Journal of Applied Economics and Business Research
JAEBR, 1(2): 65-74 (2011)

Testing the Long Run Neutrality of Money in a Developing Country: Evidence from Turkey

Seher Nur Sulku[1]

Faculty of Economics, Gazi University, Turkey

We examine the long run neutrality of money, LMN, in the Turkish economy applying Fisher and Seater (1993) ARIMA framework, considering different monetary aggregates, M1, M2, M2Y and M3, during the period of 1987:Q1-2006:Q3. It is found that LMN holds in Turkey and the results are robust under all alternative monetary aggregates.

Keywords: *Long Run Money Neutrality, Inflation Targeting, Developing Country, Unit root and ARIMA* Techniques

1. Introduction

The movements of money and their effect on real and nominal variables are among the most important research areas in macroeconomics. There are two main hypotheses which explain this relationship: the long run money neutrality (LMN) and the long run money super neutrality (LMSN). The LMN hypothesis claims that the permanent change in the level of money supply has no impact on the level of real variables in the long run. The LMSN hypothesis states that a permanent change in the growth rate of money supply does not affect the level of real variables in the long run. LMN is among the widely accepted propositions which may affect the role of monetary policy. Indeed, besides being crucial for the efficacy of monetary policy, LMN is a core characteristic of many macroeconomic models.

Bullard (1999) provides a detailed survey on money neutrality literature by considering alternative methodologies employing to test the hypothesis. Especially Fisher and Seater's (1993) ARIMA framework and King and Watson's (1997) VAR methodology are among the distinguished studies concerning time series properties of real output and money aggregates. These studies emphasize that there are two crucial properties to be fulfilled: the exogeneity of the money and specific non-stationarity conditions of the monetary and real variables. Particularly, if both monetary and real variables are integrated of order one, LMN can be controlled. On the other hand, LMSN tests require that the order of integration of the monetary variable be equal to one plus the order of the real variable. Fisher and Seater (1993)

[1] Correspondence to Nur Sülkü, E-mail: nursulku@gazi.edu.tr

 ISSN 1927-033X

consider the annual data over 1869-1975 for the US and the monthly data from hyperinflation following World War I for Germany. They find a little support in favor of LMN in the US, and reject LMSN in Germany. Boschen and Otrok's (1994) study improves Fisher and Seater's results. They introduce dummy variable for the Great Depression period and restore the test results in favor of LMN in the US. King and Watson (1997) consider post-war US experience by over the period 1949:1 to 1990:4. Their search obtains little evidence against both long run neutrality and super neutrality in the US data. Furthermore, Weber (1994), Serletis and Koustas (1998), Leon and McAller (2000), Shelley and Wallace (2006) examine the long run neutrality of money considering the order of integration of variables for industrialized countries. However, their results do not provide consensus either in favor or against LMN.

The studies considering developing countries are relatively small in number. There are two important applications of Fisher and Seater methodology to test LMN and LMSN hypothesis in developing countries: Wallace (1999) and Bae and Ratti (2000). Wallace(1999) tests LMN in Mexico for the period 1932-1992. He introduces the time dummy when domestic banks were nationalized in 1982. Consequently, his study supports the LMN. Bae and Ratti (2000) consider annual data for Argentina and Brazil over the periods 1884-1996 and 1912-1995. They find that LMN is accepted for Brazil and Argentina, but LMSN is rejected for both. They introduce the time dummy for 1930 structural change (the Great Depression era) and the intercept dummy to capture a period of bank insolvencies in both countries. However, considering the dummies does not restore the results of the LMSN tests. Chen (2007) investigates the LMN for South Korea and Taiwan by employing King and Watson (1997) methodology. He uses quarterly data from 1970 to 2004 for South Korea and from 1965 to 2004 for Taiwan. He finds strong support for the LMN in the case of South Korea. But, he finds only a little evidence in favor of the LMN in the case of Taiwan.

Although there are numerous studies investigating the LMN for developed countries, the literature on developing countries is emerging currently. We would like to contribute this emerging literature by examining the long run neutrality of money for Turkey. Turkey has been suffering of the chronicle inflation and the turbulence monetary and banking events over the past decades. However, recently the stable economic growth and the low level of inflation have been achieved employing inflation targeting as a monetary policy. The LMN is necessary for the success of inflation targeting and is at the heart of many macroeconomic models. Therefore, testing LMN in Turkey becomes even more attractive and important. Our paper considers the LMN for Turkey applying Fisher and Seater's (F-S) (1993) ARIMA framework, taking into account different monetary aggregates under the 1987-2006 period. Even though our period is relatively short, as explained in F-S paper, since there were sudden changes in money and prices, this data set is qualified to be used for controlling a long run relationship.

This paper is organized as follows: Section 3 establishes the LMN and LMSN in Fisher & Seater's (1993) ARIMA framework. In Section 4, our data set is introduced. The results of the empirical tests are presented in Section 5. Section 6 concludes our study.

2. Econometric Framework

2.1 LMN and LMSN in Fisher & Seater's (1993) ARIMA Framework

F-S (1993) considers a system of log linear, stationary and invertible ARIMA model of two variables. The following model of the log of money supply (m) and the log of real GDP (y) has been demonstrated:

$$a(L)\Delta^{<m>}m_t = b(L)\Delta^{<y>}y_t + u_t$$

$$d(L)\Delta^{<y>}y_t = c(L)\Delta^{<m>}m_t + w_t \qquad (1)$$

where <m> and <y> are the orders of integration of the money supply and the real GDP respectively. The vector $(u_t,w_t)'$ is independently identically distributed with zero mean and the covariance $\sum$ which are composed of σ_{uu} , σ_{ww}, σ_{uw} .

If we consider the specific case when $x_t= \Delta^i m_t$ and $z_t= \Delta^j y_t$ such that i and j are equals to 1 or 0, then the long run effect of permanent change in x_t on z_t is equal to the long run derivative of z with respect to x (LRDz,x):

$$LRDz,x = \lim_{k\to\infty} [\partial(z_{t+k}) / \partial u_t] / [\partial(x_{t+k}) / \partial u_t)] \qquad (2)$$

As stated in F_S, if $\lim_{k\to\infty}[\partial(x_{t+k}) / \partial u_t)] = 0$ then there are no permanent changes in monetary variables and therefore LMN and LMSN are not testable. Therefore, the long run effect is testable if there is long run variation in money which means $\lim_{k\to\infty} [\partial(x_{t+k}) / \partial u_t)] \neq 0$. It implies that money should be non-stationary in level $<m> \neq 0$.

F_S (1993) shows that for $(x)\geq 1$, LRDz,x can be written as:

$$LRDz,x= \frac{(1-L)^{<x>-<z>}\gamma(L)/_{L=1}}{\alpha(1)} \qquad (3)$$

where $\alpha(L) = d(L) / [a(L)d(L) - b(L)c(L)]$ and $\gamma(L) = c(L) / [a(L)d(L) – b(L)c(L)]$.

It is seen that the long run derivative of z with respect to x depends on <x>-<z>.

2.2. Identification Problem

The identification problem is dealt with by imposing the exogeneity of money in the long run by assuming $b(1) = \sigma_{uw} =0$. After this assumption F_S establish that c(1)/d(1) equals to the frequency zero regression coefficient when $\Delta^{<y>}y_t$ is regressed on $\Delta^{<m>}m_t$. The estimator of c(1)/d(1) is obtained by $\lim_{k\to\infty}b_k$, $b_k$is the slope coefficient of the following regression:

$$\sum_{i=0}^{k}\Delta^{<y>}y_{t-i} = a_k + b_k\sum_{i=0}^{k}\Delta^{<y>}m_{t-i} + e_{kt} \qquad (4)$$

The appropriate models for the following special cases:

1) When <m>=<y>=1, LMN is tested by applying equation (5) to estimate LRDy,m= c(1)/d(1):

$$y_t - y_{t-k-1} = a_k + b_k(m_t – m_{t-k-1}) + e_{kt} \qquad (5)$$

 ISSN 1927-033X

2) When <m>=2 and <y>=1, LMN cannot be rejected and LMSN can be tested by deriving the following equation to estimate $LRD_{y,\Delta m} = c(1)/d(1)$:

$$y_t - y_{t-k-1} = a_k + b_k(\Delta m_t - \Delta m_{t-k-1}) + e_{kt} \quad (6)$$

3) When <m>=<y>=2, in this case $LRD_{\Delta y, \Delta m} = LRD_{y,m} = c(1)/d(1)$ which means that permanent change in the growth rate of money affects the growth rate of output in the same way the level of money affects the level of output. Therefore this implies that "*growth–rate to growth-rate*" propositions are not LMSN propositions. To test LMSN in this case, first of all LMN should be held. If LMN holds, then LMSN can be tested by deriving equation (8) to estimate $LRD_{y,\Delta m} = c(1)^*/d(1)$.

$$\text{LMN}: \Delta y_t - \Delta y_{t-k-1} = a_k + b_k(\Delta m_t - \Delta m_{t-k-1}) + e_{kt} \quad (7)$$

$$\text{LMSN}: \Delta y_t - \Delta y_{t-k-1} = a_k + b_k(\Delta^2 m_t - \Delta^2 m_{t-k-1}) + e_{kt} \quad (8)$$

These linear equations (5)-(8) can be computed by applying Newey-West (1987) approach to obtain consistent estimates of b_k. Newey-West proposes a consistent covariance matrix estimator by applying GMM methodology when error terms are heteroskedastic and autocorrelated.

3. Data

As emphasized in Leong and McAleer (2000), the result of LMN test is sensitive to underlying monetary aggregate. We cannot claim LMN only depending on one money aggregate. Therefore, we consider all alternative monetary aggregates: M1, M2, M2Y and M3. M2Y is the summation of M2 and Foreign Exchange Deposits in Turkish lira. Foreign Currency Deposits are widely used in money supply. Therefore M2Y is also considered to test LMN. As a real output measure, GDP series at fixed 1987 prices is taken into account. The wholesale prices index, WPI, with 1968 base year is used to obtain an inflation series. All of the variables are achieved from the Turkish Central Bank covering the periods [1987:Q1, 2006:Q3].

The contemporary economic history of Turkey can be summarized in three main eras: 1980-1989, the financial liberalization era; 1990-2001, economic and financial crises era; 2002-2006, economic stability and growth era. During the 1987-2006 period the average inflation was 67 % on average period and the real GDP growth rate was on average 2.9 %, with 5.5 percent volatility.[2] However, during the 2002-2006 period, inflation decreased to one digit, and real GDP growth rate on average increased to 7.5 %, with 1.34 percent volatility. In Turkey, from 1987 to 2002 there was high and persistent inflation and unstable economic growth. The 1991 bankers' crisis has been followed by the 1994 foreign exchange crises. The inflation reached to 120 % in 1994. In 1999 financial crisis occurred as an infection of world financial crises and in 2001 the deepest financial melt down took place. However, after 2002 instead of exchange rate based stabilization programs, inflation targeting has been employed as a framework for monetary policy. The new Turkish lira has been introduced. Inflation has decreased to one digit. The low level inflation has been accompanied by a significant decrease in money supply growth. Indeed, stable economic growth has been achieved.(Agenor *et. al.* (1997), Boratav and Yeldan (2001), Soral *et al* (2006)). Thus, during

[2] WPI is used as price series to calculate the inflation rate. M2 and GDP with fixed 1987 prices are employed to calculate money growth and real GDP growth respectively. All these series are obtained from the Turkish Central Bank.

the 1987-2006 period Turkey faced with challenging economic events, economic and financial crises. There were sudden changes in money and prices. Therefore, although our period is relatively shorter, this data set is qualified to be used for controlling a long run relationship.[3]

In this study, we use real GDP and all monetary aggregates in their logarithms. Since these series are quarterly, we apply Miron's (1994) methodology to test the seasonality. The following regression is performed: $(1-L)X_t = \lambda_1 S_{1t} + \lambda_2 S_{2t} + \lambda_3 S_{3t} + \lambda_4 S_{4t} + \varepsilon_t$ where X_t is the logarithm of the dependent variable, S_{kt} is a seasonal dummy which takes values one in season k and zero elsewhere for k=1,2,3,4; and ε_t is a stationary and invertible ARIMA process. As a result, it is found that monetary variables do not exhibit seasonality but there is a deterministic seasonality of real GDP series.[4] The seasonality of the real GDP series is adjusted employing Census X-11.[5] Figure 1 contains the plot of the seasonally adjusted real GDP. Figure 2 exhibits the graphs of all monetary aggregates M1, M2, M2Y and M3.

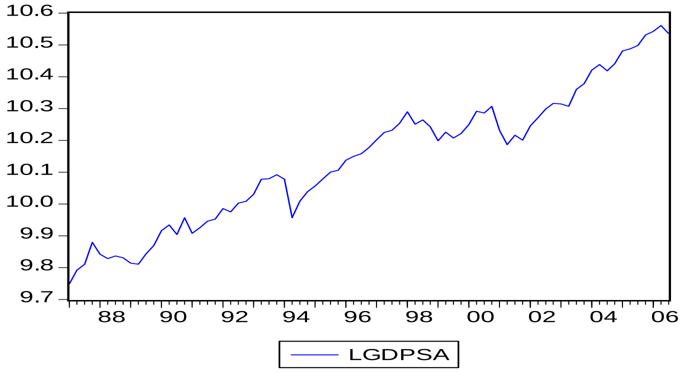

Figure 1. Logarithm of seasonally adjusted real GDP: 1987:Q1-2006:Q4

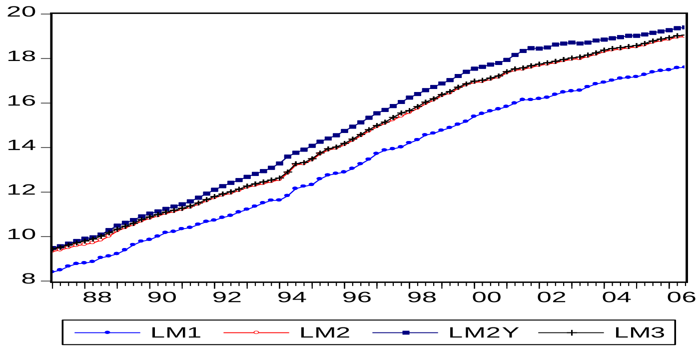

Figure 2. Logarithm of nominal money supplies: 1987:Q1-2006:Q4

4 Application of FS (1993) ARIMA Framework to LMN Theory and Results

In the FS (1993) methodology the non-stationarity of the money and real variables is the necessary condition to test LMN. Therefore, the Augmented Dickey-Fuller (1979) (ADF) and

---

[3] As explained in FS (1993), if there are subitaneous fluctuations in money and prices during the considered period, the data set can be used to control a long-run relationship. FS (2003) consider the monthly data from hyperinflation following World War I for Germany to test LMN. There were only 55 observations in the German data, but the period employed was full of turbulent economic events and sudden changes in money and prices.

[4] The results of Miron methodology are available upon request.

[5] e-views is used to employ Census X-11 seasonal adjustment.

Phillips and Perron (1988) (PP) unit root tests are applied to the series. The results of ADF and PP tests are in consensus for all variables except M3. As seen in Table 1, seasonally adjusted real GDP and all monetary aggregates are integrated of order one I(1).[6] Although M3 is found as I(1) by the PP test, the ADF test specifies it as integrated of order two I(2). Therefore, to confirm the results of unit root tests on M3 series, Kwiatkowski et al.'s (1992) test, KPSS, is employed. The KPSS test result also suggests M3 as I(1) (*See* Table 2). Consequently, we declare all of the variables as I(1).[7]

The FS analysis provides a straightforward test of LMN. Since real GDP and money are integrated of order one, the long run derivative of real GDP with regard to money is equal to the slope coefficient of a regression of growth rates of real GDP on growth rates of money. Therefore, LMN will be tested by using the equation (5). LMN is sustained if the slope coefficient (b_k) goes to zero as k goes to infinity.

Figures 3 to 6 contain the plots of the confidence intervals around estimated b_k's respectively for M1, M2, M2Y and M3. The estimates of b_k's are obtained for k=1-30. The 95 percent confidence intervals are constructed for the estimated coefficient of money supply using t-distribution with n/k (n= 79) degrees of freedom. The standard errors employed to construct the cofidence intervals are corrected for autocorrelation and heteroskedasticity by the Newey-West (1987) method.[8] First of all, using M1, M2 and M3 aggregates strong support in favor of LMN is obtained. For M1 and M3 cases, all the estimated b_k's are negative and insignificant. The confidence bands include zero for k=1-30. For the M2 case again, all of the estimated b_k's are negative and insignificant, except two cases k=1,2. The confidence bands includes zero for k=3-30. As a result there is no effect of M1, M2 and M3 on real GDP in the long run. When M2Y is used, we observe a little evidence against LMN since the confidence bands did not include zero for seven cases k=1-7.

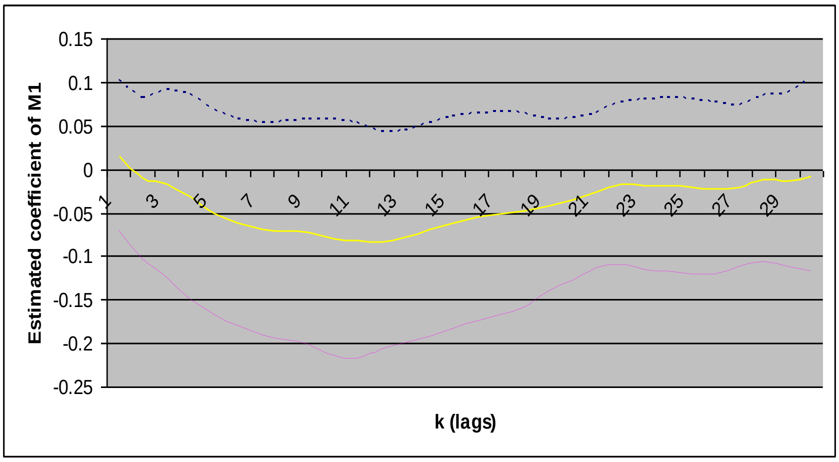

Figure 3. Long-run neutrality of money: M1

Notes: Solid line represents the estimated b_k coefficients; upper dashed line is the upper bound of the 95% confidence interval (CI) of the estimated b_k coefficients; lower dashed line is the lower bound of the CI.

[6] In this study e-views is used to derive all econometric analyses.

[7] As it has been explained in F-S (1993), LMSN tests necessitate that the order of integration of the monetary variable be equal to one plus the order of the real variable. Therefore, in our study we cannot test LMSN, but only test the LMN.

[8] The values of estimated b_k's and Newey-West standard errors are available upon request.

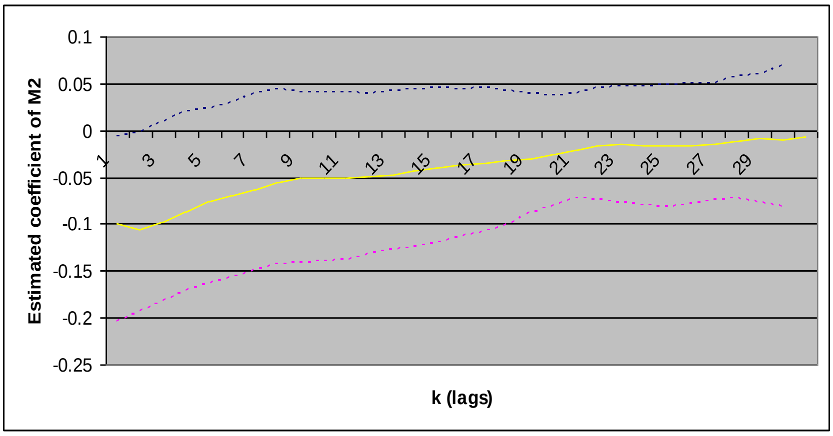

Figure 4. Long-run neutrality of money: M2

Notes: Solid line represents the estimated bk coefficients; upper dashed line is the upper bound of the 95% confidence interval (CI) of the estimated b_k coefficients; lower dashed line is the lower bound of the CI.

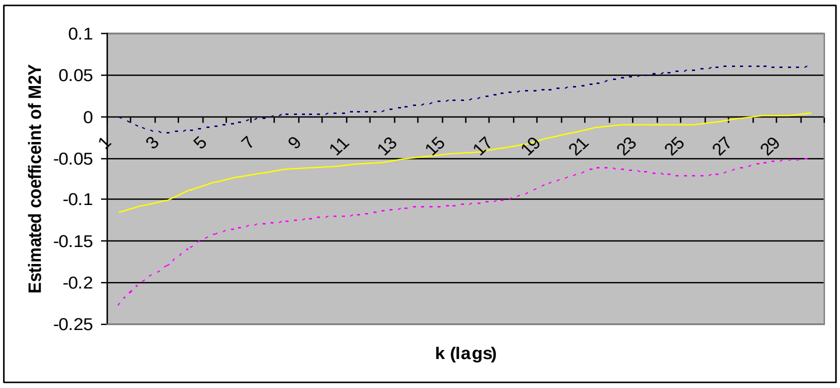

Figure 5. Long-run neutrality of money: M2Y

Notes: Solid line represents the estimated b_k coefficients; upper dashed line is the upper bound of the 95% confidence interval (CI) of the estimated b_k coefficients; lower dashed line is the lower bound of the CI.

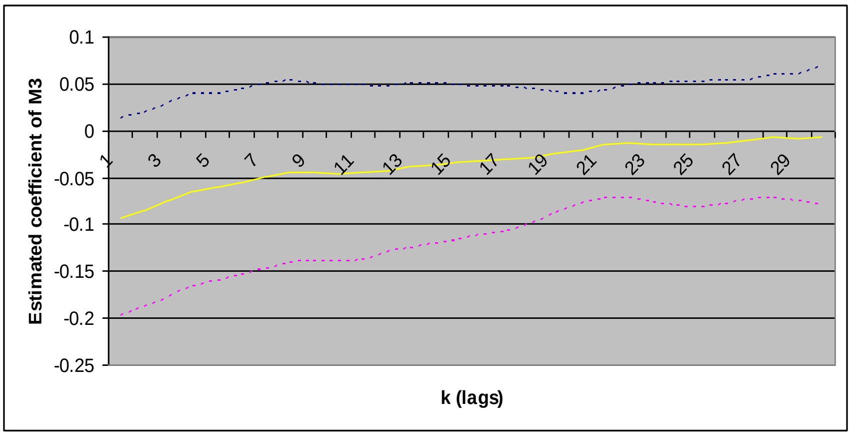

Figure 6. Long-run neutrality of money: M3

Notes: Solid line represents the estimated b_k coefficients; upper dashed line is the upper bound of the 95% confidence interval (CI) of the estimated b_k coefficients; lower dashed line is the lower bound of the CI.

Therefore, to be sure of the validity of LMN we introduced the dummy variables into equation (5) for the major banking and currency crises in years 1994, 1999, 2000, 2001 and the introduction of the new Turkish lira in 2005. Figure 7 illustrates the results of the model

 ISSN 1927-033X

with dummies. Dummy variable involves assigning 1 to observation of the chosen characteristic and 0 for the rest. It is observed that the confidence bands include zero for all cases, except two violations for cases k=3,4. Hence, M2Y also provides strong evidence in favor of LMN.

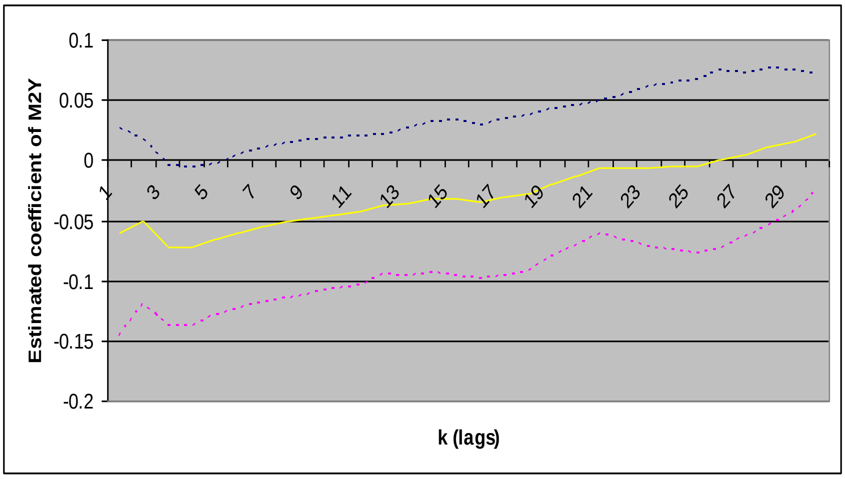

Figure 7. Long-run neutrality of money: M2Y_ Dummies

Notes: Solid line represents the estimated b_k coefficients; upper dashed line is the upper bound of the 95% confidence interval (CI) of the estimated b_k coefficients; lower dashed line is the lower bound of the CI.

5. Conclusion

This paper analyzes LMN hypothesis in Turkey by applying Fisher and Seater's (1993) ARIMA framework. We find strong evidence in favor of LMN under M1, M2 and M3. Furthermore, the test result of LMN under M2Y case is restored by adding dummy variables for the major banking and currency crises and the introduction of the new Turkish currency. As a consequence, LMN hypothesis holds in Turkey under all alternative monetary aggregates during the period 1987:Q1 to 2006:Q3.

References

Agenor, P.R., McDermott C. J., Ucer, E. M. 1997. Fiscal imbalances, capital inflows, and the real exchange rate: the case of Turkey. *IMF Working Paper* 97:1.

Bae, S.K., Ratti, R. A. 2000. Long run neutrality, high inflation and bank insolvencies in Argentina and Brazil. *Journal of Monetary Economics* 46, 581-604.

Boratav, K., Yeldan, E. 2001, *Turkey, 1980-2000: Financial liberalization, macroeconomic instability and patterns of distribution*, *New School*, Mimeo, CEPA

Boschen, J. F. Otrok, C. M. 1994. Long-run neutrality and superneutrality in an ARIMA framework: comment. *American Economic Review* 84, 1470-1473.

Bullard, J.B. 1999. Testing long-run monetary neutrality propositions: Lessons from the recent research. *Federal Reserve Bank of St. Louis Review* 81, 57-77.

Chen, Shyh-Wei 2007. Evidence of the long-run neutrality of money: the case of South Korea and Taiwan. *Economics Bulletin* 3, 1-18.

Dickey, D. A., Fuller, W. A. 1981. Likelihood ratio test statistics for autoregressive time series with a unit root. *Econometrica* 49, 1057-1072.

Fisher, M. E., Seater, J. J. 1993. Long run neutrality and super neutrality in an ARIMA framework. *The American Economic Review* 83, 402-415.

King, R. G., Watson, M. W. 1997. Testing long-run neutrality. *Federal Reserve Bank of Richmond Economic Quarterly* 83, 69-101.

Kwiatkowski, D., Phillips, P. C. B., Schmidt, P. and Shin, Y. 1992. Testing the null hypothesis of stationarity against the alternative of a unit root: how sure are we that economic series have a unit root. *Journal of Econometrics* 54, 159-178.

Leong, K. and McAleer, M. 2000. Testing long-run neutrality using intra-year data. *Applied Economics* 32, 25-37.

Miron, J. A. 1994. *The economics of seasonal cycles, Advances in Econometrics, Sixth World Congress of the Economic Society vol. 1 Ed.*. C.A. Sims, Cambridge University Pres: Cambridge. 213-251.

Newey, W. K., West, K.D. 1987. A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix. *Econometrica* 55, 703-708.

Phillips, P. C. B., Perron, P. 1988 Testing for a unit root in time series regressions. *Biometrika* 75, 335-46.

Serletis, N. and Koustas, Z. 1998), International evidence on the neutrality of money. *Journal of Money, Credit and Banking* 30, 1-25.

Shelley, G. L., Wallace, F. H. 2006. Long run effects of money on real consumption and investment in the U.S.. *International Journal of Applied Economics* 3, 71-88.

Soral, B., Iscan T., Hebb, G. 2006. Fraud, banking crisis, and regulatory enforcement: evidence from micro-level transactions data. *European Journal of Law and Economics* 21, 179-197.

Wallace, F. H. 1999. Long run neutrality of money in the Mexican economy. *Applied Economics Letters* 6, 637-639.

Weber, A. A. 1994. Testing long-run neutrality: empirical evidence for G7 countries with special emphasis on Germany. *Carnegie-Rochester Conference Series on Public Policy* 41, 67-117.

 ISSN 1927-033X

Appendix

Table 1 ADF and PP tests results

	ADF test			PP test	
Variable	I(0)	I(1)	I(2)	I(0)	I(1)
Real GDP	-2.98(0)	-9.31**(0)		-3.20(3)	-9.3**1(0)
M1	0.79(0)	-6.79**(0)		0.71(2)	-6.68**(3)
M2	0.29(1)	-5.0** (0)		0.31(4)	-5.03**(1)
M2Y	0.75(1)	-3.46**(0)		1.44(4)	-3.47**(7)
M3	0.38(1)	-2.49 (2)	-11.50**(1)	0.19(5)	-4.99**(3)

Notes: ** denotes significance at 5% level. **2)** In ADF test, lag length of the dependent variable is chosen according to Schwarz Information Criteria. The number in parenthesis denotes the significant lagged differenced terms. In PP test, Bartlett Kernel spectral estimation method and Newey-West bandwidth are employed. The number in parenthesis denotes the bandwidth. **3)** In all ADF & PP tests regressions for level of the series, I(0), both constant and trend components are included, for first and second differences of series, I(1), I(2), only the constant is included. 4) The null hypothesis (H_0) of ADF and PP tests is: H_0=Series has a unit root.

Table 2. KPSS test results for M3

Variable	KPSS statistic	95%critical value	Test Result
I (0)	0.20** (6)	0.146	Reject Ho
I(1)	0.43** (5)	0.463	Can not reject Ho

Notes: 1) **denotes significance at 5% level. 2) Bartlett Kernel spectral estimation method and Newey-West bandwidth are employed. The number in parenthesis denotes the bandwidth. 3) The KPSS regression include both a constant and a time trend for the level of the variable. For the difference of variable only a constant is included. 4) The null hypothesis of KPSS test is: Ho=Series is stationary (= Series does not have a unit root).