VELOCITY EFFECT ON INFLATIONARY GROWTH OF TURKEY: EVIDENCE FROM CO-INTEGRATION ANALYSIS AND GRANGER'S CAUSALITY TEST

Ilhan Ozturk

(Cag University, Faculty of Business and Economics, Department of Economics, Adana – Merin Karayolu uzeri, 33800 Yenice/Mersin, TYRKEY, Phone: +00 90 324 6514800, e-mail: ilhanozturk@yahoo.com)

1. Introductýon

Turkey, a developing country, has experienced recently high inflation rates. The trend of inflation has caused other macro economic indicators to be unstable over the years. This made inflationary indicators the most important and leading economic indicator in the country. Among the major causes of inflation are persistent public sector deficits, high input prices due to rapid depreciation of the Turkish Lira (TL) and persistent inflationary expectations of economic agents (Dibooglu and Kibritcioglu, 2001: 2). Many programs based their anticipations on inflationary trend. Currently, another economic program is in action and trying to control and reduce inflation and provide the stability for other macroeconomic indicators on the way to European Union, as promised to the International Monetary Fund. Among other important indicators are exchange rates and interest rates, which are highly important to both domestic and foreign indicators.

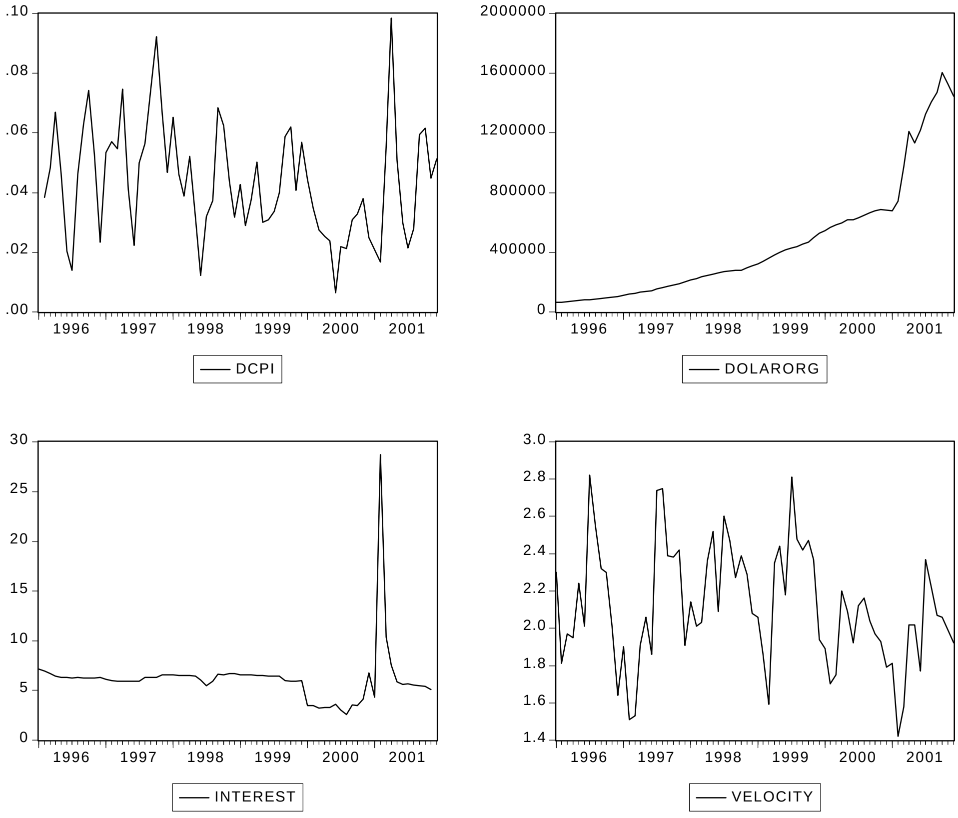

Figure 1. Trend of CPI, TL/$ Rates, Interest Rates and Velocity

Figure 1 shows the monthly trend of consumer price index (CPI) growth, the exchange rate for TL/$, the monthly compounded interest rates on deposit accounts and velocity between 1996 and 2001. Inflation rates show high fluctuations over the years. Exchange rates have a stable upward trend. Velocity has also ups and downs depending on the developments in Gross Domestic Product (GDP) and money supply (M1).

There have been previous studies on inflation in Turkey primarily seeking the major causes. Öniº and Özmucur (1990) found that non-monetary, supply side factors have significant effects on inflation in Turkey. The strong effects of devaluation policies have been estimated. Yeldan (1993) founded that public sector expenditures act as an important and strong source of demand pull inflation in Turkey. De Santis (1993) worked for a short run period to analyze the difference between the interest rate on money and the interest rate on loans having a fundamental role in controlling inflation. He found that per capita money supply affects the price level both in the short run and in the long run. According to Metin (1995) excess demand in the government sector is the main determinant of inflation in Turkey. So inflation is a fiscal matter and could be reduced by eliminating the fiscal deficit. But Insel (1995) did not support the public finance view of inflation saying that it was not the only reason for inflation. Inflation in Turkey is mainly determined by exchange rate policy, real interest rates and inflationary expectations. Lim and Papi (1997) and Darrat (1997) proved the important role of monetary variables (money and exchange rates) in the inflationary process. Alper and Uçer (1998) proved the weakness of the empirical link between fiscal imbalances and inflation, relating inflation to the visible erosion of the TL. According to Akyürek (1999) monetary and nominal exchange rate shocks have been significant sources of inflation in Turkey. He concluded that inflation also feeds itself[11].

2. The Empýrýcal Methodology and Data

In the light of empirical studies on the major cause of inflation in Turkey, this study tries to analyze basically the effect of velocity (which is GDP over M1 money supply) on the consumer price index of Turkey together with other control variables. In order to estimate the effects of velocity on inflationary trends in Turkey, monthly data for the consumer price index as a measure for inflation and velocity are selected for the period of January 01, 1996 – October 31, 2001, including 66 observations. Some control variables are added to the regression equation to have the model best fitted which was also used and tested in previous studies. Since the model is based on a growth, natural logarithmic values of both variables are calculated in Econometric Views 4.0 program. So, the co-integration equation is estimated through double logarithmic function as provided below [See Gujarati, 1995: 725-729]:

$$LogCPI = a_0 + \beta_1(LogDollar) + \beta_2(LogVelocity) + \beta_3(LogInterest) + \beta_4(LogGDP) + \beta_5(LogDollar_{-1}) + \beta_6(LogDollar_{-2}) + \beta_7(LogVelocity_{-1}) + \beta_8(LogVelocity_{-2}) + \beta_9(LogInterest_{-1}) + \beta_{10}(LogInterest_{-2}) + \beta_{11}(LogGDP_{-1}) + \beta_{12}(LogGDP_{-2}) + \beta_{13}(LogCPI_{--1}) + \beta_{14}(LogCPI_{-2}) + ut \quad \text{Eq.1}$$

Where;
LogCPI = the natural logarithm of Consumer Price Index data
LogDollar = the natural logarithm of Turkish Lira (TL) rates per United States (US) Dollar
LogVelocity = the natural logarithm of velocity
LogInterest = the natural logarithm of monthly compounded interest rates
LogGDP = the natural logarithm of Gross Domestic Product in constant prices of TL
Note: -1 and –2 in the parentheses represent lagged values.

The Augmented Dickey-Fuller (ADF) and the residual based ADF tests are used to test the integration level of each variable and the possible co-integration between variables [Dickey

[1] For detailed information, look at Kibritcioglu (2001).

and Fuller, 1981]. The number of cointegrating vectors is investigated by adopting Johansen Maximum Likelyhood Method [Johansen & Juselius, 1990].

Error Correction Mechanism (ECM) is employed to test for short run adjustment towards long run equilibrium using the residuals from the estimated co-integrating regression for equation, Eq.1 [Engle and Granger, 1987]:

$$\Delta LogCPI = a_0 + \beta_1 (\Delta LogDollar) + \beta_2(\Delta LogVelocity) + \beta_3(\Delta LogInterest) + \beta_4(\Delta LogGDP) + \beta_5(\Delta LogDollar_{-1}) + \beta_6(\Delta LogDollar_{-2}) + \beta_7(\Delta LogVelocity_{-1}) + \beta_8(\Delta LogVelocity_{-2}) + \beta_9(\Delta LogInterest_{-1}) + \beta_{10}(\Delta LogInterest_{-2}) + \beta_{11}(\Delta LogGDP_{-1}) + \beta_{12}(\Delta LogGDP_{-2}) + \beta_{13}(\Delta LogCPI_{--1}) + \beta_{14}(\Delta LogCPI_{-2}) + \beta_{15}(e_{t-1}) + v_t \qquad \text{Eq.2}$$

It is important to note that estimated error correction term (β_2) should be negative and statistically significant in the short run equation, Eq.2. With regards to Granger Representation Theorem (GRT), negative and statistically significant error correction coefficient is a necessary condition for the relevant variables in the equation to be co-integrated which provides further evidence and confirmation both in the static long run and the dynamic short run components [Ghatak and Fethi, 1998: 383-384]. Lastly, in order to test the existence of direction of causality among variables used in this study, if any, Granger's Causality Test is adopted.

3. Results of Co-Integratýon and ECM Models

The Turkish economy experienced a higly fluctuating trend in its macro economic indicators since the 1940s. Various stabilization policies have been adopted since then to stabilize the economy but couldn't be achieved yet. Figure 2 shows monthly logarithmic trend of variables since 1996 and Table 1 shows the correlation coefficents between these variables. LCPI shows a perfect correlation with logarithmic TL/US$ rates and LGDP, but a low and negative correlation with nominal interest rates and velocity.

Table 1. Correlation Matrix for Log Variables in the Model

	LCPI	LDOLLAR	LINTEREST	LGDP	LVELOCITY
LCPI	1	0.994	-0.252	0.987	-0.145
LDOLLAR	0.994	1	-0.233	0.984	-0.139
LINTEREST	-0.252	-0.233	1	-0.281	-0.092
LGDP	0.987	0.984	-0.281	1	-0.016
LVELOCITY	-0.145	-0.139	-0.092	-0.016	1

The series used in co-integration models should be stationary, otherwise the results estimated by regression models would be spurious in the case of non-stationarity [Gujarati, 1995: 710-725]. If the series are stationary, co-integration test is not required, the significancy tests can be applied and the results are spurious. If not, then the co-integration test is required to prove the reliability of the results. A unit root test is applied to test the stationarity of the series. The tests should start from the more generalized model including constant and trend series, and then if not statianary, constant and trend series should be eliminated one by one through the process until stationarity is reached [Enders, 1995: 257]. If still the series are not statioanary then the first or second differences of the series are applied into the same process until stationarity is reached.

Table 2. ADF Test for Unit Roots

Variable	Level	1st Difference	Lag	C	T	Critical Values 1%	5%	10%
LogCPI	-2.60 (1%)	NA	11	1%	1%	-4.11	-3.48	-3.17
LogDollar	-2.07 (5%)	NA	12	5%	5%	"	"	"
LogVelocity	-5.69 (1%)	NA	4	1%	10%	"	"	"
LogInterest	-3.56 (1%)	NA	12	1%	1%	"	"	"
LogGDP	-2.47 (1%)	NA	12	1%	5%	"	"	"

Table 2 shows ADF test statistics for the series. ADF test statistic for LogCPI is -2.60 and is less than McKinnon critical values but since t statistics under normal distribution for trend, constant and LogCPI terms respectively are significant at 0.01, therefore LogCPI is assumed to be stationary in level showing no unit root. The percentage values show the level of α at which the series are significant under normal distribution. So, all the series seem stationary in levels including both constant and trend terms. However, they are in different lags.

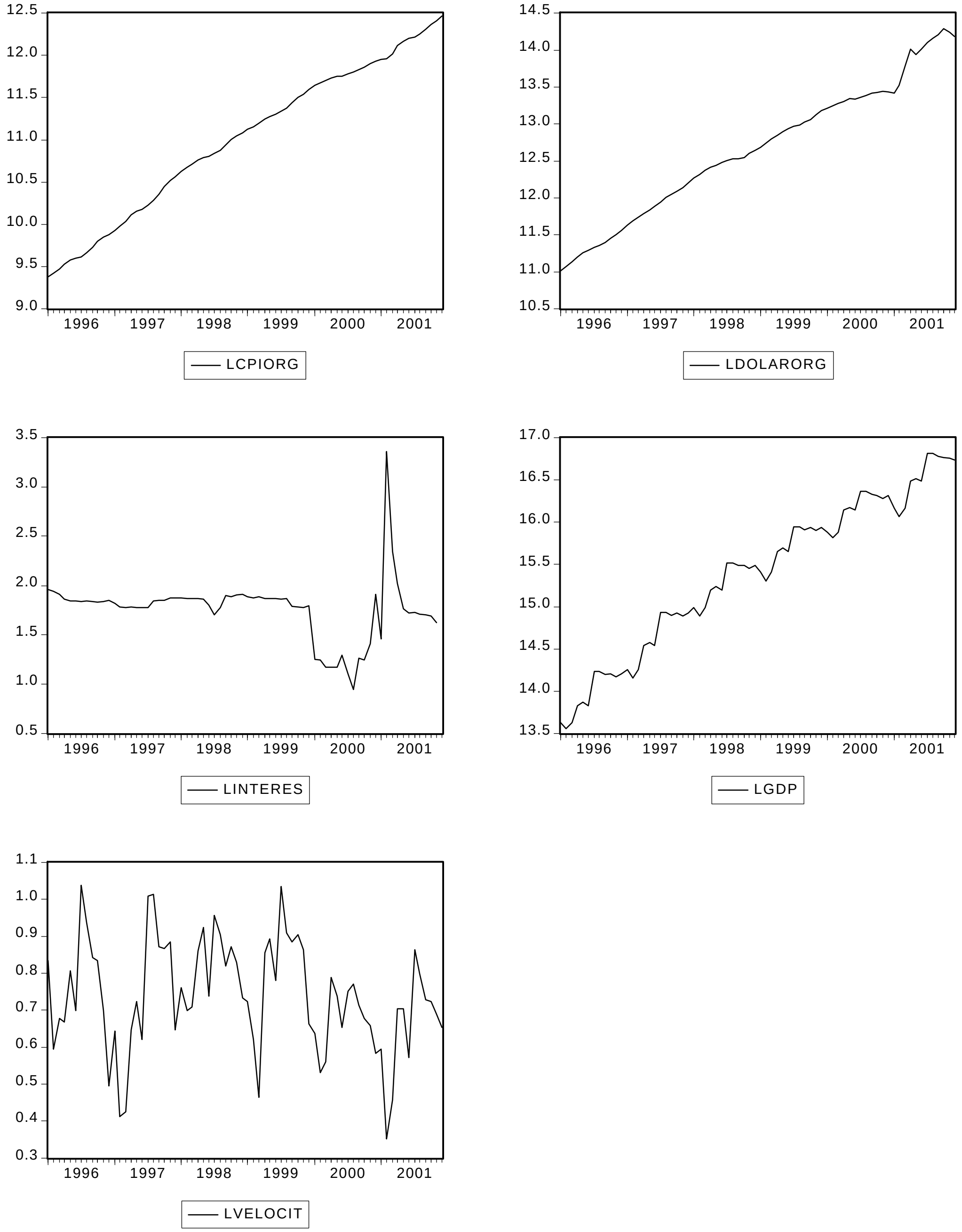

Figure 2. Logarithm Trend of Inflation Rates and Velocity

The Engel Granger (EG) static long run regression by Ordinary Least Squares (OLS) is estimated to see if the residuals are stationary which would be sufficient enough to see the existence of co-integration among variables in a long run regression [Gujarati, 1995: 726-729]:

LogCPI = -0.34 + 0.124(LogDollar) – 0.009(LogVelocity) – 0.001(LogInterest)+
(-3.53) (2.39) (-0.37) (-0.15)
0.030(LogGDP) – 0.030($LogDollar_{-1}$) - 0.097($LogDollar_{-2}$) – 0.061($LogVelocity_{-1}$) +
(1.08) (-0.39) (-1.66) (-2.51)
0.033($LogVelocity_{-2}$) + 0.0007($LogInterest_{-1}$) + 0.009($LogInterest_{-2}$) + 0.056($LogGDP_{-1}$) +
(1.30) (0.08) (1.11) (1.84)
0.007($LogGDP_{-2}$) + 1.353($LogCPI_{--1}$) – 0.448($LogCPI_{-2}$)
(0.26) (11.63) (-4.03)

R^2= 0.99 Adj. R^2= 0.99 DW = 1.86 χ^2= 32.5 (Prob= 0.25)
ADF = - 7.59 CV= -3.53 SER = 0.01 χ^2Serial Corr = 2.56 (Prob= 0.27)
(t statistic for each parameter is given in the parentheses)

The model results show that velocity has a weak and negative effect on CPI which is not significant, but 1 lagged velocity is significant at 0.01 and its elasticity coefficient is –0.061. TL/$ rates are significant in level but are not significant at 1 and 2 lags. The residual based ADF test statistic shows that the null of no-cointegration at 0.01 significant level is rejected.

Table 3. Residual Based ADF Test.

R^2	Adjusted R^2	DW	Calculated ADF Residuals	Critical Values		
				1%	5%	10%
0.46	0.45	1.92	-7.59	-3.53	-2.90	-2.59

To confirm the uniqueness of the co-integrating vectors, the Maximum Likelihood test is employed:

Table 4. Johansen Maximum Likelihood Procedure.

Null Hypothesis	Alternative Hypothesis	λ Max.	Critical Value at 5%	λ Trace Value	Critical Value at 5%
r = 0	r = 1	37.02	33.46	83.96	68.52
r ≤ 1	r = 2	23.67	27.07	46.93	47.21
r ≤ 2	r = 3	15.69	20.97	23.26	29.68
r ≤ 3	r = 4	6.56	14.07	7.57	15.41
r ≤ 4	r = 5	1.01	3.76	1.01	3.76

The results confirm the unique co-integrating vector among the relevant variables. Since the series are co-integrated, there is a long term equilibrium relationship between the series. However, there might be disequilibrium in the short term.

Due to the static structure of the co-integrating regression, the estimates of the static co-integrating regression are likely to create biased estimation [Ghatak and Fethi, 1998: 386-387]. To remedy this problem, lagged and differenced terms are suggested by some econometricians [Banarjee and Hendry, 1986: 253-277]. Thus ECM is employed through "general to specific" modelling approach for short run dynamics components [See Miller, 1991: 139-154].

The estimates of dynamic model of ECM for the short run period are as follows:

ΔLogCPI = 0.004 + 0.093(ΔLogDollar) – 0.032(ΔLogVelocity) – 0.0009(ΔLogInterest)+
(0.72) (1.98) (-1.48) (-0.14)
0.056(ΔLogGDP) – 0.087($\Delta LogDollar_{-1}$) – 0.005($\Delta LogDollar_{-2}$) – 0.074($\Delta LogVelocity_{-1}$) +
(2.30) (-1.55) (-0.09) (-2.97)
0.007($\Delta LogVelocity_{-2}$) + 0.009($\Delta LogInterest_{-1}$) + 0.018($\Delta LogInterest_{-2}$) + 0.052($\Delta LogGDP_{-1}$)

(0.28) (0.98) (2.25)
(1.93)

$$+ 0.013(\Delta LogGDP_{-2}) + 1.481(\Delta LogCPI_{-1}) - 0.714(\Delta LogCPI_{-2}) - 1.000(e_{t-1})$$
(0.46) (7.49) (-5.17) (-4.48)

R^2= 0.71 Adj. R^2= 0.62 DW = 1.99 χ^2= 32.7 (Prob= 0.34)
SER = 0.01 χ^2Serial Corr = 0.25 (Prob= 0.88)
(t statistic for each parameter is given in the parentheses)

The error correction term is negative and significant at 0.01% level. The magnitude of the corresponding coefficient shows that all of any discrepancy between the actual and the long run, or the equilibrium, value of LogInflation is eliminated or corrected each month. In other words, inflation is adjusted to its equilibrium level and error correction term provides further evidence that the variables in the equilibrium regression are co-integrated as ECM works satisfactorily. The ECM model again shows that velocity has still negative effects on CPI in the short run which is not significant at non-lagged value but significant at 1 lag at 0.01.

6. Granger Causalýty for Inflatýonary Process in Turkey

Regression analyses deals with dependency among variables, but it does not necessarily imply causation (Gujarati, 2003: 696). The Granger Test for causality is such a technique searching the direction of causality between variables. The Granger Test follows F distribution having a null hypothesis stating no causality from X → Y.

The logarithmic variables used in this study have been tested for the causing of Inflationary Growth, if any. The money supply component of M1 is added additionally to the test. Since data is monthly, 12 lagged variables are prefered. The results founded in EVIEWS 4.0 are given in Table 5:

Table 5. Granger Test for Causality for Inflationary Growth

Null Hypothesis:	Obs	F-Statistic	Probability
LDOLAR does not Granger Cause LCPI	60	2.57469	0.01458
LCPI does not Granger Cause LDOLAR		0.90631	0.55017
LGDP does not Granger Cause LCPI	60	2.40590	0.02150
LCPI does not Granger Cause LGDP		6.43638	7.3E-06
LVELOCITY does not Granger Cause LCPI	60	2.63280	0.01277
LCPI does not Granger Cause LVELOCITY		1.93128	0.06443
LM1 does not Granger Cause LCPI	60	2.95017	0.00622
LCPI does not Granger Cause LM1		1.55836	0.15020
LINTEREST does not Granger Cause LCPI	59	1.87513	0.07452
LCPI does not Granger Cause LINTEREST		0.78135	0.66520
LGDP does not Granger Cause LDOLAR	60	1.21456	0.31210
LDOLAR does not Granger Cause LGDP		3.96594	0.00070
LVELOCITY does not Granger Cause LDOLAR	60	0.90072	0.55518
LDOLAR does not Granger Cause LVELOCITY		1.36076	0.23072
LM1 does not Granger Cause LDOLAR	60	1.36463	0.22883
LDOLAR does not Granger Cause LM1		33.4092	1.4E-15
LINTERES does not Granger Cause LDOLAR	59	7.27808	2.3E-06
LDOLAR does not Granger Cause LINTEREST		5.92849	2.0E-05
LVELOCITY does not Granger Cause LGDP	60	1.03091	0.44376
LGDP does not Granger Cause LVELOCITY		1.70571	0.10793
LM1 does not Granger Cause LGDP	60	1.09852	0.39149
LGDP does not Granger Cause LM1		1.67498	0.11570
LINTEREST does not Granger Cause LGDP	59	0.80232	0.64570
LGDP does not Granger Cause LINTEREST		1.14808	0.35696
LM1 does not Granger Cause LVELOCITY	60	2.19137	0.03531
LVELOCITY does not Granger Cause LM1		1.41494	0.20552
LINTEREST does not Granger Cause LVELOCITY	59	0.69288	0.74665
LVELOCITY does not Granger Cause LINTEREST		0.68165	0.75674
LINTEREST does not Granger Cause LM1	59	25.3953	1.7E-13
LM1 does not Granger Cause LINTEREST		1.38256	0.22164

Table 5 shows that causality from TL/$ rates to Inflationary growth has been founded at α = 0.01 level. Two sided causality have been obtained between Velocity growth and inflationary growth although a low correlation exists between the two. The probability values for F statistics are given on the right side of Table 5. If these probability values are less than any α level, then the hypothesis would be rejected at that level.

6. Conclusýon

The aim of the paper is to examine the impact of velocity growth on the inflationary trend of Turkey between 1996 and 2001, using monthly data through co-integration and ECM regression analyses. The uses of co-integration and ECM showed that velocity has inelastic and negative long term effect in the EG sense on inflationary growth. In the short run dynamic model, the effect of velocity on inflation is both inelastic and significant at 1 lagged value. The Granger Test for causality proves the existence of two sided causality among Consumer Price Index growth and velocity growth.

REFERENCES

1. Akyürek, C. (1999), An Emprical Analysis of Post-Liberalization Inflation in Turkey, *Yapý Kredi Economic Review*, 10 (2): 31-53.
2. Alper, C. E. and M. Uçer (1998), Some Observations on Turkish Inflation: A Random Walk Down the Past Decade, *Bogazici Journal*, 12 (1): 7-38.
3. Banarjee, A., Hendry, D.F. and Smith, G., 1986. Exploring Equilibrium Relationships in Econometrics Through Static Model: Some Monte Carlo Evidence. *Oxford Bulletin of Economics and Statistics*, Vol. 48, pp. 253-277.
4. C.W.J. Granger (1969), *Investigating Causal Relations By Econometric Models and Cross Spectral Methods*, *Econometrica*, pp.424-438.
5. Darrat, A. F. (1997), Domestic and International Sources of Inflation in Some Muslim Countries: An Empirical Inquiry, *The Middle East Business and Economic Review*, 9 (1): 14-24.
6. De Santis, R. (1993), An Error Correction Monetary Model Explaining the Inflationary Process in Turkey, *Warwick Economic Research Papers*, No. 418.
7. Dibooglu, S. and A. Kibritcioglu (2001), Inflation, Output and Stabilization in a High Inflation Economy: Turkey, 1980-2000, University of Illinois at Urbana-Champaign, College of Commerce and Business Administration, *Office of Research Working Paper No*. 01-0112.
8. Enders, W. (1995), *Applied Econometric Time Series*, John Wiley & Sons, Inc., p.257.
9. Engle, R.F. and Granger, C.W.J. (1987), Co-Integration and Error Correction: Representation, Estimation and Testing. *Econometrica*, Vol. 55, pp. 251-276.
10. Ghatak, S. and Fethi, S., 1998. Trade Policy and Economic Growth in Northern Cyprus: A Co-integration Analysis, 1977-1996. *Second International Congress For Cypriot Studies*, Volume IB, 24-27 November, Gazimaðusa, TRNC, pp. 383-384.
11. Gujarati, D.N. (1995), *Basic Econometrics*, Third Edition, International Edition, McGraw Hill Inc., USA.
12. Ýnsel, A. (1995), The Relationship Between the Inflation Rate and Money Financed Deficit in Turkey: 1977-1993, University of New South Wales, School of Economics, *Discussion Paper*, No. 95/31.
13. Kibritcioglu, A. (2001), Causes of Inflation in Turkey: A literature Survey with Special Reference to Theories of Inflation, University of Illinois at Urbana-Champaign, College of Commerce and Business Administration, *Office of Research Working Paper No*. 01-0115.
14. Lim, C. H. and L. Hapi (1997), An Econometric Analysis of the Determinants of Inflation in Turkey, *IMF Working Paper,* No. WP/97/170.
15. Metin, K. (1995), An Integrated Analysis of Turkish Inflation, *Oxford Bulletin of Economics and Statistics*, 57 (4): 513-531.
16. Miller, S.M., 1991. Monetary Dynamics: An Application of Co-integration and EC Modeling. *Journal of Money, Credit and Banking*, Vol. 23, pp. 139-154.
17. Öniº, Z. and S. Özmucur (1990), Exchange Rates, Inflation and Money Supply in Turkey: Testing the Vicious Circle Hypothesis, *Journal of Development Economics*, 32 (1): 133-154.
18. Yeldan, E. (1993), Conflicting Interests and Structural Inflation: Turkey, 1980-1990, *The Pakistan Development Review*, 32 (3):303-327.