TÜRKİYE CUMHURİYET MERKEZ BANKASI

WORKING PAPER NO: 14/23

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July 2014

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Identification of Monetary Policy Shocks in Turkey: A Structural VAR Approach

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Abstract: This paper tries to identify the monetary policy shocks in Turkey during the explicit inflation targeting period starting from 2006 using a structural VAR approach. We model Turkey as a small open economy where domestic variables are affected by external factors like commodity prices and global demand but domestic variables do not affect external variables. We analyze the effects of four shocks on Turkish economy: two domestic shocks of interest rates and risk premium, and two external shocks of commodity prices and global demand. All shocks are found to have significant effects on main economic variables. Positive interest rate shocks appreciate the domestic currency and decrease the inflation whereas positive risk premium shocks cause a depreciation and an increase in inflation. Both of these shocks also cause a decrease in the domestic activity. Being an open and internationally integrated economy, Turkey is significantly affected by global shocks. A positive global demand innovation leads to an increase in global commodity prices, which together increase both the level of prices and economic activity in Turkey. A positive commodity price shock also increases the inflation in Turkey.

Key words: Monetary Policy, Interest Rates, Risk Premium, Small Open Economy.

JEL Codes: E43, E52, E58, F41.

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1 Introduction

As emerging economies are more integrated with international economic and financial markets, identification of both domestic and external shocks on the domestic economic activities of these countries have recently been extensively analyzed in the literature.[1] Identification of monetary policy shocks is important in these countries both to understand the transmission mechanism of monetary policy specifically and to understand the overall macroeconomic fluctuations. In this paper we try to identify monetary policy shocks in Turkey for the period of explicit inflation targeting starting from 2006. We borrow structural VAR approach with a block exogeneity assumption from Cushman and Zha (1997). Turkey, being an emerging country integrated with global markets with respect to trade and financial linkages, have important spillovers from the rest of the world. Block exogeneity assumption provides us with a structure where external variables have effects on domestic variables but not vice versa. Moreover, instead of using a standard identification scheme like Choleski decomposition, we use a structural approach in our analysis and therefore can allow richer and more proper identification of monetary policy shocks. The analysis includes world industrial production index, world commodity price index, and US Treasury bill rate as the external variables; gross domestic product, consumer price index, monetary aggregate, real exchange rate, emerging market bond index for Turkey, and overnight interest rate as the domestic variables.

We find that both domestic shocks of interest rates and risk premium, and the external shocks of commodity prices and world demand have important effects on Turkish macroeconomic variables. A positive innovation in interest rates appreciates the currency on impact and decreases the consumer prices and economic activity with some lag consistent with the economic theory. We do not get anomalies like price or exchange rate puzzles. We further show that if instead we use Choleski identification, price puzzle emerges. Risk premium shocks have also strong effects on the macro variables. A worsening in the risk premium depreciates the currency on impact and leads to an increase in the consumer prices. Output decreases with some lag. Monetary policy responds by increasing the interest rates to contain the inflation and limit the worsening in risk premium. The dynamics of these responses are consistent with standard

[1] See Neumeyer and Perri (2005), Mackowiak (2007), Uribe and Yue (2006), Canova (2005), and Garcia-Cicco, Pancrazi, and Uribe (2010) as some recent examples.

emerging country models. An important feature of the results is that risk premium shocks have stronger effects on domestic variables compared to the same size interest rate shocks. This feature is consistent with literature about the effects of risk premium shocks on emerging country economies such as Neumeyer and Perri (2005), Uribe and Yue (2006) and Garcia-Cicco et al. (2010). Furthermore, we find that both the commodity price shocks and world demand shocks have important effects on domestic variables in Turkey.

Our paper contributes to the literature on identification of monetary policy transmission through an empirical approach with structural VAR.[2] There is a large literature that uses empirical approaches like VARs to look at the effects of monetary policy decisions. For advanced countries, there is an extensive literature using this approach (see Christiano et al. (1999), Bernanke and Mihov (1998), Kim and Roubini (2000)), but the literature on emerging countries has been more limited. For example, Mackowiak (2007) uses a structural VAR model with the block exogeneity assumption to analyze the impact of external shocks on some emerging economies. He finds that external shocks are indeed an important source of macroeconomic fluctuations in these economies. He further finds that although US monetary policy shocks affect some macroeconomic variables such as short term interest rate and the exchange rates, these shocks are not important for emerging economies relative to other external shocks.

There are some other papers focused on single emerging economies. For instance, Catao et al. (2008) use a SVAR representation of a structural model to study the monetary policy transmission in Brazil. They find that the monetary policy transmission work much faster in Brazil than in the developed economies and the bulk of the effects on output and inflation take place within a year. Franken et al. (2006) use a similar SVAR model with the block exogeneity notion to study the Chilean economy between 1950-2003. This paper finds that external shocks have significant effects on domestic economy. The paper further finds that among domestic shocks, monetary policy shocks, government spending shocks, and real exchange rate shocks

[2] On the identification of monetary policy shocks, there are several approaches in the literature. For DSGE model approach, see Smets and Wouters (2007) for the US and Alp and Elekdağ (2011) for Turkey. For high frequency approach, see Cook and Hahn (1989), Kuttner (2001), Cochrane and Piazessi (2002), Rigobon and Sack (2004) and Gurkaynak et al. (2005) for the US and İnal (2006), Aktaş et al. (2008) and Demiralp and Yilmaz (2010) for Turkey. For narrative approach, see Romer and Romer (2004) for the US and Demiralp et al. (2012) for Turkey.

have significant effects on business cycle fluctuations. There are some studies on monetary policy in Turkey using VAR approach.[3] Berument (2007) attempts to analyze the monetary policy in Turkey from 1968 to 2000. This paper claims that during this period innovations in the spread between the Central Bank's interbank interest rate and the depreciation rate of local currency represents the stance of monetary policy. It finds that a positive innovation in spread (i.e. a tighter monetary policy) decreases prices and income and appreciates the currency. We find similar results for a more recent period.

The rest of the paper is organized as follows. Section 2 presents the data and Section 3 presents the SVAR model and the identification structure. Results are presented in Section 4 and concluding remarks are in Section 5. Finally, Appendices explain the data sources and the solution of the model.

2 Data

We use monthly data from January 2006 to June 2013.[4] Starting from 2006, Central Bank of Turkey switched to explicit inflation targeting framework. Because of different policy frameworks that were adopted in the earlier periods, it would be better to focus on a homogenous period with more stable economic dynamics.[5] Explicit inflation targeting period starting from 2006 serves our purpose of identifying the effects of monetary policy shocks nicely as this period has a lower and stable inflation, risk premium and interest rates with sound fiscal and banking sectors.

The data set consists of external and domestic data sections. The external (or exogenous) data includes world commodity price index ($wcpi$), construction-excluded world industrial production index ($wipi$), and US Federal Funds rate (ffr). The domestic data composes of real GDP (y), consumer price index (cpi), the money market aggregate (M3) ($m3$), the real effective exchange rate ($reer$), emerging market bond index for Turkey ($embi$), and monthly-averaged overnight interest rate (i). We take the natural logarithm of $wcpi$, $wipi$, y, cpi, $m3$, and $reer$.

[3] See Us (2004), Alper and Torul (2008), Demiralp (2008) and Civcir and Akcaglayan (2010) for some studies.

[4] Please refer to Appendix A for a detailed description of the data

[5] See Berument (2007) on how to analyze the stance of monetray policy during an earlier period.

Then we use HP filter to decompose all variables into trend and cyclical components and use the deviations of the cyclical part from the trend part.[6] Figure 1 show the data after all transformations to make the data ready for the analysis.

Energy-included World Bank Commodity Price Index (*wcpi*) from the World Bank is an important external variable for Turkey as an emerging economy. Turkish economy is significantly affected by changes in world commodity prices as Turkey heavily depends on imports of natural gas and petroleum products. Therefore, any changes in the world commodity prices, especially energy prices would affect the economy. We use construction-excluded World Industrial Production Index (*wipi*) from CPB Netherlands Bureau for Economic Policy Analysis in order to capture the world demand and its impact on Turkish economy. Instead of using US GDP as a proxy for the world demand, it is better to use another variable that can best represent the world demand. Turkish economy is more connected to Europe with respect to trade than US. Furthermore, Canova (2005) finds that US real demand and supply shocks generate insignificant fluctuations in the typical Latin American economy. Hence it is important to have a more appropriate proxy for the external demand than the US GDP since US GDP might not capture the changes in the world demand accurately. Finally, we take US federal funds rate (ffr) from the Federal Reserve Board as the third external factor. We assume that changes in the federal funds rate can possibly affect Turkish economy through exchange rate and interest rate channels.

The real GDP (y) and consumer price index (*cpi*) data come from Turkish Statistical Institute (TurkStat). We use Fernandez (1981) method to generate monthly GDP. The money market aggregate ($m3$) and the real effective exchange rate (*reer*) for Turkey come from the Central Bank of Turkey. Our EMBI (*embi*) for Turkey data comes from Bloomberg. Risk premium measured by EMBI is a very important variable for emerging countries like Turkey. Given the continuing structural problems and lower investment grades compared to advanced countries, emerging countries usually borrow at a higher rate than advanced country interest rates. This spread represents the financial conditions for the emerging country overall and fluctuations in spreads are shown to be very important as in Neumeyer and Perri (2005) and Garcia

[6] This procedure is used by Leu (2011), Fort et. all (2006), Civcir and Akcaglayan (2010), and Buckle et. all (2002) as well.

et al. (2005). Therefore, it is crucial to include risk premium in the system of equations to properly identify the related shocks and their effects. Finally, our monthly-averaged overnight interest rate (i) is from Borsa Istanbul. We have chosen monthly-averaged overnight interest as our benchmark policy rate. It is quite difficult to capture a good measure of the Central Bank policy rate not only because the Central Bank use different interest rates as benchmark rate during different time periods, but it also uses different tools for the monetary policy as well. For instance since May 2010, the Central Bank of Turkey has decided to use one week repo auction rate as the benchmark policy rate instead of overnight interest rate. Furthermore, while the bank can keep the policy rate constant, it can use other tools for monetary policy such as asymmetric interest rate corridor, reserve requirements, reserve option mechanism.[7] Hence, we have to be careful in our selection of the policy interest rate. Roush (2007), Bruggemann (2003), Alper and Torul (2008), and Peersman (2002) use overnight interest rate as the policy rate since it can reflect the effects of monetary policy decision. Hence we use monthly-averaged overnight repo interest rate as our benchmark policy rate.

3 Model and Identification Structure

We use a vector auto regression (VAR) model to identify the monetary policy shocks for Turkish economy. One must be careful when using VAR model since the order and the structure of the VAR could lead to substantial biases in results.[8] As stated above, we borrow the structural VAR (SVAR) approach with block exogeneity notion from Cushman and Zha (1997). The block exogeneity notion not only reduces the number of parameters to be estimated, but it is also appropriate for the small open economies. For instance, Mackowiak (2007), Hoffmaister and Roldos (2001), Sosa and Cashin (2009), Canova (2005), and Giordani (2004) have used SVAR model with the block exogeneity feature for emerging economies.

We define the economy by the following structural form equation:

[7] Please refer to Basci and Kara (2011) for details of monetary policy implementation in Turkey during this period.

[8] See Carlstrom et al. (2009) on how a Choleski assumption severely distort the impulse responses when the data generating process is a New-Keynesian model.

$$A(L)y(t) = \varepsilon(t) \tag{1}$$

where $y(t)$ is an m x 1 vector of observations at time t, $A(L)$ is a non-singular m x m matrix in lag operator L, and $\varepsilon(t)$ is m x 1 structural disturbances. We have partitioned the matrices according to the spirit of the block exogeneity assumption in the following way:

$$y(t) = \begin{bmatrix} y_d(t) \\ y_e(t) \end{bmatrix}, \tag{2}$$

$$A(L) = \begin{bmatrix} A_{11}(L) & A_{12}(L) \\ A_{21}(L) & A_{22}(L) \end{bmatrix}, \tag{3}$$

and

$$\varepsilon(t) = \begin{bmatrix} \varepsilon_d(t) \\ \varepsilon_e(t) \end{bmatrix}, \tag{4}$$

where $y_d(t)$ is m_1 x 1 vector of domestic variables, and $y_e(t)$ is m_2 x 1 vector of external variables at time t. The dimension of $A_{11}(L)$ is m_1 x m_1, $A_{12}(L)$ is m_1 x m_2, $A_{22}(L)$ is m_2 x m_2, $\varepsilon_d(t)$ is m_1 x 1, and $\varepsilon_e(t)$ is m_2 x 1. Finally, the structural distributions satisfy the following conditions:

$$E[\varepsilon(t)\varepsilon(t)'|y(t-s), s > 0] = I, \;\; E[\varepsilon(t)|y(t-s), s > 0] = 0. \tag{5}$$

If we define the reduced form equation (VAR) as

$$B(L)y(t) = u(t), \tag{6}$$

then the structural disturbances are related to the reduced form equation (VAR) residuals by $\varepsilon(t) = A_0 u(t)$. We can write this equation in the matrix form as:

$$
\begin{bmatrix} \varepsilon_{y_t} \\ \varepsilon_{cpi_t} \\ \varepsilon_{m3_t} \\ \varepsilon_{reer_t} \\ \varepsilon_{embi_t} \\ \varepsilon_{i_t} \\ \varepsilon_{wcpi_t} \\ \varepsilon_{wipi_t} \\ \varepsilon_{ffr_t} \end{bmatrix} = \begin{bmatrix} a^0_{1,1} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & a^0_{2,2} & 0 & a^0_{2,4} & 0 & 0 & a^0_{2,7} & 0 & 0 \\ 0 & 0 & a^0_{3,3} & 0 & 0 & a^0_{3,6} & 0 & 0 & 0 \\ a^0_{4,1} & a^0_{4,2} & a^0_{4,3} & a^0_{4,4} & a^0_{4,5} & a^0_{4,6} & a^0_{4,7} & a^0_{4,8} & a^0_{4,9} \\ a^0_{5,1} & a^0_{5,2} & 0 & a^0_{5,4} & a^0_{5,5} & a^0_{5,6} & 0 & 0 & a^0_{5,9} \\ 0 & 0 & 0 & a^0_{6,4} & a^0_{6,5} & a^0_{6,6} & 0 & 0 & a^0_{6,9} \\ 0 & 0 & 0 & 0 & 0 & 0 & a^0_{7,7} & a^0_{7,8} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & a^0_{8,8} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & a^0_{9,7} & a^0_{9,8} & a^0_{9,9} \end{bmatrix} \begin{bmatrix} u_{y_t} \\ u_{cpi_t} \\ u_{m3_t} \\ u_{reer_t} \\ u_{embi_t} \\ u_{i_t} \\ u_{wcpi_t} \\ u_{wipi_t} \\ u_{ffr_t} \end{bmatrix}
$$

Our identification structure is very flexible and realistic compared to standard Choleski approach and therefore has the potential to generate more sensible results. Above equation displays the restriction matrix. The identification structure allows for variables to react contemporaneously to other domestic and external variables. For instance, the monetary policy is identified in a way that it can react to many domestic and external variables whose data are available to policy makers immediately. However, if we use the standard Choleski decomposition, we would not be able to allow for rich simultaneous relations between variables.

Furthermore, the block exogeneity feature has the advantage of allowing for a large set of exogenous (external) variables to be included in the model. The inclusion of these variables is important for correct specification of the model and for controlling exogenous variables in proper identification of the domestic shocks. The block exogeneity restriction, $A_{21}(L) = 0$, implies that the domestic variables do not enter into the structural forms of external variables neither contemporaneously nor for lagged forms. This assumption, which is suitable for the notion of the small economy concept, plays an important role in the identification structure for us.

As far as the external variables are concerned, we assume that any changes in the *wcpi* would affect the domestic inflation in the same period. Kim and Roubini (2000) and Cushman and Zha (1997) assume that prices are affected contemporaneously by *wcpi* within even in the same month. Furthermore, commodity price changes, especially energy prices, could deteriorate local currency as demand for the foreign currency increases in commodity importing countries like Turkey. However, we assume that shocks to commodity price have no contemporaneous impact on the interest rate in a month. The domestic output is assumed not to be affected by *wcpi* shocks in the same month because the realization of the supply-side effects of commodity price changes take some time to realize.

We use World Industrial Production Index (*wipi*) as a proxy for the external demand. We assume that *wipi* has contemporaneous impact only on exchange rate in the same month because exchange rate is supposed to immediately reflect most domestic and external information in a very short time period. However we do not expect to have the effects of *wipi* on other variables, especially domestic output, in the same month as the results of the external demand shocks take some time to have effects. However, if instead we use quarterly data, then we would take the contemporaneous effects of the external demand on domestic output as in Catao (2008) and prices as in Allegret and Sand-Zantman (2009).

Finally, we include the US ffr as the foreign interest rate because emerging countries are affected by the advanced country monetary policy stance (see Mackowiak (2007)). We assume that ffr has contemporaneous impact on exchange rate, *embi*, and interest rate of the domestic country as these high-frequency variables can absorb the changes in ffr in a very short period of time. However, we assume that the other variables respond to the changes in the ffr with lags.

Regarding the domestic variables, we first assume that shocks to output can influence only exchange rate and *embi* in the same month. However, we do not think that the same shock could have any impact on prices, monetary aggregates, and interest rate in the same month. We also assume that, within the same month no domestic or external variable has contemporaneous impact on domestic output as it represents the sluggish reaction of the real economic activity to other shocks in the same month (Kim and Roubini (2000), Peersman and Smets (2001), and Catao et all. (2008)).

Following Sims and Zha (2006), Peersmand and Smets (2001), and Berumet (1997) among many, we assume that in the same month the monetary authority has immediate access to information on monetary aggregates, exchange rate, and country risk indicator but it would be unable to access information about output and price level. The identification assumption further suggests that our benchmark interest rate has contemporaneous effect on money aggregates, the real exchange rate, and *embi* and has impact on other domestic variables including prices and output in the following months as it would take some time to observe the real effects of monetary policy decision on economic activity.

Exchange rate is an important variable in proper identification of monetary policy shocks for at least two reasons. First, monetary policies are either explicitly or implicitly concerned about the effects of any depreciation or appreciation of the local currency on the inflation. Second, as part of the interest rate movements are responses of depreciation of local currency, it is important to identify the part of the interest rate movements that are truly exogenous to currency movements. Since exchange rate is a forward-looking asset price, it reflects indirectly other sources of information that might not be available in the same time period. We take the standard assumption in the literature and assume that all domestic and external variables have contemporaneous impact on the exchange rate as it reacts immediately to all innovations.[9] On the other hand, exchange rate can only affect prices, $embi_t$, and interest rate contemporaneously.

Furthermore, we assume that any good (bad) news from *embi* of Turkey can improve (deteriorate) the exchange rate and the interest rate in the same month but can have impact on the other variables in the subsequent periods because it would take some time to see the impact on real economic activity. However, innovations from output, prices, exchange rate and the interest rate do have contemporaneous impact on the *embi* as *embi* can reflect even daily innovations.

Finally, regarding the block of external variables, we assume that ffr can responds to news from commodity prices and world demand; and commodity prices responds to news from world demand in the same period. However, we assume that world demand does not respond to any of them contemporaneously because of the sluggishness of the real economic activity.

The lag length of the SVAR model is determined by both Schwarz, Hannan-Quinn, and Bayesian information criteria. The optimum lag length suggested by these criteria is one month. The solution of the model is explained in Appendix B.

[9] See for instance Cushman anz Zha (1997), Peersman and Smets (2001), Kim and Roubini (2000), Elbourne (2008), Peersman (2002), Franken, Le Fort, and Parrado (2006).

4 Results

In this part we look at the impulse responses of four shocks to understand the transmission mechanisms in Turkey. We analyze two external shocks of commodity prices and world demand, and two domestic shocks of risk premium and interest rates.

Figure 2 shows impulse response to an unanticipated tightening in monetary policy which we quantify as a positive 100 bps interest rate shock. The external variables never responds to the domestic interest rate shocks by construction of the model. In the domestic variable section, we see the monetary transmission mechanism. In response to tightening shock in interest rates, economic activity decreases. This contractionary effect is strongest around second and third quarters. This result is consistent with the evidence on several countries like Brazil in Catao et al. (2008), the US in Christiano et al. (1996). There might be several channels of monetary policy transmission.[10] For example, in the direct interest rate channel, a higher policy rate leads to higher real interest rates and this in return decreases the demand for investment and durable goods. Also, in the credit channel, with balance sheet effects or bank lending effects, amount of available credit to agents in the economy can be restricted thereby decreasing the demand. Even though we do not study the details of such transmission channels of monetary policy, overall we see that a tightening in policy rate decreases economic activity in Turkey.

Figure 2 shows that a positive interest rate shock leads to statistically significant appreciation of the local currency which is found in Berument (2007), Kim and Roubini (2000), and Catao et al. (2008). Our results do not indicate any exchange rate puzzle, the case in which exchange rate depreciates in response to monetary tightening. As shown by Kim and Roubini (2002), a more proper identification with structural VAR can be considered important for this result.

A particular outcome of the interest rate shock is on the prices. Prices decrease in response to a tightening shock in interest rates, with stronger effects starting from second quarter onwards. Our identification does not generate a price puzzle, a case in which prices increase in response to a monetary tightening. As Cushman and Zha (1997) pointed out the price puzzle might be eliminated as one uses a proper identification procedure instead of using standard Choleski decomposition. Carlstrom et al. (2009) shows this case in detail, where a true data generating

[10] See for example Ireland (2008).

process is a New Keynesian model, the identification from a Choleski decomposition might wrongfully lead to price puzzle. These studies support the importance of using structural VAR in our identification.

For a comparative analysis, we use Choleski decomposition to investigate impulse responses under this specification. In the Choleski setup, we set the order of variables as $wcpi$, $wipi$, ffr, y, cpi, $m3$,$reer$,$embi$,i so that the domestic variables have no contemporaneous impact on the external ones. Figure 3 shows the impulse responses of a positive monetary policy shock under the Choleski recursive identification. Two important drawbacks of the Choleski specification in the case of a tight monetary policy are the presence of price puzzle and nonnegligible impact on external variables. The impulse responses of the Choleski setup indicates that both block exogeneity feature and proper identification structure are quite important to measure monetary policy shocks in small open economies like Turkey.

For the lower prices in response to tighter monetary policy in Figure 2, exchange rate pass-through from the appreciation of domestic currency and a lower demand might be considered as important factors. Especially exchange rate pass-through is considered to be an important factor in inflation dynamics of Turkey (Kara and Öğünç (2012)). In order to quantify the impact of an exchange rate shock on domestic prices in our model, we next look at the impulse responses and estimate exchange rate pass-through to consumer prices. In Figure 4, we analyze the impulse responses to a positive real exchange rate shock. In response to the appreciation of domestic currency, consumer prices starts to decline on impact and this decrease continues significantly around a year. In our model, we use real exchange rate but most of the pass-through analysis is done through nominal exchange rates. To be comparable with relevant studies, we use nominal exchange rate instead of real exchange rate, and then estimate pass-through as cumulative change in prices as a ratio of cumulative changes in nominal exchange rates. Figure 5 plots the pass-through coefficient for different time horizons. We see that our model produces around 10 percent exchange rate pass-through to consumer prices around a year and most of the effect takes place in a year.

The next domestic shock comes from risk premium variable of $embi$. A risk premium shock corresponds to a 100 bps increase in the level of $embi$ for Turkey. This shock has some similarities to the interest rate shocks as it is a cost variable but also differs from interest rate shocks in some important aspects. Figure 6 shows the impulse response of variables to a positive *embi* shock. There is a contraction in economic activity with strongest effects happening around the third quarter. Usually, higher risk premiums are associated with capital outflows in emerging countries, and as a result exchange rate depreciates strongly immediately. The pass-through effects feed into prices and we observe that prices start to increase quickly as well. We see that monetary policy responds by increasing the interest rates, partly to contain the inflation pressures and limit the worsening in risk premiums.

Even though both interest rate and risk premiums shocks lead to higher funding costs for economic agents and lead to lower economic activity, their implications for exchange rates and prices are quite different. A positive interest rate innovation lead to an appreciation, possibly by attracting capital inflows through higher yields. In the case of risk premium shocks, usually worsening of risk perceptions about the country and higher risk premiums are associated with capital outflows form the country thereby leading to depreciation of currency. Lower level of economic activity in both shocks would put downward pressures on inflation, however, in the case of risk premium shocks large and immediate depreciation of the currency puts strong cost pressures on prices. When we compare the effects of interest rate and risk premium shocks we see that larger effects are observed on domestic variables in the case of risk premium shocks. This result is consistent with studies showing the importance of risk premium shocks in emerging countries such as Neumeyer and Perri (2005) in Argentina and Tiryaki (2012) in Turkey.

Next, we look at the effects of commodity price shock in Figure 7. Energy imports are an important part of current account deficit in Turkey and energy-related goods have an important share in consumption basket. Therefore, we might expect significant effects from commodity prices. Moreover, high level of commodity imports put negative risks on current account balance in Turkey, possibly worsening the risk perceptions. In line with these assessments, inflation increases in Turkey after a commodity price shock. Moreover, risk premium increases and real exchange rate depreciates slightly. These are consistent with a worsening in risk perceptions, as in *embi* shocks of Figure 4. Interest rates also increase in response to these developments.

Finally, Figure 8 shows the impulse responses of a positive world industrial production (*wipi*) shock. A positive shock in *wipi* can be viewed as an increase in external demand. We observe a significant increase in Turkish GDP due to a positive external demand shock. Similar empirical results are found in Sousa and Zaghini (2006), Utlaut and Roye (2010), and Franken et al. (2006). As the world production increases, demand for commodity prices increases which contributes to an increase in the Turkish inflation. In response to the increase in the prices and economic activity, interest rates increase.

In the Figure 9, we compare the interest rate shocks generated from the SVAR model to the first difference of the interest rate in the data. As expected, not all of the interest rate changes are shocks. Model dynamics can account part of the interest rate changes as responses to the economic variables. One interesting feature of the shock series is that they follow the interest rate changes very closely since 2011. Central Bank of Turkey implemented a new policy mix in this period to support financial stability (see Basçı and Kara (2011) and Aysan et al. (2014)). Some new tools of monetary policy were used in this period and special emphasis were put on variables like credit growth, current account and currency. Since our model does not take into account these concerns in detail, we might see most changes in the interest rates as shocks from the perspective of the model. This shows that new monetary policy framework for the aftermath of global financial crisis might not be properly captured by our standard SVAR approach and as a result there should be some caution when interpreting the results of the model. During this period, Central Bank of Turkey used other tools like interest rate corridor and reserve requirements intensively to deal with financial stability issues. It was openly mentioned that Central Bank would follow credit growth and current account developments closely. However, in our model we do not have these variables. A more detailed identification of monetary policy during this period for emerging markets overall and Turkey specifically stays as an important question. Short span of the data and the lack of a coherent modelling of new policy instruments stand as challenges for empirical identification for this period. Nevertheless, up to the extent that the actions of new policy approach are reflected in overnight interest rates, our modelling identification might control for the transmission.

5 Conclusion

In this paper we have utilized a structural VAR model with the block exogeneity notion to identify and analyze the effects of some domestic and external shocks and in particular the effects of monetary policy shocks on macroeconomic variables in Turkey. We define monthly-averaged overnight repo interest rate as the policy rate. The results shows that a positive shock to the policy rate have negative influence on output and monetary aggregates, appreciates the local currency and decreases the inflation. We do not get anomalies like price and exchange rate puzzles.

Risk premium shocks have also important consequences for macroeconomic variables. A worsening in risk perception towards Turkey measured by higher risk premium depreciates the currency, increases the prices and lowers the economy activity. Monetary policy responds by increasing the interest rates to contain the inflationary pressures and to limit the worsening in risk perceptions. Moreover, risk premium shocks are found to be strong consistent with results on emerging countries.

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6 Appendices

6.1 Appendix A: Data

The data consists of three exogenous and six endogenous variables. The exogenous variables are world commodity price index (WCPI), World Industrial Production Index (WIPI), and US federal funds rate (FFR). The endogenous variables are gross domestic product (GDP), consumer price index (CPI), monetary aggregate (M3), real effective exchange rate (REER), emerging market bond index (EMBI), and overnight interest rate (INT RATE).

World commodity price index ($wcpi$): The energy-included monthly WCPI data comes from the World Bank. The index consists of three series: energy, non-energy, and precious metals. The energy section covers coal, oil and natural gas. The non-energy section includes metals, agriculture, fertilizer, beverages, food, raw materials, cereals, fats and oils, and other food parts. Finally, the precious metals formed by gold, silver, and platinum.

World Industrial Production Index ($wipi$): We obtained the construction-excluded monthly WIPI data from the CPB Netherlands Bureau for Economic Policy Analysis. This index is calculated through the import weight of each economic region. The base year is 2000.

Federal Funds Rate (ffr): We obtained monthly data on FFR from the Federal Reserve.

GDP of Turkey (y): The GDP of Turkey comes from the Turkish Statistical Institute (TurkStat). The data is reported quarterly. In order to have monthly data, we perform Fernandez (1981) method and use monthly industrial production index to get the monthly GDP data.

CPI of Turkey (cpi): The monthly CPI data is from TurkStat.

M3 of Turkey ($m3$): The M3 data comes from the Central Bank of Turkey.

Reel Effective Exchange Rate ($reer$): We use CPI based REER data retrieved from the Central Bank of Turkey.

Emerging Market Bond Index for Turkey ($embi$): The EMBI data comes from the Bloomberg with JPSSGTUR Ticker. Monthly data is calculated through the averages of each month.

Overnight Interest Rate (i) **:** Our measure of monetary policy rate is overnight repo interest rate obtained from Istanbul Stock Exchange. The monthly data is calculated through calculating the average of each month.

6.2 Appendix B: Solution of the Model

Regarding the solution of the model, we use the method of Zha (1999). The solution method of this model consists of three parts. In the first part, the domestic section of the SVAR model is estimated using Chris Sims' "*csminwel*" optimization routine. In the second part, the simple external section of the model is solved. Finally, in the third part, both domestic and external sections of the model are assembled. The error band are obtained through bootstrap method. Artificial data is sequentially generated from time 1 to T using the estimated parameters with initially drawn data from uniform distribution. In each period, the next period's artificial data is obtained by using the estimated parameters and this period's artificial data. This routine is performed from time 1 to T and for 10000 simulations. Out of all simulations, the medians and the one point standard error deviations are plotted.

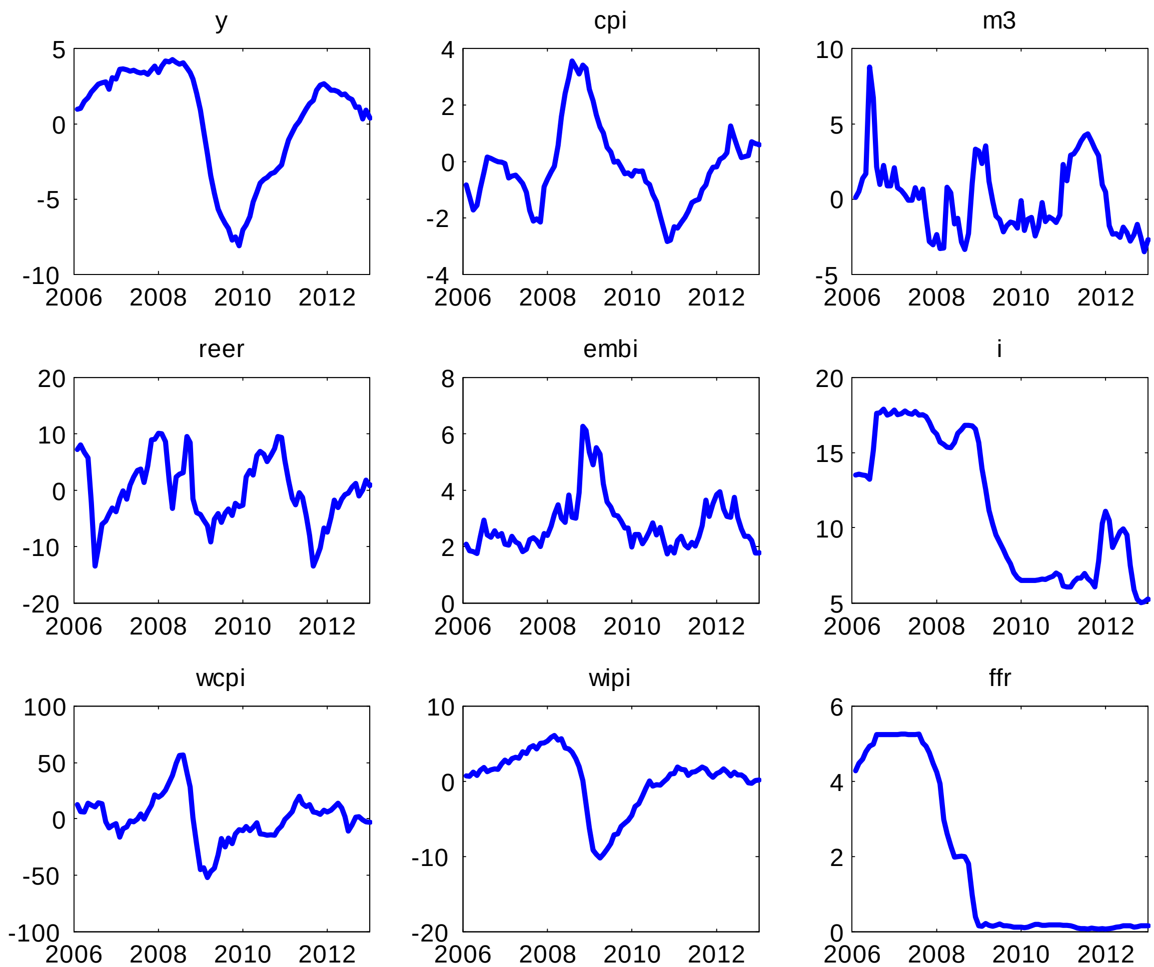

Figure 1: Data (Percent Log Deviations from HP Trend, except for Embi, Domestic Interest Rates (i) and Fed Funds Rate (ffr))

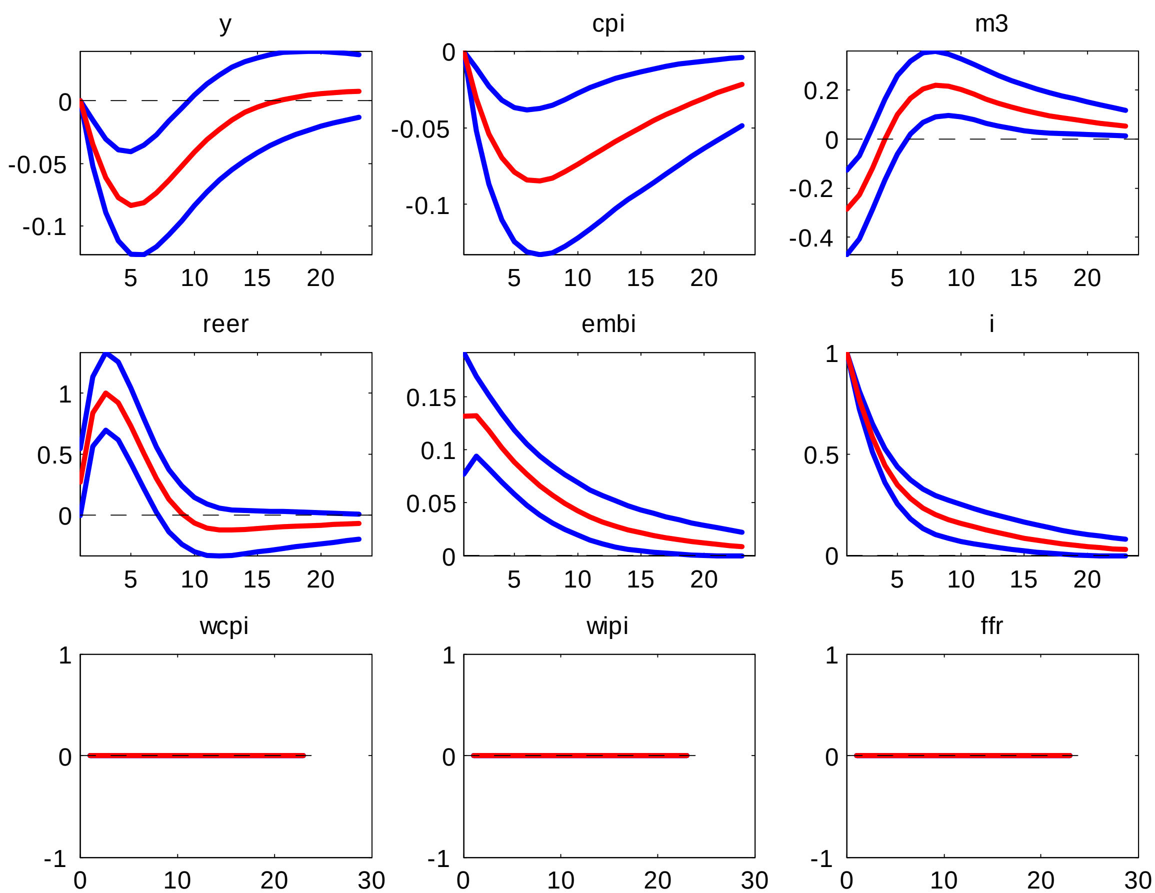

Figure 2: Impulse Response to a Positive Interest Rate Shock in SVAR Model

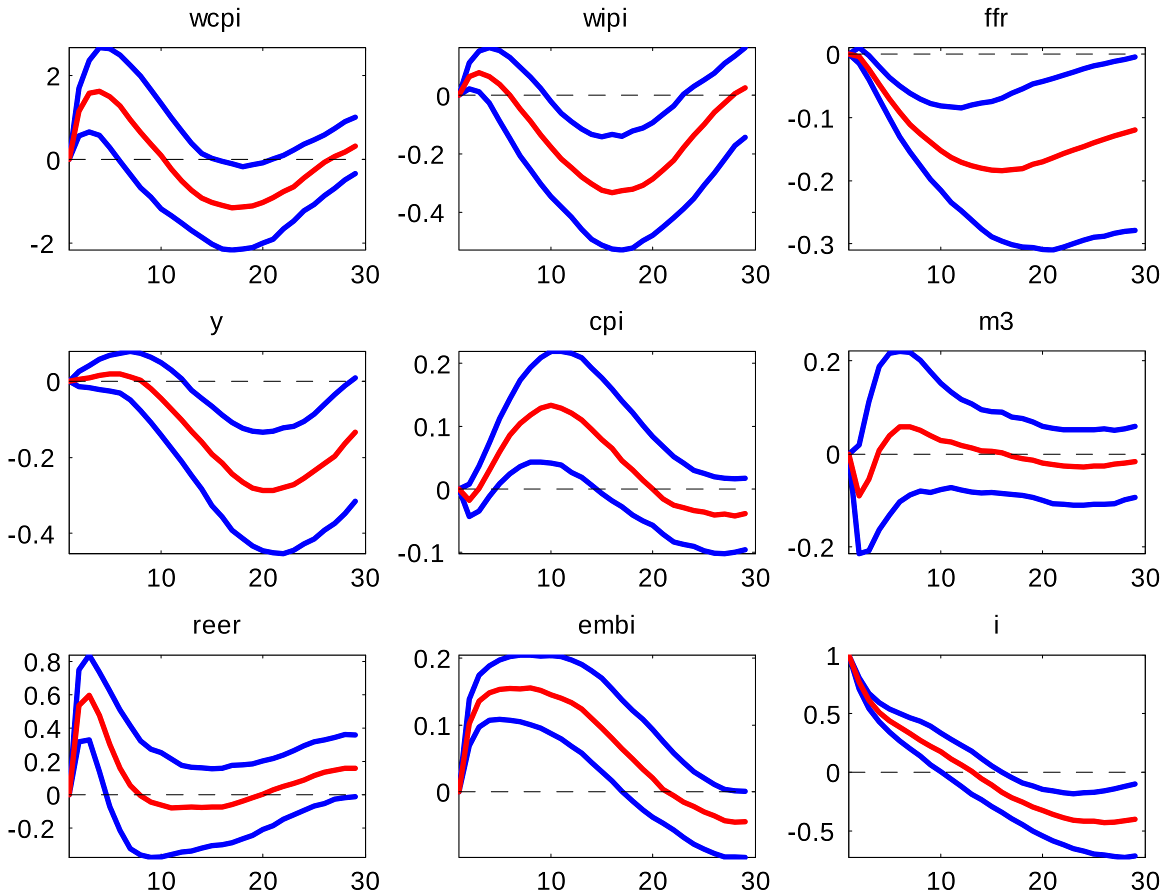

Figure 3: Impulse Responses to a Positive Interest Rate Shock under Choleski Decomposition

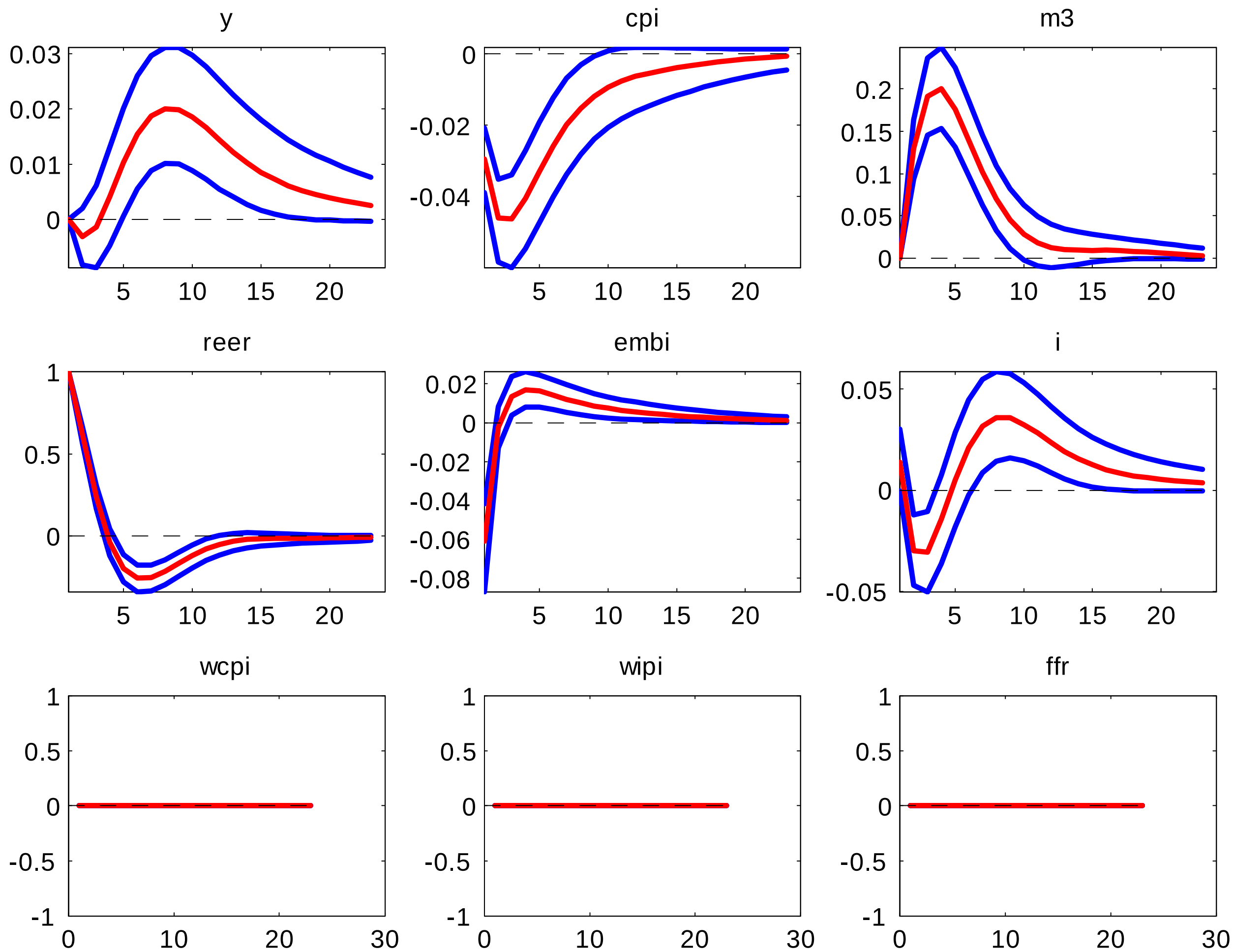

Figure 4: Impulse Responses to a Positive Real Exchange Rate Shock

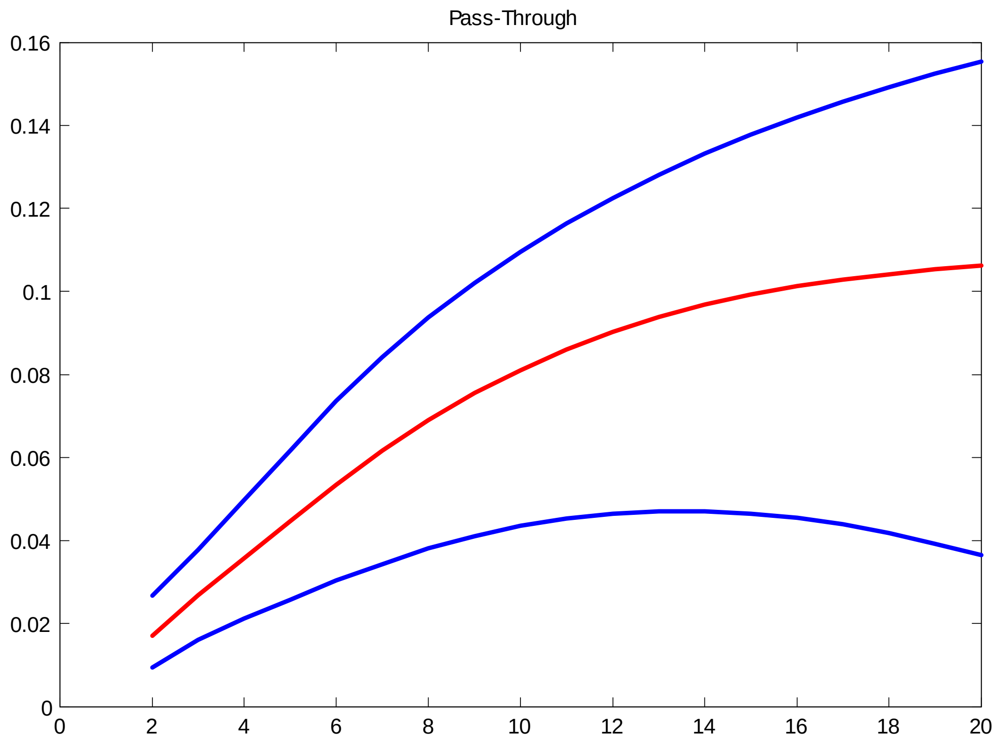

Figure 5: Exchange Rate Pass-through effect on Inflation from Nominal Exchange Rate Changes

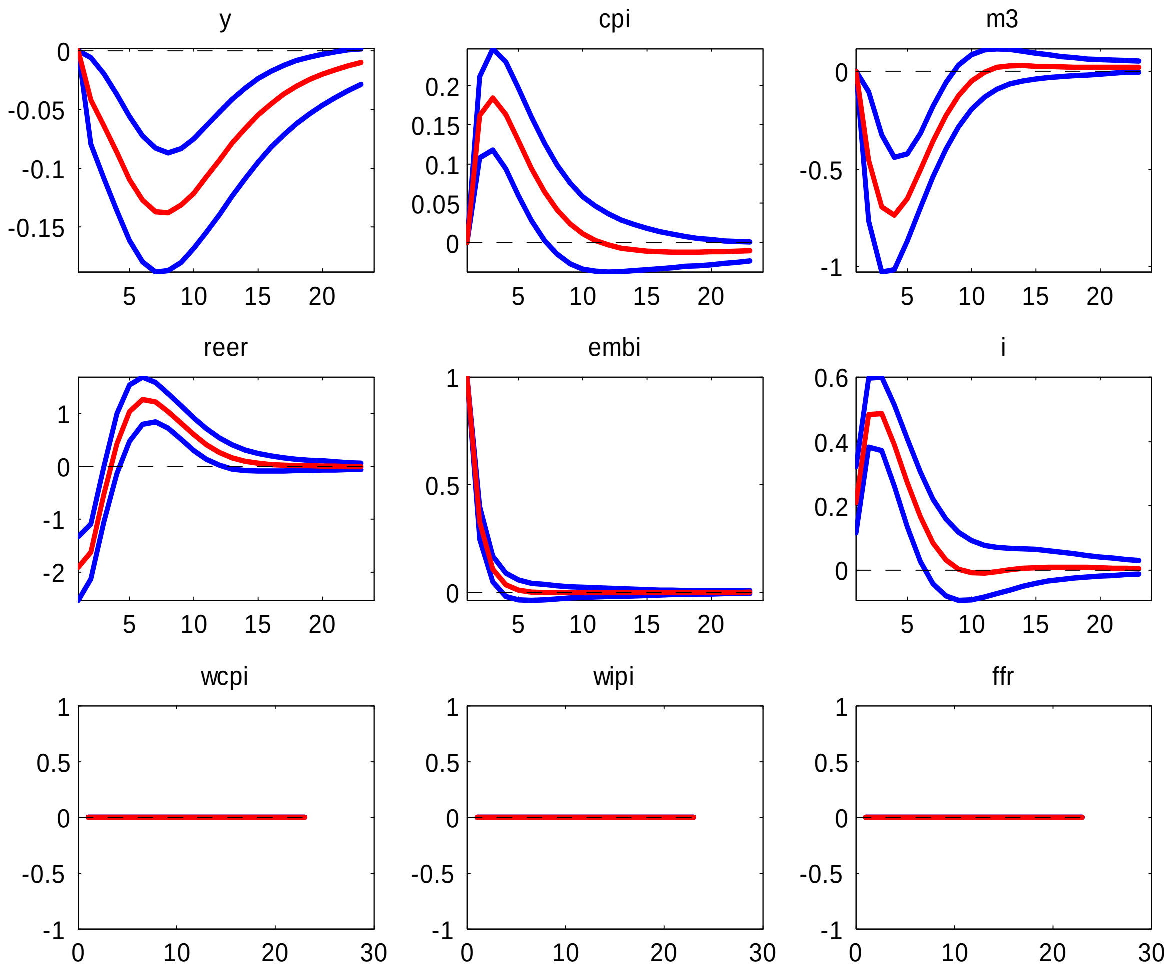

Figure 6: Impulse Response to a Positive EMBI Shock

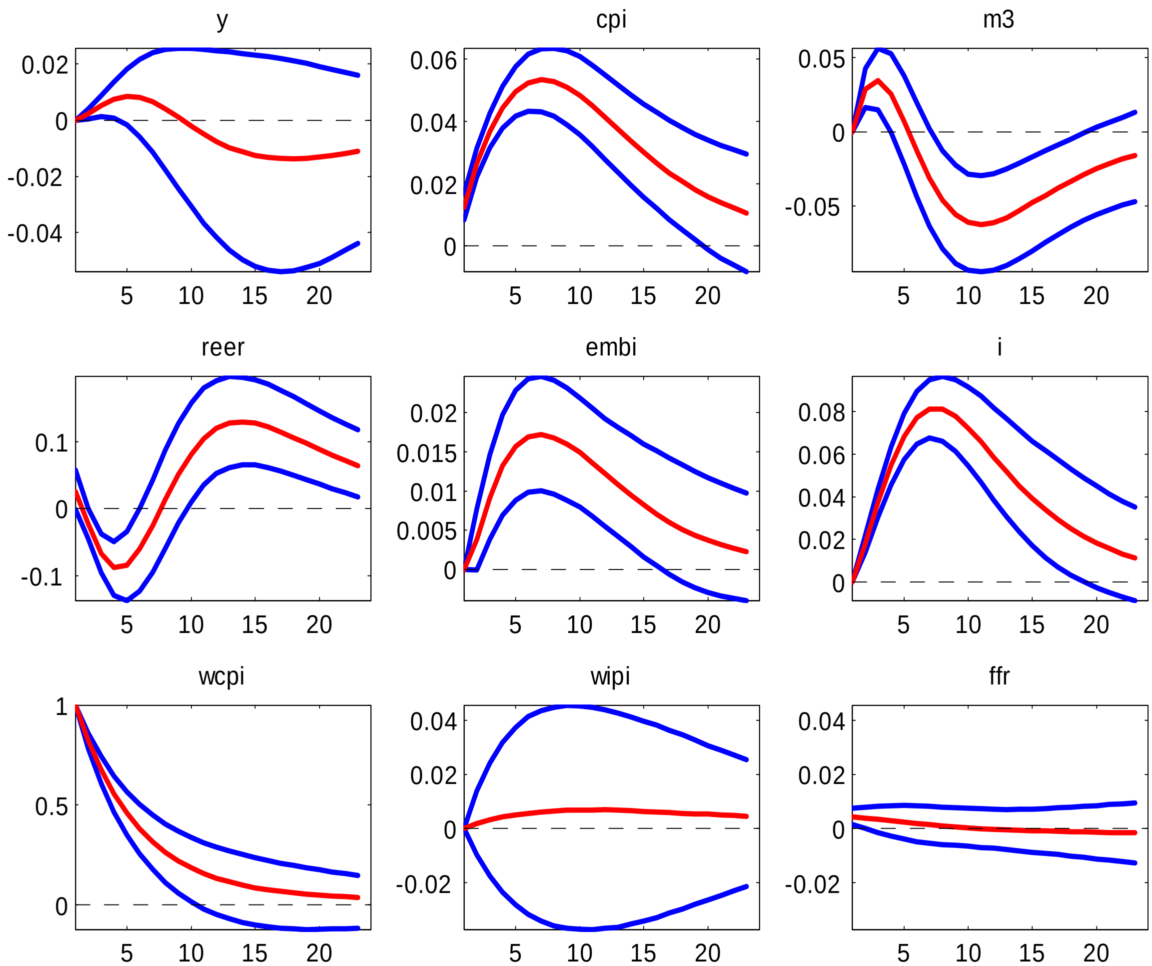

Figure 7: Impulse Response to a Positive WCPI Shock

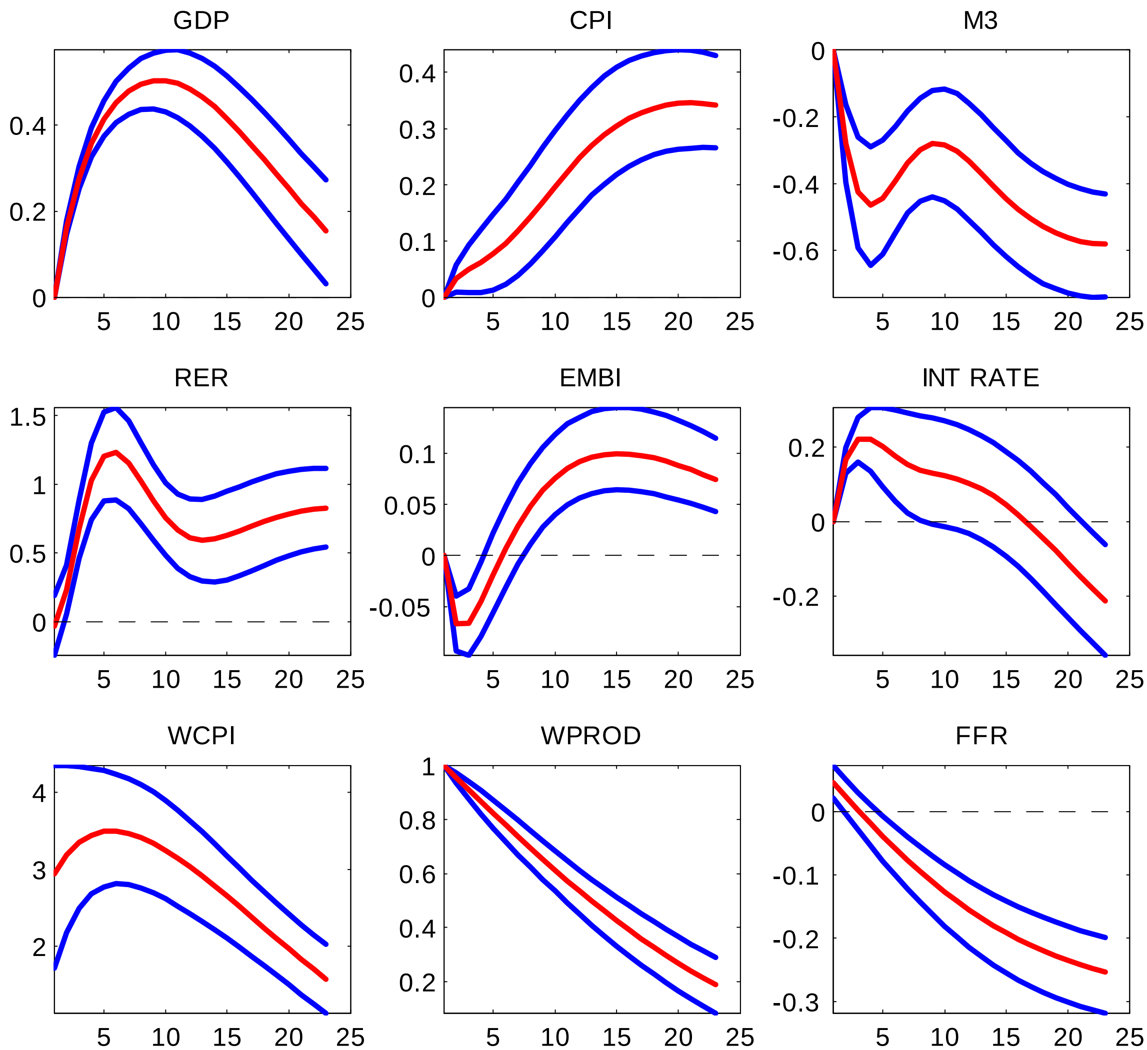

Figure 8: Impulse Response to a Positive WIPI Shock

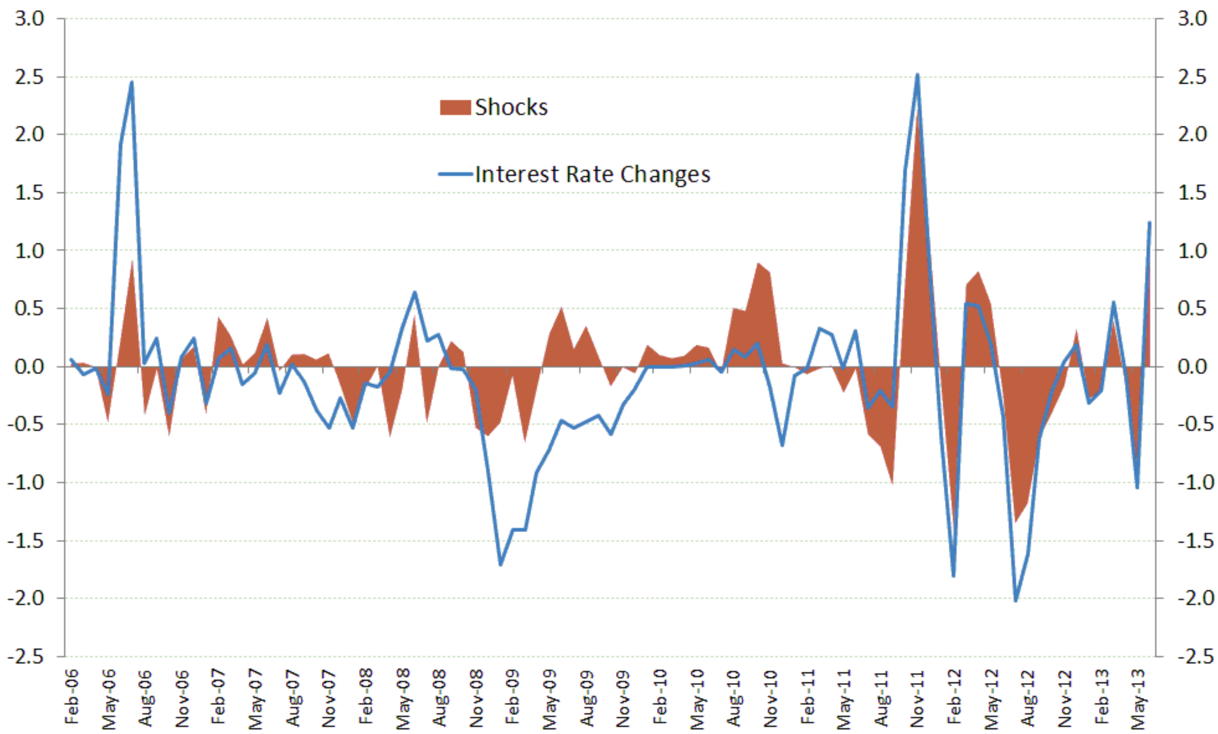

Figure 9: Interest Rate Changes from Data and Shocks from SVAR Model

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