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Testing the Quantity Theory of Money for the Turkish Economy: Evidence from the Maki Co-integration Test

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Abstract In this study, the validity of the quantity theory of money is tested for the Turkish economy over the period 2006:01-2022:12. For this purpose, the unit root and co-integration tests that do not neglect structural breaks are employed. Findings from the Maki co-integration test reveal that M1, M2, and M3 money supplies are co-integrated with the inflation rate. Then, the breaks from the Maki test are integrated into the DOLS model for the long-run coefficients. According to the DOLS estimator, a 1% increase in M1, M2, and M3 causes an increase in the inflation rate by 0.24, 0.58, and 0.81 percent, respectively, in the long-run. Finally, the causality analysis also verifies the unidirectional relationship from the money supply to the inflation rate. The results indicate that the quantity theory of money is largely valid for the Turkish economy.

Keywords Inflation · Money supply · Quantity theory of money

Jel Codes E31, E51, C32

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In order to understand the importance of money, it is necessary to consider its functions. The fact that money is a unit of account provides savings at the knowledge level by providing fewer prices in the market. Thanks to being a medium of exchange, more trade volume is reached with fewer trade points. Being a store of value encourages savings, investment, economic growth, and welfare. Money, especially by promoting trade, connects nations and even hostile nations, and increases the division of labour and productivity, thus contributing to the development of civilisation. Davies (2002: 47) points to the existence of a close relationship between money and civilisation.

The history of monetary theory is engrossing. Mercantilist economists have associated the wealth of countries entirely with precious metals such as silver and gold, which are used as money. Although they attached great importance to money, they could not develop a systematic monetary theory. Classical and Neoclassical economists associated the wealth of countries with the amount of production and did not attach much importance to money. Surprisingly, however, they made a significant contribution to monetary theory (Paya, 2007: 8).

David Hume, influenced by Aristotle and the Salamanca school, evaluated money within the framework of quantity theory (Ekstedt, 2012: 32). He stated that monetary expansion only leads to a proportional increase in the general level of prices, not a change in relative prices. Hume (1895) saw money as a practical tool that facilitated exchange and likened it to oil, which made the wheels turn more easily. According to him, the amount of money in the economy is not that important. Even if the amount of oil is less or more than the optimum level, the wheels continue to rotate.

The quantity theory is generally represented as in equation 1.

$MV = PY \ (1)$

In equation 1, *M* is the nominal money stock, *V* its velocity, *P* the general price level, and *Y* the real income or output level. The right side of the equation represents monetary income. Classical and neoclassical economists generally concentrate on the left side (Rousseau, 2007: 266). *V* and *Y* are assumed to be fixed in the short-run.

The quantity theory is analysed in two different ways: the direct mechanism and the indirect mechanism. Monetary expansion raises the individual cash balance above the desired level. In the direct mechanism, at this stage, the Cambridge effect emerges and aggregate expenditures increase (Paya, 2007: 217). In the indirect mechanism, the supply of funds increases and so the interest rate decreases. A low interest rate encourages consumption rather than saving, and aggregate expenditure increases. After all, in both mechanisms, the general price level increases at the same rate as the money supply.

The most renowned versions of the direct mechanism are the Fisher and Cambridge equations. The equation proposed by Fisher (1911) can be presented as follows:

$M = \frac{1}{V} PT \ (2)$

Where *T* shows the volume of trade. The Cambridge form of the quantity theory can be presented as follows (Marcuzzo, 2017: 260):

$M = kPY$, $k = \frac{1}{V}$ (3)

Where *k* shows the desired amount of money. Equation 3 can be represented as follows:

$\frac{\Delta M}{M} = \frac{\Delta P}{P} + \frac{\Delta Y}{Y} - \frac{\Delta V}{V}$ (4)

$\frac{\Delta M}{M} = \frac{\Delta P}{P}$, $\frac{\Delta Y}{Y} = \frac{\Delta V}{V} = 0$ (5)

V and *Y* are assumed to be fixed and hence *M* and *P* increase in equal proportion. Additionally, the direction of causality is from M to P (Humphrey, 1997: 72).

The quantity theory is also valid in modern economies. Friedman and Friedman (1980:255) stated that inflation is a monetary phenomenon, but there is no one-to-one relationship between monetary expansion and inflation. The difference between monetary expansion and inflation arises from real GDP growth. Therefore, they examined the relationship between the quantity per unit of output and the inflation rate in Japan, Germany, the USA, the UK and Brazil for the period 1964-1977. The investigations showed that the two aforementioned variables act together in all five countries (Friedman & Friedman, 1980: 257-261).

New Zealand was the first country to implement inflation targeting in 1990. The strategy began to be widely used in a short time because it reduced exchange rate pass-through, interest rates, inflation volatility, and inflation level, and also promoted stable economic growth (Mishkin & Schmidt-Hebbel, 2007). Turkiye did not immediately adopt this new strategy. However, due to the impact of the 2001 financial crisis, the implicit inflation targeting regime was introduced in 2002 and the explicit inflation targeting in 2006 (Kara, 2006).

Table 1

Monetary Growth and Inflation Rate in Turkiye

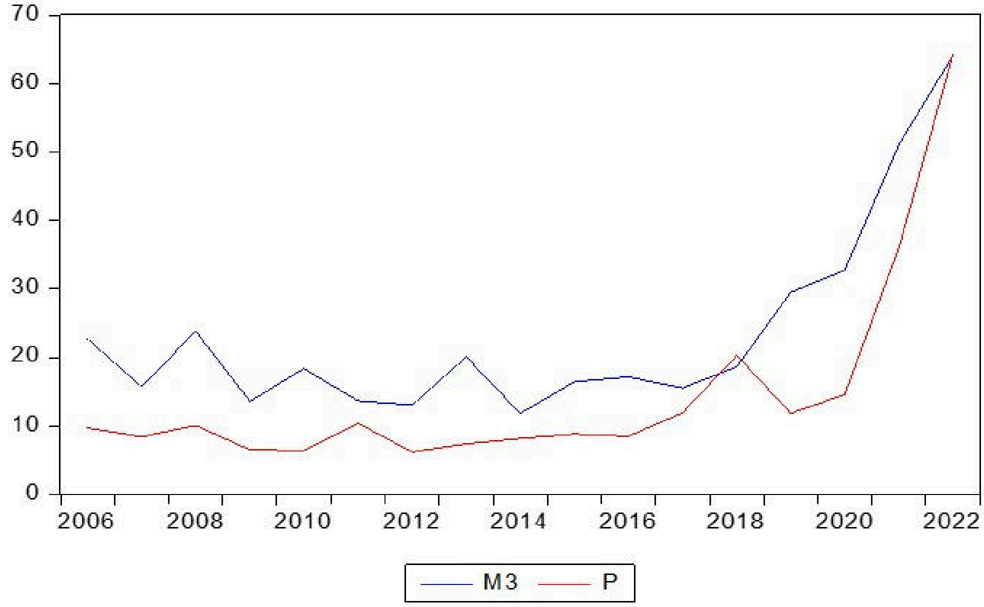
Year	M1	M2	M3	Inflation Target	Inflation
2006	16.51	25.02	22.72	5	9.7
2007	7.64	15.98	15.71	4	8.4
2008	7.35	25.85	23.86	4	10.1
2009	28.39	13.78	13.59	7.5	6.5
2010	25.07	18.98	18.35	6.5	6.4
2011	10.88	13.24	13.68	5.5	10.4
2012	22.55	12.54	13.06	5	6.2
2013	23.86	21.48	20.07	5	7.4
2014	11.83	11.92	11.8	5	8.2
2015	23.82	17.4	16.45	5	8.8
2016	22.55	17.64	17.17	5	8.5
2017	17.6	15.49	15.52	5	11.92
2018	13.99	19.44	18.65	5	20.3
2019	39.08	26.64	29.52	5	11.84
2020	71.13	35.3	32.75	5	14.6
2021	71.92	52.23	51.11	5	36.08
2022	49.3	62.25	64.13	5	64.27

Source: Central Bank of the Republic of Turkiye

Table 1 presents the annual increase rates of the M1, M2, and M3 growth rates and the annual inflation rate in Turkiye. The correlation coefficients of the inflation rate with the growth rates of M1, M2, and M3 are 0.54, 0.9, and 0.92, respectively. In the explicit inflation targeting regime, the inflation target was reached only twice. These years are 2009 and 2010, after the global crisis that shrunk aggregate demand. Peker (2011) associated with external shocks the fact that the explicit inflation targeting regime was not as successful as the implicit inflation regime. However, if there is a failure, the reasons for this are probably related to monetary facts.

Figure 1

Monetary Expansion and Inflation Rate



Source: Central Bank of the Republic of Turkiye

Figure 1 presents the annual increase rates of M3 and the general price level in Turkiye over the period 2006-2022. Here, three facts attract attention: First, the series is generally compatible with each other. Second, the monetary expansion rate is higher than the inflation rate due to real economic growth. Third, the volatility in the inflation series is lower.

This study tests the validity of the quantity theory for Turkiye. For this purpose, the unit root and co-integration tests that take structural breaks into account are preferred. In the next part of the study, we present a summary of the relevant literature. In the other section, information is given about the dataset and the method used. Then, empirical findings are obtained and finally these findings are discussed.

A Review of the Empirical Literature

It is possible to epitomise the literature on the relationship between the monetary aggregate and inflation in Turkiye as follows:

Cesur (2006) investigated the period 1994:Q1-2004:Q4 with the regression analysis. The findings showed that the inflationary effect of the broad money supply is greater than M0, M1, and M2 money supplies. Özmen and Koçak (2012) analysed the period 1994:Q1-2011:Q4 using the ARDL approach and the Granger test. According to the study, the increase in the broad money supply causes a 42 percent increase in inflation. Alper (2018) evaluated the years 1971-2016 using the Bayer Hanck cointegration test, and Kara and Sağır

(2021) assessed the period 2006:Q1-2020:Q2 using the ARDL bounds test approach. Both studies found that the quantity theory of money is largely valid.

In the study carried out by Karpat Çatalbaş (2007), the period 1999Q1-2006Q3 was surveyed with the non-parametric regression technique. According to the findings, an increase in inflation increases the M2 money supply. Similar findings were obtained in the surveying by Erdoğan (2023), who examined the period 2006:Q1-2022:Q3 with the VAR analysis. Inflation affects M1 according to the Granger test results and M2 according to the Pairwise Granger test results.

Çiçek (2011) and İslatince (2017) examined the periods 1987:Q1-2007:Q3 and 1988Q1-2016:Q4, respectively, using the Johansen and Granger tests. Both researchers found that there is a bidirectional relationship between the monetary aggregate and inflation. Şahin and Karanfil (2015) analysed the period from 1980 to 2013 with the same tests and stated that there is no causality between M2 and inflation. On the other hand, Gabaçlı (2020) investigated the period 2000:Q1-2017:Q2 using the same methods and revealed a unidirectional causality relationship from M2 to inflation.

In the studies conducted by Kaya and Öz (2016) and Kılavuz and Altınöz (2020), the periods 1980:Q1-2014:Q4 and 2006:Q4-2018Q4, respectively, were investigated through the ARDL test. The first study revealed that M2 affects inflation negatively in the short-run and positively in the long-run. The second study showed that M1 and M3 money supplies are not effective on inflation, while the increase of M2 money supply causes inflation by only 29 percent.

Bağcı (2021) examined the relationship between M0, M1, M2, and M3 money supplies and inflation using the 2008:03-2020:08 monthly time series. According to the findings obtained from the quantile on quantile regression approach, the relationship between monetary aggregate and inflation is not homogeneous. Eroğlu and Yeter (2022) analysed the period 2007:01-2022:06 with the time-varying causality test and reached similar results.

The studies focusing on different countries in this field can be summarised as follows:

Simwaka, Ligoya, Kabango and Chikonda (2012) analysed the comparative importance of monetary variables on inflation in Malawi for the period 1995:01-2011:03. The findings showed that monetary expansion leads to inflation after three to six months. Sean, Pastpipatkul and Boonyakunakorn (2019) investigated Cambodia for the period 2009:10-2018:04 with the Bayesian VAR analysis. They found that the money supply impacts inflation and is dependent on its previous period.

Kiganda (2014) surveyed the relationship between the monetary aggregate and inflation in Kenya using the VECM and the Granger test. In the study covering the years from 1984 to 2012, it was determined that there is a long-run relationship between the series and a unidirectional causality relationship from money supply to inflation. Mbongo, Mutasa, and Msigwa (2014) researched Tanzania for the period 2000:01-2011:12 through the Augmented Engle-Granger cointegration and Granger causality tests and reached the same results. Ofori, Danquah, and Zhang (2017) investigated Ghana for the period 1967-2015 using the OLS method. The findings showed that monetary growth increases inflation by 71 percent. Sasongko and Huruta (2018) examined Indonesia for the period 2007:01-2017:07 with the Granger test and determined a unidirectional relationship between monetary aggregate and inflation. Hicham (2020) analysed Algeria using both symmetric and asymmetric causality and co-integration tests. The paper spanning the period from 1970 to 2018 confirmed the Monetarist view. Madurapperuma (2023) researched the Sri Lankan economy over the period from 1990 to 2021 using the Johansen and Granger tests and found that M2 affects inflation.

Amassoma, Sunday and Onyedikachi (2018) investigated Nigeria using the Johansen and Granger tests. According to the study covering the years from 1970 to 2016, money supply affects inflation neither in the short-term nor in the long-term. Moreover, they stated that there is no relationship between the mentioned variables. Doan Van (2020) analysed China and Vietnam for the period from 2012 to 2016. According to the study employing the ANOVA method, money supply leads to inflation in the long-run but not in the short-run. Jawo, Jebou and Bayo (2023) perused Gambia over the period 1985-2021 using the Gregory-Hansen co-integration test and the ARDL bounds test approach. The findings indicated that the M2 money supply influences inflation negatively in the short-term and positively in the long-term. Stylianou, Nasir and Waqas (2024) examined Pakistan through the ARDL bounds testing approach. In this paper, which covers the years from 1981 to 2021, it was determined that the money supply stimulates inflation both in the short-run and in the long-run.

Lee and Yu (2021) analysed China for the period 1980-2018 with the ARDL test, and Titei (2022) examined Romania over the period 2005-2021 using the Engle-Granger cointegration test. Both revealed that the M3 money supply is associated with inflation in the long-term. Long, Hien and Ngoc (2024) evaluated Vietnam and China using regression analysis and found that the money supply has an effect on inflation. It was emphasised that this effect is greater in China because of its large economic scale.

Data and Methodology

Data

This study utilises monthly data covering the period between 2006:01 and 2022:12. The consumer price index (2015=100) attained from the FRED is used to represent inflation. The paper also employs three different money supply indicators, M1, M2, and M3. The ratio of these money supply indicators to the industrial production index (2015=100) is taken into account, all of which are retrieved from the Central Bank of the Republic of Turkiye. All series were converted to logarithmic form after being seasonally adjusted by the TRAMO/SEATS method.

Empirical Methodology

This study employs the unit root and co-integration tests that do not ignore the structural breaks in series. The unit root test proposed by Lumsdaine and Papell (1997), unlike the unit root test proposed by Zivot and Andrews (1992), permits two structural breaks in the series. While model AA allows structural breaks only in the level, model CC allows structural breaks in both the level and trend. The Lumsdaine-Papell unit root test can be identified as follows (Lumsdaine & Papell, 1997: 212):

$$\Delta y_t = \mu + \beta_t + \theta DU1_t + \gamma DT1_t + \omega DU2_t + \psi DT2_t + \alpha y_{t-1} + \sum_{i=1}^{k} c_i \Delta y_{t-i} + \epsilon_t \quad (6)$$

In Equation 5, $DU1_t$ and $DU2_t$ are dummy variables that represent the break in the level, and $DT1_t$ and $DT2_t$ are dummy variables that represent the break in the trend. The smallest t-value is taken into account and the null hypothesis that the variable has a unit root is tested ($\alpha=1$) against the alternative hypothesis that the variable does not have a unit root ($\alpha<1$). The break dates chosen in this test are the dates that give the strongest backing to the alternative hypothesis (Konya, 2000: 8).

We employed the Maki co-integration test developed by Maki (2012) to test the co-integration relationship between LM1, LM2, LM3, and LCPI in this study. This test, based on the tests suggested by Bai and Peron (1998) and Kapetanios (2005), unlike the tests proposed by Gregory and Hansen (1996) and Hatemi-J (2008), takes into account five structural breaks. Moreover, it does not require a priori knowledge and determines both the number and date of breaks endogenously. The following equations were used to perform the test (Maki, 2012: 2011-2012):

$$y_t = \mu \sum_{i=1}^{k} \mu_i D_{i,t} + \beta' x_t + \mu_t \ (7)$$

$$y_t = \mu \sum_{i=1}^{k} \mu_i D_{i,t} + \beta' x_t + \sum_{i=1}^{k} \beta_i' x_t D_{i,t} + \mu_t \ (8)$$

$$y_t = \mu \sum_{i=1}^{k} \mu_i D_{i,t} + \gamma t + \beta' x_t + \sum_{i=1}^{k} \beta_i' x_t D_{i,t} + \mu_t \ (9)$$

$$y_t = \mu \sum_{i=1}^{k} \mu_i D_{i,t} + \gamma t + \sum_{i=1}^{k} \gamma_i t D_{i,t} + \beta' x_t + \sum_{i=1}^{k} \beta_i' x_t D_{i,t} + \mu_t \ (10)$$

Where $D_{i,t}$ represents the dummy variable and μ_t the error term. If t is greater than the break year in the variable, the dummy variable takes the value of 1 (Maki, 2012: 2012). Equations 7 and 8 show Model 0 and Model 1, respectively, which include no trend. Model 1 makes allowances for structural breaks not only in the constant but also in the coefficient. Equations 9 and 10 depict Model 2 and Model 3, respectively, which include the trend. Model 3, unlike Model 2, takes into account both the trend and structural breaks in the trend (Model 3, unlike Model 2, takes into account structural breaks in the trend (Rafindadi & Usman, 2019: 267). Maki (2012: 2012) defines a six-step procedure to administer the test. At the end of the process, the null hypothesis that the variables are not co-integrated is tested against the alternative hypothesis that they are co-integrated. Maki (2012: 2013) tabulates the critical values needed for the test.

Empirical Findings

First, the ADF test is used to test the stationarity of the variables. Table 2 presents the results:

Table 2

ADF Test Results

Variable	Constant	Constant and Trend
LCPI	2.512	2.632
LM1	2.256	−0.296
LM2	1.545	−0.128
LM3	1.326	−1.252
ΔLCPI	−3.809*	−4.437*
ΔLM1	−16.010*	−16.386*
ΔLM2	−11.481*	−11.636*
ΔLM3	−11.361*	−11.495*

Note: * indicates the significance at the 1 % level.

The results in Table 2 indicate that all the series have a unit root in their levels, while they do not have a unit root in the first differences. However, this test does not provide reliable results because it ignores structural breaks. Therefore, we used the LP unit root test and submitted the findings in Table 3.

Table 3

LP Multiple Structural Break Unit Root Test Results

Variable	Test Static	Optimal Lag Length	Breakpoints
Model AA			
LCPI	1.020	7	2011:04; 2020:01
LM1	−4.753	0	2011:04; 2020:01
LM2	-3.418	0	2011:06; 2020:01
LM3	-3.476	0	2011:06; 2020:01
ΔLCPI	−5.484	6	2018:07; 2020:01
ΔLM1	−6.215***	8	2009:10; 2019:11
ΔLM2	−13.132*	1	2008:10; 2018:06
ΔLM3	−12.795*	1	2008:10; 2018:06
Model CC			
LCPI	-3.629	3	2017:02; 2020:01
LM1	−5.527	0	2018:03; 2019:12
LM2	−5.323	0	2008:08; 2017:05
LM3	−5.436	0	2008:08; 2016:06
ΔLCPI	-7.377*	6	2018:02; 2019:12
ΔLM1	−6.498***	8	2009:01; 2016:05
ΔLM2	−13.421*	1	2008:10; 2018:06
ΔLM3	−12.970*	1	2008:10; 2018:06

Note: * and *** indicate the significance at the 1 % and 10 % levels, respectively. Critical values for model AA and model CC, respectively: −6.94 (1 %), −6.24 (5 %), −5.96 (10 %); -7.34 (1 %), −6.82 (5 %), −6.49 (10 %).

Table 3 shows that the three variables for model AA and all the variables for model CC are stationary in their first differences. Since the series contain trend and constant, it would be more appropriate to decide based on model CC rather than model AA. Therefore, all the series are accepted to be I(1). We employed the Maki test to survey the existence of a long-term relationship between LM1, LM2, LM3, and LCPI. Table 4 presents the results:

Table 4

Maki Co-integration Test Results

Independent V.	Models	Test Statistic	Breakpoints
LM1	Model 0	−4.745	2011:08; 2016:07; 2018:08; 2020:03; 2021:07
	Model 1	−6.213*	2018:08; 2021:07
	Model 2	−6.357**	2006:12; 2010:11; 2012:01; 2017:11; 2021:07
	Model 3	-7.156***	2009:03; 2016:08; 2017:10; 2018:12; 2021:09
LM2	Model 0	−6.410*	2006:12; 2008:11; 2009:10; 2011:09; 2016:07
	Model 1	−5.867*	2018:08; 2020:05; 2021:05
	Model 2	-7.277*	2011:11; 2021:07
	Model 3	-7.470**	2009:01; 2016:10; 2018:08; 2019:07; 2021:04
LM3	Model 0	−5.866**	2010:11; 2011:09; 2016:07; 2020:05; 2021:07
	Model 1	−5.949**	2010:10; 2018:08; 2020:05; 2021:07

Independent V.	Models	Test Statistic	Breakpoints
	Model 2	−5.907*	2020:03; 2021:07
	Model 3	−7.558**	2009:01; 2016:10; 2018:08; 2019:07; 2021:04

Note: *, **, and *** show the significance at the 1 %, 5 %, and 10 % levels, respectively.

When Table 4 is examined, it is observed that there is no long-term relationship only for model 0 in models where LM1 is the independent variable. There is a long-term relationship in all models where LM2 and LM3 are independent variables. Therefore, it is possible to state that LM1, LM2, and LM3 are co-integrated with LCPI. We use the DOLS method to estimate the long-run coefficients. Table 5 presents the results:

Table 5

DOLS Estimations

Independent V.	Coefficient	Std. Er.	t-Statistic	Prob.
LM1	0.243	0.041	5.974*	0.000
LM2	0.578	0.033	17.306*	0.000
LM3	0.813	0.025	33.081*	0.000

Note: * indicates the significance at the 1 % level.

As seen in Table 5, the long-run coefficients are all positive and statistically significant. A 100 percent increase in LM1, LM2, and LM3 increases LCPI by 24 percent, 58 percent, and 81 percent, respectively. It is noteworthy that the coefficient grows when there is a broader definition of money. Finally, we apply the Granger test. Table 6 presents the results:

Table 6

Granger Test Results

Dependent Variable	Independent Variable	Statistic	Prob.
LCPI	LM1	6.711*	0.010
LM1	LCPI	1.662	0.197
LCPI	LM2	3.945**	0.047
LM2	LCPI	2.573	0.109
LCPI	LM3	6.606**	0.024
LM3	LCPI	1.640	0.146

Note: * and ** show the significance at the 1 % and 5 % levels, respectively

Table 6 shows that the null hypothesis is rejected in models where LCPI is the dependent variable. On the contrary, the null hypothesis is not rejected in models where LCPI is the independent variable. This finding confirms the findings from the Maki co-integration test. The findings obtained show that there is a unidirectional relationship between money supply and inflation in Turkiye and that the quantity theory is substantially valid.

Conclusion

For centuries, the relationship between the quantity of money and the general price level has been discussed within the framework of quantity theory. Although the neutrality of money hypothesis was rejected during the period when the Keynesian approach was dominant, it has been accepted to be valid, at least in the long-run, for the last half century.

This study tested the validity of the quantity theory in Turkiye. For this purpose, the monthly data covering the period 2006:01-2022:12 for M1, M2, and M3 money supplies and the inflation rate series were employed. Unit root analysis showed that all series are I(1). The Maki co-integration test was implemented to survey the existence of a possible long-term relationship between the series. The findings showed that the money supply series are co-integrated with the inflation rate. According to the DOLS estimator, a 1% increase in M1, M2, and M3 leads to a rise in the inflation rate by 0.24, 0.58, and 0.81 percent, respectively, in the long-run. The causality analysis also confirmed the unidirectional relationship between these series. Therefore, the money supply must be kept under control to ensure price stability.

In contrast to the studies conducted by Karpat Çatalbaş (2007), Çiçek (2011), and İslatince (2017), the results are similar to the studies carried out by Cesur (2006), Özmen and Koçak (2012), Kaya and Öz (2016), Alper (2018), Gabaçlı (2020), and Kara and Sağır (2021). This paper reveals that the quantity theory is largely valid for Turkiye. However, the validity of the theory may vary depending on the definition of money used. Broader monetary aggregates have a greater impact on the general price level. For this reason, the central bank should focus on the broad money supply, not the narrow money supply. Focusing on the narrow money supply can create the false notion that money is not neutral. This leads to a misjudgment of the effectiveness of monetary policy. For further studies on this issue, implicit and explicit inflation targeting experiences in Turkiye can be compared empirically. Such an analysis can be a guide for determining the optimal monetary policy.

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