THE CAUSE AND EFFECT RELATIONSHIP BETWEEN MONEY AND OUTPUT IN TURKEY

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I. INTRODUCTION

The causal relationship between money and output in the context of time series has been associated with Monetarist-Keynesian debate over the effectiveness of monetary policy.

In general, Monetarist theories that originate from the quantity theory of money interpret the observed statistical money-output correlation as a causation from money to real economic activity. According to their interpretation, changes in money cause changes in real economic activity besides changes in price level, and monetary policy is relevant for output behaviour. Therefore, in their monetary policy analyses, Monetarist theories treat money as a reflector of economic activity (Friedman and Schwartz, 1963).

On the other hand, some Keynesian theories that posit an independent role for money in determining economic activity reject Monetarist interpretation and accept some level at which money is itself determined by economic activity. According to their interpretation, monetary policy is not completely relevant for output behaviour, and it is possible to find a reverse causation from the statistical correlation between the real economic activity and money (Davidson and Weintraub, 1973; Moore, 1979; Lavoie, 1984).

The modern investigation of the causal relationship between money and economic activity in the context of time series begins with Sims's (1972) introduction of Granger causality test into the debate. Sims (1972) found that money had a significant ability to forecast economic activity when real output was regressed on lagged values of itself and money, supporting Monetarist theories.

Following Sims, a bulk of studies used Granger test procedure to investigate the causal relationship between money and output. The findings of the previous studies differed depending on the variables used to measure money and output, on the frequency of observation of the data, on the sample used in regression, and on the specification of the Granger test regression. In addition, most of the previous studies have carried out their tests under industrial country samples. One way to examine the strength of the findings of the previous studies and to provide further evidence to the literature is to replicate the exercises in developing countries. In the light of this argument, the main objective of the present study is to provide the Turkish evidence to the literature on the causal relationship between money and output by using the monthly money (M1 and M2) and output data (industrial production index) from 1980:1 to 1991:3, and by using the Granger causality test procedure.

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II. METHODOLOGY AND DATA

In this study, the Granger causality test procedure was used to determine the causal relationship between money and output[1]. Since Granger's definition of causality is based upon an incremental predictability criterion, it is a two-step regression procedure. To determine the causality relationship between X and Y variables, the following regression equations are estimated by using the method of Ordinary Least Squares.

$$Y_t = a + \sum_{i=1}^{n} a_i Y_{t-i} \qquad (1)$$

$$Y_t = a + \sum_{i=1}^{n} a_i Y_{t-i} + \sum_{j=1}^{m} b_j X_{t-j} \qquad (2)$$

$$X_t = a + \sum_{i=1}^{k} c_i X_{t-i} \qquad (3)$$

$$X_t = a + \sum_{i=1}^{k} c_i X_{t-i} + \sum_{j=1}^{h} d_j Y_{t-j} \qquad (4)$$

Where a ,a_i, bj, ci and dj represent least-squares estimates, n and k represent the appropriate lag lengths on the dependent variables whereas m and h represent the appropriate lag lengths on the independent variables.

The first and third regression equations are called restricted equations whereas the second and fourth regression equations are called unrestricted equations. From the above regression equations, four possible cases on the causal relationship between X and Y can be obtained:

1. If the inclusion of the past values of X significantly improves the estimation of Y, that is, coefficients of the past values of X (Σb_j) are significantly different from zero as a group, it is then said that there is causality in the Granger sense from X to Y.

2. If the inclusion of the past values of Y significantly improves the estimation of X, that is, the coefficients of the past values of Y (Σd_j) are significantly different from zero as a group, it is then said that Y is the Granger cause of X.

3. If both cases (1) and (2) exist, it is then said that both variables are cause and effect variables at the same time. In other words, feedback is said to occur.

4. If none of cases (1) and (2) exist, it is then said that there is no causal relationship between X and Y.

Although the Granger test technique is a significant contribution of an operational definition of causality in the context of time series, the previous studies have shown that the empirical results on the causal relationship are sensitive to the choice of the lag

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1. In the literature, there are other parametric test procedures such as the Sims test besides the Granger test procedure. In addition to parametric test procedures, there are also nonparametric test techniques such as Holmes-Hutton (1992). However, Monte Carlo experiments by Guilkey and Salemi (1982) indicated that the Granger test appears to be more powerful technique for testing causality then the others.

lengths. In this study, following the findings of Jones (1989), non-statistical *ad hoc* methods, arbitrary and rule-of-thumb were used to determine the appropriate lag lengths[2]. Arbitrary lag lengths were selected as 6-6, 12-12, 18-18, and 24-24. For the rule-of-thumb approach, lag lengths were 6-3, 12-6, 18-9, and 24-12 on the dependent and independent variables, respectively[3].

The data are monthly observations of industrial production index (IP) for output and two different monetary measures (M1 and M2) for money. Since all series are seasonally unadjusted from the original source, the trend and the seasonal behaviour of the data are removed by exponential smoothing procedure in RATS computer program[4]. All series were taken from the Quarterly Bulletins of the Central Bank of the Republic of Turkey.

Before estimating equations (1), (2), (3) and (4), it is important to investigate for the stationarity of the variables in order to assure that the estimation results are not spurious. In order to check the stationarity conditions of the variables, we used the Augmented Dickey-Fuller test (ADF) statistics which inspect whether a given variable, X_t, has a unit root. The ADF test procedure requires the following steps; first, regression equation (5) for the given variable is estimated by the method of Ordinary Least Squares, then by conducting t-test on the estimated coefficient r , the null hypothesis of non-stationarity that implies that there is a unit root in the original level of the variable is tested. If the null hypothesis is not rejected, the same procedure is repeated for the first difference of the variable. If the null hypothesis is rejected, it is said that the given variable is stationary in its first difference.

$$\Delta X_t = a + rX_{t-1} + \sum_{s=1}^{k} b_s \Delta X_{t-s} + \varepsilon_t \qquad (5)$$

Where, $\Delta X_t = X_t - X_{t-1}$, $X_t = \log(X_t)$, a, b_s and r are least-squares estimates, k is the number of lag on the dependent variable, and ε_t is uncorrelated white-noise disturbance term.

III. EMPIRICAL RESULTS

The results of the ADF tests with four, six, and eight lags are reported in Table I. As seen from the table, when the series are used in their original forms, the null hypothesis which is the presence of a unit root in all series could not be rejected at any acceptable level. However, the first differences of all series guarantee that all are stationary since the calculated t-statistics on r for all variables exceeded the critical values based on simulation provided by Fuller (1976). Accordingly, the causality test will be carried out in the first differences of the natural logarithms of the data[5].

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2. In general, there are two methods to determine lag length in distributed lag models: statistical search and non-statistical *ad hoc* methods. In his paper, Jones (1989) resulted that non-statistical methods for lag-length determination performed somewhat better than the statistical search methods.
3. According to Friedman and Kuttner (1990), the standard lag length in the literature based on monthly data is 12.
4. The exponential smoothing methodology chooses one from small group of models which focus upon the trend and the seasonal behaviour of the data. RATS tests three options (linear, exponential, none) for the trend behaviour and the seasonal behaviour (additive, multiplicative and none), and then chooses the best fitting model. For more information, see Rats User's Manual, Version 4, pp 7-6. For output and M1, the best fitting model is the multiplicative model. But for M2, no seasonal model exists.
5. DLIPt=(log IPt-log IPt-1); DLM1t=(log M1t-log M1t-1); DLM2t=(log M2t-log M2t-1); LIPt=log IPt; LM1t=log M1t; and LM2t=log M2t.

TABLE I: RESULTS OF ADF TESTS

Variables	k=4	k=6	k=8
LIP	-3. 36	-3. 21	-2. 81
LM1	-0. 61	-0. 39	-0. 31
LM2	-2. 57	-2. 22	-2. 38
DLIP	-6. 07***	-5. 23***	-4. 59***
DLM1	-6. 30***	-5. 50***	-4. 00**
DLM2	-5. 48***	-4. 50***	-3. 63*

Note: The critical t-values of ADF tests are -4. 04, -3. 69 and -3. 41 for 0. 01, 0. 05 and 0.10 levels, respectively. ***, **, * denote significance at 1 %, 5%, and 10% levels, respectively. LIP=natural log of industrial production; LM1=Natural log of M1; LM2=natural log of M2; DLIP=first difference of LIP; DLM1=first difference of LM1; DLM2=first difference of LM2.

Having ensured the stationarity of all series, we proceeded to the estimation of equations (1) to (4). The results of the Granger tests for M1 are reported in Table I. In all tests except 1 (where the number of lags is 6 for dependent variable and 3 for independent variable) the F-statistics from the tests for causality from M1 to output exceed the critical values at least at the 0. 10 level, indicating that the lagged values of the independent variable (M1) are statistically significant as a group. In other words, in 7 of 8 regressions, the null hypothesis of no causality from M1 to output can be rejected at least at the 0. 10 level. In 3 of 8 tests, the null hypothesis can be rejected at the 0. 01 level, supporting the hypothesis of causality from money to output.

However, when reverse causation for the M1-output correlation is tested, the findings indicate that there is no strong evidence that causality runs from real output to M1. As seen from the Table II, in all tests except 1 (where the number of lags is 24 and 12 for dependent and independent variables, respectively), the null hypothesis of no causality from real economic activity to M1 cannot be rejected at least at the 0. 05 level. In only 4 of 8 regressions, the F-statistics exceed the critical values at the 0. 10 level, indicating that the coefficients of the lagged independent variables (output) are statistically significant as a group only at the 0. 10 level. In only 1 of 8 regressions, the coefficients of the lagged output variables are statistically significant as a group at the 0. 05 level. The results of the tests for M1-output generally indicate causality from money to output, but not from output to money.

TABLE II: RESULTS FROM GRANGER TESTS FOR CAUSALITY BETWEEN M1 AND OUTPUT

Dependent Variables (number of lags)	Independent Variables (number of lags)	F-Values	Degrees of Freedom
DLIP(6)	DLM1(6)	2. 28**	(6, 115)
DLIP(6)	DLM1(3)	1. 01	(3, 118)
DLIP(12)	DLM1(12)	1. 86**	(12, 97)
DLIP(12)	DLM1(6)	3. 03***	(6, 103)
DLIP(18)	DLM1(18)	1. 63*	(18, 79)
DLIP(18)	DLM1(9)	2. 09**	(9, 88)
DLIP(24)	DLM1(24)	2. 59***	(24, 61)
DLIP(24)	DLM1(12)	2. 40***	(12, 73)
DLM1(6)	DLIP(6)	1. 61	(6, 115)
DLM1(6)	DLIP(3)	2. 41*	(3, 118)
DLM1(12)	DLIP(12)	1. 76*	(12, 97)
DLM1(12)	DLIP(6)	1. 92*	(6, 103)
DLM1(18)	DLIP(18)	1. 55*	(18, 79)
DLM1(18)	DLIP(9)	0. 89	(9, 88)
DLM1(24)	DLIP(24)	1. 22	(24, 61)
DLM1(24)	DLIP(12)	2. 40**	(12,78)

Note: ***, **, * denote significance at 1%, 5%, and 10% levels, respectively. DLIP=first difference of natural log of industrial production; DLM1=first difference of natural log of M1.

On the other hand, when M2 is used as a measure of money, the findings indicate no causality from money to output. Table III reports the results of the Granger causality for M2-output correlation. As seen from Table III, in all of the 8 tests, the F-statistics for the causality from money to output do not exceed the critical values at any acceptable level. The results also do not support the hypothesis of causality fro output to money. In 3 of 8 regressions, the lagged values of independent variable (output) are statistically significant as a group at the 0. 10 level. In only one regression, F-statistics for the causality from output to money exceeds the critical value at the 0. 05 level.

TABLE III: RESULTS FROM GRANGER TESTS FOR CAUSALITY BETWEEN M2 AND OUTPUT

Dependent Variables (number of lags)	Independent Variables (number of lags)	F-Values	Degrees of Freedom
DLIP(6)	DLM2(6)	0. 76	(6, 115)
DLIP(6)	DLM2(3)	0. 14	(3, 118)
DLIP(12)	DLM2(12)	0. 90	(12, 97)
DLIP(12)	DLM2(6)	0. 88	(6, 103)
DLIP(18)	DLM2(18)	0. 96	(18, 79)
DLIP(18)	DLM2(9)	0. 66	(9, 88)
DLIP(24)	DLM2(24)	1. 17	(24, 61)
DLIP(24)	DLM2(12)	0. 97	(12, 73)
DLM2(6)	DLIP(6)	1. 70	(6, 115)
DLM2(6)	DLIP(3)	0. 75	(3, 118)
DLM2(12)	DLIP(12)	1. 73*	(12, 97)
DLM2(12)	DLIP(6)	1. 72*	(6, 103)
DLM2(18)	DLIP(18)	1. 56*	(18, 79)
DLM2(18)	DLIP(9)	1. 27	(9, 88)
DLM2(24)	DLIP(24)	1. 76**	(24, 61)
DLM2(24)	DLIP(12)	0. 97	(12, 78)

Note: ***, **, * denote significance at 1%, 5%, and 10% levels, respectively. DLIP=first difference of natural log of industrial production; DLM2=first difference of natural log of M2

IV. CONCLUSION

In this study, the Granger causality test was used to determine the direction of causal relationship between money (as measured by M1 and M2, separately) and output (as measured by industrial production index) for the 1980:1-1991:3 period in Turkey.

The findings of the study strongly indicate causality from money to output, but not from output to money when M1 is used as a measure of money. They are completely consistent with Monetarist argument that the money supply (at least narrowly defined) is a leading indicator of real economic activity. The results are also consistent with a number of similar studies on the developed countries such as the United States (Sims, 1972) and the

United Kingdom (Thornton, 1993). However, when M2 is used as a measure of money, the results do not strongly support any causal relation between money and output. According to the Granger test statistics, changes in M2 do not contain information on future changes in real output.

To sum up, the evidence found in this study supports Monetarist argument, but not Keynesian argument on the causal relationship between money and output. Naturally, from this evidence, it can be argued that monetary policy that uses M1 as an intermediate target in Turkey would be more effective than the other that uses M2.

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