Received: 10 May 2018 | Revised: 5 July 2019 | Accepted: 20 September 2019

DOI: 10.1111/boer.12219

BULLETIN OF ECONOMIC RESEARCH

ARTICLE

Monetary policy under a multiple-tool environment

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We would like to thank Rana Nelson and the anonymous referee for their valuable comments.

Abstract

Since the 2008 global financial crisis, central banks have been using a new set of policy tools in addition to conventional tools (such as short-term interest rates) to conduct monetary policy. This paper employs a methodology that captures 25 of these tools with a limited number of factors for Turkey. Due to a set of factors such as the high volatility of inflation, market-friendly financial architecture and its size, Turkey provides a unique environment to capture these factors and their effects on economic performance. The three factors identified here can be categorized as interest rate, central bank foreign exchange position and liquidity. The empirical evidence reveals that these three factors affect all the economic-state variables considered in the paper in different directions and magnitudes.

KEYWORDS

FAVAR, monetary policy, multiple policy tools

JEL CLASSIFICATIONS

C38, E52, E58

1 | INTRODUCTION

In the conventional inflation targeting framework, that is, pre-2008 era, central banks mainly used a single policy tool, such as short-term interest rate, as their main monetary policy tool in attaining the price stability goal. In the post-2008 financial environment, central banks have encountered additional challenges around this goal, such as the ineffectiveness of conventional monetary policy tools in affecting economic performance, and excessive capital inflows that threaten commercial bank lending practices. For example, the global financial crisis resulted in a surge of capital inflows induced by increasing global liquidity due to a quantitative easing policy in developed economies. These policies then

influenced emerging market economies, especially small open economies, and using short-term interest rate as a policy tool to implement inflation-targeting frameworks became problematic. When central banks decrease short-term interest rate to discourage capital inflows, it may cause excessive risk-taking behaviour. This behaviour is called the *risk-taking channel of monetary policy* (Borio & Zhu, 2008) or the *credit-driven* and/or *irrational exuberance asset price bubble* (Mishkin, 2010), and it increases the leverage ratio of financial institutions, which encourage investors to take on more risky investments (Adrian & Shin, 2010). On the other hand, when central banks raise short-term interest rates, it encourages more short-term capital inflows. This scenario can cause excessive credit growth from a different channel, which results in high current-account deficits, higher asset prices over the fundamentals and a high level of foreign-currency-denominated liabilities (Elekdağ & Wu, 2011; Gourinchas, Valdes, & Landerretche, 2001; and Magud, Reinhart, & Vesperoni, 2012).

In other words, for emerging economies, using short-term interest rate alone was not sufficient to provide price stability and financial stability simultaneously in the post-2008 environment (Agénor & Da Silva, 2013; Borio, 2011; and Sahay et al., 2014). These developments have forced emerging market economies, especially small open economies, to employ other tools and/or develop new tools to use simultaneously – but not independently – in conducting their monetary policies, rather than solely using short-term interest rate(s).[1]

The purpose of this paper is, for Turkey, to categorize the various policy tools that the central bank uses with a limited number of factors so we can group these tools into a limited number of categories by using factor analyses. Thereby, we aim to reduce dimensionality of monetary policy tools in order to capture and simplify monetary policy analysis. In this way, we can better summarize central bank policy actions, with the aim to assess the effects of these policies on economic performance more efficiently. Using multiple monetary policy tools to attain different policy objectives within specific groups has been also recognized as effective by central bank officials (see, for example, Aysan, Fendoglu, & Kilinc, 2014; Başçı & Kara, 2011; Binici, Erol, Kara, Özlü, & Ünalmış, 2013; Kara, 2012; Kara, 2015; Oduncu, Ermisoglu, & Polat, 2013a; Özatay, 2011; and Varlik & Berument, 2017). Next, we estimate the effect of these factors on economic performance.

There are several reasons for using Turkish data: (i) The Central Bank of the Republic of Turkey (CBRT) was using multiple monetary policy tools before the 2008 crisis and has continued to do so since.[2] Moreover, the importance and scope of a multiple-policy tool set have been increasing since 2008 under the unconventional global monetary policy framework. (ii) Turkey is a market-oriented economy and economic variables respond to policy variables (e.g., for the period that we consider, Turkey did not freeze prices or fix exchange rates). (iii) Turkey is one of the few countries that has had high inflation and volatile inflation (average annualized inflation is 9.83 per cent for CPI and 9.68 per cent for PPI inflation rates. The maximum and minimum values are 37.99 per cent and 3.91 per cent for the CPI inflation rate and 40.07 per cent and 3.82 per cent for the PPI inflation rate). Thus, the evidence gathered from Turkey does not have *Type II error* in its inferences. (iv) In Turkey, interest rates have never reached the zero bound, thus an asymmetric effect of policy variables on interest rate will not lead to biased/inconsistent estimates. (v) As of 2015, the Turkish economy was the seventeenth-largest

[1]Using multiple policy tools may also give more desired outcomes under uncertainty. Note that to attain any number of policy objectives, the policy authority should have at least the same amount of policy tools to attain these objectives. Under uncertainty, the more number policy tools the policy authority has, the better outcome it will attain (Brainard, 1967). In other words, with more tools, it is more likely that the policy maker will get closer to the desired outcome. Thus, a multiple-tool environment in monetary policy provides better economic outcomes compared to the single-tool environment.

[2]Berument (2007) notes that prior to 2000, the CBRT was using interest rate and exchange rate together rather than separately to conduct its monetary policy.

in the world,[3] and Turkey is aiming to become a full member of the European Union. These facts show that Turkey is an actor with some influence in world economic affairs.

Our paper differs from previous studies in the literature on monetary policy in various ways. After observing a large number of policy tools with a few auxiliary variables (factors), we assess the effects of these factors on economic performance. The conventional Vector Autoregressive (VAR) models assume that monetary policy authorities look at a limited number of variables to set policies. These studies encounter the limited-information problem in terms of the monetary policy tool set and economic-state variables as policy authority follows more than a few economic-state variables a VAR model may incorporate. We follow Bernanke, Boivin and Eliasz's (2005) work and use their Factor Augmented Vector Autoregressive (FAVAR) model to address these problems. Thus, we allow that central banks actually observe a large number of economic-state variables when they set up their economic policies, and here, we capture those variables with a few auxiliary variables. However, the FAVAR literature around applications of monetary policy transmission mechanisms (such as Baumeister, Liu, & Mumtaz, 2010; Bernanke, 2005; Blaes, 2009; Boivin, Kiley, & Mishkin, 2010; Fernald, Spiegel, & Swanson, 2014; Gupta, Jurgilas, & Kabundi, 2010; He, Leung, & Chong, 2013; Igan, Kabundi, Nadal de Simone, & Tamirisa, 2013; Soares, 2013; and Stock & Watson, 2005) focuses on the effects of a single monetary policy tool (e.g., short-term interest rate) on economic performance, and thus capture the economic-state variables but not monetary policy tools entirely. Our paper recognizes this situation and allows for the fact that central banks use multiple tools to conduct their monetary policies, thus extending Bernanke et al.'s (2005) FAVAR approach. Similar to the economic-state variables, our paper allows capturing a large number of monetary policy tools with a limited number of auxiliary variables and assesses how these monetary policy variables affect economic performance. Thus, the first contribution of this paper is to identify the groups of monetary policy tool sets, and the second contribution is to examine the effects of using multiple monetary policy tools rather than a single tool on economic performance.

Using Turkish data, we identify three groups of factors to categorize 25 tools used by the CBRT. These groups are categorized as *interest rate*, *CBRT's foreign exchange position* and *Turkish Lira (TL) liquidity*. We then assess the effects of each of three groups of factors on economic performance for the period between May 2002 to March 2017, a time when the CBRT employed multiple unconventional policy tools. The empirical evidence reveals that a positive innovation in the interest rate factor, which means greater tightness in the monetary policy stance, increases capital inflows (hot money), stimulates economic performance, increases the current account deficit and decreases the inflation rate by appreciating domestic currency and decreasing credits; these findings parallel what Borio and Zhu (2008) and Mishkin (2010) foresee. A positive innovation in the CBRT's foreign exchange position factor, which means tightening foreign currency liquidity and higher TL supply, thus depreciating domestic currency, improving the CBRT's international reserves, decreasing credit interest rates and increasing credits but not stimulating economic performance. Lastly, a positive innovation in the TL liquidity factor, which indicates an increase in market liquidity, depreciates domestic currency, decreases the CBRT's international reserve and credit interest rates and increases credits, but does not adequately stimulate economic performance. All the estimates gathered from the impulse response analyses are in line with economic priors; the empirical evidence suggests that each monetary policy tool set affects all the economic-state variables that we consider in different directions and magnitudes. In this sense, using multiple policy tools provides superior outcomes than using a single policy tool.

The paper is organized as follows: In Section 2, we briefly explain the framework of the CBRT's unconventional monetary policy. In Section 3, we introduce the extension of the FAVAR methodology

[3]For the World Bank's PPP-based GDP ranking, see http://data.worldbank.org/data-catalog/GDP-PPP-based-table.

employed by Bernanke et al. (2005). In Section 4, we provide the empirical evidence that reports how the 25 policy variables are categorized using factor analyses and then we examine the effects of monetary policy factors on economic performance. In Section 5, we conclude the paper.

2 | A NEW MONETARY POLICY ENVIRONMENT: THE CBRT'S UNCONVENTIONAL MONETARY POLICY FRAMEWORK

In this section, we discuss the CBRT's monetary policy framework in the post-2008 era, then elaborate on the set of unconventional monetary policy framework tools the central bank has been employing. Just before the 2008 global financial crisis, the CBRT had been primarily using short-term interest rate to attain its inflation target. This framework did not mean that the CBRT used only this tool, but rather that other tools (such as required reserve ratios and interest rate in a discount window) were not being used as actively as short-term interest rate was.

The 2008 global financial crisis altered the CBRT's monetary policy framework. Short-term capital inflows triggered by the excessively loose monetary policies of more-developed economies threatened Turkey's price stability and financial stability. These inflows sparked excessive credit growth and currency appreciation in Turkey and further widened the current account deficit,[4] causing macroeconomic and financial instability (Ekinci, Erdem, & Kilinc, 2015; Ganioğlu, 2012; Kara, 2012; and Özatay, 2011). These occurrences forced the CBRT to transform its monetary policy framework by enlarging its main monetary policy objective to include financial stability (*de facto*): The CBRT *has gradually introduced a new monetary policy framework as of late 2010 through modifying the inflation targeting regime that has been implemented since 2006. The new framework treats financial stability as a supplementary objective without prejudice to price stability.… The newly constructed regime preserves the main objective of price stability, while risks to financial stability are also taken into consideration in the conduct of monetary policy* CBRT (2012a, p. 2). For the above reasons, the CBRT has been focusing not only on providing price stability but also financial stability through an unconventional monetary policy framework. Özatay (2011) (former CBRT deputy governor and former member of the CBRT's Monetary Policy Commission), Başçı and Kara (2011) (former governor[5] and chief economist of the CBRT, respectively) and Kara (2012) note that the CBRT began to emphasize financial stability as equally as price stability in its new policy framework, developed shortly after the 2008 global financial crisis. Başçı (2013) and Oduncu et al. (2013a) call this new policy mix *inflation targeting*++ (IT++). In IT++, and while price stability is still the primary objective, financial stability is stated as a secondary objective. The ++ reflects credit growth and real exchange rate, respectively, as these two factors are accepted as key indicators for financial stability. For example, for the year 2013, then-Governor Başçı listed a set of reference points that credit growth and real exchange rate should follow. In other words, financial stability can be evaluated as a complementary objective to price stability in the new monetary policy design, reflecting the new macroeconomic perspective.

To provide financial stability, the CBRT considers two intermediate targets: (i) decreasing the adverse effect of short-term capital inflows (foreign exchange stability) and (ii) slowing excessive credit growth. Furthermore, the CBRT has been aiming to prolong the average maturity of deposits

[4]For example, the CBRT's former governor Yılmaz (2010) stated that a five percent increase in credit growth would trigger a 2.1 per cent increase in the current account deficit in Turkey for the year 2011. Thus, a high or unsustainable current account deficit is the main challenge for the Turkish economy.

[5]His tenure ended 19 April, 2016.

to strengthen financial stability. It is expected that this framework facilitates communicating monetary policy by also increasing the comprehensibility of the implemented monetary policy (Özatay, 2011).

Transforming the monetary policy framework required the CBRT to diversify its monetary policy tools. The Central Bank explains this approach as follows:

> Opting for an alternative policy design that takes financial stability into account since late 2010, the CBRT has diversified its set of instruments…. [The] CBRT jointly employs multiple instruments in order to implement a monetary policy strategy that safeguards financial stability without prejudice to the price stability *(CBRT, 2012a, p. 12).*

Further,

> [t]he current global conjuncture urges the Central Bank to implement a policy composition that entails the effective use of alternative instruments such as liquidity management and required reserves besides the short-term interest rates utilized as the key policy instrument *(CBRT, 2010, p. 4).*

Thus, in addition to the overnight interbank interest rate, which the CBRT used primarily as a tool for price stability in its conventional monetary policy framework, the central bank has been extensively using tools such as the reserve requirement ratio (RRR) and reserve option mechanisms (ROM) (detailed later in the paper), as well as cyclical tools such as other short-term interest rates (e.g., a one-week repo auction rate), liquidity management tools and an interest rate corridor system in its new unconventional monetary policy framework (also detailed later in the paper) (CBRT, 2012a). Both the structural and cyclical tools, which we call a multiple-tool set, are employed to ensure price stability and financial stability together. For example, the CBRT (2015) claims that the monetary policy stance for 2015 was tight on inflation, compensatory on foreign currency liquidity and supportive for financial stability.

The CBRT emphasizes that '*[t]he monetary policy stance in the new economic climate is not only determined by the level of policy rates, but also by the combination of all policy instruments*…' (CBRT, 2010, p. 4). Further:

> [t]he Central Bank's main policy instrument to achieve price stability is the repo auction rate with [a] one-week maturity. Besides, when deemed necessary, required reserve ratios and liquidity management can be used as supplementary instruments to enhance the efficiency of monetary policy and to contain macro financial risks *(CBRT, 2010, p. 7).*

In short, towards the goal of financial stability, the CBRT has been employing various unconventional policy tools in a multiple-tool set in addition to the conventional interest rate tool(s).

2.1 | The CBRT's new policy tools

The CBRT uses various short-term interest rates, including its borrowing rate, lending rate, one-week repo interest rate, interbank repo and reverse repo overnight interest rates, as well as Borsa Istanbul's (BIST) overnight repo and reverse repo interest rates.[6] These rates are not necessarily the same across

[6]In addition to these short-term interest rates, the CBRT uses the late liquidity window borrowing rate and the late liquidity window lending rate to fulfill its lender-of-last-resort role (see CBRT, 2012a; 2013a; 2014).

large spans of time, but are all the same for overnight, except for the one-week repo interest rate. Some of these interest rates are determined in the markets, where the CBRT is one of the participants, and others are set by the CBRT as fixed. The central bank considers that these interest rates affect different economic variables in different degrees. For example, the CBRT argues that (i) the upper band of the interest rate corridor is considered the benchmark for commercial banks' credit interest rates, (ii) the interbank funding rate (BIST interbank overnight repo and reverse repo auctions interest rate) serves as benchmark for the short-term funding costs of commercial bank, (iii) the average cost of central bank funding for commercial banks (weighted average cost of the CBRT funding rate) is crucial to commercial banks' deposits, loans and other financial instruments and (iv) the lower corridor of interest rates is important for short-term capital flows (Kara, 2015). Varlik and Berument (2017) also show that four of the overnight interest rates controlled by the CBRT affect different economic variables differently.

The CBRT participates in two overnight interbank interest rate markets as one of the several players whose rates are not necessarily the same. One rate is that from the market hosted at the CBRT, and the other rate is that from the market at BIST. Each day, these rates are reported as their weighted averages. The two rates differ because their operating hours are different, with BIST closing after the CBRT.

After the global financial crisis, the CBRT began to implement the interest rate corridor system as one of its new monetary policy tools. The interest rate corridor is an asymmetric band around the CBRT policy rate; the policy rate is the one-week repo auction rate for the period after May 2010 and was the CBRT's overnight interest rate before May 2010. The lower band of the corridor is the overnight borrowing rate and the upper band is the lending rate (also called the marginal funding rate). The central bank's average cost of funding across maturities and different types of interest rates fluctuates between these two bands. By adjusting the width of the interest rate corridor around the policy interest rate asymmetrically, the CBRT intends to control short-term capital flows and excessive credit growth through the credit and exchange rate channels of monetary policy (CBRT, 2012a).

Monetary policy application in the asymmetric interest rate corridor system reflects a countercyclical policy stance, not only for short-term capital flows but also for credits and deposits. The weighted average cost of the CBRT funding rate, the BIST interbank overnight repo and reverse repo interest rate as well as the interbank overnight repo interest rate play a crucial role in monetary policy (Kara, 2015). These rates in the asymmetric corridor system reflect the CBRT's monetary policy stance around excessive credit growth and short-term capital flows.

To prevent excessive credit growth, the CBRT increases the difference between the lending rate and the one-week repo interest rate by increasing the upper band of the corridor without changing the one-week repo interest rate. This tightening of the monetary policy stance is conducted through liquidity management. Specifically, although the CBRT announces a one-week repo interest rate (the policy rate since May 2010) on a monthly basis, it provides liquidity to the banking system via various channels, including one-week quantity repo auctions on a daily basis. By using the cheaper one-week repo rates in limited amount, the CBRT provides only a fraction of Turkish banks' total liquidity requirements. Banks are thus forced to borrow the rest of their total liquidity requirements from more expensive channels, for example, from the overnight marginal funding rate, which is limited by the bank's borrowing capacities.[7] This strategy decreases a bank's incentive to increase its loan supply. This policy is also expected to discourage excessive credit growth by increasing the volatility of the weighted average cost of the CBRT funding rate for the banking system as the width of the corridor increases. As banks like

[7]The CBRT not only uses TL liquidity management but also foreign currency liquidity management, via foreign exchange purchasing and selling auctions and foreign exchange purchasing and selling interventions. In this respect, the CBRT's foreign exchange assets and its gross and net international reserves are important monetary policy tools for its foreign currency liquidity management.

to be more liquid in their balance sheets, a higher width or higher volatility mimics a tighter monetary policy stance (Binici et al., 2013; Dogan, Sahin, & Berument, 2016; Kara, 2015; and Mumtaz & Zanetti, 2013).

Another contribution of the asymmetric interest rate corridor system is to smooth volatility in short-term capital flows and therefore also smooth exchange rate volatility. During capital inflows and a high risk-appetite period, the CBRT may decrease capital flows by decreasing the predictability of monetary policy, decreasing the overnight borrowing rate and thus decreasing commercial banks' funding costs from the CBRT. In this case, an increase in the width of the corridor by lowering the lower band is expected to reduce short-term yields for investors. Conversely, during capital outflows and a low risk-appetite period, the CBRT increases the borrowing rate to increase predictability around monetary policy. However, when global liquidity narrows, then the CBRT increases the lending rate in the interest rate corridor system (Aysan et al., 2014; Küçük, Özlü, Talaslı, Ünalmış, & Yüksel, 2014).

We now move on to the reserve requirement ratio (RRR). Although the RRR was an important monetary policy tool for the CBRT in its conventional monetary policy framework, it was not actively used. In its new framework, however, the CBRT has been using the RRR policy more regularly. The '*Central Bank has been using the arrangements [of] the reserve requirements… as tools supplementary to the monetary policy since the last quarter of 2010*" (CBRT, 2011a, p. 18). The RRR has been used to control excessive credit growth and to rebalance domestic and foreign demand. The CBRT increases the RRR to control excessive credit growth in the case of high capital inflows, and in the case of capital outflows, the CBRT eases the banking system's credit facilities by decreasing the RRR. Thus, the RRR has been implemented in a countercyclical manner, similar to the interest rate corridor system (Mimir et al., 2013; Oduncu, Akcelik, & Ermisoglu, 2013b). Moreover, to extend the maturities of domestic- and foreign-currency-denominated deposit accounts, the CBRT has been differentiating the RRR based on the maturity structure of these deposits, imposing lower reserve requirements on higher maturity deposits to encourage banks to hold long-term deposits. Since November 2014, the central bank has been remunerating reserve requirements to support balanced growth and domestic savings. Another novel aspect of the CBRT's reserve requirement applications is the leverage-based required reserves system, put into effect in 2013 to control commercial banks' indebtedness (CBRT, 2010; 2012a).

The RRR affects credit volume via two channels: cost and liquidity. For the former, a change in RRR determines the funding cost of the banking system and thus commercial banks' credit decisions. However, when the deposit interest rate is low, an increase in the RRR is not sufficient to affect credit volume. As the liquidity channel has a close relationship with the liquidity management of monetary policy, this stream is more efficient than the cost channel. If the deposit interest rate is low and the term structure of the deposit is short, the RRR application may be inefficient because banks compensate for liquidity requirements by appealing to the open market operation, and this method may damage the efficiency of the liquidity channel. In such a case, the CBRT supports the RRR application by using constructive ambiguity via the interest rate corridor system (Başçı & Kara, 2011; Kara, 2012). This policy mix suggests that these unconventional policy tools complete each other in a countercyclical manner.

Since September 2011, the CBRT has been implementing the reserve option mechanism (ROM) as a macroprudential policy tool, using it as an automatic stabilizer. The ROM allows banks to hold a certain fraction of their TL reserve requirements (the reserve option ratio or ROR) in foreign currency (United States Dollars; USD) and standard gold. The CBRT then computes the amount of held USD and/or gold requirements by multiplying the TL requirement with a reserve option coefficient (ROC) for each segment of the ROR. Thereby, banks can use their foreign-currency-denominated assets to fulfill TL liquidity requirements. Note that TL-denominated funds have higher interest rates than foreign-currency-denominated funds and gold. Thus, the ROM allows for a cheaper funding facility for commercial banks. When an increase in capital inflows causes currency to appreciate and causes a

decrease in borrowing costs in terms of foreign currency, the ROM encourages banks to hold a higher fraction of their TL reserve requirement as foreign currency in the CBRT. Thus, an increase in ROM usage may increase either the CBRT's gross international reserves or TL liquidity on the banking sector's balance sheets, and decrease excess foreign exchange liquidity in the market. Similarly, during a capital outflow period, a decrease in borrowing costs in terms of TL encourages banks to hold their TL reserve requirement in the CBRT. To fulfill foreign currency liquidity, banks can choose to withdraw their foreign-currency-denominated reserve requirements in the ROM system. In this case, a decrease in ROM usage will decrease the CBRT's gross international reserves as well as TL liquidity on banking sector balance sheets. Thus, the ROM is expected to alleviate pressures in the exchange rate market. In this respect, the ROM resembles unsterilized foreign exchange purchasing or selling auctions (CBRT, 2011b; CBRT, 2012b; Küçüksaraç and Özel, 2012; and Sahin, Dogan, & Berument, 2015). Given this property of the ROM, it can be considered the CBRT's foreign currency liquidity tool. Thus, the bank argues that '*[t]he Reserve Option Mechanism, which is another instrument developed by the CBRT, mainly aims at reducing the adverse impact of… excessive volatility in capital movements on…macroeconomic and financial stability*' (CBRT, 2012a, p. 5). The CBRT also uses the ROM to decrease foreign currency liquidity in the financial system by increasing the ROC (Alper, Kara, & Yörükoğlu, 2012).

3 | METHOD

Our approach is an extension of Bernanke et al.'s (2005) FAVAR modelling; however, where they apply this approach to economic-state variables only, we apply the approach to policy as well. Bernanke et al. (2005) note that small-scale VAR models suffer from the omitted-information problem because, to set up their monetary policies, central banks look at more variables than the limited number of variables VAR models usually use. Their FAVAR modelling approach provides a method to exploit a large information set and account for the omitted-information problem often found in standard limited-variable VAR models.

Bernanke et al. (2005) consider the federal funds rate as the only monetary policy tool for the US. However, central banks use additional tools to conduct monetary policy, such as multiple interest rates, foreign currency purchases, regulations of deposits, and more, especially since 2008. The contribution of this paper is to examine the effects of using multiple tools rather than a single tool on economic performance. As Bernanke et al. (2005) use a large number of economic-state variables as the sum of a limited number of common components (factors), and an idiosyncratic component for economic-state variables for only those variables, we also capture a large number of monetary policy tool variables as the sum of a limited number of common components (policy factors), as well as economic-state variables.

Factor models allow us to represent zero-mean, stationary time series as linear combinations of a common component that are driven by a small number of factors and idiosyncratic components. Let X_t be $N \times 1$ economic state variables and Y_t $M \times 1$ policy variables such that Y is a subset of X_t. F_t is a $k \times 1$ vector of unobservable factors that captures most of the information in X_t, and G_t is an $l \times 1$ vector of unobservable factors for Y_t. The joint dynamics of F_t and G_t can be written as:[8]

$$\begin{bmatrix} F_t \\ G_t \end{bmatrix} = \Phi^* (L) \begin{bmatrix} F_{t-1} \\ G_{t-1} \end{bmatrix} + \upsilon_t \leftrightarrow \Phi (L) \begin{bmatrix} F_t \\ G_t \end{bmatrix} = \upsilon_t \tag{1}$$

[8]For an excellent and easy-to-follow presentation of the FAVAR methodology, see Soares (2013).

where $\Phi(L) = I - \Phi^*(L) = I - \Phi_1 L - \Phi_2 L^2 - \ldots - \Phi_d L^d$, $\Phi(L)$ is a finite order lag polynomial, L is the lag operator, d is the lag order, v_t is an error term with zero mean and Q is associated with the variance-covariance matrix. Equation (1) is a VAR specification but uses unobservable factors F_t and G_t. The above specification is labeled as a FAVAR by Bernanke et al. (2005), in which they have G_t as observable in a one-monetary-policy-tool environment: the federal funds rate. Note that since F_t and G_t are not observed, the above equation cannot be estimated directly, and thus X_t can be represented as a function of unobservable F_t and G_t such that

$$X_t = \Lambda^f F_t + \Lambda^g G_t + e_t \tag{2}$$

in which G_t is gathered from the variables in Y_t. Here, Λ^f is an $N \times k$ and Λ^g is an $N \times l$ matrix of the factor loadings and $e_t$is an $N \times 1$ vector of residuals. Following Bernanke et al. (2005), we adopt the two-step principal-component method to estimate Equations (1) and (2). In the first set-up, $C(F_t, G_t)$ is estimated by using the first $k + l$ principal component of X_t. Then, F_t and G_t are replaced with $\hat{F}_t$ and $\hat{G}_t$in the second step, respectively.

4 | EMPIRICAL EVIDENCE

The purpose of this paper is to categorize a large number of monetary policy tools a central bank employs within a limited number of factors so that we can group these tools into a limited number of categories for Turkey by using factor analysis. Moreover, we aim to examine the effects of these monetary policy tool factors on economic performance. The data span covers monthly observations from May 2002 to March 2017. As the monetary policy variables, we consider 25 variables that the CBRT employs. Table 1 provides the list of these 25 monetary policy tools, as well as their transformation treatments, acronyms and sources.

To incorporate information gathered from these many variables of monetary policy setup, we use a limited number of common components and idiosyncratic components, where the common components are captured by a few common factors that have variable-specific loadings. To determine whether these series have a long-run constant mean, we perform a set of unit root tests. These test statistics suggest that the series are mostly stationary, and thus we treat them all as stationary. To determine the robustness of this conclusion, we also perform Im-Pesaran-Shin's (2003) panel unit root test, and find that we reject the null of the unit root again.[9]

We use the Minimum Average Partial (MAP) method to determine the number of factors. Zwick and Velicer (1986) provide evidence that MAP outperforms a set of other methods that they consider. The MAP method suggests that the optimal number of factors is three. We also use Bai and Ng's (2002) Factor Determination Test to determine the number of factors. The test results are reported in Table 2, and also suggest that for the three test statistics the optimum number of factors is three. The table shows that these three factors explain 73 per cent of the total variation in the 25 monetary policy variables.

Next, we use principal-component analysis to acquire the factor loadings. Table 3 reports the eigenvectors or weights that are assigned to those variables for each factor. Note that we use a standardized version of the variables in the analyses. Thus, the absolute value of these parameters can be taken as the level of importance of these 25 variables in each factor. These three factors are orthogonal to each other, however, their interpretation is not straightforward. In the factor analysis, the loadings are not unique

[9]These unit root tests results and other test results are discussed but not reported in the paper to save space. They are available from the authors upon request.

TABLE 1 CBRT monetary policy tools

	Series Name	Treatment	Acronym	Sources
1	Reserve Requirement Ratio of TL Deposits	1	RRRTL	EDDS
2	Reserve Requirement Ratio of Foreign Currency Deposits	1	RRRFX	EDDS
3	Discount Rate	1	DSCNT	EDDS
4	Late Liquidity Window Borrowing Rate	1	LONBRW	EDDS
5	Late Liquidity Window Lending Rate	1	LONLR	EDDS
6	Foreign Exchange Purchasing Intervention over International Reserve	1	FXPI	EDDS
7	Foreign Exchange Selling Intervention over International Reserve	1	FXSI	EDDS
8	ROM Gold Utilization Rate	1	ROMGLDUR	EDDS
9	ROM Foreign Currency Utilization Rate	1	ROMFCUR	EDDS
10	ROM Gold over International Reserve	1	ROMGLD	EDDS
11	ROM Foreign Currency over International Reserve	1	ROMFC	EDDS
12	Foreign Exchange Purchasing Auctions over International Reserve	1	FXPA	EDDS
13	Foreign Exchange Selling Auctions over International Reserve	1	FXSA	EDDS
14	Central Bank Money	3	CBM	EDDS
15	Monetary Base	3	MB	EDDS
16	Reserve Money	3	RM	EDDS
17	Open Market Operation over CBRT's Total Assets	1	OMO	EDDS
18	One-Week Repo Auctions Interest Rate	1	OWINT	EDDS
19	Overnight Borrowing Interest Rate	1	BRWINT	EDDS
20	Overnight Lending Interest Rate	1	LRINT	EDDS
21	BIST Overnight Repo and Reverse Repo Interest Rate	1	BISTON	EDDS
22	Interbank Overnight Minimum Interest Rate	1	INTONMIN	TRDS
23	Interbank Overnight Average Interest Rate	1	INTONAVG	TRDS
24	Interbank Overnight Maximum Interest Rate	1	INTONMAX	TRDS
25	Weighted Average Cost of the CBRT Funding Rate	1	WACF	EDDS

Note: Treatment shows how the series is transformed before being added to the database, with 1 = level; 3 = logarithmic first difference. EDDS is the CBRT's Electronic Data Delivery System; TRDS is Thomson Reuters Data Stream.

and are subject to rotations. In general, there are two types of factor rotations. One is an orthogonal factors rotation, such that the correlations among the factors are zero. The other is an oblique rotation, which allows the correlations to be non-zero among the factors. Since the CBRT is considered to use these three sets of tools together, we use oblique rotation as the type of factor rotation. Specifically, we choose the Promax method of oblique rotation as it assigns the loadings such that each loading gets closer to zero or one in absolute value. This method makes categorizing each of the 25 variables for each factor easier because it is more apparent whether each variable should be included in each factor. Loadings closer to zero in absolute value make it less likely that a variable will be included in a particular factor; loadings closer to one make it more likely to be included.

TABLE 2 Bai-Ng's factor determination test and cumulated variance shares for monetary policy tools

# Factors	PCP1	PCP2	PCP3	Cumulated Variance Share
1	0.5310	0.5207	0.5134	0.496071
2	0.4682	0.4475	0.4331	0.640355
3	0.4556*	0.4246*	0.4029*	0.729854
4	0.4797	0.4382	0.4093	0.779375
5	0.5087	0.4569	0.4207	0.823432
6	0.5421	0.4800	0.4366	0.862682
7	0.5793	0.5068	0.4562	0.897861
8	0.6256	0.5427	0.4849	0.923086
9	0.6740	0.5808	0.5157	0.945988
10	0.7239	0.6204	0.5480	0.967266

Note: * is for the number of optimum factors.

Table 4 reports the factors after the Promax rotations and Table 5 presents the variation in each factor. Table 5 provides a mean for the identification of factor names based on which monetary policy instrument is weighted under which factor. In the first factor, the parameters are generally highest for interest rates and open market operation variables. Table 6 gives a list of the variables in each factor. For the first factors, interest rate variables and open market operation variables explain around 91 per cent of the variation in the 25 variables. The coefficients of these variables are also positive, which we calculate from Table 4. The positive values of open market operations suggest that the central bank withdraws liquidity from the markets, an indication of tighter monetary policy.[10] The factor coefficients of the remaining monetary policy tools, which have a nine per cent variation in these 25 variables, are used in a tightening way. Hence, we interpret these results to mean that higher levels of Factor 1 mean greater tightness in monetary policy stance. Therefore, we call Factor 1 (F1) the measure of the *interest rate factor*.

Factor 2 (F2) has the highest coefficients in absolute value mostly for the ROM tools, the RRR for Turkish Lira (TL) and foreign-currency-denominated deposits, foreign exchange purchasing auctions and the late liquidity window borrowing rate (see Table 6). The CBRT uses these tools, which are directly or indirectly related to the exchange rate market, in the tightness of foreign currency liquidity. Eighty per cent of the variation in Factor 2 that we gather from Table 4 is explained by these exchange rate market tools (see Table 5). A higher factor value might be an indicator of lower foreign currency liquidity through the CBRT's operations in the financial markets. Otherwise, the interest rate tools listed in the first column of Table 6, which have a 12 per cent variation in Factor 2 and negative coefficients, reflect lower foreign currency liquidity but a higher TL liquidity presence in the financial markets. Hence, this factor captures a loose monetary policy stance by the CBRT. Thus, we interpret innovation in Factor 2 as a tightening of foreign currency liquidity in the foreign exchange market, which loosens the monetary policy stance through interest rates. Therefore, we call Factor 2 (F2) the *CBRT's foreign exchange position*.

Factor 3 (F3) has the highest coefficients for the TL and foreign currency liquidity measures, such as foreign exchange purchasing and selling interventions, foreign exchange selling auctions, central bank money, monetary base, and reserve money in absolute value. Higher values of TL liquidity measures

[10] As suggested by the CBRT's analytical balance sheet, a negative sign of open market operations data shows that the central bank is a net provider of market liquidity. Conversely, a positive sign shows the central bank as a net borrower in the markets.

TABLE 3 Orthogonal factors for monetary policy tools: Principal factors method

Series Name	F1	F2	F3	Communality	Uniqueness
Reserve Requirement Ratio of TL Deposits	−0.7647	0.4863	−0.0134	0.8215	0.1784
Reserve Requirement Ratio of Foreign Currency Deposits	−0.3227	0.6082	0.2240	0.5243	0.4756
Discount Rate	0.9620	0.1414	−0.0123	0.9456	0.0543
Late Liquidity Window Borrowing Rate	0.6065	−0.3610	−0.0948	0.5073	0.4926
Late Liquidity Window Lending Rate	0.9289	0.3475	−0.0369	0.9850	0.0149
Foreign Exchange Purchasing Intervention over International Reserve	0.1874	−0.1014	0.2229	0.0951	0.9048
Foreign Exchange Selling Intervention over International Reserve	−0.0799	0.0137	−0.3654	0.1401	0.8598
ROM Gold Utilization Rate	−0.7495	0.6174	0.1393	0.9624	0.0375
ROM Foreign Currency Utilization Rate	−0.7669	0.6110	0.0528	0.9643	0.0356
ROM Gold over International Reserve	−0.7371	0.6235	0.1664	0.9599	0.0400
ROM Foreign Currency over International Reserve	−0.7420	0.6121	0.0918	0.9337	0.0662
Foreign Exchange Purchasing Auctions over International Reserve	0.3561	−0.3312	0.2861	0.3184	0.6815
Foreign Exchange Selling Auctions over International Reserve	−0.3745	0.2395	−0.4267	0.3797	0.6202
Central Bank Money	0.1263	−0.0860	0.7356	0.5645	0.4354
Monetary Base	0.0934	−0.0661	0.6361	0.4177	0.5822
Reserve Money	0.1682	−0.0750	0.3858	0.1827	0.8172
Open Market Operation over CBRT's Total Assets	0.8211	−0.1389	0.1167	0.7071	0.2928
One-Week Repo Auctions Interest Rate	0.9675	0.2384	−0.0098	0.9931	0.0068
Overnight Borrowing Interest Rate	0.9296	0.3597	−0.0201	0.9941	0.0059
Overnight Lending Interest Rate	0.9258	0.3637	−0.0465	0.9917	0.0082
BIST Overnight Repo and Reverse Repo Interest Rate	0.9362	0.3426	−0.0355	0.9952	0.0047
Interbank Overnight Minimum Interest Rate	0.9343	0.3483	0.0072	0.9943	0.0056
Interbank Overnight Average Interest Rate	0.9131	0.3928	0.0106	0.9881	0.0118

(Continues)

TABLE 3 (Continued)

Series Name	F1	F2	F3	Communality	Uniqueness
Interbank Overnight Maximum Interest Rate	0.9315	0.3408	−0.0245	0.9845	0.0154
Weighted Average Cost of the CBRT Funding Rate	0.9362	0.3426	−0.0355	0.9952	0.0047
Factor	**Variance**	**Cumulative**	**Difference**	**Proportion**	**Cumulative**
F1	13.1104	13.1104	9.5550	0.7145	0.7145
F2	3.5554	16.6658	1.8746	0.1937	0.9083
F3	1.6807	18.3466	–	0.0916	1.0000
Total	18.3466	18.3466		1.0000	
	Model	**Independence**	**Saturated**		
Discrepancy	0.3875	85.1130	0.0000		
Parameters	97	25	325		
Degrees of freedom	228	300	–		

capture a higher liquidity stance, and negative values of foreign currency liquidity measures (when appropriate) may also suggest higher TL liquidity at the expense of lower foreign currency liquidity due to foreign currency interventions. Therefore, we label this factor as the *TL liquidity factor*. These variables explain the approximately 71 per cent variation in Factor 3 (see Table 5) because TL liquidity tools, such as central bank money, monetary base and reserve money, take a smaller share in interest rate and foreign currency liquidity factors, but not in the TL liquidity factor. Moreover, since the coefficients of the TL liquidity tools are positive, we interpret innovation in the *TL liquidity factor* (F3) as a higher TL liquidity position.

Last, we calculate factors F_1^*, F_2^* and F_3^* such that each factor includes the averages of the standardized variables, as reported in Table 6. Thus, the average of each factor should be zero. The sign of each factor is generally not important, but having an increasing or decreasing trend is important. Also, note that the variables are not an indicator of monetary policy stance but rather an indicator of monetary policy tool status. F_1^* can be interpreted as the cost of money; therefore, an increase in F_1^* means an increase in the cost of money. F_2^* captures the CBRT's foreign exchange position; therefore, an increase in F_2^* means an increase in the CBRT's international reserves. F_3^* is for TL liquidity, and an increase in F_3^* can be interpreted as an increase in market liquidity.

This paper argues that the CBRT jointly uses 25 policy tools; however, to align its policy, some of these tools are used in close association more than others are. Thus, we should be able to observe a relationship among these closely associated tools. For example, the correlation coefficients among F_1^*, F_2^* and F_3^* are non-zero. They are statistically significant, but as they are not highly correlated – as one might expect from a time series data set – the factor loadings support the argument that although these three tools are used together, the relationships among each variable in each factor are stronger.

Table 7 reports the correlation coefficients of the generated variables (F_1^*, F_2^* and F_3^*). The correlation coefficients vary between 0.22 and 0.54 in absolute value, and all of them are statistically significant. The correlation coefficients between F_1^* and F_2^*, and F_1^* and F_3^* are −0.54 and 0.22, respectively, the latter of which is parallel with CBRT's suggestions. The correlation coefficient between F_2^* and F_3^* is −0.27; this suggests that the CBRT was ready to provide liquidity to the market at a higher TL cost, which it had suggested in the past (see; CBRT, 2016). If this liquidity were partially supplied with foreign currency transactions, then this result would be parallel with the correlation coefficients of

TABLE 4 Rotated oblique factors for monetary policy tools: Promax

Monetary Policy Tools	**F1**	**F2**	**F3**
Reserve Requirement Ratio of TL Deposits	−0.1691	0.7869	−0.0944
Reserve Requirement Ratio of Foreign Currency Deposits	0.2505	0.8190	0.1569
Discount Rate	0.8554	−0.2028	0.0165
Late Liquidity Window Borrowing Rate	0.1645	−0.6264	−0.0356
Late Liquidity Window Lending Rate	1.0073	0.0200	−0.0298
Foreign Exchange Purchasing Intervention over International Reserve	0.0370	−0.1152	0.2464
Foreign Exchange Selling Intervention over International Reserve	−0.0169	−0.0545	−0.3793
ROM Gold Utilization Rate	−0.0598	0.9607	0.0502
ROM Foreign Currency Utilization Rate	−0.0708	0.9371	−0.0385
ROM Gold over International Reserve	−0.0475	0.9700	0.0779
ROM Foreign Currency over International Reserve	−0.0543	0.9397	0.0024
Foreign Exchange Purchasing Auctions over International Reserve	−0.0349	−0.4019	0.3408
Foreign Exchange Selling Auctions over International Reserve	−0.0444	0.2741	−0.4768
Central Bank Money	−0.0418	0.0606	0.7676
Monetary Base	−0.0412	0.0669	0.6622
Reserve Money	0.0303	−0.0367	0.4100
Open Market Operation over CBRT's Total Assets	0.4982	−0.4130	0.1693
One-Week Repo Auctions Interest Rate	0.9418	−0.1017	0.0100
Overnight Borrowing Interest Rate	1.0168	0.0371	−0.0138
Overnight Lending Interest Rate	1.0197	0.0356	−0.0414
BIST Overnight Repo and Reverse Repo Interest Rate	1.0087	0.0126	−0.0276
Interbank Overnight Minimum Interest Rate	1.0083	0.0308	0.0155
Interbank Overnight Average Interest Rate	1.0295	0.0863	0.0138
Interbank Overnight Maximum Interest Rate	1.0025	0.0153	−0.0164
Weighted Average Cost of the CBRT Funding Rate	1.0087	0.0126	−0.0276
Rotated factor correlation: T'T	**F1**	**F2**	**F3**
F1	1.0000		
F2	−0.4765	1.0000	
F3	0.2011	−0.2106	1.0000
Initial factor rotation matrix: T_0	**F1**	**F2**	**F3**
F1	1.0000	0.0000	0.0000
F2	0.0000	1.0000	0.0000
F3	0.0000	0.0000	1.0000
Factor rotation matrix: T	**F1**	**F2**	**F3**
F1	0.9448	−0.7356	0.2743
F2	0.3272	0.6707	−0.1472
F3	−0.0103	0.0946	0.9502

(Continues)

TABLE 4 (Continued)

Loading rotation matrix: inv(T)'	F1	F2	F3
F1	0.7631	−0.3626	0.0444
F2	0.8495	1.0553	−0.0959
F3	−0.0886	0.2682	1.0246
Initial rotation objective	11.3298		
Final rotation objective	7.75605		

TABLE 5 Variation in each factor

	F1		F2		F3	
Factor Name	Total	Share	Total	Share	Total	Share
Interest Rate	10.3969	0.9072	0.9678	0.1207	0.3817	0.0926
CBRT's Foreign Exchange Position	0.8514	0.0742	6.4417	0.8034	0.7967	0.1933
TL Liquidity	0.2116	0.0203	0.608	0.0758	2.9423	0.7140

TABLE 6 Categorization of monetary policy tools in each factor

Interest Rate (F1)	CBRT Foreign Exchange Position (F2)	TL Liquidity (F3)
Discount Rate	Reserve Requirement Ratio of TL Deposits	Foreign Exchange Purchasing Intervention over International Reserve
Late Liquidity Window Lending Rate	Reserve Requirement Ratio of Foreign Currency Deposits	Foreign Exchange Selling Intervention over International Reserve
Open Market Operation over CBRT's Total Assets	Late Liquidity Window Borrowing Rate	Foreign Exchange Selling Auctions over International Reserve
One-Week Repo Auctions Interest Rate	ROM Gold Utilization Rate	Central Bank Money
Overnight Borrowing Interest Rate	ROM Foreign Currency Utilization Rate	Monetary Base
Overnight Lending Interest Rate	ROM Gold over International Reserve	Reserve Money
BIST Overnight Repo and Reverse Repo Interest Rate	ROM Foreign Currency over International Reserve	
Interbank Overnight Minimum Interest Rate	Foreign Exchange Purchasing Auctions over International Reserve	
Interbank Overnight Average Interest Rate		
Interbank Overnight Maximum Interest Rate		
Weighted Average Cost of the CBRT Funding Rate		

TABLE 7 Correlation coefficients for each policy factor

	F_1^*	F_2^*	F_3^*
F_1^*	1.0000		
F_2^*	– 0.5380	1.0000	
	(– 10.0726)		
F_3^*	0.2230	– 0.2660	1.0000
	(3.0438)	(–3.6714)	

Note: The values in parentheses are the t statistics of the related correlation coefficients.

TABLE 8 Correlation coefficients between each policy variable and each policy factor

Series Name	F_1^*	F_2^*	F_3^*
Reserve Requirement Ratio of TL Deposits	−0.5967	0.8906	−0.2993
Reserve Requirement Ratio of Foreign Currency Deposits	−0.1472	0.6718	−0.0203
Discount Rate	0.9656	−0.6368	0.2458
Late Liquidity Window Borrowing Rate	0.4820	−0.7121	0.1559
Late Liquidity Window Lending Rate	0.9892	−0.4822	0.1838
Foreign Exchange Purchasing Intervention over International Reserve	0.1368	−0.1854	0.4286
Foreign Exchange Selling Intervention over International Reserve	−0.0626	0.0256	−0.5114
ROM Gold Utilization Rate	−0.5372	0.9726	−0.2118
ROM Foreign Currency Utilization Rate	−0.5543	0.9734	−0.2869
ROM Gold over International Reserve	−0.5247	0.9694	−0.1939
ROM Foreign Currency over International Reserve	−0.5293	0.96234	−0.2559
Foreign Exchange Purchasing Auctions over International Reserve	0.1430	−0.5650	0.34685
Foreign Exchange Selling Auctions over International Reserve	−0.2459	0.2918	−0.6244
Central Bank Money	0.0850	−0.0953	0.7576
Monetary Base	0.0599	−0.0663	0.66583
Reserve Money	0.1288	−0.1472	0.5381
Open Market Operation over CBRT's Total Assets	0.7573	−0.6876	0.3461
One-Week Repo Auctions Interest Rate	−0.6629	0.83495	−0.2099
Overnight Borrowing Interest Rate	0.9930	−0.4743	0.1909
Overnight Lending Interest Rate	0.9909	−0.4730	0.1666
BIST Overnight Repo and Reverse Repo Interest Rate	0.9936	−0.4947	0.1815
Interbank Overnight Minimum Interest Rate	0.9941	−0.4846	0.2158
Interbank Overnight Average Interest Rate	0.9854	−0.4397	0.2046
Interbank Overnight Maximum Interest Rate	0.9904	−0.4873	0.1945
Weighted Average Cost of the CBRT Funding Rate	0.9936	−0.4947	0.1815

−0.54 for F_1^* and F_2^* and −0.27 for F_2^* and F_3^*. We also examine the correlation coefficients between the each of 25 policy variables and each policy factor. These results are reported in Table 8. The correlation coefficients between the each of 25 policy variables and each policy factor clearly indicate the high correlation between each policy factor and its relevant varibales.

Figure 1 reports the plots of F_1^*, F_2^* and F_3^*. Figure 1 suggests that F_1^* has been on a downward trend since 2002. This finding can be explained by the CBRT's success at reducing inflation until the 2008

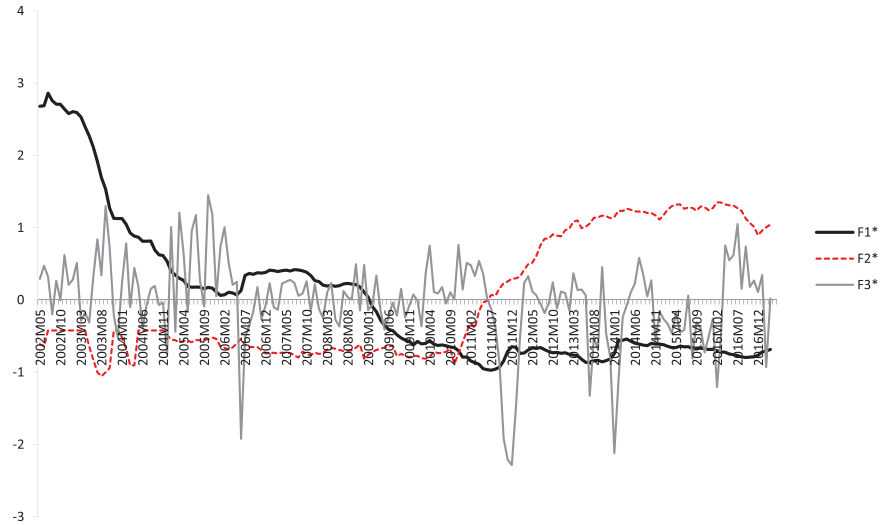

FIGURE 1 Factor variables: F_1^*, F_2^* and F_3^* [Colour figure can be viewed at wileyonlinelibrary.com]

global financial crisis, and by transforming monetary policy after the crisis. Reducing the interest rate against the fragility of the global liquidity surplus that emerged after 2008 coincides with the policies the CBRT implemented within the interest rate corridor. Moreover, since F_1^* includes interest rate tools and open market operation tools alike, the change in interest rates is supported by the changing amount of TL liquidity tools in the market as a result of open market operations. Otherwise, while the interest rate moves in the opposite direction from the CBRT's foreign exchange position (F_2^*), TL liquidity (F_3^*) moves in the same direction that we consider. The CBRT's foreign exchange liquidity position (F_2^*) was kept low until 2008. The increase in this position for the post-2008 era is compatible with the central bank's policy of accumulating foreign exchange reserves at a higher level. Since the second half of 2011, this increase is in line with the policies implemented in the ROM framework. While the CBRT's foreign exchange reserves have been decreasing, especially during fluctuations in the exchange rate, then an increase in its TL liquidity factor is in line with expectations. While TL liquidity tools were used more moderately before 2008, they began to be used more proactively after 2008, with more moderate use of the interest rate corridor system. Thus, we further claim that the behavior of the three-factor groups is in parallel with the CBRT practices.

Now, we examine the effects of these three monetary policy factors on a large numbers of economic-state variables captured with a limited number of variables (factors). Therefore, our analyses require using a large data set comprising various economic-state variables. Thus, we employ a version of Bernanke et al.'s (2005) FAVAR model, which provides a number of advantages: (i) We observe the effects of monetary policy innovations over time. (ii) The conventional VAR model has a degrees-of-freedom problem when a large number of economic-state variables are included, we eliminate this problem. (iii) The FAVAR model includes a large number of data series, and the FAVAR reduces large data sets to factors without any big loss of information. Thus, FAVAR addresses the omitted-information problem.

The data set of the economic-state variables and their transformation treatment, acronym and sources are reported in Table 9. We consider 57 economic-state variables for economic performance. The selection of these variables is mostly due to the availability and reliability of the series. We employ the Bai-Ng Factor Determination Test for the number of factors that we can proxy for the these

TABLE 9 Economic-State variables

#	Series Name	Treatment	Acronym	Sources
1	Number of Dwelling Residential Buildings	3	BUILT	CBRT
2	Number of New Firms	3	FIRM	CBRT
3	Number of Registered Road Motor Vehicles	3	RMV	CBRT
4	Unemployment Rate	1	UNEMP	CBRT
5	Government Consumption (Constant Prices)	3	GCNS	CBRT
6	Private Consumption (Constant Prices)	3	PCNS	CBRT
7	Industrial Production	3	IP	CBRT
8	Industrial Production of Manufacturing	3	IPM	CBRT
9	Capacity Utilization Rate	1	CPCTY	CBRT
10	Real Sector Confidence Index	3	RCONF	CBRT
11	Gross Fixed Capital Formation (Constant Prices)	3	GFCF	CBRT
12	Net Export over GDP (Constant Prices)	1	NX	CBRT
13	CPI (H)	3	HCPI	CBRT
14	CPI (I)	3	ICPI	CBRT
15	CPI	3	CPI	CBRT
16	PPI	3	PPI	CBRT
17	Budget Expenditures over Budget Revenues	1	BDGTEXP	CBRT
18	Budget Interest Rate Payments over Budget Revenues	1	BDGTINT	CBRT
19	Government External Debt over GDP	1	GEXDBT	CBRT
20	Financial Sector External Debt over GDP	1	FEXDBT	CBRT
21	Non-financial Sector External Debt over GDP	1	NFEXDBT	CBRT
22	Long-Term External Debt over GDP	1	LREXDBT	CBRT
23	Short-Term External Debt over GDP	1	SREXDBT	CBRT
24	Direct Investment over GDP	1	DRINV	CBRT
25	Current Account Balance over GDP	1	CAB	CBRT
26	Trade Term	3	TRDTERM	Thomson Reuters Data Stream
27	Broad Definition of Hot Money over GDP (authors' calculation)	1	HOT	CBRT
28	Net Error and Omission over GDP	1	NEO	CBRT
29	Gross International Reserve	3	IRRES	CBRT
30	Net International Reserve	3	NIRRES	CBRT
31	M3	3	M3	CBRT
32	M2	3	M2	CBRT

(Continues)

TABLE 9 (Continued)

#	Series Name	Treatment	Acronym	Sources
33	M1	3	M1	CBRT
34	FX Deposits	3	FXD	CBRT
35	Demand Deposits	3	DD	CBRT
36	Time Deposits	3	TD	CBRT
37	Credits to Private Sector over GDP	1	CRDT	CBRT
38	Consumer Credits over GDP	1	CNSCRDT	CBRT
39	Commercial EU Credit Interest Rate	1	CMEUCRDT	CBRT
40	Commercial US Credit Interest Rate	1	CMUSCRDT	CBRT
41	Commercial TL Credit Interest Rate	1	CMTLCRDT	CBRT
42	Consumer Credit Interest Rate	1	CRDTCNS	CBRT
43	Residential TL Credit Interest Rate	1	CRDTRSTL	CBRT
44	Vehicle TL Credit Interest Rate	1	CRDTVTL	CBRT
45	Need TL Credit Interest Rate	1	CRDTNDTL	CBRT
46	More than One-Year Deposit Interest Rate	1	DEPLR	
47	Six-Month Deposit Interest Rate	1	DEPSIX	CBRT
48	Three-Month Deposit Interest Rate	1	DEPTHREE	CBRT
49	One-Month Deposit Interest Rate	1	DEPONE	CBRT
50	Domestic Borrowing Interest Rate (Average Compound)	1	DBI	Ministry of Development
51	Interest Rate of 2 Year Government Debt Securities	1	TRTWO	Thomson Reuters Data Stream
52	EMBI+TR	3	EMBITR	Thomson Reuters Data Stream
53	BIST-100	3	BIST	CBRT
54	Real Effective Exchange Rate	3	REER	CBRT
55	USD Exchange Rate	3	USD	CBRT
56	EURO Exchange Rate	3	EURO	CBRT
57	Exchange Rate Basket	3	EXCHBSKT	CBRT

Note: Treatment shows how the series is transformed before being added to the database, with 1 = level; 3 = log difference.

stationary economic-state variables.[11] The test results are reported in Table 10. The test statistics suggest the number of factors should be four.

We rank the economic-state variables from 'slow-moving' to 'fast-moving' as the identifying assumption for the ordering. In this sense, the slow-moving variables are predetermined as of the current period. Monetary policy shocks or other shocks, such as economic news, do not affect the slow-moving variables within the month. The fast-moving variables contemporaneously respond to economic news or monetary policy shocks.

[11]To determine whether these economic-state variables have a long-run constant mean, we perform a set of unit root tests. These test statistics suggest that the series are mostly stationary and thus we treat them all as stationary. To determine the robustness of this conclusion, we also perform Im-Pesaran-Shin's (2003) panel unit root test and we reject the null of the unit root again (not reported here).

TABLE 10 Bai-Ng factor determination test for economic-state variables

# Factors	PCP1	PCP2	PCP3
1	0.75415	0.75792	0.74632
2	0.69863	0.70619	0.68297
3	0.66265	0.67399	0.63916
4	0.63882	0.65394*	0.6075
5	0.63634*	0.65524	0.59719
6	0.63726	0.65993	0.59027*
7	0.64798	0.67443	0.59316
8	0.66332	0.69355	0.60068
9	0.68148	0.71548	0.611
10	0.70074	0.73852	0.62243

Note: * is the number of optimum factor number.

We determine a lag order of three to estimate the FAVAR model by using the sequential modified LR Test Statistic, the Akaike Information and the Bayesian Information Criteria. We also place 11 seasonal dummy variables to account for seasonality, a crisis dummy for September 2008, an unconventional monetary policy dummy for the post-November 2010 era and a ROM dummy for the post-September 2011 era. Furthermore, we use a set of control variables as external variables, such as the VIX index, US 10-Year Treasury Bond interest rate, change in Brent petroleum barrel price and growth of world output.

To identify the shocks, we use the Cholesky decomposition. We place the monetary policy factors such that monetary policy affects the economic-state variables but is not affected by these variables contemporaneously. However, each variable affects the others with a lag. This is parallel with the existing literature for Turkey, such as Berument (2007).

Figure 2 reports the impulse responses for 13 economic-state variables when a one-standard-deviation shock is given to each of the three factors. The middle line is the median of the impulse responses. The dotted lines are for the one-standard-deviation confidence bands. Each column reports the impulses for each of the three factors.

The first column of Figure 2 suggests that a positive innovation in the interest rate factor (F_1^*) increases portfolio investments (hot money: short-term capital flows measured by the methodology of Loungani and Mauro (2000)[12] from the Balance of Payments and International Investment Position Manual, 6th Edition; BPM6), appreciates domestic currency,[13] increases international reserves, increases the current account deficit, decreases credits to the private sector, decreases the unemployment rate, increases production and decreases prices in a statistically significant fashion. In this sense, these responses are parallel with economic priors, as suggested by Borio and Zhu (2008) and Mishkin (2010). These results suggests that tight monetary policy via an increase in interest rate tools induces capital inflows (hot money here) and this process may cause an expansion of economic activity even though credit to the private sector decreases. This result might be due to the fact that big and/or

[12] We adopt the Broad Hot Money definition of Loungani and Mauro (2000). The definition consists of the sum of Net Error and Omissions, Other Investment (Assets) and Other Investment (Liabilities) held by entities other than monetary authorities, the government and banks, plus Other Investment (Assets) and Other Investment (Liabilities) held by banks, plus Net Flows of Portfolio Investment Assets and Liabilities in the form of Debt Securities.

[13] A lower value of exchange rate basket or higher value of real effective exchange rate means appreciation of the local currency.

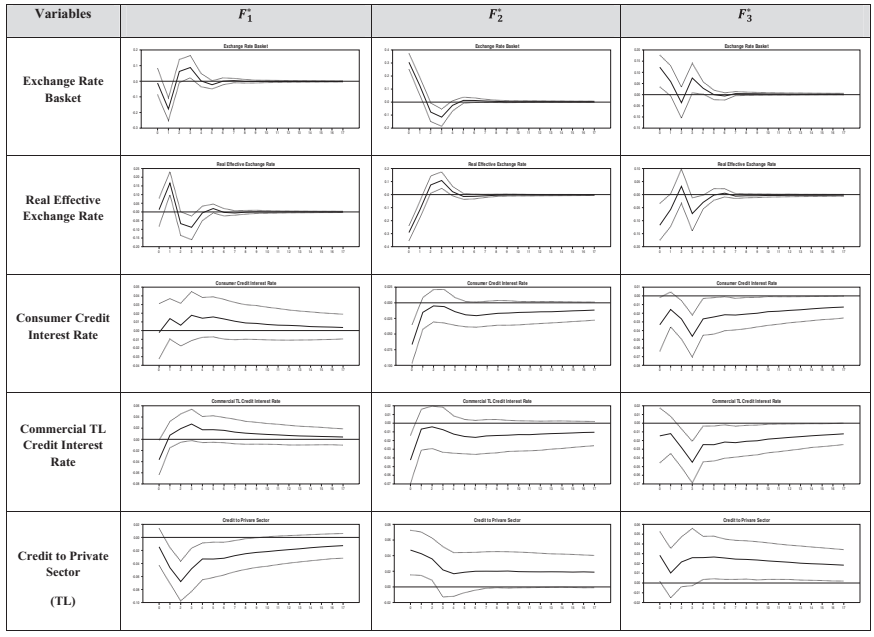

FIGURE 2 Responses of economic state variables to different monetary policy tool sets

Note: The solid lines represent the impulse responses. The dashed lines report the upper and lower bands for the impulse responses.

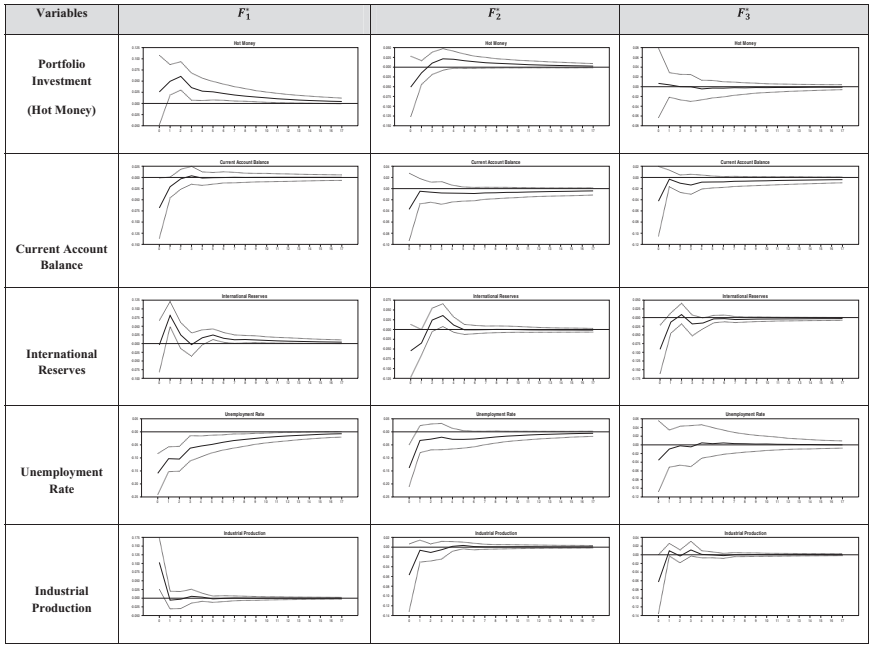

FIGURE 2 Continued

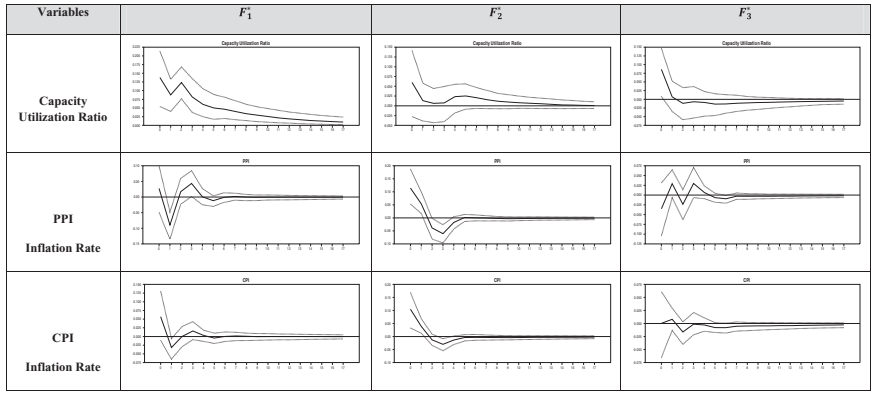

FIGURE 2 Continued

reputable companies may borrow from the rest of the world directly by not using the banking system, thus decreasing banking sector's credit expansions.

The estimates of the responses to a positive innovation in the CBRT's foreign exchange position (F_2^*) are more interesting. Note that a higher foreign currency demand from the CBRT in the market might also be interpreted as a higher TL supply for the CBRT.[14] The CBRT (2013b) publicly declares that it has been using its foreign exchange rate policy as a 'balancing' method.[15] A positive innovation in F_2^* depreciates domestic currency, improves the CBRT's international reserves, decreases the consumer credit interest rate and commercial TL credit interest rate, increases credits to the private sector, increases prices, and decreases the unemployment rate in a statistically significant fashion. However, the responses of industrial production, capacity utilization ratio, capital inflows and current account balance are not statistically significant. These results are not surprising; as a matter of fact, they are the intended outcome of the exchange rate or ROM policy (see Sahin et al., 2015 for details of the ROM mechanism). As the CBRT increases the ROC, foreign-currency-denominated liabilities of commercial banks to the CBRT increase but domestic-currency-denominated liabilities of the banking system decrease. Thus, commercial banks can extend their balance sheet as credits to the private sector, which boosts the economy (note that private consumers cannot use foreign-currency-denominated loans, and only firms that have export exposures can borrow in foreign-currency-denominated loans, and only to a limited extent). Moreover, with the ROM system, commercial banks are encouraged to seek long-term foreign-currency-denominated loans from international financial markets. The results of these policies are also evident in the CBRT's international reserves.

A positive innovation in the TL liquidity factor (F_3^*) indicates that an increase in market liquidity depreciates domestic currency, decreases the CBRT's international reserves, decreases the consumer credit interest rate and commercial TL credit interest rate, increases credit to private sectors

[14] We evaluate a positive innovation in the foreign currency factor as tightness of foreign currency liquidity, as that is what the CBRT calls this practice, rather than calling it a loose monetary policy stance.

[15] 'Balancing' means that the CBRT provides foreign currency liquidity through auctions and direct interventions to withstand excessive volatility in the exchange rate market. The CBRT (2013b, p. 11) emphasizes, *the exchange rate is determined by supply and demand conditions in the market under the floating exchange rate regime. [The] main determinants of foreign currency supply and demand are the monetary and fiscal policies in practice, economic fundamentals, international developments and expectations. The CBRT does not have a nominal or real exchange rate target under the current exchange rate regime. Nonetheless, with a view to limiting the risks to… financial stability, the CBRT does not remain unresponsive to the excessive appreciation or depreciation of the TL.*

and increases the capacity utilization ratio. The above responses are statistically significant but not the others. Overall, the estimates on the effect of liquidity factors are in line with the economic priors.

As discussed earlier, there are other rotation methods by which to gather the factors. We also employ Varimax, Quartimax, Equamax and Orthomax rotation methods to identify the three factors. When we generate these factors, for Factors (1) and (2), the generated variables were mostly identical. When we gather the impulse responses for the factors on the economic-state variables, the impulse responses were either almost identical or statistically weaker. Thus, we can claim that our inferences are robust.[16]

In this paper, we propose to identify the three groups of CBRT's monetary policy tool sets, and to examine the effects of using multiple monetary policy mix rather than a single tool on economic performance. In order to show the superiority of our analyses, we repeat the estimation exercise for a single-tool framework. In this framework, we estimate the impulse response when we give a one-standard deviation shock to BIST Overnight Interest Rate (as a proxy for factor 1), ROM Foreign Currency Utilization Rate (as a proxy for factor 2) and Central Bank Money (as a proxy for factor 3). In order to save space, we did not report the impulse responses in the main text. Impulse responses reveal that there is a set of inconsistent estimates. For example, an increase in interest rate increases prices rather than decreases; this is known as *price puzzle* in the VAR literature. Moreover, increase Central Bank Money (i) decreases the credit level rather than increases credit level and (ii) increases the unemployment rate rather than decrease it. Thus, our specification is superior to the single-tool VAR specification.

In sum, these results provide an important interpretation that each policy tool set will have a different effect on the direction and the magnitude of economic outcomes. Thereby, a multiple-tool environment of monetary policy gives better economic outcomes than a single-tool environment does. This finding is precisely what Brainard (1967, p. 416) calls the 'wrong way,' i.e., central banks using their various policy tools to conduct monetary policy in a contraindicatory fashion.[17]

5 | CONCLUSION

In the post-2008 era, central banks were forced to change their monetary policy practices to cope with new challenges brought on by the global financial crisis, as conventional monetary policy tools did not have the desired/conventional effects on macroeconomic variables. Especially in emerging market economies, central banks have had to cope with this new environment in new ways: (i) develop a new set of tools to conduct monetary policy to affect different parts of their economies differently; (ii) refine the tools (such as multiple short-term interest rates) that are likely to affect different components of commercial banks' balance sheets and have a heterogeneous effect on lendings and deposits practices of commercail banks, for example, the tools that affect the domestic-currency versus foreign-currency composition of the balance sheet differently, and (iii) use these tools simultaneously.

This paper combines 25 of these monetary policy tools within three factors in order to reduce dimensionality of monetary policy tools, showing that, for Turkey, the tools can be categorized into areas such as interest rate, foreign exchange position and TL liquidity. Thus, we capture the monetary policy stance and assess the effect of each factor on Turkey's economic performance.

A positive innovation in the interest rate factor, which captures treater tightness in monetary policy stance, increases capital flows (hot money), appreciates domestic currency, increases international

[16]These estimates are not reported here but are available from the authors upon request.

[17]Brainard (1967, p. 416) argues that if there are more instruments than targets, it is generally more optimal to use some combination of these instruments even if they may be used in a 'wrong way'"

reserves, decreases credits to the private sector, decreases the unemployment rate, increases production, increases the current account deficit, and decreases prices. These results parallel to economic priors in emerging market countries. Tight monetary policy via an increase in interest rate tools induces an expanding effect in economic activity by increasing capital inflows. In addition, in this process, inflation rate decreases through appreciation of domestic currency and a decrease in credits. A positive innovation in the CBRT's foreign exchange position factor depreciates the domestic currency, improves the CBRT's international reserves, decreases credit interest rates, increases credits to the private sector, decreases the unemployment rate and increases prices. Thus, due to the micro design of these policy tools, the results are parallel with what the CBRT expects from them. A positive innovation in the TL liquidity factor depreciates domestic currency, decreases the CBRT's international reserves, decreases credit interest rates and increases the capacity utilization ratio.

In sum, we can claim that each policy factor will have a different effect on the direction as well as the magnitude of economic outcomes. In this sense, the multiple-tool environment delivers better economic outcomes compared to the single-tool environment.

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SUPPORTING INFORMATION

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How to cite this article: Varlik S, Berument MH. Monetary policy under a multiple-tool environment. *Bull Econ Res*. 2020;72:225–250. https://doi.org/10.1111/boer.12219