TÜRKİYE CUMHURİYET
MERKEZ BANKASI

RESEARCH NOTES IN ECONOMICS

Endogeneity of Money Supply: Evidence From Turkey[1]

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Abstract: There is a long discussion among academics and central bankers about the theories of money supply. According to the exogenous view, central banks have full control over money supply via policy actions including the adjustments of interest rates and reserve ratios, both of which alter commercial banks' lending decisions. However, the theory of endogenous money supply emphasizes the role of demand for bank loans in money creation. More specifically, banks create money by meeting the demand of economic agents. In this study, we investigate which of the money supply theories holds in the Turkish economy for the period 2006-2015 by employing cointegration and causality tests. Our findings show that the relation runs from bank loans to money supply both in the short and long terms, which supports the endogenous view in a sense that central bank and the banks fully meet the total demand for money in the Turkish economy.

Özet: Akademisyenler ve merkez bankacıları içinde para arzı teorileri ile ilgili uzun süredir devam eden bir tartışma bulunmaktadır. Dışsal bakış açısına göre, merkez bankaları ticari bankaların borç verme kararları üzerinde etkili olan faiz ve rezerv oranındaki değişiklikleri içeren politika adımları ile para arzı üzerinde tam kontrole sahiptir. Ancak, para arzının içselliği teorisi para oluşturmada banka kredilerine olan talebin rolünü vurgulamaktadır. Diğer bir deyişle, bankalar iktisadi ajanların taleplerini karşılayarak para oluşturmaktadır. Bu çalışmada, eşbütünleşme ve nedensellik testleri kullanılarak 2006-2015 yılları arasında Türkiye ekonomisi için hangi para arzı teorisinin geçerli olduğu incelenmektedir. Bulgularımız, hem kısa hem de uzun vadelerde nedenselliğin banka kredilerinden para arzına doğru olduğunu gösterdiğinden, Türkiye ekonomisinde Merkez Bankası ve bankaların toplam para talebini karşıladığı ve para arzının içsel olduğu görüşlerini desteklemektedir.

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1. Introduction

Theoretical concept of money has been one of the most discussed topics in the field of economics. According to the modern central banking perspective, money is defined as the liabilities of money creating sectors that are used as means of exchange in the economy. Bank money is defined as the sum of "deposits (sight+time)" while central bank money is the sum of "banknotes in circulation" and "bank reserves".

Although there exists a vast literature on the theory of money supply, there is no consensus among academicians and central bankers on the drivers of money creation. According to the classical view (i.e., Monetarist or Neo-Keynesian view), money supply is assumed to be exogenous since the central bank plays a crucial role on the growth of supply. This approach considers that the central bank has full control over monetary base, which comprises its liabilities. Under the assumption that the money multiplier, defined as the ratio of money supply to the monetary base, is empirically stable, the proponents of this view assert that the central bank could exogenously control the monetary base to achieve the targeted money supply levels (Moore, 1998).

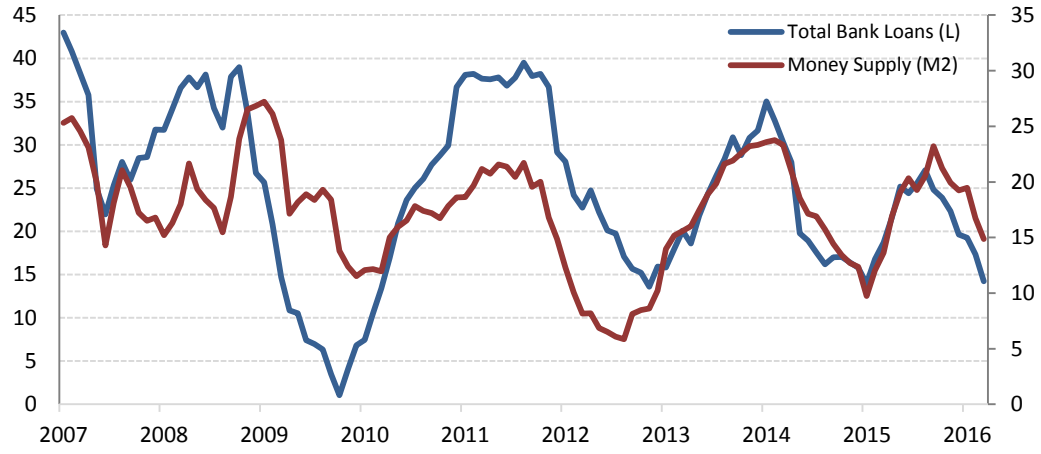
However, starting with the seminal paper of Kaldor (1982), endogeneity of money supply has received considerable attention. The main idea behind the endogenous view is that money supply is determined by the interaction of loan demand and bank lending practices. Once loans have been granted and deposits have increased, central banks have no choice but to accommodate all increases in demand for central bank money to maintain the solvency and liquidity of the financial system. This obligation of central bank is called "the lender of last resort". In this approach, both commercial banks and the central bank create money. Commercial banks create money via granting loans and the central bank accommodates money demand of banks due to the illiquid nature of banking activity.

Keeping these contrary money supply theories in mind; when we look at the year-on-year (yoy) percent change in total bank loans and the money supply (M2)[2] in Turkey, as seen in Figure 1, they have exhibited similar patterns in the last decade. Another striking observation is that the changes in the funding need of the Turkish banking system has been almost equal to the changes in Turkish lira (TL) banknotes in recent years. Table 1 summarizes contributions to the balance of net open market operations of the Central Bank of the Republic of Turkey (CBRT) for the July 2012 – July 2015 period. As evident, CBRT and Treasury operations have cancelled out each other and the increase in funding need has

[2] The majority of the existing literature use M2 to represent money supply. For sensitivity purposes, we also incorporate M1 and M3 to our empirical analysis.

been a result of the increase in Turkish lira banknotes.[3] More specifically, as bank deposit holders withdraw their funds in the form of banknotes, CBRT has fully met the liquidity needed to clear their obligations.

Figure1. Total Banks Loans- Money Supply Relationship (YoY % Change)



Source: Bloomberg, CBRT.

Table 1. Changes in the Funding Needs of the Banking System (20.07.2012 - 31.07.2015)

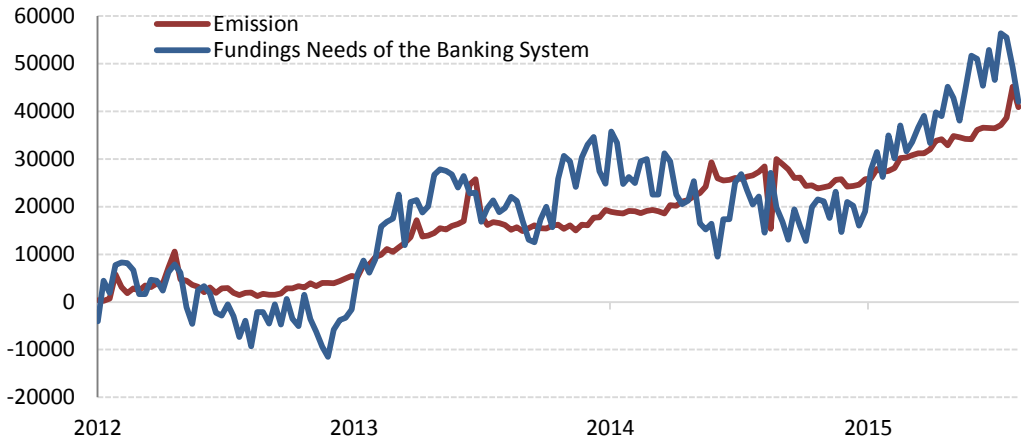
Net Open Market Operations: *20.07.2012 (Million TL)*	**-21.446,40**
CBRT Operations	-11.033,93
Treasury Operations	10.848,33
Base Money	-41.887,00
Net Open Market Operations: *31.07.2015 (Million TL)*	**-63.777,00**

Source: CBRT

Finally, to have more evidence on this observation, we study the relationship between emission and the funding needs of the banking system for the same period. Figure 2 shows that the liquidity demand of Turkish banking system seems to be supplied by the CBRT in recent years.

[3] According to Article No.87 of the Constitution of the Republic of Turkey, the privilege of issuing banknotes belongs to Grand National Assembly. This privilege was given to CBRT and was extended for an unlimited time.

Figure 2. Emission-Funding Needs of the Banking System Relationship
(Normalized as of 07.20.2012)



Source: Bloomberg, CBRT

Motivated by these observations, in this note we examine the endogeneity of money supply in Turkish economy with recent data by applying cointegration and causality test, taking into account structural changes in monetary base. In our empirical analysis, we test the relation between loans and money supply. To this end, we apply cointegration and causality tests. Then, we check the robustness of our results by employing a trivariate Vector Autoregression (VAR) methodology suggested by Badarudin et al. (2013).[4] Our findings provide evidence for the endogeneity of money in Turkey. Specifically, we observe that the causality runs from bank loans to money supply both in the short and long run, which implies that the CBRT accommodates the increases in liquidity demand of the banking system. In general, central banks have only an imperfect control over money supply. Therefore, the efficiency of inflation targeting policies, which uses short term interest rates as the main policy tool, may improve by clarifying the elasticity of credit demand to the interest rates in an economy with endogenous money supply.

2. Literature Review

Three theoretical perspectives with regard to endogenous money supply exist in the literature. According to the accommodationist view, once loans have been granted and deposits have increased, the central bank has no choice but to fully accommodate commercial banks' funding needs to maintain the solvency and liquidity of the financial

[4] Badarudin et al. (2013) use trivariate (VAR) to check the possibility that earlier inferences were wrong because of the omission of a third relevant variable such as deposits.

system and to fulfill its role as the lender of last resort (Moore, 1989a, 1989b). Accommodationists believe that the central bank can only control the interest rates but not the supply of reserves. On the other hand, structuralist view asserts that the central bank may not fully accommodate reserves demanded by commercial banks. As bank lending increases, the demand for reserves will rise, but there may be only a partial accommodation from the Central Bank, and hence interest rates would be raised in the process. In other words, the Central Bank has an option of controlling interest rates or the quantity of its liabilities. This view also proposes that banks could overcome reserve constraints imposed by the Central Bank via liability management (Palley, 1994, 1998). Liquidity preference view is the third approach, which questions the demand-driven money supply. Howells (1995) argues that economic agents have different liquidity preferences about the amount of money they wish to hold. If the supply of deposits is insufficient to meet the demand for loans, individual preferences will change relative interest rates to fill the gap by increasing the supply of deposits and reducing the demand for loans.

Several articles in the empirical literature investigated the nature of money supply for different countries. Panagopoulos and Spiliotis (1998) support the accommodationist view by showing that money supply was primarily determined by the banking system in response to the demand for loans in Greece. In a recent study, Lavoie (2005) states that in Canadian financial system credits rely on a fully endogenous supply of money and the main purpose of the central bank is precisely to ensure that the supply of high-powered money is exactly equal to its demand. Haghighat (2011) examines the direction of causality in both the short and long run in order to test the endogeneity/exogeneity hypotheses of money supply in Iran and finds supportive evidence of endogenous money hypothesis. In another study, Tas and Togay (2012) use the data from GCC (Gulf Cooperation Council) countries to implement a direct test of endogenous money supply. Granger causality test results show that money is endogenous for all GCC countries except Bahrain and Kuwait. Therefore, their results provide insights for understanding the money generation mechanism in order to implement an effective monetary policy in a monetary union. Recently, Badarudin et al. (2013) argue that monetary policies adopted by the G7 countries allow for the creation of money supply endogenously via the banking system, thus the central banks do not necessarily fully control the money supply.

International institutions such as the Bank for International Settlements (BIS) and studies in central banks provide evidence supporting the endogeneity of money. For example, in a BIS study, Disyatat (2008) states that the central bank's main liquidity management duty is to ensure a sufficient supply of balances for the system as a whole to maintain reserve

requirements and the proposition that the monetary policy is implemented mainly by controlling quantity aggregates is a pervasive misconception. Also, Bank of England's Quarterly Bulletin (2014 Q1) elaborates on the money creation in England and indicates that most of the money in circulation is created by the commercial banks via lending activities or asset purchase programs. Hence, the Bank of England does not directly control the quantity of either base or broad money.

Similar to other studies in the literature, Çifter and Ozun (2007) test the monetary transmission mechanism and the endogeneity of money supply in Turkey for the sample period of 1997-2006. They conclude that the central bank and banks could fully accommodate the demand for loans. However, the nature of money supply in Turkey could change significantly in the last decade due to unconventional monetary policy tools. In this study, we empirically analyze the nature of money supply for the Turkish economy for the period of 2006-2015 and investigate the direction of the relationship between money supply and bank loans in both the short and long run.

3. Data and Methodology

The data is extracted from Bloomberg and the electronic data delivery system of CBRT. We utilize monthly data over the period January 2006 - May 2015. Total bank loans (BL)[5], deposits (DEP)[6], monetary base (MB) and the money supply variables (M1, M2, M3) are used in our empirical analysis. All variables are transformed into a logarithmic form.

In line with the literature, we employ vector error correction (VECM) and vector autoregressive (VAR) models in our empirical analysis. Johansen cointegration and Granger causality tests are applied to determine the relationships between variables. In order to check stationarity, we start with an augmented Dickey–Fuller (ADF) unit root test. As a robustness check, Phillips and Perron test is also utilized, since it is relatively more powerful than ADF test.[7] The results given in Table 3 show that the null hypothesis, existence of a unit root, could not be rejected for all variables except DEP and MB1[8] at levels. More specifically, DEP and MB1 are trend-stationary but the remaining variables are nonstationary. Therefore, we detrend DEP and MB1 and take the first difference for the other variables in our empirical analysis.

[5] Bank loans includes TL and FX loans used by households and corporates.
[6] It covers all deposits TL and FX.
[7] See Davidson and MacKinnon (1993) for details.
[8] Monetary base divided into two part as a result of Chow test.

Table 2. Unit Root Tests				
	ADF Test		P-P Test	
Variables	**Lag**	**t-statistic**	**t-statistic**	**Result**
Bank Loans (BL)	*2*	*-4.15****	*-8.46****	*I(1) Non-Stationary*
Deposits (DEP)	*0*	*-3.59***	*-3.49***	*I(0) Trend-Stationary*
MB1	*0*	*-7.06****	*-7.15****	*I(0) Trend-Stationary*
MB2	*0*	*-9.72****	*-9.55****	*I(1) Non-Stationary*
M1	*0*	*-10.49****	*-10.49****	*I(1) Non-Stationary*
M2	*2*	*-2.47***	*-4.79****	*I(1) Non-Stationary*
M3	*0*	*-8.85****	*-8.78****	*I(1) Non-Stationary*

Next step is to check cointegration between variables. There is no need to check the cointegration for the variables, one of which is stationary and the other is nonstationary. However, when the variables are I(1), Johansen cointegration test is conducted. The optimal lag lengths of the VAR are determined by minimizing the Akaike (AIC) and Schwarz Bayesian Information Criteria (SBC). After selecting the optimal lag length, VAR residual serial correlation Lagrange Multiplier (LM) test is implemented. When there is no cointegration between variables which are nonstationary, the standard Granger causality test is applied. However, for the cointegrated variables, the causality is checked by using the Vector Error Correction (VECM) model given as follows:

$$\Delta y_t = \beta_0 + \sum_{i=1}^{n} \beta_{1i}\ \Delta y_{t-\mathrm{i}} + \sum_{i=1}^{n} \beta_{2i}\ \Delta x_{t-\mathrm{i}} + \beta_3\ EC_{\mathrm{t}} + \epsilon_t \qquad (1)$$

where y_t is the dependent variable; x_t is an independent variable; EC_t is the error correction term, and ϵ_t is the error term. In this model, the short run relation is found by checking the joint significance of the lagged coefficients of β_{2i} based on a standard Wald test. On the other hand, the long run relation is determined by examining whether the error correction term is significantly different from zero. However, in the presence of non-stationary variables, Wald test statistic does not follow its standard asymptotic chi-square distribution under the null hypothesis. Therefore, we have followed Toda and Yamamoto (1995) causality testing procedure to account for the presence of non-stationary variables.[9] Finally, to verify the validity of causal relationships between variables, trivariate VAR model is applied as a robustness check. In the context of trivariate systems, the omission of a third relevant variable in the model can alter the causal inference based on the simple bivariate system. In order to explore whether earlier inferences are robust, causality test is implemented between

[9] After having determined an optimal lag length k with the usual lag selection methods, this procedure requires the estimation of a $(k + d_{max})$th-order of VAR in levels by adding extra d_{max} lags, where d_{max} is the maximal order of integration between variables.

variables bank loans (BL), deposits (DEP), monetary base (MB) and money supply (M1, M2, M3) by applying a trivariate VAR model given as follows:

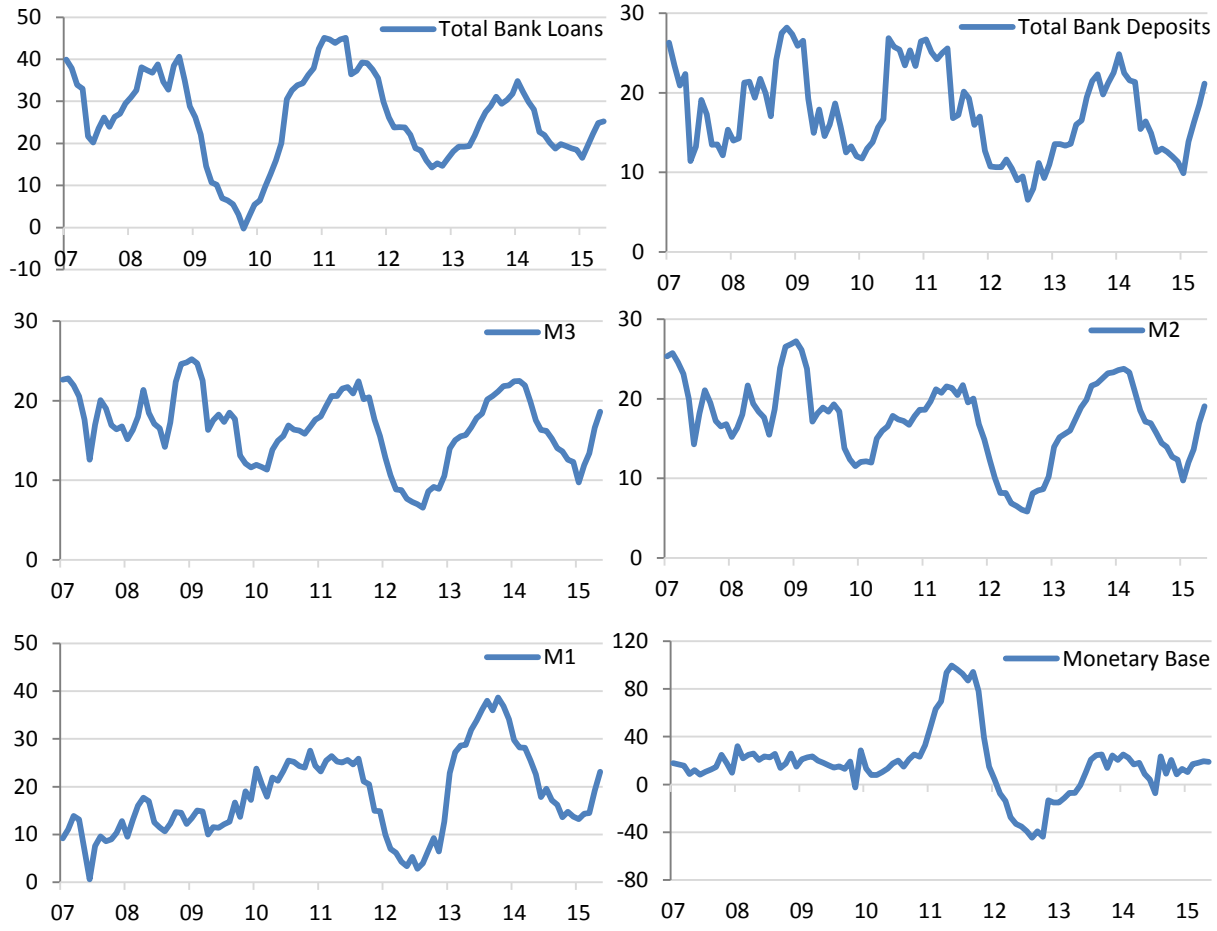
$$\begin{bmatrix} BL_t \\ DEP_t \\ MS_t \end{bmatrix} = \beta_0 + \sum_{i=1}^{k} \left(\beta_i \begin{bmatrix} BL_{t-i} \\ DEP_{t-i} \\ MS_{t-i} \end{bmatrix} \right) + \sum_{j=k+1}^{k+d_{max}} \left(\beta_j \begin{bmatrix} BL_{t-i} \\ DEP_{t-i} \\ MS_{t-i} \end{bmatrix} \right) + \begin{bmatrix} \varepsilon_{BL_t} \\ \varepsilon_{DEP_t} \\ \varepsilon_{MS_t} \end{bmatrix}$$

where β_0 is a 3x1 constant vector, β_i and β_j are 3x3 coefficient matrices, and ε is a 3x1 white noise error term vector.

4. Empirical Findings

We start the empirical analysis with descriptive graphs. Figure 3 exhibits the evolution of all variables over the period 2006-2015.

Figure 3. Descriptive Graphs (YoY % Change)



Source: Bloomberg, CBRT.

We observe a structural break for the monetary base as a result of the reserve requirement decision of CBRT. Since monetary base is equal to the sum of TL in circulation and commercial bank deposits held in the CBRT's reserves, with the effect of that decision, the latter increased rapidly. However, CBRT introduced reserve option mechanism (ROM) in the following period, which provides banks the option to hold their required reserves in FX or gold. Banks utilized that mechanism by withdrawing some portion of their TL reserve requirement, which in turn decreased monetary base. We also check whether this structural break is statistically significant by applying a Chow (1960) Test. The results given in Table 2 verify that there is a structural break in MB as shown by F-statistic and the log likelihood ratio test value, which are statistically significant at 1% level. Accordingly, monetary base series is divided into two parts. The split series are labelled as follows: MB1 (January 2006 – November 2010) and MB2 (December 2010 – May 2015).

Table 3. Chow Breakpoint Test : 2010 M11

	F-Test		Log Likelihood Ratio	
Equation Sample	**t-statistic**	**P-Value**	**t-statistic**	**P-Value**
2006M01 2015M05	*330.99*	*< 0.001*	*156.14*	*< 0.001*

Next, we perform pairwise cointegration tests. There is no cointegration between BL and MB1 since one of them is nonstationary and the other is trend-stationary. For the remaining variables, Johansen cointegration test results displayed in Table 4 indicate that there exist long run relationships between bank loans and money supply variables. However, the null hypothesis of no cointegration between BL and MB2 could not be rejected based on maximal eigenvalue and trace tests.

Table 4. Johansen Cointegration Test Results

Variables	**Lag**	**Trace**	**Eigenvalue**	**Co-integration**
BL and MB2	*2*	*5.13*	*4.96*	*NO*
BL and M1	*6*	*31.07***	*24.36****	*YES*
BL and M2	*11*	*29.47***	*24.80****	*YES*
BL and M3	*11*	*27.61***	*23.21***	*YES*

Given these findings, we proceed with Granger causality tests for the variables BL, MB1 and MB2. We find no strong evidence in favor of cointegration relationship. The results are summarized in Table 5.

Table 5: Granger Causality Test Results				
DV	**INDV**	**Chi-square**	**Conclusion**	**Lag**
BL	MB1	*2.46*	-	*3*
MB1	BL	*14.64***	*BL → MB1*	*3*
BL	MB2	*1.59*	-	*3*
MB2	BL	*8.37***	*BL → MB2*	*3*

We observe short run relation from bank loans to monetary base variables that provides supportive of endogenous money supply. As a next step, in order to check short and long run relations between bank loans and money supply variables, VECM tests are implemented. The results of VECM model are given in Table 6. Long run relations are determined by the significance of error correction term (ECT). Short run relations are identified by the joint significance of lagged explanatory variables using a Wald Test.

Table 6. Results of Vector Error Correction Models									
Long Run Coefficients				**Long Run**	**Short Run Coefficients**			**Short Run (Wald Test)**	
DV	**INDV**	**ECT**	**t-stat**	**Conclusion**	**DV**	**INDV**	**Chi-square**	**Conclusion**	**Lag**
BL	**M1**	*-0.019*	*-1.05*	--	**BL**	**M1**	*3.31*	--	*4*
M1	**BL**	*0.067*	*2.66****	*BL → M1*	**M1**	**BL**	*12.87***	*BL → M1*	*4*
BL	**M2**	*-0.033*	*-1.12*	--	**BL**	**M2**	*5.85*	--	*3*
M2	**BL**	*0.026*	*1.64**	*BL → M2*	**M2**	**BL**	*52.24****	*BL → M2*	*3*
BL	**M3**	*-0.034*	*-1.18*	--	**BL**	**M3**	*6.33**	*M3→ BL*	*3*
M3	**BL**	*0.029*	*1.70***	*BL → M3*	**M3**	**BL**	*52.86****	*BL → M3*	*3*

Main observations from Table 6 are: the speed of adjustment of money supply to bank loans varies from 2.6% (0.026 in the table) to 6.7%. In other words, money supply reacts with a deviation from long run relationship between 2.6% for M2 to 6.7% for M1. In addition, long run relation from bank loans to money supply variables provides evidence for the endogeneity in the sense that CBRT and the commercial banks fully meet the demand for money. Moreover, Wald test results suggest that long run relation from bank loans to M1 and M2 also hold in the short run. However, we observe a bidirectional relation between bank loans and M3 in the short run, which indicates that liquidity channel has also an effect on endogenous money supply.

Finally, we apply trivariate VAR model of Toda and Yamamoto (1995) in order to check the robustness of earlier inferences between bank loans and money supply. For this purpose, we incorporate deposits (DEP) as a third variable to our model. Bivariate relation between deposits and the other variables are also examined. The results are summarized in

Table 7. First observation from the trivariate VAR model is that relation between bank loans and the money supply variables are preserved in the new framework as well. This result confirms the robustness of above findings. Second, we observe a bidirectional relation between bank loans and deposits, which is an expected result due to the accounting operations of commercial banks. Moreover, the observed relation from bank loans to deposits together with the relation from deposits to money supply approve also the endogenous nature of money in Turkey. To sum up, deposits also play a crucial role in the monetary transmission mechanism.

Table 7. Trivariate VAR Results

DV	INDV	Result	DV	INDV	Result	DV	INDV	Result
BL	DEP	*DEP→ BL*	BL	DEP	*DEP→ BL*	BL	DEP	*DEP→ BL*
BL	M1	---	BL	M2	---	BL	M3	*M3→ BL*
BL	DEP&M1	*DEP → BL*	BL	DEP&M2	*DEP → BL*	BL	DEP&M3	*DEP → BL*
DEP	BL	*BL→ DEP*	DEP	BL	*BL→ DEP*	DEP	BL	*BL→ DEP*
DEP	M1	----	DEP	M2	----	DEP	M3	----
DEP	BL&M1	*BL→ DEP*	DEP	BL&M2	*BL→ DEP*	DEP	BL&M3	*BL→ DEP*
M1	BL	*BL → M1*	M2	BL	*BL → M2*	M3	BL	*BL → M3*
M1	DEP	*DEP → M1*	M2	DEP	*DEP → M2*	M3	DEP	*DEP → M3*
M1	BL&DEP	*BL → M1*	M2	BL&DEP	*BL→M2*	M3	BL&DEP	*BL→M3*

5. Conclusion

In this study, we empirically test the endogenous money supply hypothesis for the Turkish economy. Using time series data for the period 2006-2015, we employ Johansen cointegration and Granger causality tests between total bank loans, monetary base and money supply variables. The empirical evidence is strongly supportive of the hypothesis that money supply is loan-driven and demand-determined in Turkey. More specifically, loans granted by banks to meet the public demand for money construct the basis of money supply. For robustness check, we also include deposits to our empirical analysis. Endogenous nature of money supply still exists and the deposits are found to be significant in our framework. Our findings suggest that understanding the impact of bank loans on the monetary transmission mechanism is important for a proper formulation of monetary policy.

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