Yapi Kredi Economic Review, 1998, 9(1), pp. 15-25.

ANTICIPATED VERSUS UNANTICIPATED MONEY IN TURKEY

Rahmi Yamak,* Yakup Küçükkale**

ABSTRACT

This Study investigates the validity of the policy ineffectiveness hypothesis of Rational Expectations-Natural Rate Models that only unanticipated policy changes affect real economic variables by using Turkish data over the period of 1980:I-1995:I. The procedure used to test the hypothesis is the autoregressive system introduced by McGee and Stasiak (1985). The empirical results reported in this paper imply that unanticipated monetary policy appears to play an insignificant role in improving real economic activity, and that anticipated monetary policy exerts a significant expansionary impact upon real economic activity. Such evidence for Turkey strongly rejects the policy ineffectiveness hypothesis of Rational Expectations-Natural Rate Models.

1. INTRODUCTION

The Rational Expectations-Natural Rate (hereafter RENR) Models developed by Lucas (1973) and Sargent and Wallace (1975) imply that the monetary policy affects the real economic activity (e.g. real output, employment, etc.) only when such monetary policy is purely unanticipated. This idea is usually called neutrality hypothesis of the new classical macroeconomics. The theoretical studies of Fischer (1977) and Phelps and Taylor (1977), on the other hand, conclude that anticipated monetary policy influences real economic variables at least in the short-run because of the rigidities in wage and price contracts. This idea is also called non-neutrality hypothesis of the non-classical RENR models.

The neutrality hypothesis of the new classical macroeconomics has not only theoretically but also empirically created a disagreement over the effectiveness of the monetary policy. In a series of influential studies, Barro (1977, 1978) investigated the neutrality hypothesis of the RENR model that only unanticipated, and not anticipated, monetary policy does matter by using a two step estimation procedure[1]. His statistical results supported the neutrality hypothesis that only unanticipated monetary policy is relevant to the real economic activity. Following Barro, numerous studies (e.g. Barro and Rush, 1980; Wogin, 1980; Attfield *et al.*, 1981; Bellante *et al.*, 1982; Canarella and Pollard, 1989) found results similar to those of Barro in support of the neutrality hypothesis.

In contrast to these studies, Mishkin (1982a, 1982b) employed a somewhat different methodology and found no evidence that anticipated monetary policy does not influence real economic activity. Recently, McGee and Stasiak (1985) introduced another methodology for examining the RENR

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* Associate Professor of Economics Karadeniz Technical University, Department of Economics
** Research Assistant, Karadeniz Technical University, Department of Economics in Unye

[1] First a money growth rate forecasting equation was estimated. Second, the predicted values of the money growth rate were used as a measure of anticipated monetary policy and the residuals as a measure of unanticipated monetary policy.

hypothesis. By focusing on the stationarity and restriction issues of the variables, they developed an autoregressive system. Their results supported the findings of Mishkin that anticipated monetary policy does influence real output in the short-run. Following McGee and Stasiak's methodology, Khatri-Chetri *et al* (1990) and Marashdeh (1993) provided additional evidences that did not support the neutrality hypothesis of the RENR models.

The purpose of this paper is to reexamine the hypothesis that only unanticipated money growth affects real variables by applying a framework similar to McGee and Stasiak's to Turkey over the period 1980:I-1995:I.

2. METHODOLOGY AND DATA

Expanding McGee and Stasiak procedure, the following autoregressive system that consist of five variables was set up and estimated[2],

$$\begin{bmatrix} Q_t \\ M_t \\ G_t \\ P_t \\ D_t \end{bmatrix} = \begin{bmatrix} \alpha_{11}(L) & \alpha_{12}(L) & \alpha_{13}(L) & \alpha_{14}(L) & \alpha_{15}(L) \\ \alpha_{21}(L) & \alpha_{22}(L) & \alpha_{23}(L) & \alpha_{24}(L) & \alpha_{25}(L) \\ \alpha_{31}(L) & \alpha_{32}(L) & \alpha_{33}(L) & \alpha_{34}(L) & \alpha_{35}(L) \\ \alpha_{31}(L) & \alpha_{32}(L) & \alpha_{33}(L) & \alpha_{34}(L) & \alpha_{35}(L) \\ \alpha_{41}(L) & \alpha_{42}(L) & \alpha_{43}(L) & \alpha_{44}(L) & \alpha_{45}(L) \end{bmatrix} \times \begin{bmatrix} Q_t \\ M_t \\ G_t \\ P_t \\ D_t \end{bmatrix} + \begin{bmatrix} e_{1t} \\ e_{2t} \\ e_{3t} \\ e_{4t} \\ e_{5t} \end{bmatrix} \quad (1)$$

where Q_t is real output at time t (measured as real industrial production index), M_t is narrow money supply (M1) at time t,[3] G_t is nominal government expenditures at time t, P_t is consumer price index at time t, D_t is a series of exchange rate for US Dollar at time t, L is a lag operator, $\alpha_{ij}(L)$'s are polynomials in the lag operator and e_{it} is the innovation of each equation at time t. Each variable in the autoregressive system was used as a stationary series. The autoregressive model is treated as a system and estimated using Zellner's technique for seemingly unrelated regressions (SUR).

The neutrality hypothesis requires a number of restrictions on the coefficients and the relationships among the innovations of the equations in the autoregressive system. If the innovations of the first (output) equation are found to be significantly correlated with current innovations of the second equation, this provides strong support to the proposition that unanticipated monetary policy matters. On the other hand, if the coefficient(s) of the monetary variables in the first equation is (are) jointly and statistically insignificant, it is then concluded that anticipated monetary policy does not matter. Similar interpretation can be made for the remaining equations.

As an initial step in the autoregressive system, stationarity tests must be performed for each of the variables. There have been a variety of proposed methods for implementing stationarity tests (for example, Dickey and Fuller, 1979; Sargan and Bhargava, 1983; Phillips and Perron, 1988 among the others) and each has been widely used in the applied economics literature. However, there is now a growing consensus that the stationarity test procedure (hereafter ADF) due to Dickey and Fuller (1979) has superior small sample properties compared to its alternatives. Therefore, in this study, ADF test procedure was employed for implementing stationarity tests. The ADF test procedure requires to run

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[2] This procedure has some advantages over its alternatives. First, it does not depend on a priori knowledge of the spesific structural model of the economy. Second, it provides information on any exogeneity assumption as a consequence of model estimation. Third, it guarantees that residuals are serially uncorrelated. Finally, the output equation in the system is a reduced form where the coefficients in α_{12}, α_{13}, α_{14}, and α_{15} represent the direct impact of anticipated nominal variables on output, under the assumption that there is a pure one-period delay in information.

[3] This narrow definition of money is chosen here for two reasons. First, M1 has a very close relation to monetary base, which is under the control of the monetary authorities. Second, M1 appears to be exogenous and policy determined (Abaan, 1987).

the following regression for both level and first difference of each variable, separately. If necessary, the ADF regression can be run for the higher levels of the variables.

$$DLX_t = \alpha + \gamma t + \Phi LX_{t-1} + \sum_{i=1}^{m} \delta_i DLX_{t-i} + w_i \qquad (2)$$

where LX is the logarithmic form of the variable in question, α and t are a constant term and a time trend, respectively, "D" is the first difference operator, w is the white noise reidusl and m is the lagged values of DLX_t that are included to allow for serial correlation in the residuals. In the context of the ADF test, a test for nonstationarity of the series, LX, amounts to a t-test of Φ=0. The alternative hypothesis of stationarity requires that Φ be significant negative. If the absolute value of the computed t-statistic for Φ exceeds the absolute critical value given in Dickey (1976), then the null hypothesis that the log level of X series is not stationary must be rejected against its alternative. If, on the other hand, it is less than the critical value, it is concluded that the logarithmic level of X, Lx, is nonstationary. In this case, the same regression must be repeated for the first difference of the logarithmic value of the series. In estimating ADF regressions, the number of own lags (m) was chosen using the "Akaike Information Criterion" (AIC).

If the series under consideration turn out to be integrated of the same order, it is possible to proceed by testing for cointegration relationships between the integrated variables. In this paper cointegration tests were carried by means of the method developed by Johansen (1988), and Johansen and Juselius (1990). The Johansen method applies the maximum likelihood procedure to determine the presence of cointegrating vectors in nonstationary time series as a vector autoregressive (VAR):

$$\Delta Z_t = C + \sum_{i=1}^{K} \Gamma_i \Delta Z_{t-i} + \Pi Z_{t-1} + \eta_t \qquad (3)$$

where Z_t is a vector of nonstationary (in log levels) variables and C is the constant term. The information on the coefficient matrix between the levels of the series Π is decomposed as $\Pi = \alpha\beta'$ where the relevant elements of the α matrix are adjustment coefficients and the β matrix contains the cointegrating vectors. Johansen and Juselius (1990) specify two likelihood ratio test statistics to test for the number of cointegrating vectors. The first likelihood ratio statistics for the null of exactly r cointegrating vectors against the alternative of r+1 vectors is the maximum eigenvalue statistic. The second statistic for the hypothesis of at most r cointegrating vectors against the alternative is the trace statistic. Critical values for both test statistics are tabulated in Johansen and Juselius (1990). The number of lags applied in the cointegration test are based on the information provided by the multivariate generalization of the AIC[4].

If the time series integrated of order of one are not cointegrated, the autoregressive system set up in Equation (1) is estimated by utilizing the first differences of the series. On the other hand, there are two approaches in using of cointegrated nonstationary data in a system model. One is to estimate the model in terms of the levels of the data, without modeling the cointegrating relationships. An alternative to this approach is to estimate the model in the first differences with the addition of cointegrating terms.

The estimation of the autoregressive system in this study was done under two different lag specifications. The first lag specification was based on the results of the final prediction error criterion

[4] The multivariate generalization of the AIC is AIC = Tlog|Σ|+2N. Where |Σ| is determinant of the covariance matrix of the residuals and N is total number of parameters estimated in all equations.

(FPE) due to Akaike (1969). By varying the order of lags from 1 to 6 for each equation in the system, the optimum number of lags was selected by minimizing the FPE statistics defined as:

$$FPE(m) = [(T + m + 1)/(T - m - 1)][SSR(m)/T] \quad (4)$$

where T is the total number of observations, m is the number of lags, and SSR(m) is the related sum of squared residuals.

The second specification which was also used by McGee and Stasiak (1985) was based on stepwise selection procedure. The maximum number of lags was arbitrarily restricted to six for each variable. The only variables which contributed significantly to the overall regression were entered and retained in the final regression. All variables were added to the regression sequentially until none of the remaining variables would have t-statistics with a P-value smaller than 20 percent. Starting from the full set of regressors, variables were then deleted sequentially as long as their t-statistics produce a P-value larger than 20 percent. At the beginning of the procedure, a constant term was forced to include in the system equations.

The data used in this study are quarterly and seasonally unadjusted. The data also cover the period of 1980:I-1995:I. All data come from various issues of the Monthly Statistical Bulletin of the State Institute of Statistics and the Monthly Statistical Bulletin of the Central Bank of Turkey.

3. EMPIRICAL RESULTS

Table 1 presents the ADF test results for the log levels as well as the first (logged) differences of the series.

Table 1: The Augmented Dickey-Fuller Test for Unit Roots

Variables	ADF-t Statistics	m	Ljung Q-Box Statistics	Significance of Q Statistics
LQ	-1.53	4	16.71	0.27
LM	-0.42	2	13.87	0.46
LG	-2.59	4	5.59	0.96
LP	0.14	1	21.08	0.10
LD	-0.81	1	11.29	0.66
DLQ	-5.12[b]	6	11.15	0.60
DLM	-8.23[b]	1	13.78	0.47
DLG	-4.09[b]	3	4.76	0.98
DLP	-5.80[b]	1	20.06	0.13
DLD	-4.90[b]	1	7.22	0.93

Note: [b] Significant at the 5% level. The 5% critical value of the ADF statistic for 50 observations is –3.50.

The second column in Table 1 records the ADF-t statistics for the levels and first differences of the variables. Critical value is given at the bottom of the table. As seen from the table, the absolute value of the calculated ADF-t statistics is greater than its critical value only for the first differences of the variables. Thus, the evidence suggests that each of the variables has one unit root, that is, first differencing of each variable appears to be sufficient to achieve stationarity. However, a single significant cointegrating vector was identified by applying Johansen's maximum likelihood approach. The maximum eigenvalue and trace statistics for a VAR of 4 are presented in Table 2. On the basis of such results, the autoregressive system constructed in Equation (1) was estimated in terms of the log levels of the variables[5].

Table 2: The Johansen Test for Cointegrating Vectors

H_0	H_1	Maximum Eigenvalue Test Statistic	Critical Values (95 per cent)
r=0	r=1	47.63[b]	33.31
r≤1	r=2	23.19	27.13
r≤2	r=3	16.80	21.07
r≤3	r=4	9.99	14.90
r≤4	r=5	0.90	8.17
H_0	**H_1**	**Maximum Eigenvalue Test Statistic**	**Critical Values (95 per cent)**
r=0	r≥1	98.53[b]	70.59
r≤1	r≥2	40.90	48.28
r≤2	r≥3	27.70	31.52
r≤3	r≥4	10.89	17.95
r≤4	r≥5	0.90	8.17

Note: r indicates the number of cointegrating relationships. [b] Significant at the 5% level. Critical values are taken from Johansen and Juselius (1990).

The results of the FPE criterion of the autoregressive model for real output (LQ), money supply (LM), nominal government expenditures (LG), exchange rate (LD) and price level (LP) are reported in Table 3. The χ^2 statistics for the joint significance of the coefficients of the lags on each variable are also reported in Table 3. Ljung Q-Box statistics for the first 13 autocorrelations of the residuals indicate that autocorrelation does not appear to be a serious problem for any equation in the system. As seen from the second column of the table, in the real output equation the estimated coefficients on the lags of money are statistically different from zero as a whole, indicating that anticipated money affects anticipated component of real output. Based on the χ^2 statistics, anticipated changes in all other variables affect real output. The correlation matrix of the unanticipated changes of the variables in where lag specification is based on the FPE criterion is presented in Table 4. Table indicates that unanticipated money does not affect real output. The correlation coefficient between unanticipated money and real output is not statistically different from zero. However, unanticipated component in government expenditures has a significant effect on real output. The correlation coefficient between unanticipated government expenditures and real output was found to be significant and positive, indicating that unanticipated component of government expenditures affects real output positively. The results given in Tables 3-4 imply that the only anticipated monetary policy influences real output, thus directly rejecting the neutrality hypothesis. At the same time, both anticipated and unanticipated fiscal policy affects real output significantly, lending support to the non-classical RENR models and rejecting the neutrality hypothesis.

The results of the autoregressive system estimation where lag specification was based on stepwise selection procedure are reported in Table 5. Taking into consideration Ljung Q-Box statistics, it is found that there is no autocorrelation in these regressions. There is a positive and significant relationship between anticipated money and real output. The estimated coefficients on the lags of money are statistically and jointly significant at the 1% level. This result shows that the RENR hypothesis is once more rejected for Turkish case. In addition, as seen from Table 6, there does not

[5] We also estimated the system using the first differences of all variables with the addition of cointegrating terms. The results, which were essentially the same, are available from the authors upon requests.

exist a positive and significant correlation between the residuals of output equation and the residuals of money equation. It is resulted that unanticipated money in Turkey does not matter in the context of the RENR hypothesis.

Table 3: Estimation Results (Final Prediction Error)

Variables	LQ	LM	LG	LP	LD
Constant	1.873[a]	1.320[a]	-0.285	-0.643	-4.145[a]
LQ_{t-1}	0.252[b]	-0.345[a]	-1.573[a]	0.245[b]	0.574[a]
LQ_{t-2}	-0.163		-0.495	-0.111	0.178
LQ_{t-3}	-0.018		-0.259	-0.173	-0.015
LQ_{t-4}	0.386		2.487[a]	0.117	0.037
LQ_{t-5}					0.299[b]
LQ_{t-6}					0.059
LM_{t-1}	0.211[b]	0.913[a]	-1.032[b]	0.002	-0.708[a]
LM_{t-2}	-0.231[c]		0.376	0.379[a]	0.291[b]
LM_{t-3}	-0.195		-0.239	-0.236[c]	-0.002
LM_{t-4}	0.381[a]		1.037[c]	0.129	0.467[a]
LM_{t-5}					0.153
LM_{t-6}					-0.252[b]
LG_{t-1}	-0.031	-0.017	0.342[a]	-0.010	-0.017
LG_{t-2}	0.037		0.161	0.018	-0.115[a]
LG_{t-3}	0.020		-0.148	0.001	-0.067[b]
LG_{t-4}	0.078[a]		0.332[b]	-0.013	-0.077[b]
LG_{t-5}					-0.117[a]
LG_{t-6}					0.029
LP_{t-1}	0.113	0.056	1.499[b]	0.425[a]	-0.124
LP_{t-2}	-0.299[c]		0.375	0.327[c]	0.001
LP_{t-3}	0.119		-0.033	0.279	0.401[b]
LP_{t-4}	-0.197		-1.635[c]	-0.352[b]	-0.089
LP_{t-5}					0.116
LP_{t-6}					0.172
LD_{t-1}	-0.162	0.129[a]	-0.998	0.497[a]	1.006[a]
LD_{t-2}	0.061		-0.235	-0.519[b]	-0.572[a]
LD_{t-3}	-0.141		0.314	0.288	0.747[a]
LD_{t-4}	0.338[a]		0.863	-0.187	-0.363[b]
LD_{t-5}					0.445[a]
LD_{t-6}					-0.527[a]
R^2					
Q(1)	0.017	0.241	0.935	1.060	2.281
Q(4)	5.056	4.210	4.252	3.765	6.065
Q(13)	9.791	10.612	17.841	6.994	16.219
χ^2_{LQ}	17.163[a]	6.772[a]	23.999[a]	6.834	48.039[a]
χ^2_{LM}	15.652[a]	114.639[a]	9.049[c]	19.706[a]	76.211[a]
χ^2_{LG}	15.717[a]	0.274	14.187[a]	0.769	58.964[a]
χ^2_{LP}	10.787[b]	0.291	14.641[a]	52.998[a]	26.047[a]
χ^2_{LD}	19.813[a]	6.967[a]	10.479[c]	15.525[a]	312.929[a]

Note: a, b and c superscripts refer to the relevant parameter is significant at 1%, 5% and 10%, respectively.

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The neutrality hypothesis of the new classical macroeconomics is also rejected in the case of fiscal policy. Fiscal policy does affect real output whenever such policy is anticipated or unanticipated. The estimated coefficients on the lags of government expenditures are statistically and jointly significant at the 1% level. At the same time, the correlation between real output and unanticipated component in government expenditures was found to be positive and statistically significant at 5% level.

Table 4: Correlation Matrix of Residuals (FPE)

Variables	LQ	LG	LD	LP
LG	0.385[a]			
LD	-0.142	-0.285[b]		
LP	-0.071	0.076	0.514[a]	
LM	0.119	0.242[c]	-0.238[c]	0.006

Note: a, b and c superscripts refer to the relevant parameter is significant at 1%, 5% and 10%, respectively.

4. CONCLUSION

The purpose of this paper was to test the neutrality hypothesis of the new classical macroeconomics in the context of five-variate autoregressive system that consist of real output, monetary policy, fiscal policy, exchange rate and price level. The estimation of the autoregressive system was done under two alternative lag specification: final prediction error criterion and stepwise selection procedure. The empirical evidence provides decisive results regarding the neytrality hypothesis: unanticipated component of money does not influence real output while anticipated component of money exerts a significant impact upon real output, rejecting the neutrality hypothesis of RENR models and lending support to the non-classical RENR models. These results were robust with respect to choice of the lag specification. The neutrality hypothesis is also rejected when fiscal policy is considered as a part of aggregate demand policy. The results indicate that both anticipated and unanticipated fiscal policy matters as a determinant of real economic activity.

The empirical evidence from Turkey does not support the predictions of the new classical rational expectations model in which wages and prices are assumed to be completely flexible and thus all adjustments are instantaneous. The evidence lends support to the non-classical rational expectations model where wages and prices are assumed to be rigid.

Table 6: Correlation Matrix of Residuals (Stepwise)

Variables	LQ	LG	LD	LP
LG	0.316[b]			
LD	-0.127	0.148		
LP	-0.152	0.001	0.486[a]	
LM	0.146	0.119	-0.195	0.023

Note: a and b superscripts refer to the relevant parameter is significant at 1% and 5%, respectively.

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Table 5: Estimation Results (Stepwise Procedure)

Variables	**LQ**	**LM**	**LG**	**LP**	**LD**
Constant	2.074[a]	0.577	-2.609	-1.589[a]	-1.475[a]
LQ_{t-1}		-0.499[a]	-1.051[b]	0.371[a]	0.421[a]
LQ_{t-3}		0.407[a]			
LQ_{t-4}	0.396[a]		2.689[a]		
LQ_{t-5}			-0.839		
LM_{t-1}	0.188[a]	0.744[a]			
LM_{t-2}		0.355[a]			
LM_{t-4}		-0.317[a]		0.114[c]	
LM_{t-6}				0.034	
LG_{t-1}			0.375[a]		
LG_{t-2}			0.234[a]		-0.078[a]
LG_{t-3}	0.034[c]		0.277[a]	-0.051[a]	
LG_{t-4}	0.096[a]			-0.008	
LG_{t-5}				-0.084[a]	
LG_{t-6}					0.142[a]
LP_{t-1}	-0.206[a]			0.744[a]	
LP_{t-3}		0.147[c]		0.254[b]	
LP_{t-5}	-0.127[c]				
LD_{t-1}		0.097[a]			1.513[a]
LD_{t-2}					-0.652[a]
LD_{t-5}				-0.019	
LD_{t-6}	0.124[a]				
R^2					
Q(1)	1.413	0.396	1.757	0.507	0.014
Q(4)	7.073	1.045	3.534	0.582	1.303
Q(13)	14.215	5.749	8.163	11.640	4.974
χ^2_{LQ}	13.250[a]	40.161[a]	37.899[a]	13.741[a]	13.548[a]
χ^2_{LM}	9.974[a]	126.141[a]		5.515[c]	
χ^2_{LG}	27.511[a]		141.615[a]	21.285[a]	24.656[a]
χ^2_{LP}	36.293[a]	2.831[c]		195.836[a]	
χ^2_{LD}	16.896[a]	6.905[a]		0.345	1404.60[a]

Note: a, b and c superscripts refer to the relevant parameter is significant at 1%, 5% and 10%, respectively.

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