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Combining Monetary and Fiscal Policy in an SVAR for a Small Open Economy*

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Abstract

This paper combines a monetary structural vector-autoregression (SVAR) with a fiscal SVAR for Poland. Fiscal foresight, in the form of implementation lags, is accounted for with respect to both discretionary government spending and tax changes. We demonstrate the importance of combining monetary and fiscal transmission mechanisms. However, ignoring fiscal foresight has no statistically significant effects. We calculate an initial government spending multiplier of 0.14, which later peaks at 0.48. The tax multiplier is close to zero. We also find that monetary policy in Poland transmits mainly through the real sector, that is through real GDP and the real exchange rate.

JEL Classification: E52, E62, C51

Keywords: Structural vector autoregressions; monetary and fiscal policy; fiscal foresight; narrative approach.

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1. Introduction

Poland is the only country in the European Union (EU) that did not fall into recession in 2009, in the aftermath of the global financial crisis (European Commission, 2011). Also, until recently, aside from Germany, Poland has been the only country in the EU to have a constitutional fiscal policy rule. The constitutional rule sets a public debt ceiling of 60% of GDP (European Commission, 2013a). Poland has also been receiving in recent years increasing amounts of EU funds, getting the largest share of any individual country in 2011 (European Commission, 2013b) and is expected to continue receiving increasing amounts of EU funds (Polish Ministry of the Treasury, 2013). These unique features make it interesting to empirically analyze the small open economy of Poland with respect to its monetary and fiscal policies and their combined effects on the Polish economy. It is also of interest to study how the Polish economy has been responding to external shocks.

The empirical literature has mostly looked in separation either at monetary structural vector-autoregressions (SVARs), such as those assessed by Christiano *et al.* (2007), or at fiscal SVARs of the type pioneered by Blanchard and Perotti (2002).[1] We apply an SVAR that combines a monetary SVAR with a fiscal SVAR, motivated by Rossi and Zubairy (2011), who demonstrated the importance of considering monetary policy and fiscal policy shocks together. Further, Leeper *et al.* (2008) explained the role of fiscal foresight or anticipation. Unlike monetary policy measures, changes to discretionary fiscal spending or taxation involve often an implementation lag so that the new measures will not take effect in the same quarter they are legislated. If the econometrician ignores this information in a vector-autoregression (VAR), the moving average representation of the VAR becomes non-invertible and a reduced-form VAR cannot be derived. In this case, a reduced-form VAR is misspecified, if used, and the associated impulse-response functions are inconsistent. Furthermore, Leeper (1989) traced out how the econometrician might incorrectly attribute to monetary policy some of the effects of fiscal policy when fiscal policy is anticipated by the public and the econometrician ignores fiscal foresight.

[1] See also Favero (2001), who reviewed monetary SVARs.

In this paper we combine the fiscal and monetary SVAR-model with the narrative approach in order to account for the implementation lags of fiscal legislation. Thus, we align the information set of the econometrician with that of the private agents in regards to fiscal foresight. Fiscal shocks are defined as government spending shocks and government revenue shocks. We determine the implementation lags for shocks to government spending and for shocks to taxation (revenue) from official government documents. This is in contrast to Favero and Giavazzi (2012) and Mertens and Ravn (2012), among others, who considered fiscal foresight in relation to shocks to taxation (in the form of exogenous tax changes) but not fiscal foresight in relation to government spending. This is also in contrast to Ramey (2011b), among others, who considered fiscal foresight with respect to shocks to government spending (in the form of military build-ups) but not with respect to shocks to taxation.

The paper is organized as follows. We review the empirical SVARs for fiscal policy in Sections 2.1 to 2.3. In Section 2.4, we motivate combining the monetary SVAR with the fiscal SVAR for both fiscal policies (government spending and taxation) and accounting for fiscal foresight for both policies. Section 3 reviews the literature on monetary and fiscal VARs that are specific to Poland. Section 4 discusses the data used and Section 5 explains the structural identification scheme. Section 6 compares the monetary SVAR to a combined monetary and fiscal SVAR with and without fiscal foresight. Section 7 presents the empirical results for the baseline model chosen in Section 6. Section 8 carries out a sensitivity analysis and Section 9 summarizes the findings and concludes the paper.

2. A Brief Review of Some Recent Empirical Fiscal Studies and the Motivation for the Combined SVAR

First, we provide in this section a brief and selective overview of studies that used a fiscal SVAR without narrative features and did not explicitly include monetary policy in the SVAR. Next, we discuss several papers that combine the fiscal SVAR with the narrative approach. The third sub-section points to theoretical models that

emphasize the interaction between monetary and fiscal policy and the sparseness of empirical SVARs that combine monetary and fiscal policy. The last sub-section argues for an SVAR that combines monetary and fiscal policy and in addition models fiscal foresight for both government spending and taxation simultaneously in order to align the information set of the econometrician and private agents. We would like to emphasize that in this paper we do not use the narrative method to identify exogenous shocks but instead use the SVAR model for the identification of shocks after accounting for fiscal foresight based on the narrative method.

2.1 Recent Studies on the Quantitative Effects of Fiscal Policy: The SVAR Versus the Narrative Approach

Until the start of the global financial crisis in 2008, countries had relied mostly on monetary policy to stabilize their economies over the business cycle. Empirical research on macroeconomic policy reflected this emphasis by focusing on the transmission of monetary shocks to the real economy. However, when the global crisis hit, discretionary fiscal policy came into play with large stimulus measures in many countries, followed by recent fiscal consolidation in the aftermath of the European sovereign debt crisis that unfolded in 2010 and is continuing. This has brought the issue of the macroeconomic impact of fiscal policy to the forefront of the economic debate. Since then, numerous empirical studies on fiscal policy have been produced and there is an ongoing controversy over the quantitative and qualitative effects of government spending and tax changes. The issue is the size of the fiscal multipliers.

The recent literature has applied mainly two approaches to assess the quantitative effects of fiscal policy on economic activity: the narrative approach and the SVAR-based methodology.[2] These research efforts concentrated on the U.S. economy and only a few studies have looked at Central and Eastern European economies. The narrative approach has been used to identify changes in government expenditure that are not due to business cycle considerations, i.e., government expenditures that are exogenous and orthogonal to other information available at the time. Ramey and

[2]A literature review was carried out by Ramey (2011a).

Shapiro (1998) and Ramey (2011b) estimated government expenditure effects based on large U.S. military build-ups.[3] Ramey and Shapiro used one dummy variable (set to 1 in 1950Q3, 1965Q1 and 1980Q1 and to 0 otherwise; later, researchers added 2001Q3 to capture the 9/11 event). Ramey (2011b) in addition studied a narrative news variable based on expected present values of government spending caused by military events as reported in news media. On the other hand, Romer and Romer (2010) used narrative records, such as presidential speeches and Congressional reports, to document the timing of legislative changes to U.S. taxation in the post-World War II period that were not motivated by business cycle conditions. They quantified the effect of such exogenous tax changes on macroeconomic variables and calculated a tax multiplier for output of almost -3, i.e., a cut in tax revenue equivalent to 1% of output leads to an increase in output of almost 3%.

The seminal paper by Blanchard and Perotti (2002) developed an SVAR for the analysis of fiscal policy, i.e., for the analysis of the transmission mechanism of fiscal policy shocks. The appeal of this approach is that it controls for the endogenous dynamics that follow unexpected fiscal policy changes and the identifying assumptions are transparent and relatively few. Blanchard and Perotti's SVAR included three variables in natural logarithms and real per-capita terms, observed quarterly for the U.S.: government purchases of goods and services, tax revenues net of government transfers, and GDP. They used institutional features, i.e., fiscal policy does not respond to shocks that occur within the quarter when using quarterly data, and auxiliary calculations for fiscal elasticities in order to achieve identification. They estimated a tax revenue multiplier for output that peaks at -0.78 (or -1.33, depending on the specification used), i.e., a positive one dollar revenue shock leads to a fall in GDP of 78 cents. In an SVAR all variables are treated as endogenous, whereas the opposite is the case for the regressors in the narrative approach where they need to be orthogonal to the regression error term. The SVAR necessitates specifying all

[3]In a regression context this means that such narrative variables are, as long as orthogonality holds, uncorrelated with other included and other omitted regression variables and their regression coefficient estimates are unbiased. In this case, the only effect of omitted variables is to increase the residual variance. It is therefore, in principle, possible to analyze the effects of exogenous military expenditure on economic activity, such as real GDP, without specifying an economic model that includes other fiscal and monetary policy variables, and to estimate a fiscal expenditure multiplier.

dynamic interactions.

Ilzetzki *et al.* (2013) extended the SVAR model of Blanchard and Perotti to a new quarterly data set with 44 countries covering spans of about ten years. Ilzetzki *et al.* identified structural shocks by imposing contemporaneous restrictions on their effects in the form of a recursive Cholesky decomposition, following Blanchard and Perotti. Ilzetzki *et al.* pooled data into panels for various groupings: high-income versus developing countries, countries with flexible versus predetermined exchange rates, countries relatively open versus relatively closed to trade, and periods of high debt-to-GDP ratios for the various countries. A major problem with their SVAR model is that it did not include tax revenues, or any other tax variables, due to data limitations, in contrast to Blanchard and Perotti. This likely biases their empirical results because an important part of fiscal policy is ignored. Furthermore, a panel is bound to mask differences in fiscal effects across countries due to differences in tax legislation, tax compliance, the way financial markets operate in relation to government debt, welfare programs, and labor market flexibility.[4] Deviations from Ricardian equivalence may be quite different for the various countries being pooled together, leading to distinct country-specific multipliers. Finally, while the Cholesky identification scheme seems robust in various ways, it is sensitive in a statistically significant way to the ordering of the fiscal and monetary variables, as the authors (p. 246, fn. 12) acknowledged.

There are limits to how much a government can borrow relative to the size of its economy before sovereign default risk premiums matter. The framework of Blanchard and Perotti did not account for the intertemporal limits to government borrowing. Favero and Giavazzi (2007) extended the SVAR model of Blanchard and Perotti, using U.S. data, by explicitly imposing limits to government borrowing in their impulse response function analysis within the framework of the model of Blanchard and Perotti. However, Favero and Giavazzi (2007) found only minor effects, and Favero and Giavazzi (2012) found no effects when debt dynamics were included.

[4]Favero *et al.* (2011) demonstrated that fiscal multipliers vary across countries due to heterogeneity in government debt dynamics, styles of fiscal corrections and degrees of openness of the economy, using a global VAR (GVAR) with Belgium, Canada, France, Italy, Japan, Sweden, the U.K. and U.S.

Therefore, we will not include debt dynamics in our empirical model.

2.2 Controlling for Fiscal Foresight in VARs: Fiscal VARs with Narrative Measures

Leeper *et al.* (2008) criticized the omission of fiscal policy announcement effects, or fiscal foresight or anticipation.[5] In contrast to monetary policy changes, changes to discretionary fiscal spending or new tax rules and rates must first be legislated by parliament before they can take effect. In addition, once a new fiscal policy is approved, it often takes a considerable amount of time before it is implemented. News about fiscal policy taking effect at a future date will affect decisions about consumption, saving and investment ahead of the implementation date.[6] SVAR shocks that the econometrician identifies (as unpredictable) may have been predicted by the private sector because the econometrician did not account for fiscal policies that have been decided on in a previous quarter, ahead of the date when they take effect.[7]

Favero and Giavazzi (2012) included exogenous tax shocks, identified with the narrative method of Romer and Romer (2010), in a fiscal VAR. Romer and Romer categorized legislated changes in taxation as exogenous if they were motivated by concerns about long-run economic growth or about the level of government debt. They categorized changes in taxation as endogenous if they were motivated by concerns about short-run business-cycle factors. In addition, Favero and Giavazzi (2012) separated out discretionary anticipated, but not yet implemented, exogenous tax shocks (announced more than 90 days ago), following Mertens and Ravn (2012).[8]

[5]Blanchard and Perotti (2002) tried to capture implementation lags by imposing a lag of two quarters for fiscal policy to react. Along similar lines, Montford and Uhlig (2009) imposed a lag of four quarters. However, the narrative analysis by Mertens and Ravn (2012) showed that actual implementation lags for U.S. tax data are mostly longer, and some shorter, so that a single fixed lag cannot capture the implementation lag structure of fiscal policy adequately.

[6]The issue is the extent to which the present value of the stream of future government expenditure is affected and to what extent the Ricardian equivalence hypothesis holds when it comes to the way in which government expenditures are financed by either current or future taxes. Perotti (2012) discussed theoretical aspects and the role of liquidity constraints.

[7]An example is the large increase in value added tax in Germany in 2007 from 16% to 19%. It was approved by the lower house of parliament in May 2006 and by the upper house in June 2006 and took effect from January 2007. It was the largest tax increase since World War II and led to sizeable intertemporal shifts for purchasing goods and services in order to avoid higher taxes from 2007 onwards.

[8]Mertens and Ravn used a VAR with exogenous tax shocks that are anticipated and unanticipated

The VAR with U.S. data included the inflation rate, the average rate for the nominal cost of federal public debt, and in real per-capita terms and natural logarithms the following: GDP, federal government revenues and expenditures net of interest, and federal government debt held by the public. Romer and Romer (2010) used instead a single-equation regression expressing output as a linear relationship with current and past exogenous tax shocks (derived with the narrative method). Favero and Giavazzi (2012) argued that this approach produced a biased tax multiplier due to correlation of the narrative shocks with distant lags of output and tax receipts that the single-equation method does not capture. In other words, the Romer and Romer approach did not fully capture how tax shocks were transmitted to output. The advantage of Favero ad Giavazzi's combined (narrative and VAR) approach avoided the standard identification of SVAR shocks via moving-average representations of the VAR that are non-invertible when fiscal foresight is not modelled within the VAR by the econometrician. They estimated a tax multiplier not far from -1, similar to Blanchard and Perotti (2002) but very different from Romer and Romer (2010).

2.3 Combining Monetary and Fiscal Policy in an SVAR and the Role of Fiscal Foresight

A widely used empirical methodology for the analysis of how monetary policy is transmitted to other economic variables is the SVAR. Christiano *et al.* (2007) provided an assessment of SVARs, as applied to monetary transmission, favoring short-run restrictions for structural identification over long-run restrictions. In this paper, we combine monetary and fiscal policy within an SVAR and use short-run restrictions. We also account for the announcement effects of fiscal policy. Fiscal and monetary policies interact with each other and should not be studied in separation, as Rossi and Zubairy (2011) showed for the U.S. with an SVAR that combines the two.[9] In addition, Leeper (1989) showed how the econometrician might incorrectly attribute to monetary policy some of the effects of fiscal policy in the case when

(announced in the current period).

[9]An early important theoretical macroeconomic model that discussed the interdependence of monetary and fiscal policy was that of Sargent and Wallace (1981).

fiscal policy is anticipated by the public but this anticipation is not modelled. When considering the effects of fiscal policy, Davig and Leeper (2011) demonstrated in a New Keynesian dynamic stochastic general equilibrium (DSGE) model that effects differ considerably depending on whether monetary policy is active or passive, fitting a Markov-switching rule to U.S. data.

In order to model the announcement effects, or fiscal foresight, in Poland, we follow the narrative approach developed by Ramey and Shapiro (1998), Romer and Romer (2010) and Ramey (2011b) for the US. Ramey (2011b) emphasized that the standard SVAR methods identify shocks that may be anticipated and are therefore not true shocks. Ramey (2011b) argued that military spending due to wars constitutes a proper (exogenous) shock that can be used to study the effects of government spending on the economy.[10] Based on the same idea, Romer and Romer (2010) provided a narrative analysis of U.S. federal tax legislation, as described earlier.

Blanchard and Perotti's (2002) SVAR did not include channels for the transmission of monetary policy shocks that possibly interact with fiscal shocks. Rossi and Zubairy (2011) also explained how neglected monetary policy shocks could be wrongly attributed to fiscal policy shocks instead. Rossi and Zubairy combined monetary and fiscal policy in an SVAR and included dummy variables for U.S. military spending announcements from Ramey (2011b) but not for other fiscal announcements (that occurred at least one period ahead of the implementation). On the other hand, Favero and Giavazzi (2012) combined the narrative approach for tax shocks from Romer and Romer (2010) with the fiscal VAR of their earlier paper (Favero and Gizvazzi, 2007). Favero and Giavazzi (2012) did not include fiscal foresight with respect to government spending. Ramey (2011b) demonstrated that fiscal spending shocks identified in an SVAR are predicted by private professional forecasts and by narrative shocks, using U.S. data and Granger-causality tests. Therefore, she argued that residuals from SVAR regressions are anticipated by the private sector. We account for such anticipation in our SVAR.

The narrative approach has been used to identify orthogonal (exogenous) shocks to government spending and orthogonal shocks to taxes in order to derive

[10]See also Perotti (2007).

fiscal multipliers. However, such an approach is not suitable for analyzing the interaction between monetary and fiscal policies. An SVAR is suitable for this purpose. Government spending and tax announcement effects together have, to the best of our knowledge, not yet been embedded in an SVAR with monetary and fiscal policy combined.

2.4 The Empirical Model: A Combined Monetary and Fiscal Policy SVAR With Fiscal Foresight for Both Government Spending and Taxes

Mertens and Ravn (2012) used a basic VAR with real per capita U.S. GDP, private consumption expenditure and gross private investment augmented with narrative exogenous tax shocks that were unanticipated (announced in the current period) and anticipated (announced in previous periods but not yet implemented). Thus they accounted for implementation lags and anticipation horizons of changes in taxation based on the narrative approach of Romer and Romer (2010). In addition, they controlled in their VAR, in turn, for government spending shocks and monetary policy shocks. In order to bring government spending shocks into the model, they added government spending and tax revenue to the above set of endogenous VAR variables. In order to capture exogenous government spending shocks, they included in the basic VAR scaled war dummies, similar to Ramey (2011a). However, and most importantly, they did not account for fiscal foresight in relation to government spending shocks, as they (p. 170) acknowledged. This means that tax and government spending changes are not treated symmetrically. In addition, non-exogenous (discretionary) tax changes in the sense of Romer and Romer, and non-war (discretionary) government shocks have usually components that are affected by fiscal foresight as well, when they are implemented with a lag, and they are not accounted for in the VAR of Mertens and Ravn.

In this paper, we apply short-run contemporaneous restrictions for the identification of shocks in an SVAR in order to derive impulse response functions (IRFs) for a small open economy. We compare IRFs in an SVAR with and without fiscal

variables. In contrast to Rossi and Zubairy (2011), who achieved identification with a Cholesky decomposition that may be too restrictive, we use a more general structural identification scheme that is not recursive. Further, we calculate IRFs from a VMA representation that is invertible because we align the information set of the private agents with that of the econometrician by including narrative features of fiscal policy. Giannone and Reichlin (2006) suggested the inclusion of forward looking variables in order to deal with the invertibility problem. In our case, we are able to model directly the cause of this problem. We include scaled (to GDP) dummy variables for the announcements of major changes to government spending and in addition simultaneously the announcements of legislated changes to taxation in order to capture fiscal anticipation.

Discretionary fiscal policy involves two lags, a decision lag and an implementation lag. Once a shock occurs, we assume for our SVAR model that discretionary fiscal policy actions are not taken within the same quarter because it takes time to legislate fiscal changes. This is one assumption that was used by Blanchard and Perotti (2002) in order to achieve identification of fiscal shocks, along with other contemporaneous restrictions. After a discretionary fiscal policy action has been taken, the implementation may occur in the same quarter or it may occur in a future quarter. The implementation often does not happen in the same quarter when the decision is taken, and implementation may be several quarters in the future. We use scaled dummy variables in order to account for the implementation lags with the narrative method, collecting information on lags from official government records. These dummies cannot be correlated with fiscal shocks contemporaneously or in the other periods of the implementation lag. Otherwise, VAR estimates will be biased and inconsistent. There is no correlation between the dummy variable and the contemporaneous error term if discretionary fiscal decisions are taken based on shocks that happened in a previous quarter, due to the assumed decision lag. In other words, we assume that discretionary fiscal policy decisions are based on past shocks and once a policy decision is taken, it is not influenced by shocks hitting thereafter. For the implementation lags in our Polish data this is indeed the case. In summary, we model anticipated shocks (due to implementation lags) with the narrative method by includ-

ing in the SVAR the scaled dummy variables. Unanticipated shocks due to taxation and government spending changes are identified within the structural SVAR, using short-run restrictions and externally calculated automatic fiscal-effects elasticities as in Blanchard and Perotti (2002).

This is different from Favero and Giavazzi (2012) and Mertens and Ravn (2012), who included only exogenous tax change announcements from Romer and Romer (2010). This is also different from Rossi and Zubairy (2011) and the extended VAR of Mertens and Ravn (2012), who included only military expenditure announcements and did not account for fiscal foresight with respect to government expenditures in their VARs.

We model monetary policy in the form of a Taylor rule, as is generally the case in many SVARs on monetary policy transmission.[11] A short-term market-based interest rate is usually used as the rate relevant for monetary policy, such as the effective federal funds rate for studies with U.S. data. Taylor (1999) raised the issue of how fiscal policy interferes with the Taylor rule. Government borrowing can affect real interest rates and lead to crowding out effects if Ricardian equivalence does not hold. If Ricardian equivalence holds, the way government spending is financed is irrelevant and only the present value of the real government spending stream matters for private agents.[12] Some fiscal VARs, such as Favero and Giavazzi (2007, 2012), included an interest rate but as a measure of the average cost of government borrowing and not intended to capture the stance of monetary policy.[13] Other fiscal SVARs, such as Ilzetzki *et al.* (2013) did not include prices or inflation at all.

[11] See, for example, the studies in Angeloni *et al.* (2003).

[12] See, for example, Haug (1996) for mixed empirical evidence on Ricardian equivalence.

[13] They used the average cost of servicing the public debt, obtained from dividing net U.S. government interest payments by the federal government debt held by the public. Similarly, Perotti (2004) used 10-year government bond yields as the relevant interest rate.

3. The Monetary and Fiscal Transmission Mechanisms in Poland: Previous Studies

In this section we review papers which used VAR or SVAR models in order to examine the Polish monetary transmission mechanism (MTM) and the Polish fiscal transmission mechanism. We should point out that none of these studies considered the interaction between fiscal and monetary policy or fiscal foresight.

Some papers focused on the MTM in the Polish economy, whereas others have focused on the MTM in several transition economies, including Poland. Important papers concerned with the Polish economy are Wróbel and Pawłowska (2002), Łyziak *et al.* (2008), and Łyziak *et al.* (2011). The results of these studies were updated and summarized in a report on the MTM in Poland by Demchuk *et al.* (2012). Generally, it was found that the interest rate shock statistically significantly affects the consumer price index and the real economy. Also, monetary tightening caused initially Polish zloty appreciation and a subsequent depreciation.

Wróbel and Pawłowska (2002) provided one of the earliest studies for the Polish MTM. Their results indicated smaller and slower monetary transmission in Poland than in the euro zone. Łyziak *et al.* (2008) examined the credit channel operation. They obtained results that were mixed and the authors concluded that the role of the credit channel is rather weak. Łyziak *et al.* (2011) were concerned with the impact of the financial crisis on the Polish monetary transmission mechanism. They reported a significant drop in monetary policy effectiveness during the financial crisis. Also, studies showed that the speed of monetary transmission increased until the financial crisis, then decreased and currently seems to increase again. Based on previously published results, Havránek and Rusnák (2012) calculated the maximum reaction of prices in Poland to happen on average after 18.7 months or, if one omitted results with price puzzles, after 14.0 months, however, the results differ considerably across studies.

The other group of papers compared the MTM among Central and Eastern European (CEE) countries (Elbourne and de Haan, 2006; Elbourne and de Haan 2009;

and Gavin and Kemme 2009)[14] and among CEE and advanced economies (Jarociński 2010; and Anzuini and Levy, 2007). For the Polish economy all of these studies showed that an increase in the interest rate led to a decline in output and, except for Gavin and Kemme (2009), to a decline in prices as well.

Jarociński (2010) used Bayesian estimation methods and compared impulse response functions for monetary policy shocks between the CEE and Western European countries before the adoption of the euro. The impulse responses were very similar, despite differences in the development of the financial system and differences in the flexibility of prices. Anzuini and Levy (2007) also reported qualitatively very similar impulse response functions in the CEE and in Western European countries. But quantitatively the IRFs in the CEE countries were weaker than in the old EU member countries. The reported transmission for Poland was very weak.

Unlike Jarociński (2010) or Anzuini and Levy (2007), who stated that the MTM is very similar across the CEE countries, Elbourne and de Haan (2006, 2009) found that the MTM differed across the EU accession countries. Elbourne and de Haan's (2006) studied ten transition countries and reported no link between financial structure indicators and monetary policy. It implies that the differences in the MTMs were not caused by differences in the financial structure. This is opposite to Havránek and Rusnák (2012), who presented a meta-analysis of 67 published studies on monetary transmission mechanisms, and found that higher degrees of financial development corresponded to slower transmission. However, unlike Jarociński (2010), they did not take into account differences in price flexibility across countries. Further, Elbourne and de Haan (2009) showed that the identifications scheme imposed matters for the MTM between the five new EU members.

In a similar vein, Gavin and Kemme (2009) compared monetary SVAR models for individual countries and in augmented SVAR models with extraneous information from a panel of OECD countries. The impulse response functions for the augmented models seemed more precise and more consistent with the theory, depending of course on what theory is being considered. Also, Georgiadis (2012) found that individual

[14] Égert and MacDonald (2008) summarized the findings for MTMs in the CEE countries and pointed out the large heterogeneity of the results.

country-specific SVARs vary across countries in unique ways that make a comparison difficult, if not impossible. Furthermore, for non-standard panel SVARs, the asymmetries for the impulse responses across countries could be largely explained by differences in the financial structure, labor market rigidities and industry mix.

Only a few studies of fiscal policy using VAR and SVAR approaches have been conducted using data for economies of CEE countries.[15] As far as we are aware, none of these studies dealt with fiscal foresight. While specific methodological approaches differed, two general observations can be made. First, all of the studies were based on relatively short time series, spanning 8-15 years of quarterly data, as the post-transition history of CEE countries is still relatively short. Second, these countries are generally small open economies so that there are considerable leakages for domestic fiscal shocks. As a result, spending multipliers obtained in those studies are much lower than in studies based on U.S. data, such as Blanchard and Perotti (2002). The multipliers also vary considerably depending not only on the country in question, but also on the approach and sample period.

Two fiscal studies were conducted on a group of CEE economies which include Poland, Cuaresma *et al.* (2011) and Mirdala (2009). Cuaresma *et al.* (2011) extended the standard SVAR approach to include fiscal shocks from abroad. The authors found that the response of output to both foreign and domestic fiscal shocks differed among CEE countries. The responses to domestic spending shocks were found to be Keynesian in Hungary and Slovakia and non-Keynesian in the Czech Republic, Poland and Slovenia. However, the estimated absolute values of these responses were very low and did not exceed 0.04, while the peak elasticity for Poland was -0.02 after 8 quarters. According to Mirdala's (2009) results, the response of output to spending shocks also differed greatly among CEE countries - from close to zero or below zero in the Czech Republic and Hungary to around 1.8 in Romania (after 8 quarters). The peak response for Poland was found to be 0.3 after 6 quarters.

[15] See, for example, Pelinescu (2011).

4. Data

4.1 Basic Data

We use quarterly data from 1998:Q1 to 2012:Q4. Before 1998 Poland faced major structural changes associated with the process of economic transformation, which began in 1989, from a centrally planned economy to a market economy. Facing a hyperinflation, fast depreciation of the Polish zloty, the threat of recession and relatively large foreign debt, monetary policy was mainly focused on stabilizing the economy and on foreign debt restructuring. In October 1997, Poland's new Constitution came into force, providing more independence to the central bank, prohibiting debt monetization and introducing a 60% of GDP ceiling for public debt. Also, the newly created Monetary Policy Council formally introduced an inflation targeting strategy in June of 1998. Since 1998, the main aim of the National Bank of Poland has been to maintain price stability in order to provide sustainable economic growth, using direct inflation targeting accompanied by a freely floating exchange rate regime. The constitutional debt ceiling has become the primary anchor of fiscal policy. Therefore, our sample is homogenous in terms of monetary and fiscal policy regimes. In addition, the zloty exchange rate has been a floating rate over our sample period for all practical purposes. Furthermore, the choice of the sample period is based on the availability of high quality quarterly data. In particular, we use quarterly fiscal data that has not been interpolated from annual data.

Our baseline SVAR model includes the following six variables: real GDP, the inflation rate based on the consumer price index, the real effective exchange rate, the 3-month Polish money market interest rate (WIBOR), and general (central and local) government spending and revenue (including EU funding). We follow Perotti (2004) and use government consumption plus government sector gross capital formation (net of investment by government enterprises) to represent government spending. Government revenue is defined net of market output produced by government enterprises and net of transfers to households and net of subsidies to enterprises, including farmers. Excluding government enterprises is important due to ongoing privatization in Poland. This means that our measures are largely unaffected by privatization. Fur-

thermore, the relatively small number of observation in our sample dictates keeping the SVAR as small as possible. We limit the number of variables included in our SVAR model as much as possible in order to preserve degrees of freedom and keep the model as parsimonious as possible.

We analyze sensitivity of our results to different variable definitions and to including, in turn, additional variables. We replace CPI-inflation with CPI core inflation that excludes food and energy items, the 3-month WIBOR with the 1-month WIBOR and the real effective exchange rate with the nominal effective exchange rate. Further, we add to our baseline SVAR as an additional seventh endogenous variable the public debt measured using the domestic methodology that is relevant for the constitutional debt limit. Moreover, we check whether using instead public debt measured according to the European System of Accounts 1995 (ESA95) standard affects our results. In addition, we use total general government revenue from taxes plus social security contributions as an alternative measure of government revenue. Further, we add sequentially, as a seventh variable, measures of money and credit to the SVAR model: the M2 and M3 monetary aggregates, and total loans and other claims of monetary financial institution on the non-financial sector (i.e., credit). Furthermore, because Poland is a small open economy, we add to the baseline SVAR as an additional exogenous variable the real GDP in the euro area (based on 17 members with a fixed composition). We also explore instead other exogenous variables to capture foreign shocks from the rest of the world: the foreign inflation rate based on the harmonized index of consumer prices in the euro area and the 1-month money market rate in the euro area (EURIBOR).

All series, except for interest rates, are in natural logarithms. The inflation rate is the quarterly first difference of the logarithm of the consumer price index (CPI), at an annualized rate. We use seasonally adjusted data when appropriate. The GDP deflator is used to obtain real values.[16]

The data are from the National Bank of Poland's (NBP) statistics database,

[16]We do not use per-capita figures due to an inconsistency (jump) in the official population figures connected with the national census in 2011. However, using a smoothed population series, interpolated between national census dates, in order to get per-capita figures (except for dummies and exchange, inflation and interest rates) leaves all our results virtually unchanged. These results are available form the authors on request.

the Polish central statistical office, the European Central Bank (ECB), and Eurostat (see Table A1 in the Appendix for details). The exceptions are general government revenue and expenditure figures for the years 1998-2003, where we have concerns over the quality of the ESA95 fiscal data, and NBP-calculated figures were used instead extending the currently used methodology backwards in time to the start of our sample period. For research and modelling purposes, the NBP has compiled its own set of 'ESA95' data for the period 1995-2003, on the basis of domestic cash data, but with corrections made to bring it in line with an accruals approach (notably concerning the changes in the size of payment arrears). A more detailed description of the compilation exercise is published in Jędrzejowicz *et al.* (2009).

In our sample period the Polish fiscal and monetary transmission mechanisms might have been affected, first, by the Polish entry into the EU in May 2004, which may have caused some structural changes in the labor market and foreign trade, and second, by the financial crisis (see Łyziak *et al.* 2011). However, it could be argued that the EU entry of Poland was already anticipated at the start of our sample period in 1998. Also, in October 2008 the NBP introduced special policies (a so-called Confidence Package) to provide banks with liquidity during the period of high uncertainty and volatility in financial markets. Hence, we consider one dummy variable to account for the global financial crisis. We also explored an additional dummy variable for the EU entry, however, it had no noticeable effect on our results.

4.2 Construction of Elasticities and Fiscal Foresight Dummies

Identification of the structural shocks in our SVAR model is based on contemporaneous restrictions. Several of the contemporaneous relations are the elasticities for the automatic (endogenous and non-discretionary) responses of tax revenue and government spending with respect to shocks to output, inflation, the interest rate, and the exchange rate. We follow the procedures outlined in Blanchard and Perotti (2002) and Perotti (2004) and calculate quarterly elasticities, evaluated at their sample means, from OECD and European Commission tax data as provided by Girouard and André (2005) and Mourre *et al.* (2013). Girouard and André (2005) computed

elasticities for four groupings of taxes based on the Polish tax code and on the distribution of taxpayers in each tax bracket for the year 2003. We arrived at the following contemporaneous average quarterly elasticities of tax revenue with respect to real output: 1.18 for personal income tax revenue, 0.84 for social security contributions, 1.0 for corporate income tax revenue, 1.0 for indirect tax revenue, and -0.14 for automatic government transfer payments to households in the form of unemployment benefits. We aggregate these four elasticities to get an output elasticity of tax revenue (net of transfers) of 0.95, using the 2002-2011 shares in the totals taken from Mourre *et al.* (2013), and also having accounted for collection lags in corporate income taxes. This value is within the quarterly range reported by others, for example, 0.5 by Giordano *et al.* (2007) for Italy, 1.54 by Burriel *et al.* (2009) for the euro area, and 1.85 and 2.08 by Favero and Giavazzi (2012) and Blanchard and Perotti (2002) for the U.S. We calculate the other contemporaneous elasticities for government revenue and spending following the procedures in Perotti (2004): 0.9 for the inflation elasticity of revenue, -0.5 for the inflation elasticity of spending, and zero for all others.[17] Setting the other elasticities to zero follows Perotti (2004) and Favero and Giavazzi (2012) among many others.[18] In the empirical section, we will study the sensitivity of the SVAR to various alternative values for these elasticities.

We construct scaled dummy variables in order to account for the implementation lags of discretionary fiscal policy. Based on official Polish government records, we determine whether a discretionary fiscal policy action was implemented in the same quarter it was decided on or whether it was instead implemented in a future quarter. Table A2 in the Appendix gives details for the discretionary fiscal policy lags and the government documents that we used. If there is an implementation lag, we record the date of implementation and the reported amount (in Polish zloty) for the estimated impact on tax revenue or government spending. Next, we calculate the fraction of the reported amount to GDP over the implementation lag period and take this value for our scaled dummy variable for every quarter in the implementation lag period

[17]For comparison, Favero and Giavazzi (2012) reported 1.25 and -0.5 for the U.S. and Burriel *et al.* 1.14 and -0.5 for the euro area for the first two elasticities and also zero for all others.

[18]See footnote 51 (p. 47) in Perotti (2004) on setting the interest elasticity of revenue equal to zero.

and zeros otherwise. We construct four dummy variables, one for legislated personal income tax, social security tax and corporate income tax changes, one for value added and excise tax changes, one for legislated discretionary government spending changes, and one for discretionary changes to EU funding. In our baseline model, we combine the first two and the last two dummies in order to keep it as parsimonious as possible.

5. Structural Identification

The reduced-form VAR residuals are not interpretable in an economic sense, whereas the unobserved structural-form shocks have an economic interpretation. In order to achieve identification of the structural shocks from the estimated variance-covariance matrix of the reduced-form residuals, we impose contemporaneous (short-run) restrictions. When we impose such a restriction, the response of a variable to a structural shock is restricted to zero only within the current quarter t, leaving the responses in all later quarters unrestricted. Consider a structural vector autoregression of the following form, ignoring dummy variables for convenience:

$$\mathbf{A}\mathbf{y}_t = \beta + \mathbf{B}_1\mathbf{y}_{t-1} + \ldots + \mathbf{B}_p\mathbf{y}_{t-p} + \mathbf{B}\mathbf{u}_t,$$

where $\mathbf{y}_t$ is an $n \times 1$ vector of macroeconomic variables at time t; β is an $n \times 1$ vector of constants; $\mathbf{A}$ and $\mathbf{B}_\ell$ are each an $n \times n$ matrix of parameters for $\ell = 1, \ldots, p$; and $\mathbf{u}_t$ is an $n \times 1$ vector of structural shocks with $\mathbf{u}_t \sim \mathrm{N}(0,\ \mathbf{B}E(\mathbf{u_t}\mathbf{u_t'})\mathbf{B}')$. Our baseline model consists of the following variables, as described in the data section: real GDP (denoted *gdp*), inflation (π), the interest (i), the real effective exchange rate (*reer*), general government expenditure (*exp*) and government tax revenue (*rev*). All variables are in natural logarithms, except for the inflation and interest rates.[19] The reduced-form equation is given by

$$\mathbf{y}_t = \mathbf{A}^{-1}\beta + \mathbf{A}^{-1}\mathbf{B}_1\mathbf{y}_{t-1} + \ldots + \mathbf{A}^{-1}\mathbf{B}_p\mathbf{y}_{t-p} + \mathbf{A}^{-1}\mathbf{B}\mathbf{u}_t$$

[19] In addition, the baseline model includes a dummy variable for the global financial crisis, with values of one from 2008Q4 onwards and zeros otherwise.

or, equivalently,

$$\mathbf{y}_t = \alpha + \mathbf{A}_1\mathbf{y}_{t-1} + \ldots + \mathbf{A}_p\mathbf{y}_{t-p} + \mathbf{e}_t$$

with $\mathbf{A}_\ell = \mathbf{A}^{-1}\mathbf{B}_\ell$, $\mathbf{e}_t = \mathbf{A}^{-1}\mathbf{B}\mathbf{u}_t$ and $E(\mathbf{e_t}\mathbf{e_t'}) = \mathbf{A}^{-1}\mathbf{B}E(\mathbf{u_t}\mathbf{u_t'})\mathbf{B}'\mathbf{A}'^{-1}$. In order to achieve identification of the structural parameters, we impose the following contemporaneous zero-value restrictions for $\mathbf{A}\mathbf{e}_t = \mathbf{B}\mathbf{u}_t$:

$$\begin{bmatrix} \mathrm{a}_{11} & 0 & 0 & 0 & \mathrm{a}_{15} & \mathrm{a}_{16} \\ \mathrm{a}_{21} & \mathrm{a}_{22} & 0 & 0 & \mathrm{a}_{25} & \mathrm{a}_{26} \\ \mathrm{a}_{31} & \mathrm{a}_{32} & \mathrm{a}_{33} & 0 & \mathrm{a}_{35} & \mathrm{a}_{36} \\ \mathrm{a}_{41} & \mathrm{a}_{42} & \mathrm{a}_{43} & \mathrm{a}_{44} & \mathrm{a}_{45} & \mathrm{a}_{46} \\ \mathrm{a}_{exp,gdp} & \mathrm{a}_{exp,\pi} & \mathrm{a}_{exp,i} & \mathrm{a}_{exp,reer} & \mathrm{a}_{55} & 0 \\ \mathrm{a}_{rev,gdp} & \mathrm{a}_{rev,\pi} & \mathrm{a}_{rev,i} & \mathrm{a}_{rev,reer} & 0 & \mathrm{a}_{66} \end{bmatrix} \begin{bmatrix} e_t^{gdp} \\ e_t^{\pi} \\ e_t^{i} \\ e_t^{reer} \\ e_t^{exp} \\ e_t^{rev} \end{bmatrix} =$$

$$\begin{bmatrix} \mathrm{b}_{11} & 0 & 0 & 0 & 0 & 0 \\ 0 & \mathrm{b}_{22} & 0 & 0 & 0 & 0 \\ 0 & 0 & \mathrm{b}_{33} & 0 & 0 & 0 \\ 0 & 0 & 0 & \mathrm{b}_{44} & 0 & 0 \\ 0 & 0 & 0 & 0 & \mathrm{b}_{55} & \mathrm{b}_{56} \\ 0 & 0 & 0 & 0 & \mathrm{b}_{65} & \mathrm{b}_{66} \end{bmatrix} \begin{bmatrix} u_t^{gdp} \\ u_t^{\pi} \\ u_t^{i} \\ u_t^{reer} \\ u_t^{exp} \\ u_t^{rev} \end{bmatrix}$$

The restrictions of zeroes in the first four rows and columns of $\mathbf{A}$ and $\mathbf{B}$ are standard ones in the literature on monetary SVARs (see, Angeloni *et al.* 2003, and, e.g., Haug and Smith, 2012). Additional restrictions are required. The diagonal elements of the matrix $\mathbf{A}$ are usually set to 1 in the literature, which we do as well. Furthermore, the $\mathrm{a}_{exp,\,j}$ and $\mathrm{a}_{rev,\,j}$ (for $j = gdp, \pi, i$ and $reer$) are the various elasticities of government spending and revenue. We use the procedure pioneered by Blanchard and Perotti (2002), and followed by many others, and impose the values for these elasticities as presented in our data section: $\mathrm{a}_{exp,gdp} = 0$, $\mathrm{a}_{exp,\pi} = -0.5$, $\mathrm{a}_{exp,i} = 0$, $\mathrm{a}_{exp,reer} = 0$, $\mathrm{a}_{rev,gdp} = 0.95$, $\mathrm{a}_{rev,\pi} = 0.9$, $\mathrm{a}_{rev,i} = 0$ and $\mathrm{a}_{rev,reer} = 0$. Also, we set $b_{56} = 0$, however, imposing instead $b_{65} = 0$, and not restricting b_{56}, does not materially affect the results, which is what other researchers have found as well (e.g., Favero and Giavazzi, 2012). The parameters in $\mathbf{A}$ and $\mathbf{B}$ are estimated by maximum likelihood.

6. Specification of the Baseline SVAR: A Monetary SVAR or a Monetary and Fiscal SVAR With or Without Fiscal Foresight?

We fit a reduced-form VAR to the data for three different models: (1) a monetary SVAR with real GDP, inflation, and the interest and exchange rates; (2) a combined monetary and fiscal SVAR without fiscal foresight, where we add to the monetary SVAR government expenditure and revenue as additional endogenous variables; and (3) a combined monetary and fiscal SVAR with fiscal foresight that includes in addition to model (2) the two dummy variables to account for implementation lags of discretionary fiscal policy. We use the Schwarz information criterion and Lagrange Multiplier tests for serial correlation in the VAR residuals in order to determine the VAR lag length. We consider up to four lags and find that one lag is chosen by the Schwarz criterion for all three models. One lag also leads to no serial correlation in the VAR residuals in all three cases. All models include a dummy variable for the global financial crisis.

We start with the largest model (3). In order to assess whether the dummy variables that capture fiscal foresight in the combined monetary and fiscal SVAR are necessary, we run the VAR for model (3) with and without them and calculate a likelihood ratio test statistic with a p-value of 0.94. We therefore cannot reject the null hypothesis that the coefficients of the fiscal foresight dummies are zero in the VAR. In addition, we compare the VAR with and without fiscal foresight using Akaike's and Schwarz's information criteria and both clearly favor the combined monetary and fiscal model (2) without fiscal foresight dummies over model (3) that includes the fiscal foresight dummies. Furthermore, we calculate the IRFs and the fiscal multipliers for models (2) and (3) in the same way as explained in the following Section 7 for the chosen baseline model. We find that the IRFs and the expenditure and revenue multipliers are essentially the same for models (2) and (3). In order to assess whether the differences are statistically significantly different from zero, we calculate Wald tests for every horizon considered for the fiscal IRFs and the fiscal multipliers (detailed

results are available form the authors on request). We find that neither the IRF nor the multiplier differences are significantly different from zero. This means that the fiscal implementation lags present in our sample have no significant effects on the intertemporal decisions of households and firms. The fiscal foresight dummies can therefore be ignored in our Polish SVAR. In light of the recent debate about the role of fiscal foresight, this is an important finding.

We turn now to the question of whether monetary and fiscal policies can be studied in separate SVARs. Again, we calculate a likelihood ratio test for the null hypothesis, model (1), of a monetary VAR against the alternative hypothesis, model (2), of a combined monetary and fiscal VAR without fiscal foresight. It produces a large test statistic value with a p-value below 0.0001 and we reject the hypothesis that the fiscal variables are not relevant for the VAR specification. Also, the Akaike and Schwarz criteria unquestionably choose model (2) over model (1). Moreover, using the monetary SVAR in model (1) leads to changes in the impulse response functions that are very noticeable when compared to those from model (2). We use for the SVAR in model (1) a recursive identification scheme as implied by the matrix $\mathbf{A}$ when the fiscal variables are purged from the system. The impulse paths and confidence bands change in several cases statistically significantly. This shows that monetary shocks should not be analyzed without accounting for the fiscal sector of the economy. Therefore, we will use model (2) as our baseline SVAR.[20]

7. Empirical Results for the Baseline SVAR

The baseline six-variable SVAR combines monetary and fiscal policy and includes a dummy variable for the global financial crisis but does not include dummies for fiscal foresight for the reasons explained in the previous section. As is quite common in the monetary VAR impulse response function literature, we do not impose unit roots and cointegration on the baseline VAR.[21] We justify a levels specifica-

[20]The dummy variable for the global financial crisis enters the baseline VAR statistically significantly with a p-value of 0.004 for the likelihood ratio test.

[21]Standard tests show strong evidence in favor of unit roots and cointegration. Also, the VAR specification with one lag produces stable VAR roots. We find no empirical evidence for deterministic time trends in the variables. Details are available on request from the authors.

tion based on the Monte Carlo results of Lin and Tsay (1996), among others. They demonstrated that it is preferable not to impose cointegration when the true number of cointegrating vectors is unknown. Sims *et al.* (1990) showed that consistent parameter estimates can be obtained by applying least squares to levels VARs, even when unit roots and cointegration are ignored.[22] Furthermore, to ensure the robustness of our results, we investigate in the Section 8 whether they are sensitive to the inclusion of additional variables in the VAR.

Figure 1 reports the impulse response functions for the structural shocks for our baseline model. Each shock is the size of one standard deviation and the confidence bands in the graphs are two standard errors wide, in other words they are approximately 95% confidence bands. We explain the graphs going column by column, moving from the top to the bottom of each column. The first column shows the reaction of the variables to a positive shock to the log of real GDP. A GDP-shock is not very persistent and the response of GDP becomes statistically insignificantly different from zero after the first 5 quarters. The effect drops down to basically zero 7 quarters after the impact. A positive GDP shock has no statistically significant effect on the inflation rate. The interest rate effect is positive on impact of the GDP shock, followed by a slight increase before falling slowly, reaching zero after some 8 quarters. The effect becomes insignificant from the third quarter onwards. This indicates that the central bank, if one assumes it follows a Taylor-type monetary policy rule, effectively deals with GDP-shocks in regards to the inflation target and any effect of the GDP-shock on inflation is insignificant. In addition, the real effective exchange rate (reer) appreciates markedly. It increases after the impact and peaks after 5 quarters, then tapers off, falling to zero after some 12 quarters. The effects are significant from 3 to 7 quarters after the impact. The GDP shock has no statistically significant effects on government spending and tax revenue.

A positive inflation shock has no significant effects on real GDP. It does not

[22] On the other hand, a VAR specified in first differences assumes that variables are not cointegrated because no error-correction terms are included. If there is cointegration, then such a model is misspecified. Also, Phillips (1998) proved that in the longer run impulse responses do not converge to their true values with a probability of one when unit roots or near-unit roots are present and the lead time of the impulse response function is a fixed fraction of the sample size. Therefore, we focus on the short to medium run only.

show persistence and dissipates rather fast within the first quarter, from whereon it is not statistically significantly different from zero. Its impact on the interest rate is not statistically significant, which may well be due to the credibility of Polish monetary policy with respect to inflation targeting. The real exchange rate is pushed up on impact, peaks in quarter 2 and then tapers off. This effect becomes insignificant from the fourth quarter onwards. The inflation shock has on impact a positive effect on expenditure that decreases quickly and becomes insignificant already in the second quarter. The impact on tax revenue is negative. It becomes statistically insignificant 3 quarters later.

An unexpected increase in the interest rate, say as part of a surprise monetary policy move by the central bank, has a negative effect on real GDP that is significant for more than 12 quarters.[23] We calculate that the peak effect in the 12^{th} quarter is a 0.72% drop in real GDP for every 1% increase in the interest rate. On the other hand, the interest rate shock has no significant effects on inflation. The interest rate shock itself dissipated, becoming insignificantly different from zero 6 quarters after the impact. While the interest rate shock has little effect on inflation itself, it affects the Polish economy instead via the exchange rate, which appreciates statistically significantly from 2 to 6 quarters after the impact. The effects on government expenditure and revenue are both insignificant.

A positive innovation to the real exchange rate, which captures shocks originating in other economies like the euro area, has no significant effects on Polish real GDP. This indicates that the Polish economy is quite immune to external shocks, as was the case during the recent global recession, so that this result is not that surprising. The exchange rate shock negatively affects the inflation rate and the interest rate, first smoothly strengthening slightly and then tapering off to zero. The effects become statistically insignificant after the first 3 quarters in the first case and are significant from 3 to 6 quarters after the impact in the second case. The negative effect on the inflation rate indicates a decrease in import prices after the exchange rate appreciation, which is in accordance with other studies (see Demchuk *et al.*, 2012).

[23] See also Demchuk *et al.* (2012) for a similar result where the effect is significant for some 11 quarters.

The exchange rate shock itself dissipates and becomes insignificant 3 quarters after the impact. Government spending increases significantly for the first 2 quarters after the impact. On the other hand, government revenue is not affected in a statistically significant way.

We now turn to the impulse responses for fiscal shocks and to the fiscal multipliers (see Table 1). A government spending shock has a positive and statistically significant effect on real output over the whole horizon considered, except for quarter 2 when it is not statistically significantly different from zero. The effect on impact is rather small with a 1 zloty increase in real government spending leading only to a 0.14 zloty increase in real GDP, i.e., the government spending multiplier on impact is 0.14. The multiplier increases to 0.24 after 4 quarters, 0.42 after 8 quarters and 0.48 after 12 quarters, which is its peak value. After quarter 12 it tapers off. Government spending appears to be crowded out by private spending on consumption, investment and net exports. Ilzetzki (2011) reported similarly small magnitudes for government expenditure multipliers in developing countries. The effect of the spending shock on other variables is quite small and not or close to not being statistically significant. Two exceptions are that inflation is affected significantly negatively within the first quarter only and the interest rate for the first 5 quarters. One would have expected interest rates to increase due to additional government borrowing, however, the spending shock is only transitory, being significantly different from zero for just 2 quarters. Also, we include funding from the EU in our definition of government spending, which could cause a fall in interest rates due to less than expected government borrowing if it substitutes for domestically financed government spending.

Table 1: Fiscal Multiplier Values

	Quarters						
	1	4	6	8	10	12	peak (quarter)
government spending	0.14*	0.24*	0.34*	0.42*	0.46*	0.48*	0.48* (12)
tax revenue	0.09*	0.14*	0.15*	0.15*	0.14*	0.12	0.15* (6)

Note: Significance at the 5% level is indicated by *.

The impulse effects of a positive government revenue shock on the other variables in the model are mostly small and not statistically significantly different from zero. The exceptions are the effects on real output, inflation and expenditure. In-

flation increases significantly within the first quarter only and expenditure increases significantly for first 7 quarters after the impact. The effect on output is statistically significant for the first 11 quarters after the impact of the shock. The revenue multiplier is quite small with a value of 0.09 on impact, so that a revenue increase of 1 zloty increases real GDP by 0.09 zloty at the time the shock occurs. The peak effect occurs after 6 quarters with a value of only 0.15. One would have expected that a positive revenue shock leads to a negative effect on GDP. The positive effect, though very small in magnitude, is likely due to changes in the tax structure in our sample period. Income taxes and social security contributions were generally lowered whereas value added and excise taxes were generally increased, often at the same time, so that the overall tax mix changed. A net tax increase, leading to an increase in government revenue, with such a change in the tax structure, may not have the usual negative effects on output that one would expect. However, it needs to be emphasized that the magnitude of the effects is rather small.[24] Furthermore, Giordano *et al.* (2007) as well found for Italy positive and significant responses of real GDP to a positive revenue shock. Similarly, Mirdala (2009) presented positive revenue multipliers for six CEE countries that are significant in some cases. Also, Ilzetzki (2011) reported "virtually zero" tax multipliers for most groupings of countries that he considered in his study (with the exception of developing countries).

Previous studies for the Polish MTM usually concentrated on the monetary policy impulse and reported only these IRFs. As we mentioned before in Section 3, these studies commonly found that monetary tightening leads to a decline in output and prices.[25] We confirm these findings for output, but not for prices. It is worth noting that the reported transmission was often very weak, as in Anzuini and Levy (2007) and Georgiadis (2012) and/or statistically insignificant (Łyziak *et al.*, 2008).[26]

[24] Other explanations are possible. One is that a tax cut increases tax revenue and not decreases it because of a Laffer-curve effect. However, we think that this is unlikely to be the case for Poland. Another explanation is that the fiscal elasticities that we impose for identification do not capture fully cyclical (automatic) movements in tax revenue associated with asset and commodity price swings. The estimated multiplier would then pick up some of these cyclical effects that increase revenue as output goes up.

[25] Exceptions are Gavin and Kemme (2009), who found an increase in prices, and Elbourne and de Haan (2009), who found no effect on output and prices using a Cholesky decomposition.

[26] The IRFs in Łyziak *et al.* (2008) were mostly not statistically significant and Łyziak *et al.* (2011) did not show the confidence bands.

As far as the fiscal transmission mechanism is concerned, our results are qualitatively similar to those of Mirdala (2009). Meanwhile, Cuaresma *et al.* (2011) obtained a negative (and insignificant) impact of spending shocks on GDP in Poland. But they used a very different specification, which also included foreign fiscal shocks. In comparison to Blanchard and Perotti (2002) and numerous other studies with U.S. data, we find much smaller government expenditure multipliers and in absolute terms also considerably smaller tax multipliers.

8. Robustness Analysis

In order to explore the robustness of our results we consider various alternative variable definitions, add additional endogenous and exogenous variables to the SVAR model, and change the structural identification scheme. We replace the CPI-based inflation with core inflation, the 3-month WIBOR interest rate with the 1-month WIBOR, the real effective exchange rate with the nominal one, and general government revenue as defined previously in the data section with general government revenue from two sources only, namely taxes and social security contributions. All of these changes have only very minor effects on the magnitudes of the impulse responses and the confidence bands, in particular, the fiscal multipliers for output are essentially the same.

We add sequentially additional endogenous variables to the SVAR: public debt (using the domestic and the ESA95 definitions), M2, M3, and domestic credit. We assume that the additional fiscal elasticities in rows 6 and 7 of the new matrix $\mathbf{A}$ (for seven variables) are zero. The first five elements of columns 6 and 7 in $\mathbf{A}$ are all unrestricted. The sub-matrix bordered by the first 5 rows and and first 5 columns of the new $\mathbf{A}$ matrix has a recursive structure. We insert the debt variable as the fourth variable in the vector $\mathbf{y}_t$, after the interest rate. The money and credit variables are placed third, after inflation. Again, we observe overall little change in the impulse responses when we add the endogenous variables one at a time. The expenditure and tax revenue multipliers for output are basically the same, except for the following: the inclusion of public debt (either version) causes the government expenditure

multipliers for output to become insignificantly different from zero at most horizons, though these are all borderline cases. Otherwise, as far as the results for adding endogenous variables are concerned, adding credit to the SVAR shows that credit increases significantly in response to a positive exchange rate or revenue shock.

Next, we add exogenous variables form the euro area to the SVAR. We add in turn the euro area GDP, the euro-area inflation rate based on the harmonized index of consumer prices and the 1-month EURIBOR interest rate. Only the euro inflation rate leads to a few noticeable changes. First, the expenditure multiplier peaks at 0.32 and not at 0.48 as in the baseline model, though the timing of the peak is the same. Second, the revenue multipliers is essentially the same (0.16 versus previously 0.15), peaking again in quarter 6, however, the multiplier becomes now insignificant earlier, after 8 quarters. Third, the significant effect of an interest rate shock on real GDP is shortened to 9 quarters.

Last, we impose various alternative values for the fiscal elasticities. We impose -0.1 and -0.9 instead of -0.5 for the inflation elasticity of government expenditure, 0.5 and 1.5 instead of 0.95 for the output elasticity of tax revenue, and 0 and 1 instead of 0.9 for the inflation elasticity of revenue. The impulses and confidence bands are largely the same for these values. The fiscal multipliers stay essentially the same as well. None of the changes are statistically significant.

9. Conclusion

This paper contributes to the empirical SVAR literature by combining monetary and fiscal policy in an SVAR that accounts for fiscal foresight for both discretionary government spending and taxation policies. The narrative approach was used in order to account for the implementation lags of all major changes in government spending and tax legislation in Poland. The Polish economy has fared comparatively well during the global financial crisis, especially among the Central and Eastern European transition economies, and it is therefore of particular interest to study its monetary and fiscal policies in some detail.

The impulse responses to an interest rate shock indicated that Polish mone-

tary transmission works through the real sector by affecting real GDP and the real exchange rate. Polish monetary policy has been effective in neutralizing the effects of shocks that affect the inflation rate. Also, the negative effect of an interest rate shock on real GDP is very similar in duration to that found by Demchuk *et al.* (2012) in a monetary SVAR.

The government expenditure multiplier turned out to be relatively small. It is only 0.14 on impact and reaches a maximum of 0.48 (12 quarters after the impact). The government revenue multiplier is even smaller, with a value of just 0.09 on impact and peaking at a value of 0.15 (6 quarters after the impact). Even though it is very small in magnitude, one would expect the revenue multiplier to be negative and not positive. In other words, a positive shock to revenue would usually have a negative effect on real GDP. However, it is possible that the change of the tax structure over our sample period has lead to this result. Tax increases for consumption were combined with tax cuts for income, so that despite an increase in tax revenue the effect on real GDP turns out to be positive. It would be worthwhile to explore this issue further in future research, possibly using a micro-econometric analysis.

One surprising result is the role of fiscal foresight in our SVAR. When we deleted the scaled dummy variables that measure the length and magnitude of the implementation lags of discretionary taxation and government spending, there was no statistically significant effect on the impulse responses or fiscal multipliers. This finding runs counter to the arguments provided in Leeper *et al.* (2008).

Our sensitivity analysis showed that the results are quite robust to various changes in specification of the SVAR. In addition, we explored the role of fiscal variables when they are deleted from a combined monetary and fiscal SVAR, i.e., when a standard monetary SVAR is used instead. We find that the deletion has a statistically significant influence on the monetary impulse responses. Therefore, monetary and fiscal shocks interact with each other and should not be studied in separate SVAR models. This result confirms the findings in Rossi and Zubairy (2011), who used U.S. data.

One limitation of our study is that data are available for a relatively short sample period only and some caution with the interpretation of our results is therefore

indicated. We did not explore the reaction to shocks for components of GDP, like consumption, private investment, government investment and net exports, or for the role of EU funding, because it would have considerably decreased the degrees of freedom for our SVAR estimations. It is hoped that such research will be carried out in the future as more data become available over time.

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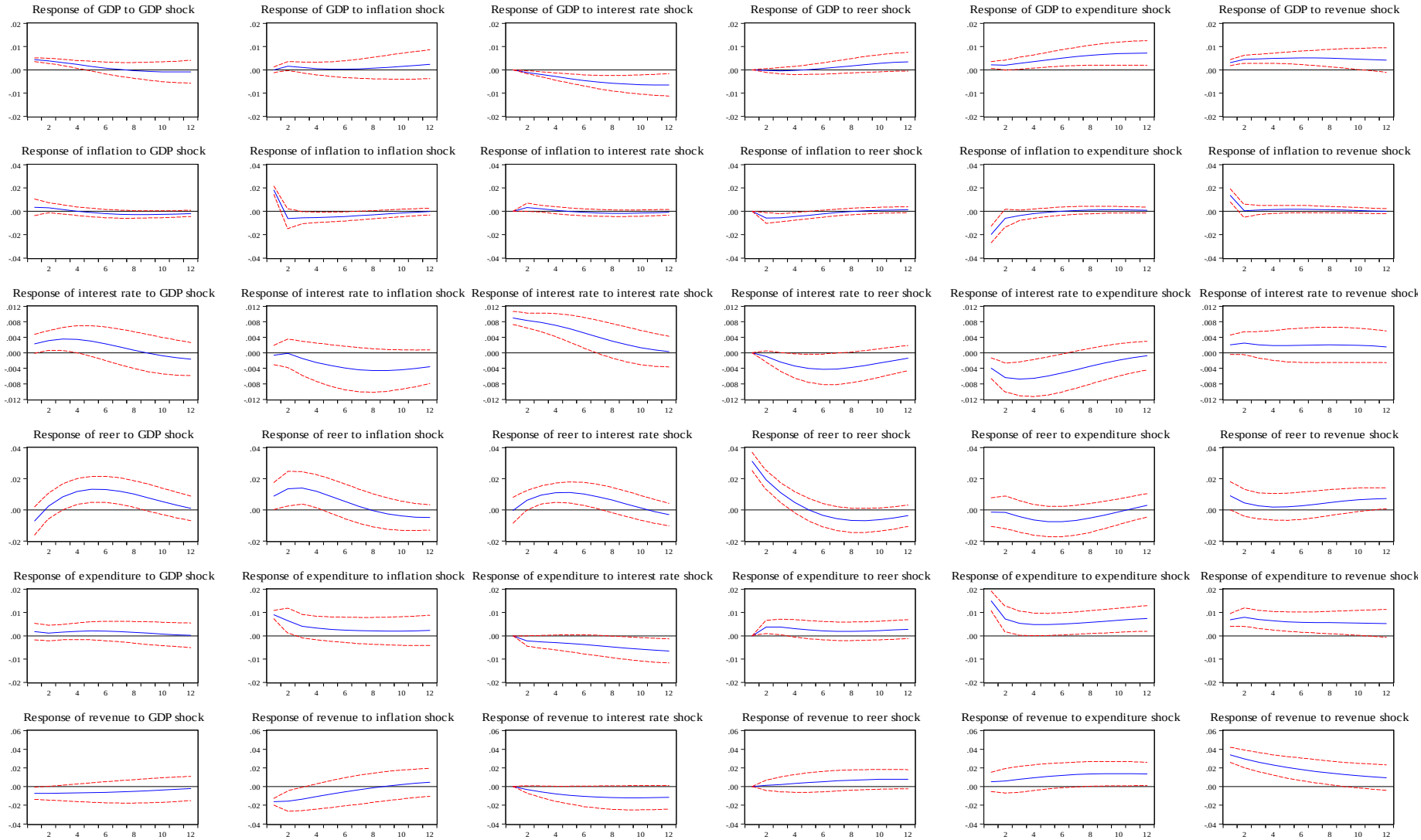
Figure 1. Impulse Responses to One Standard Deviation Structural Shocks With Two Standard Error Confidence Bands



Appendix

Table A1. Description of Basic Data

Variable	Description	Source
CPI	consumer price index for Poland, an average of monthly consumer price indices	GUS[a]
Credit	total monetary financial institution (MFI) loans and other claims on the non-financial sector in Poland, an average of monthly data, in millions of national currency	NBP data[b]
GDP	real GDP in Poland, in millions of national currency, chain-linked volumes, reference year 2000, seasonally adjusted and adjusted by working days	Eurostat
GDP-deflator	price index for Poland, based on national currency, reference year 2000, seasonally adjusted and adjusted by working days	Eurostat
Government consumption and government cross capital formation	total general (central and local) government consumption plus gross capital formation (ESA95), in millions of national currency	Eurostat (for years 2004-2012); NBP compilation (for years 1998-2003)
Government revenue net of government market output	total revenue of general government net of payments for market output (ESA95), in millions of national currency	Eurostat (for years 2004-2012); NBP compilation (for years 1998-2003)
Government revenue from taxes and social security contributions	total revenue of general government from taxes and social security contributions (ESA95), in millions of national currency	Eurostat (for years 2004-2012); NBP compilation (for years 1998-2003)
Government transfers and subsidies	social transfers to households and subsidies to enterprises, including farmers (ESA95), in millions of national currency	Eurostat (for years 2004-2012); NBP compilation (for years 1998-2003)
M2	M2 monetary aggregate for Poland, an average constructed from monthly data, in millions of national currency	NBP data[c]
M3	M3 monetary aggregate for Poland, an average constructed from monthly data, in millions of national currency	NBP data[c]
NEER	nominal effective exchange rate for Poland, reference year 1995	NBP statistics (code: 7958)
Population	Polish population, in millions	NBP interpolation between census dates
Public debt (domestic definition)	national public debt (*państwowy dług publiczny*), of the public financial sector, as defined in the Public Finance Act, in millions of national currency	Ministry of Finance
Public debt (ESA95)	gross liabilities of the general government (ESA95), in millions of national currency	Eurostat
REER	real effective exchange rate for Poland, deflated by the CPI, reference year 1995	NBP statistics (code: 7956)
WIBOR_1M	1-month Polish money market rate, an average of daily data	NBP statistics (code: 663)
WIBOR_3M	3-month Polish money market rate, an average of daily data	NBP statistics (code: 667)
EURIBOR_1M	1-month money market rate in the euro area	ECB statistics (Reuters)
Euro area population (17 members, fixed composition)	annual population figures; rates of change over each year apportioned equally to every quarter of a given year in order to arrive at quarterly figures (authors' calculations)	Eurostat
GDP in euro area	real GDP in the euro area, 17 members fixed composition, in millions of national currency, chain-linked volumes, reference year 2000, seasonally adjusted and adjusted by working days	Eurostat
HICP in euro area	harmonized index of consumer prices for the euro area, reference year 2005, an average of monthly HICP indices	Eurostat

Notes:
[a] GUS denotes the central statistical office in Poland, see http://www.stat.gov.pl/gus/5840_1636_ENG_HTML.htm
[b] http://www.nbp.pl/en/statystyka/czasowe_dwn/nalez_zobow_mif_en.zip
[c] http://www.nbp.pl/en/statystyka/m3/podaz_bilansowa_en.xls

Table A2. Major Fiscal Measures

Measure	Date announced	Date of impact	Reference
Government revenue			
Reduction in corporate income tax rate from 34% to 30%	1999Q3	2000Q1	Law proposal on *Amending the Corporate Income Tax Act* (Dz.U. Nr 95, poz. 1101) (druk sejmowy nr 1499) http://orka.sejm.gov.pl/proc3.nsf/opisy/1499.htm
Increase in excise taxes (on tobacco and fuel)	2000Q3	2001Q1	Draft 2001 budget law http://orka.sejm.gov.pl/proc3.nsf/opisy/2371.htm
Introduction of excise tax on electricity	2001Q4	2002Q2	Law Proposal on *Amending the Value Added Tax and Excise Duty Act* (Dz.U. Nr 19, poz. 185) (druk sejmowy nr 156) http://orka.sejm.gov.pl/proc4.nsf/opisy/156.htm
Reduction of corporate income tax rate from 27% to 19% and introduction of flat 19% personal income tax rate for self-employed	2003Q3	2004Q1	Law Proposal on *Amending the Corporate Income Tax Act and Some Other Acts* (Dz.U. Nr 202, poz. 1957; druk sejmowy nr 1852; http://orka.sejm.gov.pl/proc4.nsf/opisy/1852.htm)
A cut in social contributions legislated; first announced in 2006 but formal legislation postponed to spring 2007; entering into effect in two stages	2006Q2	2007Q3; 2008Q1	Law Proposal on *Amending the Social Security System Act and Some Other Acts* (Dz.U. Nr 115, poz. 792) (nr druku sejmowego 1725) (http://orka.sejm.gov.pl/Druki5ka.nsf/wgdruku/1725)
Introduction of a child tax credit	2007Q3	2008Q1	Law Proposal on *Amending the Personal Income Tax Act and Selected Other Acts* http://orka.sejm.gov.pl/Druki5ka.nsf/wgdruku/2011
A cut in personal income taxes from 19% - 30% - 40% to 18% - 32%	2006Q4	2009Q1	Law Proposal *on Amending the Personal Income Tax Act and Selected Other Acts* http://isap.sejm.gov.pl/DetailsServlet?id=WDU20062171588
Increase in VAT rates (from 7% to 8% and 22% to 23%)	2010Q3	2011Q1	Law proposal on *Amending Certain Acts with Regards to the Budget Act* (Dz.U. 2010 nr 238 poz. 1578) (nr druku sejmowego 3430) http://orka.sejm.gov.pl/Druki6ka.nsf/wgdruku/3430
Government expenditure			
Introduction of a temporary expenditure rule constraining the growth of public consumption; entering into effect in two stages	2010Q3	2011Q1; 2012Q1	Law Proposal on Amending the Public Finance Act and Selected Other Acts http://orka.sejm.gov.pl/proc6.nsf/opisy/3576.htm
Increases in public investment related to EU funds – starting from 2006; each year until 2011 public investment has been rising in relation to GDP; two funding announcements	2002Q4 2005Q4	2006Q1 2009Q1	Conclusions of the European Council meeting in Copenhagen on December 12-13, 2002 (http://www.consilium.europa.eu/ueDocs/cms_Data/docs/pressData/en/ec/73842.pdf); Conclusions of the European Council meeting in Brussels on December 15-16, 2005 (http://www.consilium.europa.eu/ueDocs/cms_Data/docs/pressData/en/misc/87677.pdf)