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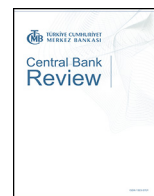
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Interaction of monetary and fiscal policies in Turkey[☆]

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ABSTRACT

This paper aims to investigate the interaction between monetary and fiscal policies in Turkey. For this purpose, a Bayesian Structural Vector Autoregression (SVAR) model with sign and zero restrictions is used. We particularly focus on how the fiscal and monetary policy variables respond to various macroeconomic shocks and whether the type of shocks matters. Our results confirm the importance of nature of shocks in terms of interaction between monetary and fiscal policies with the finding that both policy shocks are complementary in response to demand and supply shocks while they are substitute in response to shocks caused by the each other. Our main findings are robust to alternative variable definitions and identifying restrictions.

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1. Introduction

Monetary and fiscal policies are conducted by different public authorities which may have different objectives and concentrate on different aspects of providing macroeconomic stability. While monetary policy is mainly responsible for price stability, fiscal policy deals primarily with debt stabilization as well as output stabilization. As fiscal and monetary authorities conduct their policies according to their goals, these policies sometimes counteracts depending on the state of the economy and their priorities. Macroeconomic effects of each policy are affected by this interaction. Therefore, the interaction between monetary and fiscal policies plays a vital role in understanding and managing macroeconomic policies. Hence, examining this interaction has gained great interest for public authorities as well as academic pundits. This kind of policy analysis is important not only for advanced economies but also for emerging markets.

The purpose of this paper is to answer some questions about interaction of fiscal and monetary policy and effects of this interaction on macroeconomic variables in Turkey, which constitute an interesting case for this interaction.² These questions can be listed as follows: What are the effects of fiscal and monetary policy shocks on macro variables? How does the shock on non-policy variables (inflation and output) affect monetary and fiscal variables? How do policy variables affect each other? For example, how do fiscal instruments react to interest rate shock? How does monetary policy respond to fiscal shocks? Are these two shocks complementary (e.g. a tight monetary policy concurs with tight fiscal policy) or substitutes (e.g. a tight monetary policy coincides with loose fiscal policy)?

In order to answer these questions, it is a good starting point to identify the shocks, which constitutes an important part of the estimation process in a VAR analysis. In the VAR context, there are

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² Turkish economy, as an emerging market economy, provides a rich economic environment to study fiscal and monetary policy interaction between monetary and fiscal policies. Financial crisis occurred in February 2001 in Turkey leads to high inflation with a serious recession along with high level of government debt and budget deficit. After the 2001 financial crisis a new monetary (inflation targeting with floating exchange rate regime) and fiscal policy frameworks were implemented. With the help of sound and coordinated fiscal and monetary policies, Turkey achieved to decrease inflation rate from two-digit numbers to single-digit numbers and to reduce budget deficit to GDP ratio, debt to GDP ratio and provide sustainable growth levels.

different ways to identify fiscal policy shocks. While recursive (Cholesky ordering, see [Fatas and Mihov \(2001\)](#)) and [Blanchard and Perotti \(2002\)](#)'s SVAR approaches impose short run restrictions on model parameters, [Mountford and Uhlig \(2009\)](#)'s sign restriction approach imposes sign restrictions on impulse response functions. Additionally, following the paper of [Ramey and Shapiro \(1998\)](#), narrative approach (event-study) is commonly used in the literature to identify fiscal shocks. One advantage of using sign and zero restrictions approach is that it allows researchers to take into account of announcement effect of fiscal policy. Since there might be a lag between announcement and implementation of fiscal policy, forward looking economic agents (households and firms) may take decisions when they receive signal regarding the change in fiscal policy before its implementation. This implies that even if fiscal variables do not change immediately, private consumption and investment may change before the new policy is put into effect.

In our setup, we use a Bayesian methodology to estimate the model and we impose zero and sign restrictions consistent with economic theory on impulse response functions to identify six structural shocks in the six variable SVAR system. These shocks include an aggregate demand shock, an aggregate supply shock, a monetary policy shock, a government spending shock, a tax revenue shock and a capital inflow (exchange rate) shock. Having imposed appropriate sign restrictions on impulse responses to identify shocks, we remained agnostic about sign of the impulse responses of key variables of interest. Therefore, how these variables respond to identified shocks are obtained from the estimation of the SVAR.

Impulse response functions obtained from the estimated SVAR indicate that direction of interaction between monetary and fiscal policy is shaped by the type of shocks. More precisely, we find that monetary and fiscal policies are complementary in response to aggregate demand and supply shocks, i.e. for example a tight monetary policy is accompanied by a tight fiscal policy in response to an aggregate demand shock. On the other hand, monetary and fiscal policies are substitutes in respond to shocks stemmed from each other. For example a tightening monetary policy shock is accompanied by a loose fiscal policy response. Put in different way, while two public authorities move in the same direction in response to non-policy shocks, they move in opposite direction in response to policy shocks. Moreover, this study points out the importance of nature of fiscal shocks in terms of anticipated (announced before implementation) and unanticipated (announcement and implementation occurs at the same time) shocks. We compare macroeconomic effects of both anticipated and unanticipated fiscal shocks with the finding that estimation results of an anticipated tax shock are in line with the macroeconomic theory. More precisely, we find that while an unanticipated positive tax revenue shock increases output, an anticipated positive tax revenue shock decreases it.

At this point, our contributions in this paper are twofold. First, as far as we know this is the first study in Turkey which uses sign and zero restriction approach in evaluating fiscal policy. Using sign restriction approach allow us to distinguish the type of shocks and show whether or not macroeconomic effects of these shocks differ. Particularly, we are interested in whether or not the direction of the output response change when an anticipated (the shock which is announced and people know about it before actual implementation) or an unanticipated (announcement and implementation occurs at the same quarter) fiscal policy shock hits the economy. This is very important because some papers for Turkey find an evidence on positive relationship between tax revenue and output such as [Dökmen and Vural \(2011\)](#), [Karagöz and Keskin \(2016\)](#). Although this might be the case, we believe that the way of identifying fiscal shocks as anticipated or unanticipated matters and

hence changes the sign of relationship between two variables. Second, the Turkish economic history provides a very rich environment in terms of monetary and fiscal policies interaction that is interesting to investigate. Examining the interaction between two policy instruments reveals the nature of fiscal and monetary policy mix under the different type of shocks. It might be very important for policymakers to understand relationship between monetary and fiscal policies when a macroeconomic shock (aggregate demand and aggregate supply shocks) or a policy shock (interest rate, tax revenue and government spending shocks) hits the economy.

Similar analysis regarding monetary and fiscal policy interactions carried out for advanced economies (such as [Mountford and Uhlig \(2009\)](#) for the US, [Dungey and Fry \(2009\)](#) for New Zealand, [Dungey and Fry \(2010\)](#) for Australia and [Ankargren and Shahnazarian \(2019\)](#) for Sweden). Our results are more in line with [Ankargren and Shahnazarian \(2019\)](#) who find that while monetary and fiscal policies complement each other for demand and supply shocks, they act as substitutes for monetary and fiscal shocks in Sweden, although their result is in a developed country context.

The outline of the paper is as follows: Section 2 introduces the data and methodology. In section 3, we present our main empirical findings including impulse response functions and discuss the role of monetary and fiscal policy interactions when different type of shocks hits the economy. Section 4 displays some additional specifications and robustness checks. Section 5 summarizes the findings and concludes.

2. Data and methodology

To identify fiscal, monetary and macroeconomic shocks, and to analyse interaction between fiscal policy and monetary policy, we use a structural vector autoregression (SVAR) analysis applied to a small set of variables.³ Identifying zero and sign restrictions are applied on impulse response functions on the SVAR using the methodology described in [Arias et al. \(2018\)](#). Specific identifying restrictions on IRFs are discussed in more detail in Section II.2. Here we will briefly mention about the methodology using the notation borrowed from [Rubio-Ramirez et al. \(2010\)](#). Other technical details can be found in appendix B as well as in [Rubio-Ramirez et al. \(2010\)](#) and [Arias et al. \(2018\)](#). Consider the structural vector autoregression:

$$y_t' A_0 = \sum_{i=1}^N y_{t-i}' A_i + c + \varepsilon_t' \quad \text{for } 1 \leq t \leq T \quad (1)$$

where y_t is $n \times 1$ vector of endogenous variables, c is $1 \times n$ vector of parameters and ε_t is $n \times 1$ vector of exogenous structural shocks. N is lag length and T is sample size. Conditional on past information and the initial conditions, the vector ε_t is Gaussian with mean zero and with identity covariance matrix I_n . In a compact form equation (1) can be rewritten as

$$y_t' A_0 = x_t' A_+ \varepsilon_t' \quad \text{for } 1 \leq t \leq T \quad (2)$$

where $A_+ = [A_1' A_2' \dots A_p' c']$, $x_t' = [y_{t-1}' y_{t-2}' \dots y_{t-p}' 1]$ for $1 \leq t \leq T$ and A_+ is $(np+1) \times n$ matrix of structural parameters on lagged endogenous variables. As defined in [Arias et al. \(2018\)](#), given

³ Since VAR in first difference model is used in this study, we only include a constant as a deterministic term. Appropriate lag length is chosen as one based on information criteria. All of them (AIC, FPE, HQ, LR) except SC confirms this lag length. According to autocorrelation LM test, there is no autocorrelation problem at this lag length.

structural parameters (A_0, A_+) the impulse response function (IRF) at a finite horizon h corresponds to

$$L_h(A_0, A_+) = \left(A_0^{-1} J' F^h J \right)' \quad (3)$$

where

$$F = \begin{bmatrix} A_1 A_0^{-1} & I_n & \dots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ A_{p-1} A_0^{-1} & 0 & \dots & I_n \\ A_p A_0^{-1} & 0 & \dots & 0 \end{bmatrix} \quad \text{and} \quad J = \begin{bmatrix} I_n \\ 0 \\ \vdots \\ 0 \end{bmatrix}$$

the IRF of the i -th variable to the j -th structural shock at finite horizon h corresponds to the element in row i and column j of the matrix $L_h(A_0, A_+)$, which we define as $L_h(A_0, A_+)(i, j)$. The identification strategy in this paper employs a combination of zero and sign restriction on IRFs and use the methodology that is described in Arias et al. (2018). For example⁴ a zero restriction on IRF of i -th variable to the j -th structural shock at horizon h implies that

$$L_h(A_0, A_+)(i, j) = 0$$

On the other hand, a positive sign restriction on IRF of i -th variable to the j -th structural shock at horizon h implies that

$$L_h(A_0, A_+)(i, j) > 0$$

We use the same Bayesian algorithm with Normal-Wishart priors⁵ as in Arias et al. (2018). Briefly, as in Arias et al. (2018), we firstly draw (A_0, A_+) from the posterior distribution of structural parameters conditional on zero restrictions. Secondly, if the sign restrictions are satisfied, we keep the draw. Thirdly, we return to first step until the required number of draws from posterior of structural parameters conditional on zero restrictions is obtained.

2.1. Data

We use a data set covering the period between 2003Q2 and 2018Q4. Using a relatively short time span for this analysis can be attributed to the fact that the Turkish economy has gone through a major structural change following the 2001 crisis, which transformed the banking sector as well as the fiscal and monetary policy frameworks. Given the short sample, we tried to build a SVAR model that can capture the interaction between monetary and fiscal policies with a small number of variables, while identifying the other important shocks for a small open economy, namely aggregate demand, aggregate supply, and capital flow shock. We establish a six-variable SVAR model including real tax revenue growth, real government spending growth, real GDP growth, inflation, nominal interest rate and nominal exchange rate.⁶ Thus, the model combines three policy variables (interest rate, tax and spending) with three non-policy variables (growth rate, inflation rate and exchange rate). As a small open economy, international

capital flows play an important part for macroeconomic dynamics for Turkey. The exchange rate is included in the SVAR to capture the effects of capital inflows as well as the exchange rate channel of monetary transmission. We also include data on risk premium as an exogenous variable in the model to control for the effects of global financial conditions which affect size of capital inflows and hence value of exchange rate as well as the effect of uncertainty on macroeconomic aggregates. All variables are seasonally adjusted with the Tramo/Seats method except monetary policy rate and exchange rate.

Below, we describe the data used in the baseline model. We put special emphasis on explaining the construction of fiscal and monetary policy variables, since these are both critical for our main research question and are novel in our paper:

We use data on two fiscal instruments to better understand fiscal transmission mechanism in the economy. This is because they might have different effects on key variables of interest such as output and inflation. Furthermore, the responses of two different fiscal policy tools to a monetary policy shock may differ with respect to each other. We use Central Government real government spending excluding interest payments (primary government spending) and Central Government real tax revenues in this study.⁷ Since the focus of this study is monetary and fiscal interactions we prefer to use aggregate data on government spending (non-interest public expenditures) instead of core government spending (public consumption plus public investment). We deflate nominal fiscal data using the GDP deflator. We use the quarterly difference of logged real fiscal variables (i.e. growth rate of fiscal variables) to get stationary data (Fig. 1).

Considering the change in the monetary policy framework after the global financial crisis, we combine different policy rates that were relevant in the pre- and post 2010 periods as in the study of Büyükbaşaran et al. (2019). Prior to 2010, since the financial system had liquidity surplus, the overnight borrowing rate of CBRT was the policy rate. As of May 2010, the CBRT implemented wide interest rate corridor, i.e. CBRT provided weekly funding to the financial system through one-week repo auctions as well as daily funding through overnight lending. Therefore during that period, BIST overnight rate fluctuated greatly within the interest corridor. Following the studies of Kara (2015) and Küçük et al. (2016), we use a weighted average of BIST overnight rate and CBRT average funding rate as policy rate after 2010 Q2.

Since Turkey is a small open economy, we include the nominal exchange rate in the model. We measure nominal exchange rate as a basket that consists of 0.5 US dollar and 0.5 Euro. We use quarterly average nominal exchange rate (a rise in nominal exchange rate is a depreciation of Turkish lira) logged and first differenced to render a stationary series. As a robustness check we also estimate the model using the CPI-based real effective exchange rate (2003 = 100) published by the CBRT.

We obtain data on real GDP (2009 = 100) and the CPI

⁴ Specific identifying zero and sign restrictions on IRFs are discussed in more detail in Section 2.2.

⁵ We also provide robustness analysis with other alternative priors in Section 4. See Appendix B for a discussion about how using conjugate priors as Normal-Wishart priors reduce the computational burden and how the use of conjugate prior might imply wider credibility intervals.

⁶ See Appendix A, Table A1 for detailed information about definition and source of data.

⁷ Before 2006 Turkey published data on consolidated budget. Ministry of Treasury and Finance of Turkey has published monthly data on central government budget since January 2006. Ministry of Treasury and Finance of Turkey also extended the central government budget data back to 2000 on an annual basis. To convert annual central government budget data to quarterly data we calculated the shares of quarterly tax revenues in total tax revenues for each year by using consolidated budget figures. Then, we apply these quarterly ratios to the corresponding yearly central government budget tax revenues to get quarterly data for the period of 2003–2005. Tax revenues, which accounts for 82.5 percent of total budget revenues over the period of 2006–2018, consist of income tax, corporate tax, VAT, special consumption tax and other taxes. Primary government spending consists of public consumption (personnel expenditures, purchases of goods and services), public investment (capital expenditures and capital transfers) and current transfer expenditures and net lending.

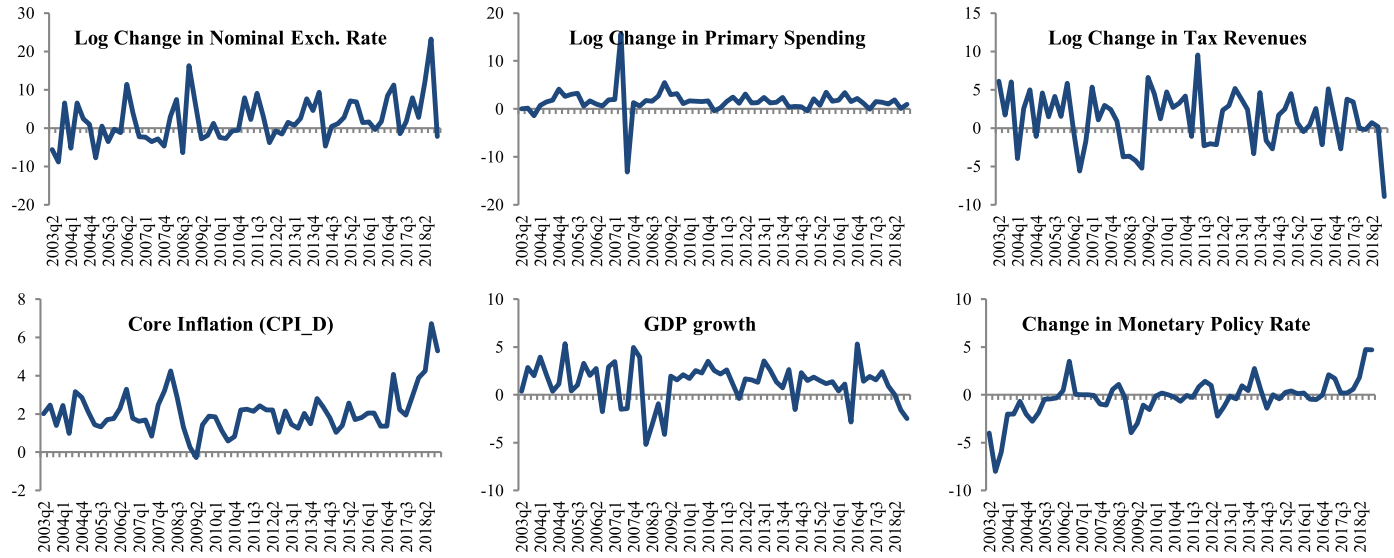


Fig. 1. Endogenous variables used in the baseline model.

Note: All series except for exchange rate and nominal policy rate are seasonally adjusted.

Table 1

The shocks and restrictions in SVAR for anticipated shocks^b.

Variables ^a	Shocks					
	Spending shock	Tax revenue shock	Aggregate demand shock	Aggregate supply shock	Monetary policy shock	Capital inflow shock
Spending	0 0 +					
Tax		0 0 +				
GDP			+	+	-	
Policy Rate					+	-
Inflation			+	-	-	-
Exchange Rate					-	-

^a Government Spending: Quarterly real primary government spending growth, Tax: Quarterly real tax revenue growth, GDP: Quarterly real GDP growth, Policy Rate: Quarterly change in CBRT Policy Rate, Exchange Rate: Quarterly change in nominal exchange rate (negative value implies nominal appreciation of Turkish lira). Inflation: Quarterly change in CPI_D. Policy Rate: Quarterly change in CBRT Policy Rate.

^b First restrictions apply to initial period of the shock ($t = 0$), second term in the cell is one quarter ahead (for $t = 1$), third term is two quarter ahead ($t = 2$) restrictions –note only spending and tax shocks are one and two quarter ahead restrictions, all other are concurrent restrictions (for $t = 0$) (+) values imply that shock will affect the corresponding variable positively, (-) values imply that shock will affect the corresponding variable negatively. (0) means there will be no simultaneous effect of the shock on the corresponding variable. Blank cells imply that there are no restrictions for the particular shock-variable combination.

(2003 = 100) from Turkstat. We use a measure of core CPI, i.e. CPI excluding unprocessed food, alcoholic beverages and tobacco (CPI-D), which accounts for nearly 84 percent of the headline CPI. The main reason to use core inflation instead of headline inflation is that the effectiveness of monetary policy rate on former is higher than latter. Since alcoholic beverages and tobacco prices are subject to heavy tax burden and they encounter frequent tax adjustments (increase in taxes), using the definition of core inflation allows us to partly eliminate the effects of administrated prices (taxes) on inflation. Both series (real GDP and the CPI_D) are seasonally adjusted, logged and first differenced (Fig. 1).

2.2. Identification of structural shocks

We use zero and sign restrictions to identify six structural shocks in the six variable SVAR system. We choose to use both zero and sign restrictions for fiscal shocks, for others we use sign restrictions only in initial period. Where there are no contemporaneous restrictions imposed (where the cells in Table 1 are left blank), impulse responses are determined agnostically, i.e. determined by the estimated model.

Three of these shocks, aggregate supply, aggregate demand and capital inflow (exchange rate) shocks are non-policy shocks for a

small open economy. Additional three shocks, monetary policy shocks, tax shocks and government spending shocks are the shocks related with policy which are the focus of this study. The underlying restrictions, which are summarized in Table 1, can be described as follows:

A *positive monetary policy shock* is a shock where an increase in interest rate causes appreciation of local currency. Additionally, a surprise rise in interest rate results in a fall in both output and inflation.

An *unanticipated positive tax shock* is a shock where an increase in tax lasts two periods, which means that a tax shock takes positive signs for first two subsequent periods. On the other hand, an *anticipated positive tax shock* lasts three quarters with zero restrictions for first two periods and a positive sign for the third quarter. We follow the same way of identification for corresponding government spending shocks (Table 1).

An *aggregate supply shock* is assumed to be a shock which moves inflation and real GDP growth in opposite directions within the same period. An *aggregate demand shock* is assumed to be a shock which moves inflation and real GDP growth in the same direction contemporaneously.

A positive (negative) *capital inflow shock* is a shock that appreciates (depreciates) the Turkish lira, reflected as a decline in

nominal exchange rate. Furthermore, in light of the evidence regarding the exchange rate pass-through to inflation in Turkey (Kara and Oğünç (2005) and Kara et al. (2007)) it is assumed that a nominal depreciation (appreciation) leads to a rise (fall) in inflation within the same quarter. Therefore, we impose a negative sign for inflation on impact following a positive capital inflow shock. Additionally, a negative sign for monetary policy rate on impact is introduced due to a decrease in inflation.

All shocks are orthogonal to each other by construction of the methodology Arias et al. (2018), which provides isolating the individual effect of each shock on variables.

We need to clarify some issues regarding with identification of fiscal policy shocks. Identification of fiscal shocks comprises of character of shocks as well as duration of shocks. Solving the first problem we distinguish fiscal shock as an anticipated and an unanticipated fiscal shocks. This might be important because of the fact that announcement of policies -before their implementation- might affect economic decision of private agents differently compared to unanticipated shocks. To capture the announcement effects of fiscal policy shocks we use a sign and zero restrictions approach. As we will explain in more detail in the subsequent section, we find some evidence that the effect of an anticipated tax revenue shock on output is in line with macroeconomic theory (a negative correlation between them in IRF of tax revenue shock). However, if we define a tax revenue shock as an unanticipated tax shock we find a positive correlation between two macro variables in IRF of tax revenue shock. This finding supports the idea that responses of output to a tax policy shock depend on nature of fiscal shocks. The second issue we need to deal with is the duration the fiscal shocks. In this study, we impose only sign restrictions on impulse responses for two periods for unanticipated fiscal shocks. In case of an anticipated fiscal shock, we use a new definition capturing three periods, with zero restriction for first two periods and a positive sign restriction for the third period. The rationale of selecting a shorter duration for fiscal shocks than literature underlines the fact that there is no big time gap between announcement and implementation of fiscal policy in Turkey. Our experience show that it takes short time (maybe one or two quarters) for the government to put into effect fiscal policy changes after the change in fiscal policy announced. Therefore, different from Mountford and Uhlig (2009), who imposes zero restrictions for four quarters and positive sign restrictions for subsequent four quarters for the US economy, we describe an anticipated tax shock where first two periods take a value of zero and a positive sign for the third quarter for the Turkish economy.

3. Empirical findings

We display the impulse response functions of SVAR model using the restrictions given in Table 1. Solid green line is the median responses of relevant variables to the corresponding shock, while the borders of shaded area with grey are the 16th and 84th percentile of credibility intervals for the responses to the same shock. Therefore, the shaded area with grey represents 68 percent credibility interval of the response. Each response function represents the response of variable to a one standard deviation innovation to relevant shock.

Since this paper aims to examine monetary and fiscal interactions, we start with the effects of policy shocks on the economy. The impulse responses shown in Fig. 2 to Fig. 5 belong to two fiscal policy shocks: tax revenue and government spending shocks. Fig. 6 shows the impulse response functions of a monetary policy shock. Figs. 7 and 8 present impulse response functions of non-policy shocks. While the former depicts macroeconomic effects of an aggregate demand shock, the latter display the effects of an aggregate supply shock. All impulse response functions to non-

fiscal shocks are obtained from the baseline model, in which both fiscal shocks are set as anticipated fiscal shocks. In each figure T, G, Y and RER denote tax revenue, primary government spending, output and nominal exchange rate, respectively.

3.1. Impulse response analysis

Impulse response functions to a positive *tax revenue shock* (a surprise rise in tax revenue growth) are presented in Figs. 2 and 3. While Fig. 2 shows the effects of an anticipated tax revenue shock, Fig. 3 displays those of an unanticipated tax revenue shock on the macro economic variables. Due to small sample size and the methodology, we have wide credibility intervals.⁸ We will use median responses to interpret the results in this section. As it is expected, we find that a rise in tax revenue negatively affects output immediately (Fig. 2). Following a rise in tax, both growth and inflation decrease, which results in a decrease in nominal interest rate. The negative correlation between tax and inflation can be explained as follows: Since an increase in tax revenue results in a decline in output, this situation might lead to a fall in inflation via demand channel. Hence, the fall in inflation make a room for applying a loose monetary policy by decreasing interest rate. Examining the interaction between fiscal and monetary policies reveals the fact that a tight fiscal policy (a rise in tax revenue) shock is accompanied by a loose monetary policy response (a decrease in interest rate); hence two authorities move in a different direction following a tax shock to ensure macroeconomic stability.

We also estimated the same model under an unanticipated tax revenue shock assumption. Fig. 3 shows the dynamic effects of an unanticipated tax revenue shock on output, inflation and fiscal variables. Different from the former case, we find some evidence on positive correlation between tax revenue growth and output growth. On the other hand, the responses of remaining variables to an unanticipated tax revenue shock is qualitatively the same.

We apply the same sign and zero restrictions on the government spending shock. We investigate the effects of both anticipated and unanticipated fiscal shocks in Fig. 4 and Fig. 5, respectively.

For the case of government spending, there is no qualitative difference between the responses of macro variables to anticipated and unanticipated shocks. Impulse response analysis show that an increase in government spending growth lead a short-lived increase in growth. We also observe a short lived positive effect on tax growth thanks to an increase in economic growth (Fig. 4). As expected, an increase in economic activity rises tax revenues due to automatic stabiliser effect.⁹ On the other hand, we find that following an increase in government spending inflation diminishes. Although we find a negative correlation between government spending and inflation, it would be useful to remind that this is not the only paper that end up with this kind of interesting result. Similar results has also been found in Mountford and Uhlig (2009) and Canova and Pappa (2007). One of the possible explanations for this conclusion is that following a rise in government spending (an expansionary fiscal policy) the monetary authority augments policy rate, which lead to a decrease in inflation. As in tax revenue shock, we observe that two authorities move in opposite direction when

⁸ See Appendix B for details.

⁹ Since majority of government spending is accepted as non-sensitive to business cycle, it would be reasonable to interpret a change in government spending as a discretionary fiscal policy change. On the other hand, since taxes are very sensitive to business cycle conditions, interpreting a change in taxes requires special attention. One should keep in mind that a movement in taxes may result from a combination of two different factors, namely the effect of automatic stabiliser and/or a discretionary fiscal policy changes such as an increase in tax rate or widen/shorten coverage of tax exemptions.

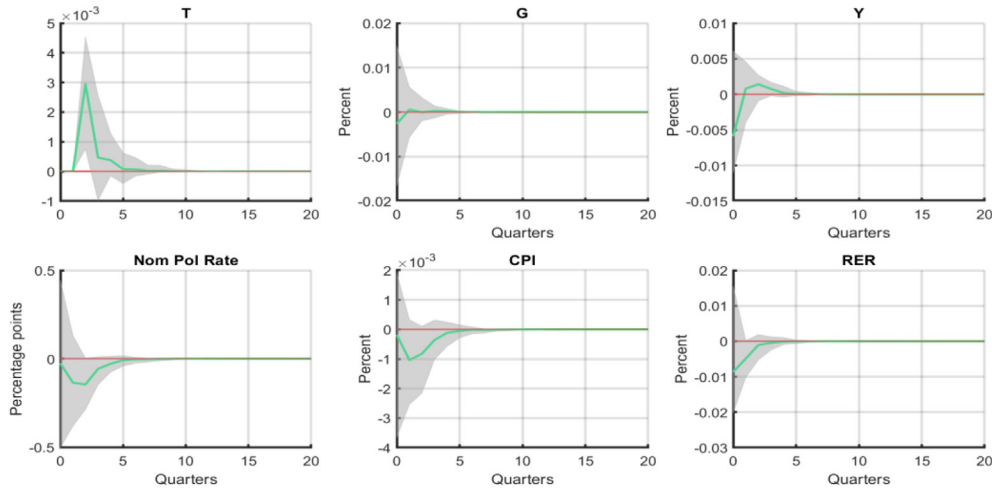


Fig. 2. Responses to anticipated tax revenue shocks.

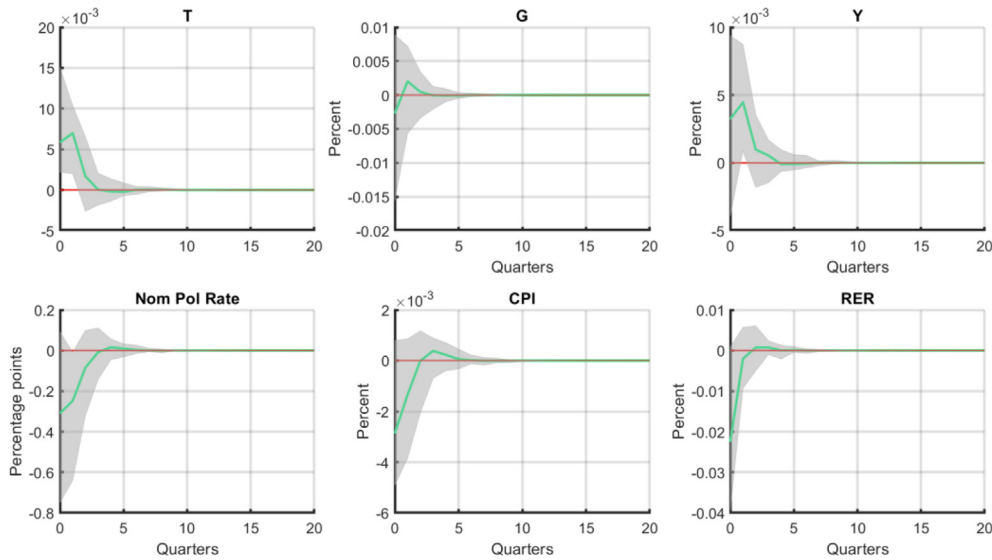


Fig. 3. Responses to unanticipated tax revenue shocks.

government shock hit the economy. In other words, we find that an expansionary fiscal policy by means of an increase in government spending leads to an implement of a tight monetary policy by means of an increase in interest rate. Therefore, the actions of two authorities, which have different objectives and possibly prioritizing different facets of macroeconomic stability, offset each other when fiscal shocks hits the economy.

Actually this argument is also valid for a monetary policy shock with the finding that a tight monetary policy shock is followed by an expansionary fiscal policy response via government spending as seen in Fig. 6.

As shown in Table 1, we put four sign restrictions on initial values of interest rate, output, inflation and exchange rate to set a monetary policy shock. In line with our restrictions we find that following a positive monetary policy shock, growth and inflation decreases and nominal exchange rate appreciates. The most striking result for us is that how to fiscal variables respond to a change in monetary policy rate. As shown in Fig. 6, following a rise in interest rate, public spending act in counter-cyclical manner (an expansionary fiscal policy).

We can investigate the nature of interaction between monetary and fiscal policies when non-policy shocks exist. A positive aggregate demand shock implies an increase in both output and inflation on impact, which requires a tight policy mix to provide macroeconomic stability. In fact, this is the result that we receive from the impulse response analysis. As shown in Fig. 7, following an aggregate demand shock, while the monetary authority increases policy rate (a tight monetary policy), the fiscal authority increases taxes and decreases government spending (a tight fiscal policy). In other words, we find an evidence that when the economy heats and inflation increases, both authorities act in counter-cyclical way, i.e.

Table 2
Monetary and fiscal policies interactions.

	Complements	Substitutes
Demand Shocks	x	
Supply Shocks	x	
Monetary Policy Shocks		x
Fiscal Policy Shocks		x

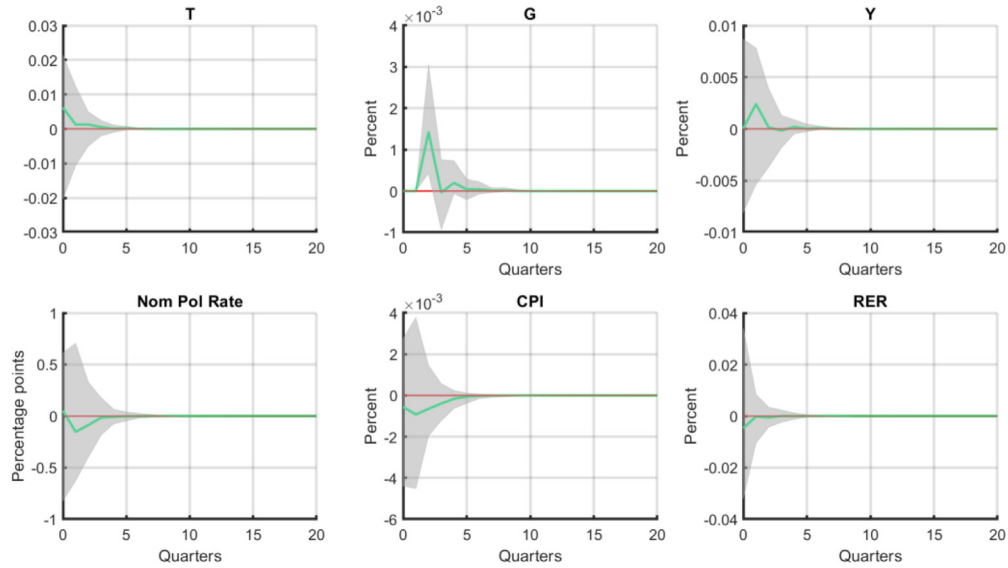


Fig. 4. Responses to anticipated government spending shocks.

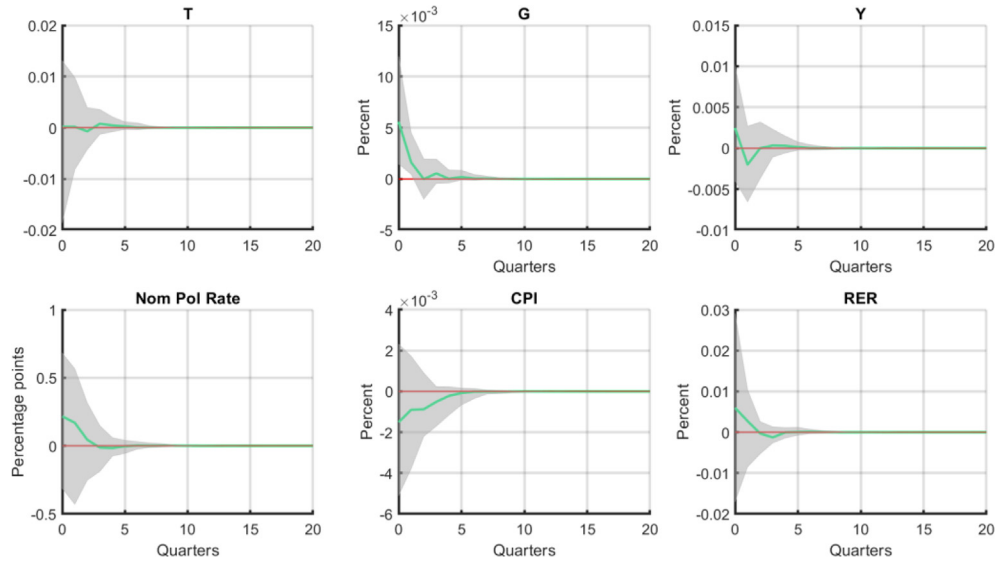


Fig. 5. Responses to unanticipated government spending shocks.

they are complementary.

Turning to the aggregate supply shock, which is identified as output growth and inflation moves in opposite direction, monetary and fiscal policies are complementary. As we see in Fig. 8, following an aggregate supply shock, the government increases public spending, albeit on a small scale. On the other hand, the monetary authority decreases nominal interest rate in line with a fall in inflation.

As a result, impulse response analysis shows that interaction between monetary and fiscal policies depends on the nature of the shocks. Table 2 summarizes the main findings of the study. More precisely we find that while two policies move in same direction (complementary) in case of non-policy shocks, they follow different

directions (substitutes) in case of policy shocks.

4. Robustness analysis

The baseline specification in this paper includes primary spending as government expenditure, total tax revenue as government revenue, nominal exchange rate as exchange rate, CPI-D as inflation indicator and it uses only risk premium and constant as exogenous variables. It also uses Normal-Wishart prior with selection of hyper-parameters, that implies a wide base for parameter and therefore comparatively higher parameter uncertainty as in Arias et al. (2018) and Mountford and Uhlig (2009). In order not to deviate from literature and to remain agnostic, we use these priors

and small set of identifying restrictions. Data selection, prior selection, specification of SVAR with such set of restrictions and with those exogenous variables are not the only possible options. Therefore we apply robustness analysis on prior selection, data specification and SVAR specification.

4.1. Prior selection and hyperparameters

As an alternative to Normal-Wishart prior we also used Minnesota prior as an alternative prior. The results did not change qualitatively. We use hyperparameters that will provide tighter priors on model parameters. As expected, the credibility intervals get narrower as we use tighter priors, whereas qualitative results (sign of the median responses) remain almost same. But since our main goal in this paper is to provide qualitative results rather than quantitative ones and since this is the first paper for Turkey to provide estimates for interactions of monetary and fiscal policy using sign and zero restrictions (hence a priori knowledge about the parameters is limited), we choose to not deviate from literature (Arias et al. (2018); Mountford and Uhlig (2009)) and remain agnostic with looser priors. As expected, small sample size results in wider credibility intervals. Caldara and Kamps (2008), 2012 discuss how agnostic approach with loose priors implies wider base for structural parameters. As a future research topic, a quantitative analysis which for example aims to pin down fiscal policy multipliers requires tighter priors and use of a priori knowledge of the structural parameters of the model.

4.2. Data specification

We take into account various alternative definition of variables in order to present the robustness of our estimation result. We replace¹⁰ tax revenues with total revenues,¹¹ primary expenditures with core expenditures,¹² CPI-D with CPI-B and CPI itself.¹³ Lastly, we replace nominal exchange rate with real exchange rate (definition and source of data is available in Appendix A, Table A1.).

Our main findings in the paper with baseline specification appears to be robust to alternative data specifications. Firstly, in all of the different data specification, definition of the anticipated shock and unanticipated shock matters for fiscal shocks either for tax revenue shock, government spending shocks or both. Therefore it can be said that the anticipated fiscal shocks differs from

unanticipated shocks in terms of its effects on economy. Secondly, interaction of monetary and fiscal shocks has a very minor change with respect to the data specification: only when real exchange rate is used for nominal exchange rate monetary policy shocks and fiscal shocks becomes substitutes rather than complementary for aggregate supply shock (Table 3). Robustness analysis on data specification indicates all the remaining qualitative results remain same in terms of interaction of monetary and fiscal policies (Table 3).

4.3. Specification of SVAR

We conduct robustness analysis on identifying restrictions, especially on fiscal shocks. We also add some other might-be-relevant exogenous variables to the VAR and conduct robustness analysis. Firstly, baseline definition have zero restrictions for the first two periods and a positive sign restriction for the third period in anticipated shocks definition while unanticipated shocks defined as positive sign restriction for the first two periods. We re-specified anticipated fiscal shocks as zero restrictions for first two periods and a positive sign restriction for the third and fourth quarter, therefore has same number of sign restriction as in the unanticipated specification. We also try the re-specification of anticipated shock as zero restrictions for the first period and a positive sign restriction for the second period, therefore has same horizon for the shocks (two periods) in the unanticipated specification. Our first main result is robust to this different specifications: definition of the anticipated shock and unanticipated shock matters for fiscal shocks either for tax revenue shock, government spending shocks or both. For our second main result, the interaction of monetary and fiscal shocks has changed qualitatively only for aggregate supply shock (Table 4). Robustness analysis on specification of identifying restrictions indicates all the remaining results remain same qualitative in terms of interaction of monetary and fiscal policies.

There is a growing literature on the effect of demand for domestic government debt securities denominated in local currency of foreign holders on interest rate (Ebeke and Lu (2015); Peiris (2010); Yılmaz and Yüksel Yücel (2016)), growth (Abbas and Christensen (2010); Hauner (2006)), and fiscal multiplier (Broner et al. (2014); Broner et al. (2019)). Therefore, we use the share of foreign investor in domestic debt, denominated in local currency, as an exogenous variable for robustness check of our baseline estimation result. We obtain that this variable does not contribute and change our baseline estimation result neither qualitatively nor quantitatively in our set up. One reason is that effect of exogenous variables on VARs is limited compared to those of endogenous variables. Other possible reason for that interest rate, inflation and exchange rate capture the pull effect of foreign investor demand for domestic government debt securities denominated in local currency, and EMBI spread captures the push effect in our baseline set up,¹⁴ already. Therefore, foreign investor share in domestic debt may not add too much additional information to change our baseline estimation result. We conclude that our methodology is not very suitable to test the hypothesis that whether foreign share in domestic debt is affective on macroeconomic shocks. Some other methodology, which is more appropriate to test this hypothesis, can be a topic of further research.

In summary, our robustness analysis show that our main results are qualitatively robust to different data specification as well as some different specification of identifying restrictions. One minor exception is that interaction of monetary and fiscal policy with

¹⁰ We replace each relevant data definition with the alternative data definition one by one, in order to distinguish the effect of that specific data definition. We also try several data specification change at once, but in the paper we discuss only individual data specification changes.

¹¹ Total tax revenues, broader government revenue item than tax revenue, include non-tax revenues, mostly one time revenues such as tax and zoning amnesty, privatization revenue and central bank profit. When expenditure exceeds tax revenues, government takes some broader measures that rely on non-tax revenues from time to time in order to curb fiscal deficit and government debt. Therefore, we conduct robustness with total revenue data definition.

¹² The main difference between primary and core expenditure stems from current transfer to private economy. During certain periods government use transfers rather than direct expenditures for either stimulating the economy or having targeted social transfers such as to the poor people. The effect of direct government expenditure and transfers on economy might be different, therefore we conduct robustness with a government spending definition that excludes mainly transfers.

¹³ CPI-D: CPI excluding unprocessed food, alcoholic beverages and tobacco. CPI-B: CPI excluding unprocessed food, energy, alcoholic beverages, tobacco and gold. As stated before CPI-D excludes some items which is beyond the scope of monetary policy effects as well as some items whose price is determined by government through taxes. Certain items in energy prices such as oil (pump) prices is administered prices by government. Some other items of energy prices and gold prices is partly beyond the control of monetary policy and determined by world prices. Therefore, we also conducted robustness analysis with CPI-B index and with the headline CPI index.

¹⁴ Forbes and Warnock (2012), Koepke (2019).

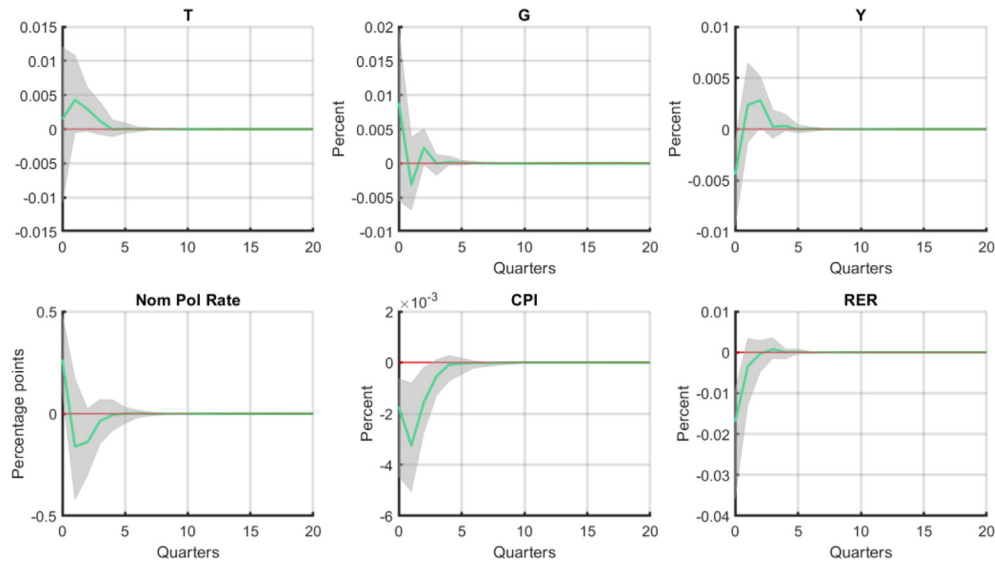


Fig. 6. Responses to monetary policy shocks.

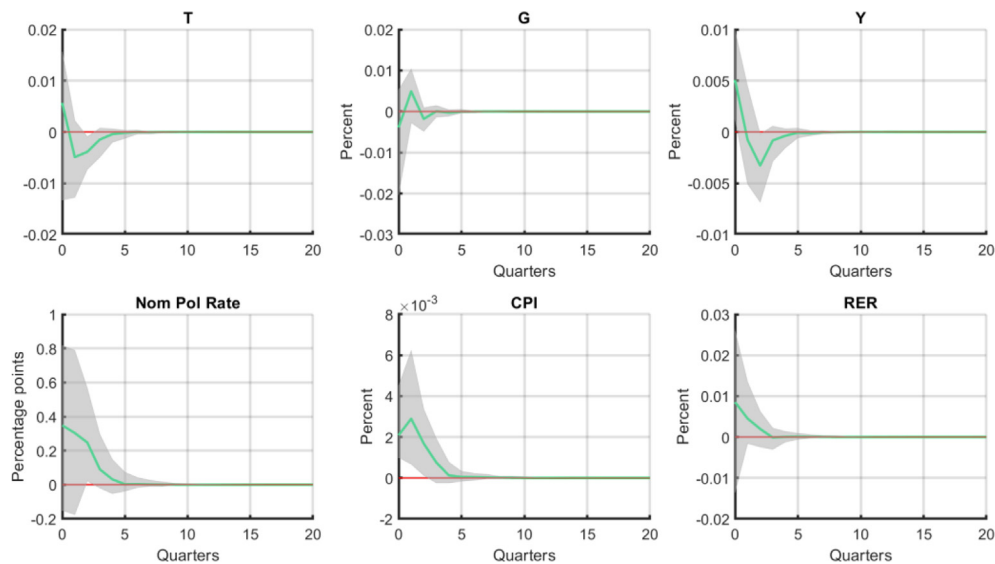


Fig. 7. Responses to aggregate demand shocks.

respect to aggregate supply shocks give different result than baseline specification on some part of the robustness analysis.

5. Conclusion

This paper investigates the monetary and fiscal policies interaction using a Bayesian Structural Vector Autoregression (SVAR) model with sign and zero restrictions. One of the goals of the paper is to better understand the dynamics behind fiscal and monetary transmission mechanism. Notably, we focus on how the behaviour of monetary and fiscal authorities change when they encounter macroeconomic shocks or policy shocks of their counterparts. We find that nature of shocks matters in terms of interaction between two policies: while they complements each other in case of aggregate demand and supply shocks (i.e. both authority apply contractionary or loose policy), they move in different direction

when the shocks resulted from the policy change (i.e. while one of the authorities follows a contractionary policy, the other implements a loose policy).

The other contribution is that it would be useful to investigate the effects of anticipated shocks rather than unanticipated shocks. Our results confirm that using anticipated fiscal shocks (especially for tax shocks) yields more reasonable results. As it is expected, we find that an increase in tax revenues lead to fall in output. On the other hand, using unanticipated tax shock ends up with opposite result, that is, an increase in tax revenues lead to augment output. This analysis reveals the fact that using an appropriate definition for tax shock is very important to produce sound results.

As future research, we plan to quantitatively analyse effects of fiscal and monetary policy shocks and their interaction. That analysis requires more quantitative restriction on SVAR parameters and/or impulse response functions. In this paper, we are

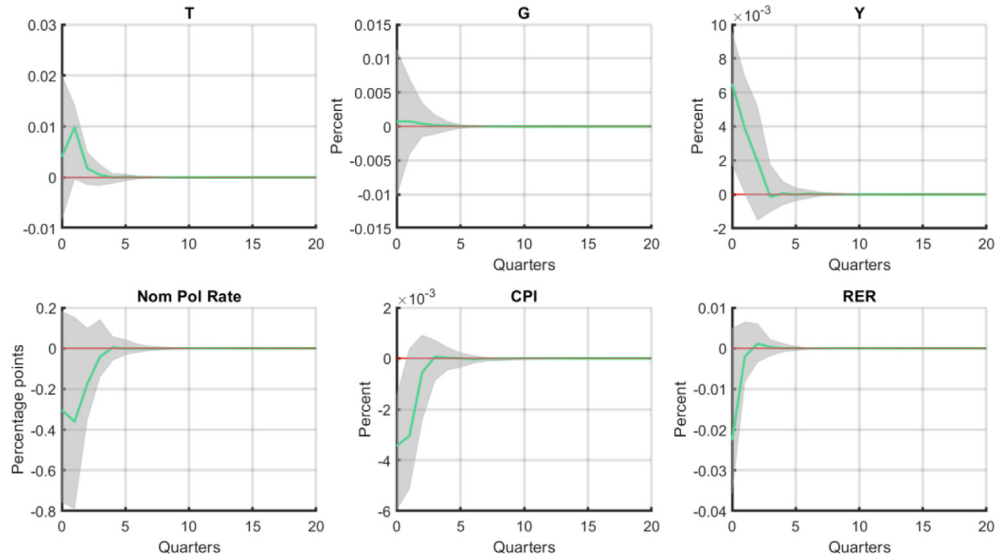


Fig. 8. Responses to aggregate supply shocks.

Table 3
Monetary and fiscal policies interactions^a.

	Baseline		TR		CS		CPI-B		CPI		RER	
			C	S	C	S	C	S	C	S	C	S
	Comp (C)	Subs (S)										
Demand Shocks	X		x	x	x	x	X				x	
Supply Shocks	X		x	x	x	x	X					x
Mon. Policy Shocks		x		x		x		x		x		x
Fiscal Policy Shocks		x		x		x		x		x		x

^a Analysis is based on median response on the shocks with only anticipated fiscal shocks definition. TR implies total revenue is used instead of tax revenue in the baseline specification (all the other data definitions are as in baseline definition). CS: core spending is used instead of primary spending. CPI-B: CPI-B index is used instead of CPI-D index, CPI: CPI index itself is used instead of CPI-D index. RER: Real effective exchange rate is used instead of nominal exchange rate. Complementary (C) implies that e.g. tight monetary policy concur with tight fiscal policies whereas substitute (S) implies that e.g. tight monetary policy is coincide with loose fiscal policy.

deliberately agnostic about the effects of shocks and magnitude of the structural parameters in order not to deviate too much from the literature. Moreover, since this is the first paper for interaction of

Table 4
Monetary and fiscal policies interactions^a.

	Baseline		2Z2S		1Z1S	
			C	S	C	S
	Comp (C)	Subs (S)				
Demand Shocks	X		x			x
Supply Shocks	X			x		x
Mon. Policy Shocks		x		x		x
Fiscal Policy Shocks		x		x		x

^a Interpretation of the table is same as Table 3. 2Z2S shows anticipated fiscal shock which is identified with zero restrictions for first two periods and a positive sign restriction for the third and fourth quarter, 1Z1S shows anticipated fiscal shock which is identified zero restriction for first period and a positive sign restriction for the second quarter.

fiscal and monetary policy using sign and zero restriction for Turkey, previous knowledge about the magnitudes of IRFs and parameters were limited. Therefore, we provide a parsimonious and agnostic set of restrictions. Quantitative future research will require more structural restrictions and provide more precise magnitude about the effects and interaction of different policies.

Appendix A. Data

Table A1
Data description.

Variable	Description	Transformation	Source
CPI	Consumer Price Index	Seasonally adjusted, Log Difference	TurkStat
Core CPI -D (net of food, alcoholic beverages and tobacco)	CPI excluding unprocessed food, alcoholic beverages and tobacco	Seasonally adjusted, Log Difference	TurkStat
Core CPI-B (net of food, alcoholic beverages, tobacco, gold and energy prices)	CPI excluding unprocessed food, energy, alcoholic beverages, tobacco and gold	Seasonally adjusted, Log Difference	TurkStat
Real GDP	Real GDP in Turkey in millions of national currency, chain-linked volumes, reference year 2009.	Seasonally adjusted, Log Difference	TurkStat
Government primary expenditure	Real total central government expenditure excluding interest payment, in million of national currency	Seasonally adjusted, Log Difference	Ministry of Treasury and Finance
Government core expenditure	Real central government public consumption plus public investment, in millions of national currency	Seasonally adjusted, Log Difference	Ministry of Treasury and Finance
Government total revenue	Real total central government revenue covering taxes and non-taxes revenues, in millions of national currency	Seasonally adjusted, Log Difference	Ministry of Treasury and Finance
Government tax revenues			

Table A1 (continued)

Variable	Description	Transformation	Source
Foreign share of domestic currency debt in domestic debt	Real total central government tax revenues, in millions of national currency	Seasonally adjusted, Log Difference	Ministry of Treasury and Finance
NEER	Foreign investors held domestic debt in domestic currency over total domestic debt, percent	Log Difference	Ministry of Treasury and Finance
REER	Nominal exchange rate, a basket consisting of 0.5 US Dollar and 0.5 Euro	Log Difference	CBRT
Monetary Policy Rate	Real effective exchange rate in Turkey deflated by the CPI, reference year 2003	Difference	CBRT
Risk Premium	Weighted average of BIST overnight rate and CBRT average funding rate, percent	Log Level	Bloomberg
	JP Morgan EMBI Global Index -Turkey		

Appendix B. Technical appendix about the Bayesian VAR methodology

Notes on Prior Selection

In Arias et al. (2018) as well as in our study, prior distributions are picked from the conjugate distributions. The reason is that once the priors are from conjugate distributions, the posterior distributions are from the same family. Although this is not a requirement for the algorithm, it greatly reduces the computational burden. In fact, without conjugate priors the algorithm specified here is almost (computationally) infeasible. We pick a Normal-Wishart prior, which is common in the literature of sign and zero restrictions, Arias et al. (2018), Uhlig (2005), and Mountford and Uhlig (2009). Moreover, some other common conjugate distributions like Minnesota prior are special cases of Normal-Wishart distributions. Hence, the choice of Normal-Wishart prior is in line with the literature. Nevertheless, one disadvantage of conjugate priors is that they are not flexible enough to fully embed expert knowledge about the parameters of the SVAR on prior distributions. Therefore, it may result in wide base for posterior distributions and wide credibility intervals for parameters and IRFs (Caldara and Kamps, 2008, 2012), which is the case in our study.

Notes on wide credibility intervals

We use median response to describe the results of IRFs since we have wide credibility intervals. Short sample size, use of conjugate priors and using agnostic approach of small set of restrictions are some of the reasons for the wide credibility intervals. Note that we use small number of zero restrictions to remain agnostic, and sign restrictions can only have a set identification (Rubio-Ramirez et al 2010). Use of conjugate priors with agnostic approach implies wide base for certain key structural parameters, Caldara and Kamps (2008, 2012) and Arias et al. (2018). In order to not deviate from literature, we still use agnostic approach and conjugate priors, therefore we have wide credibility intervals. As a further research, we will put more restrictions on structural parameters, especially to those we have a priori knowledge from previous studies, in order to get more precise quantitative results and narrower credibility interval.

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