E	e^g	e^y	e^π	e^p	e^r
1	0.004	0.004	1.082	96.36	2.549	0.000
6	0.005	6.438	5.394	79.31	3.879	4.969
12	0.005	6.959	5.414	76.97	4.359	6.292
18	0.005	7.045	5.446	76.29	4.692	6.518
24	0.005	7.051	5.452	76.13	4.715	6.640

Revenues

Months	S.E	e^g	e^y	e^π	e^p	e^r
1	0.070	4.213	11.56	0.264	83.95	0.000
6	0.087	5.240	18.65	1.017	65.18	9.900
12	0.094	4.999	25.60	1.386	57.89	10.11
18	0.099	4.520	29.72	1.327	54.21	10.21
24	0.103	4.183	32.33	1.262	51.52	10.69

Interest rate

Months	S.E	e^g	e^y	e^π	e^p	e^r
1	1.974	4.948	0.003	0.205	0.153	94.68
6	2.915	3.480	5.894	8.477	5.684	76.46
12	3.050	3.758	6.419	9.415	9.204	71.20
18	3.087	3.979	7.620	9.491	9.068	69.84
24	3.121	3.959	8.475	9.460	9.114	68.99

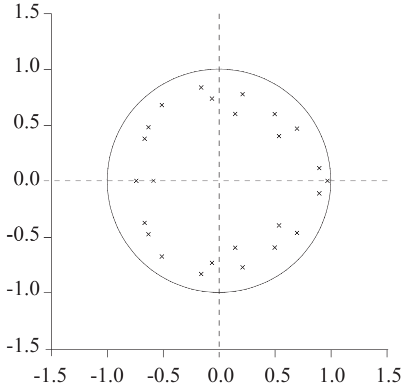
Note: e^g is structural innovation of government budget expenditure, e^y is structural innovation of output, e^π is structural innovation of inflation, while e^p and e^r are structural innovations of government budget revenues and interest rates, respectively.

Table A3
Estimated coefficients of A and B matrices using the Blanchard-Perotti method

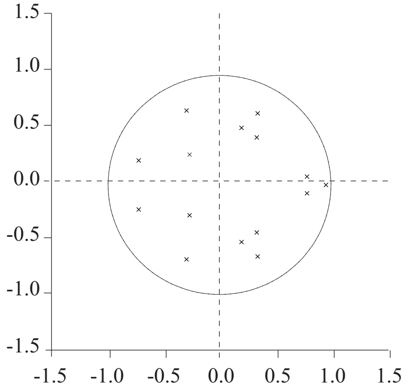
$$\hat{A}=\begin{bmatrix} 1 & 0 & 0.5 & 0 & 0 \\ 0.0057 & 1 & 0 & 0.0084 & 0 \\ 0.0023 & 0.0263 & 1 & -0.0100 & 0 \\ 0 & -0.9510 & -0.892 & 1 & 0 \\ 8.3782 & 1.0134 & -16.7556 & -0.9701 & 1 \end{bmatrix} \hat{B}=\begin{bmatrix} 0.0542 & 0 & 0 & 0 & 0 \\ 0 & 0.0259 & 0 & 0 & 0 \\ 0 & 0 & 0.0040 & 0 & 0 \\ 0.0149 & 0 & 0 & 0.0671 & 0 \\ 0 & 0 & 0 & 0 & 1.921 \end{bmatrix}$$

FIGURE A10
Inverse roots of the characteristic polynomial

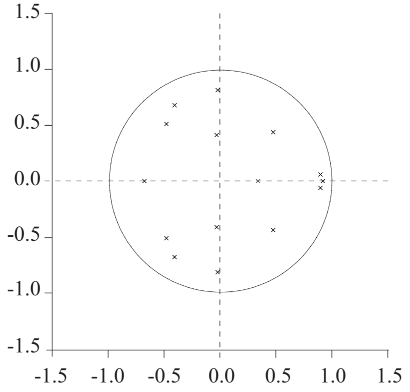
Reduced form VAR model



Reduced form VAR model for period
01/2001 – 06/2005



Reduced form VAR model for period
07/2005 – 12/2009



LITERATURE

Afonso, A. and Sousa, R. M., 2009a. "The Macroeconomic Effect of Fiscal Policy in Portugal: A Bayesian SVAR Analysis." *Technical University of Lisbon, School of Economics and Management Working Paper series* 09/2009 [online]. Available from: [http://www3.eeg.uminho.pt/economia/nipe/docs/2009/NIPE_WP_3_2009.pdf].

Afonso, A. and Sousa, R. M., 2009b. "The Macroeconomic Effects of Fiscal Policy" [online]. *ECB Working Paper,* No 991. Available from: [https://www.repository.utl.pt/bitstream/10400.5/2156/1/ecbwp991.pdf].

Bahovec, V. and Erjavec, N., 2009. *Uvod u ekonometrijsku analizu*. Zagreb: Element.

Benazić, M., 2006. "Fiskalna politika i gospodarska aktivnost u Republici Hrvatskoj: model kointegracije." *Ekonomski pregled*, 57 (12) 882-918.

Bernanke, B. S. and Mihov, I., 1997. "What Does the Bundesbank Target?" *European Economic Review,* 14 (6), 1025-1053.

Blanchard, O. J. and Perotti, R., 1999. "An Empirical Characterization of the Dynamic Effects of Changes in Government Spending and Taxes on Output" [online]. *NBER Working Paper Series*, No. 7269. Available from: [http://www.nber.org/papers/w7269.pdf].

CBS. *Monthly Statistical Report*. No. 1/06, 12/06, 01/07, 12/07, 01/08, 12/08, 01/09, 12/09, 01/10. Zagreb: Croatian Bureau of Statistics.

CNB, 2010. *CNB database* [online]. Available from: [www.hnb.hr/statistika/hstatistka.htm].

de Arcangelis, G. and Lamartina, S., 2003. "Identifying Fiscal Shocks and Policy Regimes in OECD Countries" [online]. *ECB Working Paper,* No. 281. Available from: [http://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp281.pdf].

de Castro, F. and de Cos, P. H., 2006. "The Economic Effects of Exogenous Fiscal Schocks in Spain: A SVAR Approach" [online]. *Banco de Espana, Documentos de Trabajo,* No 06104/2006. Available from: [http://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp281.pdf].

de Plesis, S., Smit, B. and Struzenegger, F., 2007. "The Cyclicality of Monetary and Fiscal Policy in South Africa Since 1994" [online]. *University of Stellenbosch Economic Working Papers,* No. 12/07. Available from: [http:*www.ekon.sun.ac.za/wpapers/2007/wp122007/wp-12-2007.pdf].*

Enders, W., 2003. *Applied Econometric Time Series*. New York: John Wiley & Sons, Inc.

Fatas, A. and Mihov, I., 2001a. "Fiscal Policy and Business Cycles: An Empirical Investigation." *Moneda y Credito,* 212, 167-210.

Fatas, A. and Mihov, I., 2001b. "The Effects of Fiscal Policy on Consumption and Employment: Theory and Evidence" [online]. *CEPR Discussion Paper,* No. 2760. Available from: [http://faculty.insead.edu/fatas/fiscal.pdf].

Favero, C., 2002. "How do Monetary and Fiscal Authorities Behave?" [online]. *CEPR Discussion paper*, No 3426. Available from: [http://ftp.igier.uni-bocconi.it/wp/2002/214.pdf].

Galí, J., López-Salidoz, J. D. and Vallés, J., 2007. "Understanding the Effects of Government Spending on Consumption." *Journal of the European Economic Association,* 5 (1), 227-270.

Gärtner, M., 2006. *Macroeconomics.* London: Prentica Hall.

Giordano, R. [et al.], 2008. "The Effects of Fiscal Policy in Italy: Estimates with a SVAR model." Presented at: *Banca d'Italia, 7th Workshop on Public Finance.*

Gottschalk, J., 2001. "An Introduction into the SVAR methodology: Identification, Interpretation and Limitations of SVAR models" [online]. *Kiel Working Paper,* No. 1072. Available from: [http://www.econstor.eu/bitstream/10419/17887/1/kap1072.pdf].

Heppke-Falk, K. H., Tenhofen, J. and Wolf, G. B., 2006. "The Macroeconomic Effects of Exogenous Fiscal Policy Shocks in Germany: a Disaggregated SVAR Analysis" [online]. *Deutsche Bundesbank Discussion Paper Series 1: Economic Studies,* No 41/2006. Available from: [http://econstor.eu/bitstream/10419/19670/1/200641dkp.pdf].

Kamps, C. and Caldara, D., 2006. "What Do we Know about the Effects of Fiscal Policy Shocks? A Comparative Analysis." *Computing in Economics and Finance Series,* No. 257/2006. [online]. Available from: [http://repec.org/sce2006/up.9905.1140994990.pdf].

Kamps, C. and Caldara, D., 2008. "What are the Effects of Fiscal Policy Shocks? A VAR-based Comparative Analysis" [online]. *ECB Working Paper*, No 877. Available from: [http://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp877.pdf].

Keating, J. W., 1992. *Structural Approaches to Vector Autoregressions*. Washington: Federal Reserve Bank of St. Louis.

Krušec., D., 2003. "The effects of fiscal policy on output in a structural VEC model framework: The case of four EMU and four non-EMU OECD countries." Presented at: *University of Crete 8th International Conference of Macroeconomics Analysis and International Finance,* 03/2004.

Lozano, I. and Rodriquez, K., 2008. "Assessing the Macroeconomic Effects of Fiscal Policy in Colombia" [online]. *Banco de la Republica, Borradores de Economia Working Paper,* No. 552/2009. Available from: [http://www.bcu.gub.uy/autoriza/peiees/jor/2009/iees03j3011009.pdf].

Lütkepohl, H., 2005. *New Introduction to Multiple Time Series Analysis*. Berlin; Heidelberg; New York: Springer.

Mankiw, G. N., 2007. *Macroeconomics.* New York: Worth Publishers.

McCoy, D., 1997. *How useful is Structural VAR Analysis for Irish Economics.* Dublin: Economic Analysis, Research and Publications Department, Central Bank of Ireland.

Ministry of Finanace. *Monthly Statistical Report of the Ministry of Finance*. No. 63, 74, 75, 86, 96, 99, 110, 111, 122, 123, 135, 136, 147, 148 [online]. Available from: [http://www.mfin.hr/mjesečni-statistički-prikazi].

Mountford, A. and Uhlig, H., 2005. "What are the Effects of Fiscal Policy Shocks?" *SFB 649 Discussion Paper* 2005-039. Berlin: Humboldt University.

Perotti, R., 2002. "Estimating the Effects of Fiscal Policy in OECD Countries" [online]. *ECB Working Paper,* No. 168. Available from: [http://www.ecb.int/pub/pdf/scpwps/ecbwp168.pdf].

Ramey, V. A. and Shapiro., M. D., 1998. "Costly Capital Reallocation and the Effects of Government Spending" [online]. *Carnegie-Rochester Conference Series on Public Policy,* 48 (June), 145-194. Available from: [http://www.sciencedirect.com/science/article/B6V8D-3VNGGBF-7/2/439a0918c6f10ff2f107f16e2036b6eb].

Rukelj, D., 2009. "Modelling Fiscal and Monetary Policy Interactions in Croatia Using Structural Vector Error Correction Model." *Privredna kretanja i ekonomska politika,* 121, 27-58.

Sopek, P., 2009. "The Effect of the Financial Crisis on Croatia's Primary Budget Deficit and Public Debt" [online]. *Financial Theory and Practice,* 33 (3), 273-298. Available from: [http://www.ijf.hr/eng/FTP/2009/3/sopek.pdf].

Štiková, R., 2006. *Effects of Fiscal Policy in the Czech Republic: a SVAR analysis* [online]. Available from: [http://ies.fsv.cuni.cz/default/file/download/id/5551].

Švaljek, S., Vizek, M. and Mervar, A., 2009. "Ciklički prilagođeni proračunski saldo: Primjer Hrvatske." *Privredna kretanja i ekonomska politika,* 120, 49-81.