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How Effective Are Macroprudential Policy Instruments? Evidence from Turkey

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Abstract: This study provides an empirical analysis of the two macroprudential instruments, namely the reserve option mechanism and the interest rate corridor, employed by the Central Bank of the Republic of Turkey in the aftermath of the global financial crisis. A nine-variable structural vector autoregressive model for Turkey is estimated with Bayesian techniques utilising data from October 2010 to May 2018. A set of timing, zero and sign restrictions are imposed to identify the reserve requirement and the interest rate shocks through the bank lending channel. The results reveal that the new policy frame is efficient in curbing the volatility in the exchange rates and in improving the current account balance. While the reserve requirements seem to be more effective on the current account and partly on the exchange rate, the interest rate fares better in controlling the price level.

Keywords: Bayesian vector autoregression; macroprudential policy; reserve requirements; interest rate corridor; reserve option mechanism

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1. Introduction

Emerging countries have enjoyed ample capital flows from industrialised countries through financial globalisation since the 1980s so much so that international financial integration was regarded as a touchstone in the development of emerging countries (Obstfeld 2004). With deepening financial linkages, capital flows to emerging countries have increased even more so during the last two decades. However, financial globalisation is not a rose without the prick. Research documents that financial integration it increased the volatility of capital flows and the vulnerability of small open economies to financial crises (Grosse 2004; Martin and Rey 2006; Lane 2013). The Mexican crisis in 1994, the Asian Crisis in 1997, the Russian Crisis in 1998, the Argentine crisis in 2001 and the Turkish crises in 1994 and 2001 are among the notable financial crises resulting from volatile capital flows (Mishkin 1999, 2001). It would not be an overstatement to assert that financial crises in emerging countries resulting from volatile capital flows are rampant in the history of financial globalisation (Mendoza 2006).

Financial crises have occurred almost periodically in recent decades but the global financial crisis of 2008 exhibits a turning point in the central banking practises of both advanced and emerging countries. In order to promote spending, pioneered mainly by the Fed and the ECB, the policy rate was lowered almost to zero and the balance sheet size of central banks grew incrementally in advanced economies as a consequence of quantitative easing (IMF 2013a, 2013b, 2013c). Capital flows from advanced countries to emerging economies increased substantially, being mostly short-term and volatile in nature, due to the policy uncertainties in advanced countries at the time (Basci and Kara 2011).

Large and volatile capital flows, if not managed accordingly, trigger excessive credit growth and increase the risk of financial instability. Concentrated solely on inflation stabilisation and armed with the conventional interest rate tool, the ordinary response of the central banks of raising interest rates does not stop the credit boom but rather attracts

more capital. As a response, the domestic currency appreciates, the improved balance sheet of borrowers promotes further expansion in credits, the current account balance deteriorates and, in turn, macroeconomic instability worsens (Calvo 1998; Mendoza and Terrones 2008; Bruno and Shin 2013, 2014). In this regard, the reserve requirements made a flash return to the stage as a macroprudential tool in order to tighten credit conditions without attracting more capital, especially in emerging economies, such as Brazil, Croatia, Russia and Turkey (Lim et al. 2011).

After being hit heavily by the crisis and experiencing a 15 percent contraction in 2009, the Turkish economy experienced a dramatic increase in capital flows in the following years, owing to quick economic recovery and strong domestic demand (Kara 2012). Not surprisingly, the outcome was an expansion in domestic credit, an excessively appreciated currency and a deteriorated current account.

Amid increasing macro financial concerns towards the end of 2010, the CBRT announced a change in its policy stance and mentioned the use of alternative policy instruments for the first time. First, it stopped paying remuneration for the required reserves and started to use the reserve requirement ratio actively to contain the risk of credit growth. Later, it designed the Reserve Option Mechanism (ROM) (Alper et al. 2012) aimed at stabilising the exchange rates. Second, the CBRT announced the one-week repo as the main policy instrument for funding, while the overnight borrowing and lending rates functioned as the lower and upper bound of the interest rate corridor (Basci and Kara 2011; Kara 2015). The interest rate corridor was mainly aimed at controlling the short-term speculative capital flows.

The operational framework of the two new policy tools is summarised below. The ROM allows banks to hold a certain fraction of their Turkish lira reserve requirements in foreign currency or, as implemented later, in gold. During periods of excessive capital inflow, banks can increase their use of ROM and hold foreign currency in place of TL reserve requirements up to a certain threshold. On the other hand, they are allowed to decrease the use of ROM during the capital outflow periods. So, the ROM is a market-friendly mechanism which helps to stabilise the volatility in the exchange rates. The other novel tool, the interest rate corridor, works principally by creating an uncertainty zone between the lending (upper bound) and the borrowing (lower bound) rates of the central banks. Reducing the lower limit of the corridor during the capital inflow periods discourages the foreign capital, while increasing the limit during the capital outflow periods holds its surge. Therefore, the corridor maintains the smoothing of foreign capital flow. The main incentive of the CBRT in employing these additional tools was to increase the resistance of the economy against volatile capital flows, therefore containing the credit growth and maintaining the external balance (Kara 2012; Oduncu et al. 2013; Aysan et al. 2014).

In this study, we provide some empirical evidence on whether the new policy mix, in particular the reserve option mechanism (ROM), has been successful in containing the key macroeconomic variables such as domestic credit conditions, the external balance, the exchange rate and domestic inflation and in promoting macroeconomic activity. Turkey constitutes a splendid example for this study: first, it is one of the hardest hit countries by the crisis. Second, it devised the monetary policy and started to implement two novel monetary policy tools right after the crisis. Third, it has a long history of homogeneous monetary policy practice since 2000 (beginning of inflation targeting regime). The homogeneous monetary policy period is important for empirical research because the reserve requirements would have different effects if the central bank had different targets other than interest rates (Glocker and Towbin 2015).

The outline of the study is as follows: Section 2 reviews the related literature. Section 3 introduces the data and the methodology. In Section 4, we present our main empirical findings including impulse response functions and forecast error variance decompositions. Section 5 discusses the results and Section 6 concludes.

2. Literature Review

The global financial crisis sparked by the subprime mortgage crisis in the US resulted in quantitative easing (QE) in many large economies. Interest rates in several countries approached the Zero Lower Bound (ZLB), which drove central banks to consider macroprudential policies (Kahou and Lehar 2017; Mester 2017). Papadamou et al. (2020) provide a recent review of the literature that burgeoned in this time period.

Quantitative easing policies by advanced economies constitute the bulk of this literature. The reader is referred to Martin and Milas (2012) for an early and Thornton (2017) for a more recent review. The spill-over effects on emerging countries have also received significant attention as many emerging economies experienced financial instability due to large and volatile capital flows as a direct consequence of QE in advanced economies. Bhattarai et al. (2021) show that QE policies have increased capital flows to emerging countries and especially to the Fragile Five group which Turkey belongs to. Belke and Fahrholz (2018) and Bartkiewicz (2018) review the empirical literature on the spill-over effects on QE policies on emerging economies. Turkey was one of the recipients of large capital inflows and responded by initiating a new monetary policy framework utilising macroprudential instruments. However, according to Lombardi and Siklos (2016), Turkey did not present a strong capacity to deploy macroprudential policies.

Reserve requirements are one of the macroprudential instruments utilised by the monetary authority of Turkey as well as of other advanced or emerging countries. Curdia and Woodford (2011), for instance, study the contribution of reserve remuneration under the zero lower bound. Kashyap and Stein (2012) analyse the role of reserve requirements in search of an optimal monetary policy and its use as a financial stability tool. Both studies are on advanced economies and suggest that the reserve requirement has re-emerged as a financial stability tool in the post crisis period. Studies on emerging countries mostly focus on the behaviour of the banking sector, such as the impact of reserve requirements on the banking spreads and the credit growth (Herrera et al. 2011; Glocker and Towbin 2012; Tovar et al. 2012; Armas et al. 2014) and are lacking in the effects on other aggregate or external factors, such as GDP, unemployment, current account, or inflation. Alternatively, Glocker and Towbin (2015) provide a broadly-based analysis of reserve requirements and investigate the joint dynamics of the basic macroeconomic variables, which also motivates our study. Lubis et al. (2021) also investigate the effect of reserve requirements as a macroprudential instrument on macroeconomic variables of the Indonesian economy but employ a different methodology.

Reserve requirements as a macroprudential instrument in Turkey has also received the attention of scholars, especially in the first couple of years of the implementation of the new policy mix. The most notable examples are as follows: Alper et al. (2014) focus on the interaction between reserve requirements and the bank lending behaviour. Aslaner et al. (2015) and Oduncu et al. (2013) analyse the reserve requirement policy in Turkey by the reserve option mechanism (ROM) and both follow a partial equilibrium approach. Other papers explain the effectiveness of reserve requirements as a macroprudential tool. Among them, Sahin et al. (2015) emphasise the supportive effect of the ROM in controlling the capital flow and emphasise the complementary effect of reserve requirements in reducing the capital flows. Değerli and Fendoğlu (2015) prove its stabilising role on the excessive movements of the exchange rate. In a more recent study, Binici et al. (2019) employ reserve requirements as an additional variable in order to explain the private bank's lending and borrowing behaviour rates during the QE period and underline the significance of reserve requirements on commercial loan and deposit rates.

Like the literature on emerging markets, the literature on Turkey has almost entirely focused on the effect of reserve requirements, as a macroprudential instrument, on the banking sector and short-term financial indicators. Varlık and Berument (2016) include industrial production and imports in their VAR and this constitutes an exception. However, the sample covers the period from January 1992 until May 2013 which cannot be characterised as a period of homogeneous monetary policy practice. Moreover, it only covers the

initial period of macroprudential policy practice. Varlık and Berument (2017) investigate the effect of different monetary policy rates on economic performance including the upper and lower bounds of the interest rate corridor, which constitutes another exception. Our study is a contribution to this literature and complements it in two important ways. First, it is a contribution to the impact of macroprudential policy on the macroeconomy and not only on the banking or financial sector. In this sense, we contribute to the literature on macroprudential policy in emerging markets as well. Second, we analyse the entire period when the macroprudential mix was in place rather than focusing on the initial years and study both macroprudential instruments.

3. Data and Methodology

Macroeconomic variables usually have a contemporaneous relationship between endogenous variables, so the vector auto-regression (VAR) estimation in reduced form is incapable of revealing how the endogenous variables affect each other as the reduced form residuals are not orthogonal. The seminal work of Sims (1980) introduced the structural vector autoregressive (SVAR) framework to capture interdependencies between endogenous variables. Nevertheless, the SVAR model cannot be estimated directly because of the feedback effects from contemporaneous variables. The reduced-form VAR, on the other hand, contains predetermined time series and can be estimated. So, it is possible to start with a reduced-form model and retrieve the structural parameters and shocks by imposing identifying restrictions on the parameters in the coefficient and residual covariance matrices.

In order to estimate the model we used a Bayesian methodology. We imposed a set of timing, zero and sign restrictions in a nine-variable structural vector auto-regression (SVAR) system to identify the reserve requirement and the interest rate shocks. We followed the method introduced by Arias et al. (2014) by using the notation borrowed from Dieppe et al. (2016). We started by writing the reduced form of the estimated model as:

$$y_t = \Psi x_t + \sum_{i=1}^{p} A_i y_{t-i} + e_i \quad \text{with } e_t \sim N(0, \Sigma) \quad t = 1, \ldots, T \tag{1}$$

where, $y_t = (y_{1,t}, y_{2,t}, \ldots, y_{n,t})$ is an $n \times 1$ vector of endogenous variables, x_t is an $m \times 1$ vector of exogenous variables (constant terms, time trends, exogenous data series), ε_t is a reduced-form error term with variance covariance matrix Σ, p is the lag length, $(A_1, A_2, \ldots\ldots A_p)$ are $n \times n$ coefficient matrices and C is an $n \times m$ coefficient matrix.

Next, we specified the model in structural form.

$$D_0 y_t = F x_t + \sum_{i=1}^{p} D_i y_{t-i} + \eta_t \quad \text{with } \eta_t \sim N(0, \Gamma) \quad t = 1, \ldots, T \tag{2}$$

η_t is a vector of structural innovations with variance covariance matrix Γ. For notational purpose define $D = D_0^{-1}$ and pre-multiply both sides of Equation (2) by D:

$$A_i = DD_i \tag{3}$$

$$C = DF \tag{4}$$

$$\varepsilon_t = D\eta_t \tag{5}$$

The one step ahead prediction error ε_t is where we looked to understand how structural shocks are transmitted through the economy. The method used to decompose ε_t into economically meaningful forms in order to understand this transmission mechanism deserves special attention. Equation (5) represents ε_t as a linear combination of orthonormal structural shocks $\varepsilon_t = D.\eta_t$, where suppose $E(\eta_t \eta_t') = I_n$ and D is the impact matrix of each structural shock. In this representation D serves as a structural matrix and helps to recover structural innovations from the reduced-form VAR residuals. In other words, the matrix D shows the immediate response of endogenous variables to one standard

error innovation in ε_t. The only restriction on the matrix D comes from the form of the variance-covariance matrix:

$$\sum = E\left[\varepsilon_t \varepsilon_t'\right] = E\left[D\eta_t \eta_t' D'\right] = DD' \quad (6)$$

This equation gives us as many as $n(n-1)/2$ degrees of freedom in specifying D matrix (given n^2 elements of D to identify, and $n(n+1)/2$ restrictions from Σ, there remains $n(n-1)/2$ restrictions to identify D matrix). Since the current restrictions on D matrix were not enough to identify the shocks to ε_t, we needed further restrictions on D. As discussed in detail in Section 3.2, in order to identify the reserve requirement and the interest rate shocks, we applied a combination of sign and zero restrictions as proposed in Uhlig (2005) and followed the algorithm as presented in Arias et al. (2014).

3.1. Data

The CBRT started to employ macroprudential instruments in the last quarter of 2010 when the aftershock of the financial crisis started to come ashore in Turkey. Following an intense implementation of this multi-tooled monetary policy, as the global economic outlook started to normalise, the country announced its roadmap to simplify the monetary policy implementation in August 2015 (CBRT 2015). The main incentive of this simplification was to form a more predictable monetary policy to improve the expectations of the economic agents. As of May 2018, the CBRT completed the simplification period and the interest rate corridor was abolished. Moreover, the active use of the ROM has been diminished gradually, and the CBRT declared that it will end its usage in 2022[1] (CBRT 2018).

We used monthly data from October 2010 to May 2018, in which both instruments were actively used, in order to capture not only the effect of each policy instrument on the economy but also to analyse the interaction between them. While the time span does not seem to be very long, the period contains adequate data to judge the effectiveness of the new policy approach with Bayesian methodology. Besides, given our sample size, we formulated a SVAR model that could capture the effects of the reserve requirement policy shocks and the interest rate shocks with a minimum number of variables. The endogenous variables include unemployment (U), the consumer price index (CPI), the current account (CA), the spread between deposit and the lending rates (SPRD), the bank credits (CRED), the bank reserves (RSRV) and the exchange rate (USD) and two variables that are directly related to the new macro-prudential policy mix: a measure for the reserve requirement policy (RR) and the overnight interest rate (ON)[2]. The lag length was chosen as one based on the following standard tests for choice of lag length: Likelihood Ratio test (LR), the Final Prediction Error (FPE), Akaike Information Criterion (AIC), Hannan-Quinn Information Criterion (HQ) and Schwarz Information Criterion (SC). At this lag length, the null hypothesis of no autocorrelation could not be rejected by the Lagrange Multiplier (LM) test. Based on the outcome of the seasonality tests[3], the consumer price index, the current account and the real credit were seasonally adjusted with the Tramo/Seats method.

We included the volatility index (VIX), the Industrial Production Index for the European Union (IP), the commodity price index (CP) and the US Federal Funds rate (FED) as exogenous variables to capture the external effects on a small open economy, Turkey. The exogenous variables were entered into the model with two lags and the vector of exogenous variables also included a time trend as a deterministic variable.

We tested the stationarity of our variables and provided the unit root test results as Supplementary Materials. We conducted in total six unit root tests: Augmented Dickey Fuller (ADF) unit root test with an intercept and with or without a trend term, Phillips-Perron (PP) unit root test with an intercept and with or without a trend term and the Kwiatkowski–Phillips–Schmidt–Shin (KPSS) unit root test with an intercept and with or without a trend term. All six unit root tests unanimously found that CPI, domestic credit (CRED), reserves (RSRV), exchange rate (USD) and federal funds rate (FED) are nonstationary. The results of the rest of the variables were mixed. Even though the analysis employed non-

tionary macroeconomic data, we used all variables in levels as recommended in Sims (1980) and Sims et al. (1990), discussed in Enders (2010, p. 303). Fanchon and Wendel (1992), Christiano et al. (1999), Uhlig (2005) and Binatli and Sohrabji (2019) are examples of VARs with nonstationary macroeconomic variables in levels. Carriero et al. (2015) further analysed Bayesian VARs with possibly nonstationary macroeconomic variables in levels along the lines of Sims (1980) and concluded that modelling choices lead to very small losses in forecasting power, thus making BVARs a versatile econometric tool.

3.2. Identification of Structural Shocks

The main question here was how to formulate a reliable identification scheme. There are several methods of identification in the VAR literature. The recursive approach (Cholesky ordering) imposes short run restrictions on model parameters and assumes that the central bank does not influence the fast-moving variables in the short run (as implemented by Fatas and Mihov (2001) and Tovar et al. (2012)). The sign restriction approach imposes restrictions on impulse response functions (as in Mountford and Uhlig (2009) and Glocker and Towbin (2015)), whereas the narrative approach imposes restrictions on the structural parameters in line with the key historical events so as to ensure that the structural shocks represent those episodes (Federico et al. 2012; Antolín-Díaz and Rubio-Ramírez 2018; Rojas et al. 2020).

In our identification scheme, we imposed timing, zero and sign restrictions on impulse response functions to identify the reserve requirement shock and the interest rate shock. We followed economic theory and used exact identification, which resulted in more accurate impulse response functions and a unique D matrix for a given parameter estimate.

A positive reserve requirement shock will trigger an increase in bank reserves and in reserve requirements. The theory behind this reaction is that the central bank needs to increase the nominal reserves in order to compensate for the upward pressure of reserve requirements on the policy rate.

A positive interest rate shock on the other hand reflects an increase in prices and a reduction in bank reserves. The implementation of an interest rate rise is executed by withdrawing money, which results in lower reserves. We further propose that the price level responds negatively in the second period to eliminate the price puzzle (Sims 1992; Christiano and Eichenbaum 1992).[4]

In order to identify the two policy shocks of the CBRT, we followed Glocker and Towbin (2015) and defined a block of slow-moving variables which responded to policy shocks with delay. This block of slow-moving variables included unemployment, the price level and the current account. The fast-moving variables on the other hand responded to shocks within a month and included the nominal exchange rate, total credit, bank reserves and the spread. The timing (or zero) restrictions were imposed on the slow-moving variables for one month and the sign restrictions were imposed on the fast-moving variables for three months. Where there was not a consensus on the response of the variables, the response was left unrestricted and an agnostic approach was accepted; the impulse responses were determined by the estimated model. The identification restrictions are summarised in Table 1.

In order to impose the zero, timing and sign restrictions, we exploited the BEAR toolbox (Dieppe et al. 2016), which followed the same algorithm as presented in Arias et al. (2014). In Bayesian framework D is regarded as a random variable, like parameters of the VAR system. Therefore, the algorithm drew the impact matrix D from the posterior distribution of structural parameters conditional on zero restrictions and applied the QR decomposition $D = QR$. Each column of the Q matrix was selected recursively by standard normal distribution on R^n. The recursive selection of Q matrix proved that it was selected from a uniform distribution of the posterior of structural parameters conditional on zero restrictions. If the sign restrictions were satisfied the draw was kept. The procedure proceeded until the required number of draws was obtained. In our study, the algorithm worked until 1000 accepted draws were obtained.

Table 1. Identification restrictions.

Variable	RR Shock	Interest Rate Shock
U	0	0
CPI	0	$\leq$0
CA	0	0
SPRD	0	0
RR	$\geq$0	•
ON	•	$\geq$0
CRED	•	•
USD	•	•
RSRV	$\geq$0	$\leq$0

Note: We imposed zero restrictions to only the first month and the sign restrictions were applied to the first quarter. The response of the CPI to an interest rate shock was left agnostically open in the first month and the sign restriction was applied in the second and the third month. For the definitions of the data, see Appendix A.

The prior selection is another important stage of the Bayesian VAR analysis. Since the literature lacks adequate previous study using Bayesian techniques to analyse the reserve requirement and the interest rate policy in Turkey, there are no ready-to-use priors to rely on. Therefore, we employed the analysis for Minnesota prior, Normal-Wishart prior and Independent Normal-Wishart prior, which are the benchmark priors in Bayesian VAR. The analysis presented in this study is based on the Minnesota prior which assumes that each variable follows a random walk and thus is appropriate for our sample with nonstationary variables.[5]

4. Empirical Findings

We display the impulse response functions iterated by using the identification scheme given in Table 1. Each response function displays the response of the given variable to a one standard deviation in the relevant shock. The solid blue line shows the median responses and the shadowed area around the line is 16% and 84% quantiles. Therefore, the shadowed area corresponds to a 68 percent credibility interval of the response.[6]

Impulse response functions to a reserve requirement shock are presented in Figure 1. The responses are largely in line with the literature and with the expectations from new policy tools implemented by the CBRT. With respect to the credit market, the spread rises for about seven months and the response stays positive for more than a year after a reserve requirement shock, which is a reasonable response considering the implicit tax effect[7]. Domestic credit is slow to respond initially but eventually declines sluggishly after about eight months and remains so for two years. Alper et al. (2014) also noted that domestic credit remained stable in the initial months of the monetary tightening cycle. The response of domestic credit is slow and limited but persistent.

The exchange rate shows a fractional decline as an immediate response and wanders around the zero axis over the scope. We observe a distinct improvement in the current account which lasts for nearly one year.

The price level shows an insignificant downward response while the unemployment rate decreases slightly over a period of more than one year. The decline in the unemployment rate, although theoretically unexpected, reflects the dynamics of the Turkish economy in the period under study.

The increase in the reserves shows that the reduction in the bank reserves following an increase in the reserve requirement is compensated by the central bank but the increase in the policy rate further reveals that it performed only partially.

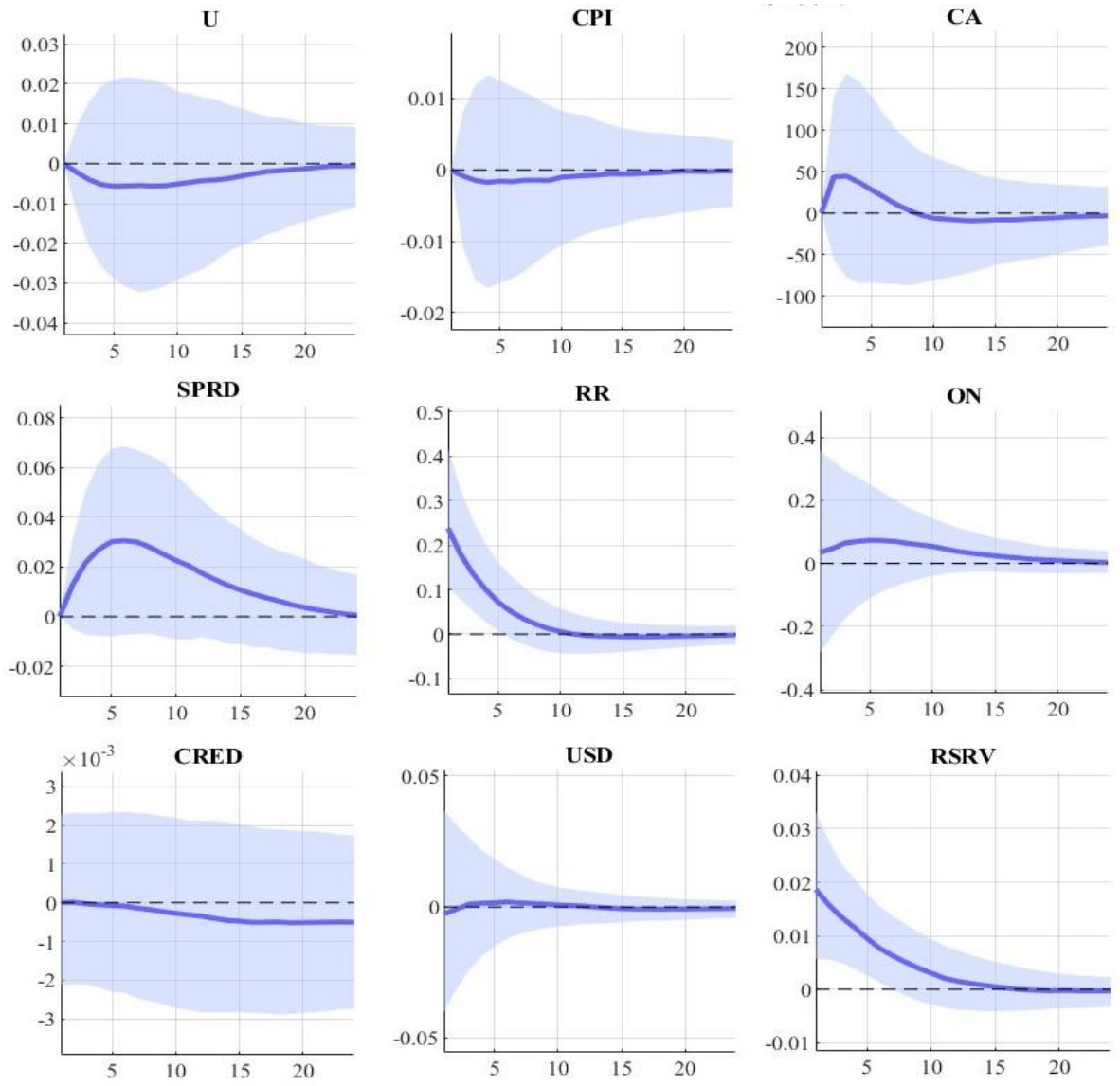

Figure 1. Responses to the reserve requirement shock.

Impulse response functions to an interest rate shock are presented in Figure 2. The responses are again consistent with the literature. We will compare our results with those of Glocker and Towbin (2015) for Brazil, since this is the most comparable analysis to ours given the methodology and the range of variables studied. In response to an increase in the overnight interest rate, which is the interest rate around which the corridor is constructed, the price level falls significantly, which shows that the identification scheme overcomes the price puzzle. A trough is reached after three months and this level is maintained for almost a year. In Glocker and Towbin's (2015) analysis of Brazil, the price response to an interest rate shock is similar but lasts much longer: a trough is reached after a year and it takes another 18 months to die out.

Regarding the external variables, the nominal exchange rate appreciates only infinitesimally and then navigates around the zero axis. The response in Brazil is an initial appreciation of 5% and the currency does not depreciate back to its initial level for almost a year. The interest rate shock in Turkey does not help increase the value of the currency but only helps maintain it. The current account turns back to its balance after a slight deterioration for about one year, which is again an expected reaction. In comparison to Brazil, we again note that the response is faster and shorter lived. Surprisingly, the unemployment rate does not increase after a tightening of the monetary policy. This response of the unem-

ployment rate is in line with our expectations since Turkish economy displayed a strong recovery after a short depression in 2009[8] due to strong domestic and external demand.

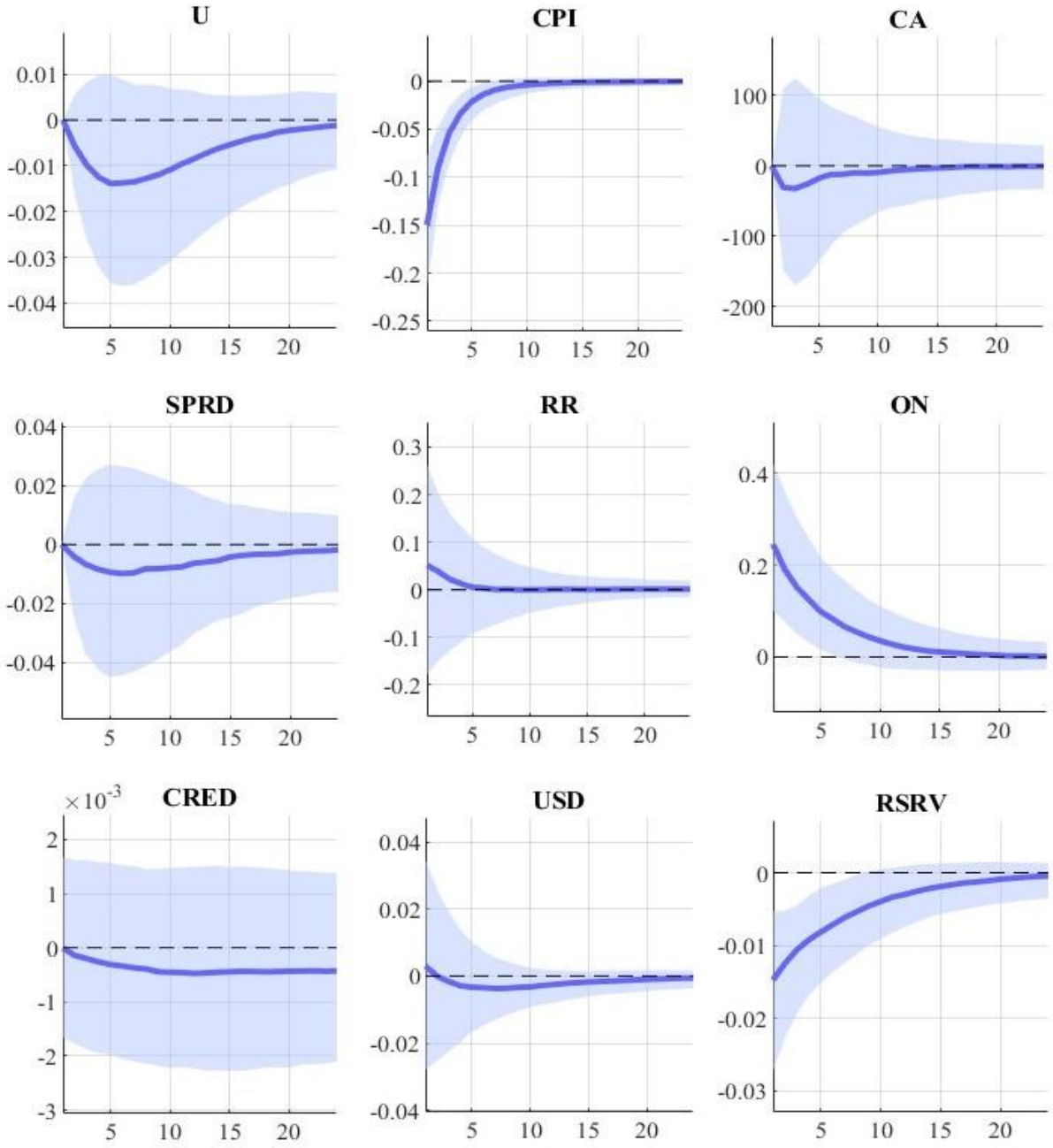

Figure 2. Responses to the interest rate shock.

The credit market shows an expected response so that the credit shrinks after the contractionary effect of the increase in the policy rate. The spread declines as the overnight rate increases which can be explained by the findings of Binici et al. (2019). They show that the overnight rate has an asymmetric effect on loan rates, affecting corporate loan rates more strongly than consumer loan rates.

Figure 3 shows the forecast error variance decomposition for the reserve requirement and the interest rate shocks, depicting what proportion of the variance in the variables is explained by each shock. In other words, the forecast error variance decomposition represents the importance of the intended shock on the variables and reveals the transmission mechanism of these policy tools.

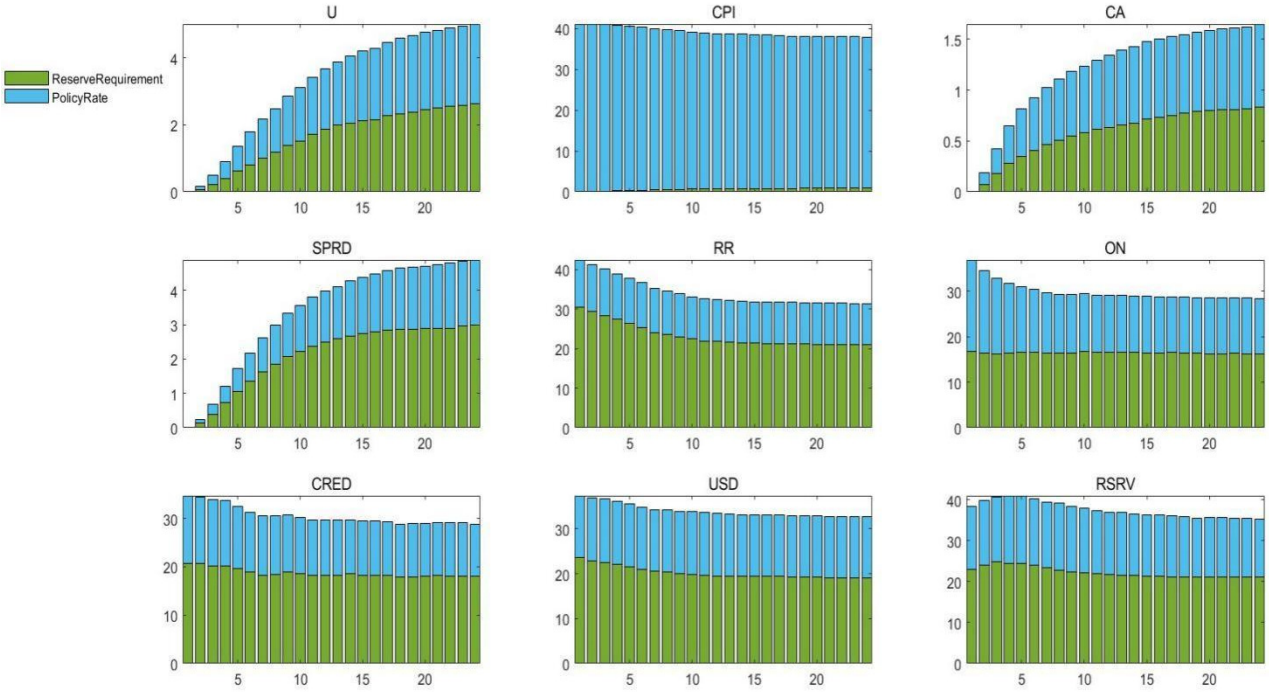

Figure 3. Forecast error variance decomposition.

After 24 months, both the reserve requirement and the interest rate shocks no longer have a significant effect on the variations in unemployment and the current account, about 2% and 1% respectively. Most of the variation in the consumer price index is explained by interest rate shock, which is to be expected from a contractionary monetary policy. The effect of the reserve requirement shock on the spread is surprisingly lower than what the theory predicts, about 3% over the two year horizon. This result may be attributed to indirect effects of other macroeconomic variables on the spread other than the reserve requirement shock. The main incentive in employing the two monetary policy tools was to contain credit growth and the volatility in the exchange rate. The results reveal that expectations are realised. The variations in domestic credits and the exchange rate are explained by the reserve requirement and the interest rate shocks to a large degree.

To further investigate the robustness of our findings, we use the weighted average funding cost as the interest rate (WAFC), the headline consumer price index (CPI) and the producers price index (PPI) instead of CPI-D. The responses to both shocks are robust to the use of these alternative measures. These results are not presented here but they are provided as Supplementary Materials.

5. Discussion

Our results are directly comparable to those of Glocker and Towbin (2015) for Brazil since both the methodologies and the range of variables studied are similar. Turkey and Brazil also share similarities regarding external risks. In Brazil, the response of the spread to a reserve requirement shock is almost identical. The response of domestic credit is immediate in contrast, but otherwise very similar, that is small in magnitude but persistent. So, in both Turkey and in Brazil, tightening lending conditions are observed after a positive reserve requirement shock. In Brazil, an improvement in the current account is observed accompanying a depreciation of the currency. In Turkey, the reserve policy which enables banks to keep reserves in foreign currency makes it possible to improve the current account without a change in the value of the currency.

A reserve requirement as a macroprudential tool is successful in stabilising the economy and reducing unemployment. Glocker and Towbin (2015) found that unemployment

in the Brazilian economy responds differently to a reserve requirement shock. Monetary tightening increases unemployment in Brazil.

The response of the Turkish credit market is qualitatively identical to the response of the Brazilian credit market but there are important differences as well. The fall in the spread is corrected after 10 months in Brazil but it takes twice as long in Turkey. The responses of the Turkish economy generally mean a faster return to pre-shock levels irrespective of the type of shock, but the response of the spread seems to be an exception which may be explained by the asymmetric effect of the overnight rate on loan rates.

6. Conclusions

In this paper we utilised a Bayesian Structural Vector Autoregression (SVAR) model with sign and zero restrictions in order to analyse the capability of the new policy tools, namely the reserve option mechanism (ROM) and the interest rate corridor, of the Central Bank of the Republic of Turkey in restraining the harmful effects of the post-crisis period on the Turkish economy. The intended purpose of employing these tools was to control the exchange rate, the current account and limit credit growth to maintain the financial stability. The results reveal that the new policy frame is efficient in curbing the volatility in the exchange rates and in improving the current account balance. While the reserve requirements seem to be more effective on the current account and partly on the exchange rate, the interest rate is explicitly better in controlling the price level and credits. In this regard, the reserve option mechanism cannot be assumed as an alternative to the interest rate but rather functions as a supplementary instrument for achieving financial stability. Moreover, the results show that the new policy framework is efficient in curbing the adverse effects of volatile capital flows, at least during the period in which it is intensely implemented.

As discussed in the literature[9], financial stability is a much broader concept than price stability, which necessitates the involvement of other regulatory authorities in policy making or restructuring the central banks to support financial stability. Therefore, at least in the Turkish case, we conclude that a comprehensive policy approach is needed to curb credit growth in order to maintain financial stability in periods of high capital inflow, which remains to be analysed in future work.

The policies implemented by the Turkish Central Bank in the aftermath of the global financial crisis represent a bold and novel policy framework that has had at least some of the intended consequences in periods when it was intensely used. The active use of this policy ended in May 2018. The Turkish economy exhibited negative growth in the last quarter of 2018 and the subsequent two quarters. The next year the COVID-19 pandemic wreaked havoc through the global economy as well as the Turkish economy. As the pandemic is considered to be over in many countries as well as in Turkey, the Turkish economy is experiencing much higher inflation than the rest of the world. The Turkish lira is very volatile and has depreciated by 60 percent between September 2021 and February 2022.[10] Monetary policy could have an important role to play in stabilising the Turkish economy during these turbulent times.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/economies10040076/s1, Figure S1: Robustness Check (PPI-RR); Figure S2: Robustness Check (PPI-ON); Figure S3: Robustness Check (CPI-RR); Figure S4: Robustness Check (CPI-ON); Figure S5: Robustness Check (WAFC-RR); Figure S6: Robustness Check (WAFC-ON); Table S1: Unit Root Tests of Variables; Estimation Results.

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Appendix A. Details on Data

Table A1. Data definitions and sources.

Variable	Definition	Transformation	Source
U	Unemployment, all persons (ages 15 and over).	Seasonally adjusted	TurkStat
CPI_D	CPI_D, excluding unprocessed food, alcoholic beverages and tobacco.	Seasonally adjusted	TurkStat
CA	Current account, balance of payments, million USD.	Seasonally adjusted,	CBRT
SPRD	The difference between the commercial loan rate (with less than three-months maturity) and the deposit rate (with maturities up to three months), averaged, monthly.		CBRT
RR	Required Reserve Rates	We take the weighted average of the reserve requirements across maturities of liabilities subject to the reserve requirement and compute the cost-effective reserve requirement ratio during the implementation period of ROM. For a detailed explanation see (Alper et al. 2014).	CBRT
ON	BIST overnight rate, monthly-averaged.	After May 2010, the CBRT utilized both the overnight lending and the one-week repo auctions at varying amounts according to its policy stance and the BIST overnight rate fluctuated within the interest rate corridor (Küçük et al. 2016). So, in order to reflect the policy stance of the CBRT, we take the BIST overnight rate as the interest rate.	BIST
CRED	Claims on private sector.	Logged	CBRT
USD	USD/TRY exchange rate.		CBRT
RSRV	Banking reserves.	Logged	CBRT
FED	The federal funds rate for US monetary policy		FED
CP	Commodity price index		IMF
VIX	The CBOE's index of 1-month implied volatility of S&P 500 Index.		CBOE
IP	Industrial Production for EU		CBP Netherlands

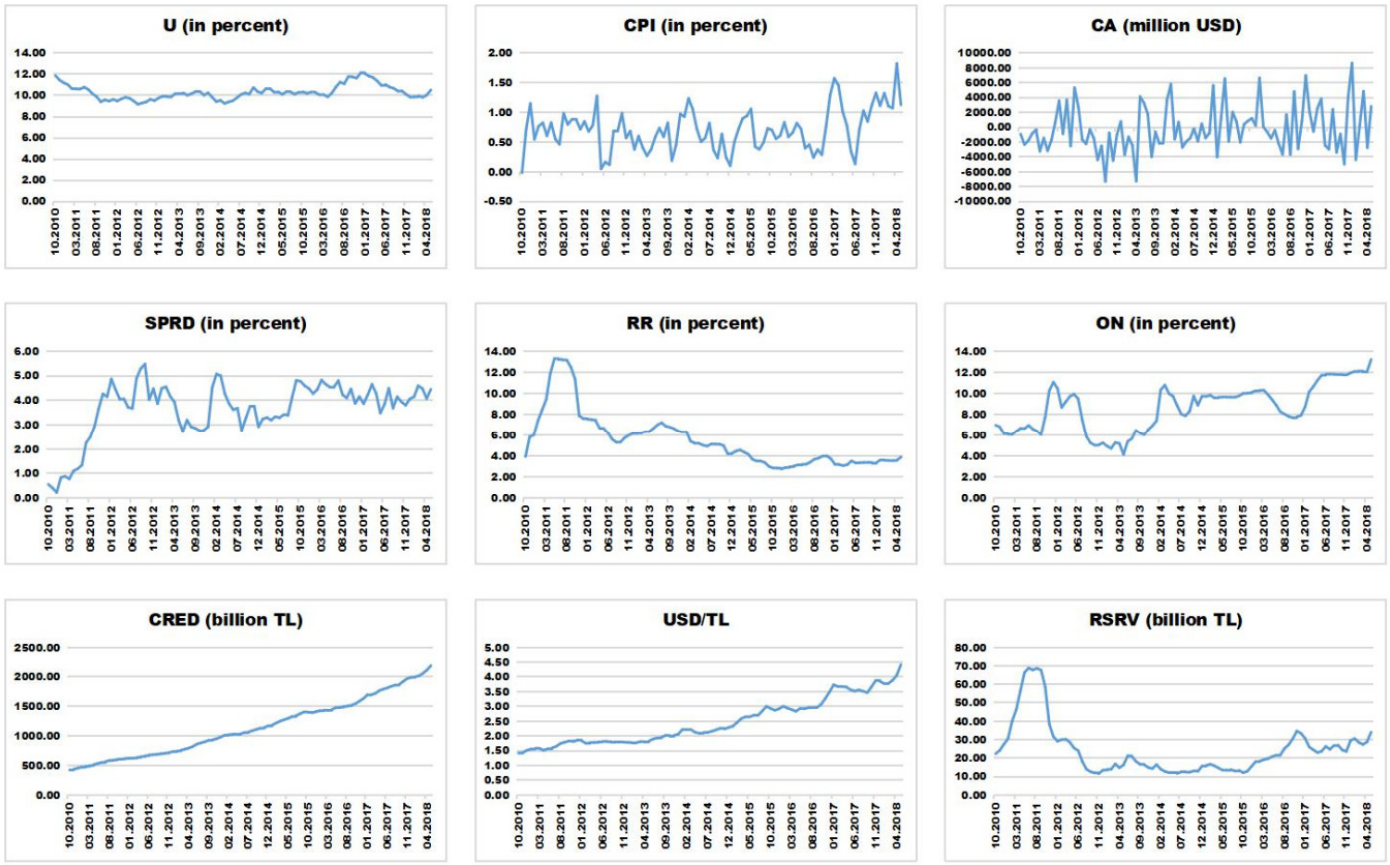

Figure A1. Endogenous variables used in the baseline model.

Table A2. BVAR estimation results on selected macroeconomic variables.

	U				CPI			
	Coefficient *	**St.dev**	**Low. Bound**	**Upp. Bound**	**Coefficient ***	**St.dev**	**Low. Bound**	**Upp. Bound**
U_{t-1}	0.825	0.049	0.776	0.874	0.007	0.044	−0.036	0.051
CPI_{t-1}	−0.014	0.039	−0.053	0.024	0.577	0.073	0.504	0.649
CA_{t-1}	−0.000	0.000	−0.000	0.000	0.000	0.000	−0.000	0.000
$SPRD_{t-1}$	0.009	0.022	−0.013	0.031	−0.001	0.026	−0.027	0.024
RR_{t-1}	−0.01	0.016	−0.026	0.005	0.001	0.018	−0.017	0.019
ON_{t-1}	−0.021	0.013	−0.034	−0.008	−0.006	0.015	−0.021	0.009
$CRED_{t-1}$	0.164	0.426	−0.26	0.588	−0.018	0.49	−0.505	0.469
USD_{t-1}	−0.116	0.132	−0.247	0.015	−0.008	0.155	−0.162	0.146
$RSRV_{t-1}$	0.118	0.184	−0.065	0.301	0.028	0.213	−0.184	0.24
Intercept	0.711	2.493	−1.768	3.191	−0.265	2.896	−3.145	2.615
VIX_{t-1}	−0.001	0.007	−0.008	0.005	0.004	0.008	−0.004	0.011
IP_{t-1}	−0.006	0.032	−0.038	0.026	0.007	0.037	−0.03	0.044
FED_{t-1}	−0.356	0.253	−0.608	−0.104	0.217	0.284	−0.065	0.499
CP_{t-1}	0.004	0.009	−0.005	0.012	0.023	0.01	0.013	0.033
Trend	−0.024	0.032	−0.056	0.008	0.009	0.036	−0.027	0.045
$Trend^2$	0.000	0.000	0.000	0.000	−0.000	0.000	−0.000	0.000
Adj. R^2	0.863				0.287			

* Coefficients are posterior estimates.

Table A3. BVAR estimation results on selected financial variables.

	SPRD				USD			
	Coefficient *	**St.dev**	**Low. Bound**	**Upp. Bound**	**Coefficient ***	**St.dev**	**Low. Bound**	**Upp. Bound**
U_{t-1}	−0.114	0.069	−0.183	−0.045	0.005	0.012	−0.007	0.016
CPI_{t-1}	−0.010	0.071	−0.081	0.061	0.007	0.012	−0.005	0.020
CA_{t-1}	−0.000	0.000	−0.000	0.000	0.000	0.000	−0.000	0.000
$SPRD_{t-1}$	0.773	0.057	0.716	0.829	−0.004	0.007	−0.011	0.003
RR_{t-1}	0.018	0.029	−0.010	0.047	0.002	0.005	−0.003	0.007
ON_{t-1}	0.016	0.024	−0.008	0.004	−0.003	0.004	−0.007	0.001
$CRED_{t-1}$	−0.473	0.778	−1.246	0.300	−0.006	0.133	−0.138	0.126
USD_{t-1}	0.323	0.242	0.082	0.564	0.816	0.060	0.757	0.875
$RSRV_{t-1}$	0.395	0.337	0.060	0.730	0.049	0.058	−0.009	0.107
Intercept	−0.892	4.560	−5.427	3.642	−0.09	0.784	−0.870	0.689
VIX_{t-1}	−0.007	0.012	−0.019	0.004	0.001	0.002	−0.001	0.003
IP_{t-1}	−0.058	0.059	−0.116	0.000	0.011	0.010	0.001	0.021
FED_{t-1}	0.143	0.455	−0.310	0.596	0.031	0.076	−0.045	0.107
CP_{t-1}	0.021	0.016	0.006	0.037	−0.001	0.003	−0.004	0.001
Trend	0.072	0.059	0.013	0.130	−0.002	0.010	−0.012	0.008
$Trend^2$	−0.000	0.000	−0.001	−0.000	0.000	0.000	−0.000	0.000
Adj. R^2	0.834				0.99			

* Coefficients are posterior estimates.

Notes

1 See Monetary and Exchange Rate Policy of the CBRT (CBRT 2019, 2020, 2021, 2022).

2 See Appendix A, Table A1 for detailed information about definition and source of data. Figure A1 displays the time series plots of all the endogenous variables.

3 A battery of tests (both parametric and nonparametric) to detect seasonality, namely the test on autocorrelation on seasonal lags, the Friedman test, the Kruskal-Wallis test, the identification of seasonal peaks with the auto-regressive spectrum and Tukey periodogram and the test on regression with seasonal dummies were performed in JDemetra+ 2.2.3.

4 A surprise policy rate hike is followed by a consecutive increase in the inflation rate.

5 Using Normal-Wishart prior or Independent Normal-Wishart did not change the results significantly. The results are available upon request.

6 The upper and lower bounds here do not correspond to error bands. Credibility intervals render information about the distribution of impulse responses to a particular shock.

7 The increase in reserve requirements behaves like an implicit tax on the banking sector and widens the spread between deposit and the lending rates (Glocker and Towbin 2015).

8 Strong domestic and external demand helped the Turkish economy recover quickly. See Kara (2012) for the condition of the Turkish economy after 2008.

9 For alternative mechanisms see Özatay (2012), Ersel (2012), Basci and Kara (2011) and see Bank for International Settlements (BIS) (2011), Bank of England (BoE) (2011) for alternative objectives for the central banks. Bruno et al. (2017) show that macroprudential policies are more effective when they complement monetary policy tightening.

10 The average monthly TL/USD exchange rate retrieved on 18 March 2022 from the online database of the Central of Bank of the Republic of Turkey (https://evds2.tcmb.gov.tr/) (accessed on 18 March 2022) was 8.51 in September 2021 and 13.62 in February 2022.

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