

Rationality of Inflation Expectations  
in a Financially Repressed Economy

A Thesis

Submitted to the Department of Economics  
and the Institute of Economic and Social Sciences  
of Etilent University

in Partial Fulfillment of the Requirements  
for the Degree of

Master of Arts in Economics

by

Erdem BASCI

October, 1990

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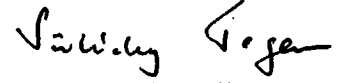
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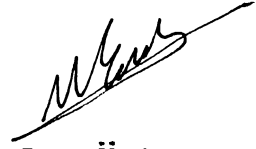
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I certify that I have read this thesis and in my opinion it is fully adequate in scope and in quality, as a thesis for the degree of Master of Arts in Economics.



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Dr. Erinc Yeldan

Approved by the Institute of Economic and Social Sciences

A B S T R A C T

RATIONALITY OF INFLATION EXPECTATIONS  
IN A FINANCIALLY REPRESSED ECONOMY

ERDEM BASCI

M.A. in Economics

Supervisor: Professor Subidey Togan

October 1990, 25 pages

This study attempts to assess the quality of public's expectations of inflation by investigating the dynamic interactions between money, prices, income and interest rates in Turkey. Four alternative hypotheses on public expectation formation rule are proposed and tested in the context of the same real money balances model. The fact that interest rates were not determined by the market forces in the investigated period provides sufficient volatility in the real interest rates, and hence reduces the confidence bands of the estimates of the interest sensitivity parameter of the real money demand function. The estimation of parameters and tests of hypotheses are carried out on restricted and unrestricted vector-autoregressive representations of the time series of four economic variables, namely growth rates of money, prices, output and interest rates. Out of sample forecasts are also carried out and compared. Most of the results are in favor of the adaptive and less informed expectations hypothesis rather than rational or more informed ones.

Keywords: Rational expectations, money demand function, vector-autoregression, stationarity, cross-equation restrictions.

## Ö Z E T

### MALİ PİYASALARI AZ GELİŞMİŞ BİR EKONOMİDE ENFLASYON BEKLENTİLERİNİN AKILCILIĞI

ERDEM BAŞÇI

Yüksek Lisans Tezi, Ekonomik ve Sosyal Bilimler Enstitüsü

Tez Yöneticisi: Prof. Dr. Sübidey Togan

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Bu çalışma halkın enflasyon beklentilerinin niteliği hakkında bir fikir edinmek amacıyla Türkiye'deki para, fiyat, milli gelir ve faiz oranları arasındaki dinamik etkileşimi incelemektedir. Halkın beklentilerini modelleyen dört ayrı hipotez önerilmiş ve bunlar aynı para talebi modeli çerçevesinde sınanmıştır. İncelenen dönemde faizlerin serbest piyasada oluşmamış bulunması, para talebinin faiz hassasiyeti parametresinin etkin bir şekilde tahmin edilebilmesine imkan verecek şekilde, reel faizlerde dalgalanmaya neden olmuştur. Model parametrelerinin tahmini ve hipotez testleri dört makroekonomik değişkenin zaman serilerinin kısıtlanmış ve serbest parametrelili vektör otoregresyon modelleri üzerinde yapılmıştır. Bu değişkenler paranın, fiyatların, reel milli gelirin ve faizlerin yıllık değişim miktarlarıdır. Ayrıca her hipotez için örnek dışı kestirimler de yapılmış ve karşılaştırılmıştır. Sonuçların çoğu az bilgilendirilmiş ve adaptif beklentiler hipotezini, çok bilgilendirilmiş veya akılcı beklentiler alternatiflerinden daha fazla desteklemektedir.

Anahtar Kelimeler: Akılcı beklentiler, adaptif beklentiler, para talebi fonksiyonu, vektör otoregresyon modeli, durağanlık, denklemler arası kısıtlamalar.

## ACKNOWLEDGEMENTS

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## I. Introduction

Turkey used to have a bank based financial system until 1980's and despite the recent efforts to develop the capital markets, money deposits in banks still constitute the major medium for savings. Moreover, together with extensive credit rationing, the nominal interest rates have been fixed at rates lower than their free market values at regular intervals by the Turkish authorities during most of the 60-80 period. This resulted in ex-post real interest rates on bank deposits that were very volatile and mostly negative.

In such an environment, due to non availability of alternative securities, the anticipated real return on money savings will effect the speed of spending on commodities, hence on prices. Therefore the real value of money balances will vary positively with the public's real return expectation on money deposits. And the real return expectation is solely determined by inflation expectations, given the nominal interest rate.

As a financially repressed economy, Turkey provides a good case for investigating this phenomena. In this paper, the effect of expectations of inflation on the path of prices is discussed. The rationality of expectations is questioned and tested in the contexts of rational and adaptive expectations specifications. Two versions of each specification is considered based on differences in the assumed information sets for the agents. section II presents the models and methodology. Section III gives the estimation results. Comparisons of out of sample forecasts of alternative models are presented in section IV. A summary of main findings are in section V.

## II. The Model

According to the model used here, the logarithm of real money balances is a linearly increasing function of both real income and real rate of return available from holding money.<sup>1</sup>

$$\ln(M/p) = a + \eta \ln y + \lambda(R-\pi) + u \quad (1)$$

with  $\eta > 0$ ,  $\lambda > 0$ , where

M: Money Stock (Currency+Demand Deposits+Time Deposits)

p: Price Level (GNP Deflator)

y: Real Income (GNP in constant prices)

R: Nominal Rate of Interest on Money (Weighted Average)

$\pi$ : Public's expected rate of inflation

u: Unobserved disturbance term due to public's preferences and technological conditions.

The important problem in estimation of the parameters of the above model is that  $\pi$  is not observable by the economist. Cagan(1956) has proposed using adaptive expectations in the form

$$\pi_t = \beta \sum_{i=0}^{\infty} (1-\beta)^i x_{t-i} \quad (2)$$

with  $\beta \in [0,1]$  where  $x_t = \ln(p_t/p_{t-1})$  is the realized inflation rate of period t. One should note that this model requires the knowledge of  $x_t$  i.e. the current period's inflation rate before it is realized and announced. Moreover, as it is shown in

<sup>1</sup>The model in principle the same as the one used by Togan(1987) for 1960-1983 period in Turkey. As a specific case one obtains Cagan's(1956) model when  $\eta=0$  and  $R=0$ .

Sargent & Wallace (1973) using (2) to estimate (1) by OLS will yield statistically inconsistent results since  $x_t$  is correlated with  $u_t$ .

An alternative form assumes public has the knowledge of the latest announce inflation i.e. they are less informed but they still form their expectations adaptively.

$$\pi_t = \beta \sum_{i=0}^{\infty} (1-\beta)^i x_{t-i-1} \quad (3)$$

Togan (1987) has estimated model (1) by using both specifications (2) and (3) for expected inflation. Although specification (2) gave higher  $R^2$  values, in all the simulations it performed worse than specification (3) which gives consistent estimates of  $\lambda$ .

Sargent & Wallace (1973) and Sargent (1977) show that unless the money supply process has feedback from inflation in a specific way, the adaptive expectations cannot be rational in the sense of being consistent with the model's expectations. In this paper the validity of the rational expectations hypothesis as opposed to adaptive expectations assumption will be tested for Turkish data in the context of the money demand function presented as equation (1). The test is based on the suitability of imposing the restrictions implied by model (1) and various expectation specifications on a vector autoregressive representation of four variables.

Differencing (1), one obtains,

$$\mu_t - x_t = \eta g_t + \lambda(r_t - \pi_t + \pi_{t-1}) + \varepsilon_t \quad (4)$$

where

$\mu_t = \ln(M_t/M_{t-1})$  is the rate of growth in money,

$g_t = \ln(y_t/y_{t-1})$  is the real income growth rate,

$r_t = R_t - R_{t-1}$  is the change in interest rate

$\varepsilon_t = u_t - u_{t-1}$  is due to changes in technology or preferences.<sup>2</sup>

It will be assumed that  $E_{t-1}(\varepsilon_t) = 0$ .<sup>3</sup>

Rationality of expectations require

$$\pi_t = E_t x_{t+1} \quad (5)$$

provided that the agents possess information about variables of the period they are in. If their information set contains only previous period's announced variables, then rational expectations take the less informed form

$$\pi_t = E_{t-1} x_{t+1} \quad (6)$$

To obtain the cross equation restrictions on a vector autoregressive representation of four variables imposed by the model and various public expectation specifications, the expected value of both sides of equation (4) is taken.

$$E_{t-1} \mu_t - E_{t-1} x_t = \eta E_{t-1} g_t + \lambda E_{t-1} r_t - \lambda E_{t-1} (\pi_t - \pi_{t-1}) \quad (7)$$

<sup>2</sup>The reader can note that (4) is a theory of inflation if money growth, expected inflation and income growth are regarded as exogenous.

<sup>3</sup> $E_{t-1}(\cdot)$  is the mathematical expectation operation given all the relevant information of period t-1.

Specificly, consider the representation<sup>4</sup> below where rate of growth in income is taken as econometricly exogenous and the change in interest rates is formulated to be Granger caused by past inflation rates. Furthermore money growth and inflation are assumed not to be caused by past income growth or interest rate changes.

$$\mu_t = c_\mu + \sum_{i=1}^n a_i \mu_{t-i} + \sum_{i=1}^n b_i x_{t-i} + \alpha_{\mu_t} \quad (8a)$$

$$x_t = c_x + \sum_{i=1}^n c_i \mu_{t-i} + \sum_{i=1}^n d_i x_{t-i} + \alpha_{x_t} \quad (8b)$$

$$g_t = c_g + \alpha_{g_t} \quad (8c)$$

$$r_t = c_r + e_1 x_{t-1} + e_2 x_{t-2} + \alpha_{r_t} \quad (8d)$$

Now equation (7) together with any of equations (2),(3),(5) or (6) impose its own restriction on the parameters of representation (8). The testing of these restrictions are carried out in the following section.

### III. Estimation Results and Tests

First consider the adaptive expectations hypotheses. The optimal value of  $\beta$  for 1961-88 period is found to be very close to 1 on the basis on minimum mean squared errors. The same value

<sup>4</sup>The reader can note that the unrestricted version presented above is not a complete vector autoregressive representation and has a total of  $11n+1$  exclusion restrictions. The reason is the shortage of degrees of freedom due to shortness of time series. The value of  $n$  is selected as 2 for the same reason. The ad hoc restrictions however are all justified by prior analysis.

of  $\beta$  is reported in Togan (1987) as estimated from the money demand equation (1) for his more satisfactory model. Given a value for  $\beta$ , it is straightforward to obtain the cross equation restrictions on parameters of (8). The restrictions for less and more informed expectation formulations are presented on table 1 as cases A and B respectively.

Under model consistent expectations of the form (5), the restrictions are presented as case C. The reader can verify the validity of these by directly substituting VAR expectations in (7) and (5).<sup>5</sup> Under the less informed formulation (6), quite simpler looking restrictions are derived and presented as case D on table 1.

Table 1  
Cross Equation Restrictions

Hypothesis:	Restrictions on parameters of (8) (n=2)
<hr/>	
Model (1) holds and	
<hr/>	
A. Adaptive Expectations Model (2) ( $\beta=1$ ) (Less Informed)	$c_{\mu} = \eta c_g + \lambda c_r + c_x$ $a_i = c_i \quad i=1,2$ $b_1 = d_1 - \lambda + \lambda e_1$ $b_2 = d_2 + \lambda + \lambda e_2$
<hr/>	
B. Adaptive Expectations Model (3) ( $\beta=1$ ) (More Informed)	$c_{\mu} = \eta c_g + \lambda c_r + c_x$ $a_i = (1-\lambda)c_i \quad i=1,2$ $b_1 = d_1 - \lambda d_1 + \lambda + \lambda e_1$ $b_2 = d_2 - \lambda d_2 + \lambda e_2$

<sup>5</sup> A more detailed derivation method of restrictions for this case can be found in Salemi & Sargent (1979) where income and interest effects do not appear.

(Table 1 continued)

---

<p>C. Rational Expectations Model (5) (More Informed)</p>	$c_{\mu} = \frac{(1-\lambda d_1)c_x}{(1+\lambda c_1)} + \eta c_g + \lambda c_r$ $a_1 = \frac{(1-\lambda d_1)c_1 - \lambda(c_2 - c_1)}{(1+\lambda c_1)}$ $a_2 = \frac{(1-\lambda d_1)c_2 + \lambda c_2}{(1+\lambda c_1)}$ $b_1 = \frac{(1-\lambda d_1)d_1 - \lambda(d_2 - d_1)}{(1+\lambda c_1)} + \lambda e_1$ $b_2 = \frac{(1-\lambda d_1)d_2 + \lambda d_2}{(1+\lambda c_1)} + \lambda e_2$
<hr/>	
<p>D. Rational Expectations Model (6) (Less Informed)</p>	$c_{\mu} = \lambda c_g + \lambda c_r + c_x$ $a_i = c_i = 0 \quad i=1,2$ $d_2 = 0$ $b_1 = d_1 - \lambda d_1^2 + \lambda e_1$ $b_2 = \lambda d_1^2 + \lambda e_2$

---

The unrestricted and restricted versions of (8) for  $n=2$  are estimated for 1963-1988 period by iterative Zellner's seemingly unrelated regression technique which is asymptotically equivalent to full information maximum likelihood estimation. The suitability of restrictions is tested by the likelihood ratio test calculated as

$$L = T(\ln|V_r| - \ln|V_u|) ,$$

where  $V_r$  and  $V_u$  are the variance covariance matrix of residuals of



restricted and unrestricted models respectively and T is the number of observations. The statistic is asymptotically distributed chi-squared with k degrees of freedom, where k is the number of independent restrictions, under the null hypothesis that the restrictions are correct. The values of this statistic and the marginal significance levels are reported as Table 2 for the 1963-88 period. The results lead to the rejection of all specifications except A at 95% and to the rejection of the more informed cases B and C at 99% confidence levels.

Table 2

The Likelihood Ratio Tests  
for Four Alternative Specifications (1963-1988)

Case:	q*	$\chi^2(q)$	Marginal Significance	At 95% Hypothesis
A	3	5.9	0.117	Not Rejected
B	3	13.9	0.003	Rejected
C	3	14.4	0.002	Rejected
D	6	16.0	0.014	Rejected

\*  
Number of Independent Restrictions

The estimated parameters are seen on Table 3. All the income elasticities  $\eta$  are of plausible magnitudes. The interest rate coefficient  $\lambda$  however is significantly positive only for cases A and D, i.e. the cases of less informed expectations. For cases B and C the estimated  $\lambda$  is negative but not significantly different from zero. Both the likelihood ratio test and parameter estimates seems to justify the less informed adaptive

expectations specification over the other three.

Table 3  
Parameter Estimates  
of Four Alternative Specifications (1963-88)

Case:	Estimate of $\eta^*$	Estimate of $\lambda^{**}$
A	1.003 (0.2909)	0.494 (3.297)
B	1.140 (0.362)	-0.335 (-0.805)
C	1.282 (0.910)	-1.062 (-1.257)
D	0.878 (0.318)	0.793 (2.903)

\* Asymptotic Standard Errors in Parantheses

\*\* t-ratios in parantheses

Regarding money supply and interest rate as policy variables, the above type of analysis determines the stochastic process of inflation given the money growth, interest rate and income processes. The strategic dependence of behavior on policy is the key argument of the rational expectations "school"<sup>6</sup>. For our case there has been an apparent change in the money supply rule and the interest determination rule after the 1973 and 1974 oil shocks. Substantial feedback from inflation to money creation has took place in 1976-88 period whereas it has been negligible in 1963-75. If there is such a switching in the stochastic policy processes within 1963-88 period, the above results will be biased and misleading. For this reason the time period is

<sup>6</sup>Sargent(1986,p.101) point out that there is not a unique school of rational expectations. The common feature of the very diverse class of such models is the model consistency of expectations.

separated into two equal intervals 1963-75 and 1976-88. The unrestricted system estimates of money growth and interest change processes are given on Table 4 for the two periods. The changes especially in the money growth rule but also the interest determination rule are remarkable. The restricted estimation

Table 4

The Change in Policy Rules  
Implied by Parameter Changes in Money and Interest Processes

Parameter:	1963-75*	1976-88
$c_{\mu}$	0.05 (3.18)	0.13 (3.49)
$a_1$	1.39 (7.65)	-0.07 (-0.29)
$a_2$	-0.68 (-0.84)	0.20 (1.44)
$b_1$	-0.11 (-0.84)	0.45 (5.88)
$b_2$	0.28 (1.75)	0.21 (1.79)
$c_r$	0.003 (2.517)	-0.037 (-0.966)
$e_1$	0.049 (2.905)	0.184 (1.640)
$e_2$	-0.078 (-3.704)	0.030 (0.250)

\* t-ratios in parantheses

results are on Tables 5 & 6. The likelihood ratio test (Table 5) this time fails to reject rational expectation hypotheses of cases C and D at 95 per cent confidence level. for the 76-88 period. For the 63-75 period however case D is rejected at 99

percent confidence level. Case A passes the 95% test in both periods but Case B is rejected for the second half at 95%. The interest sensitivity coefficients on Table 6 have the correct sign except for case B in the first half. However none of the rational expectations estimates are significantly greater than zero. Similarly the confidence band for income elasticity estimates is large. They are large enough to include plus one, with one exception for case C, although some point estimates are negative. Still, the reduction in the value of this estimate in the second half is common to all cases. These results weaken the evidence against validity of the rational expectations as depicted by estimation on the entire 1963-88 period. The next section compares forecasting power of the alternative models on out of sample data.

Table 5  
The Likelihood Ratio Tests  
for Four Alternative Specifications  
in Two Time Periods

Case:	q*	$\chi^2(q)$		Marginal Significance	
		1963-75	1976-88	1963-75	1976-88
A	3	2.4	7.8	0.494	0.051
B	3	0.8	10.8	0.850	0.013
C	3	6.4	7.1	0.094	0.069
D	6	26.1	7.9	0.001	0.246

\*  
Number of Independent Restrictions

Table 6  
Parameter Estimates  
of Four Alternative Specifications  
in Two Time Periods

Case:	Estimate of $\eta^*$		Estimate of $\lambda^{**}$	
	1963-75	1976-88	1963-75	1976-88
A	1.387 (0.186)	0.493 (0.720)	0.794 (2.587)	0.498 (2.537)
B	1.005 (0.201)	-0.653 (1.506)	-1.072 (-1.225)	0.323 (2.243)
C	0.503 (0.105)	-0.423 (1.399)	3.046 (1.522)	1.684 (1.392)
D	1.329 (0.188)	-0.790 (1.565)	1.532 (2.299)	2.035 (1.570)

\* Asymptotic standard errors in parantheses

\*\* t-ratios in parantheses

#### IV. Parameter Stability and Out-of-Sample Forecasts

The basic task of the econometric rational expectations models is reported in Sargent (1986) to be the isolation of the parameters related to preferences, technology or more generally the parameters that are independent of the strategy of policy makers. For our case, this means that the expectation generation rule of the public, rather than being fixed over time, depends on the policy rules of authorities in determining money growth and interest rates.

If the policy dependence were to hold in our case, and if the parameters  $\lambda$  and  $\eta$  were stable over time, one would expect the

rational expectations models to perform better than the adaptive expectation models in forecasting the inflation rates of the 1976-88 period, since there has been an apparent change in policy rules<sup>7</sup>.

To have an idea about stability of  $\lambda$  and  $\eta$  the point estimates of them for the 1963-75 period is put as additional restrictions on the same models in the 1976-88 period. The likelihood ratio statistics on table 7 fail to reject the hypotheses of no parameter change and model validity for cases A, C and D at 99 percent confidence.

Table 7  
The Likelihood Ratio Tests  
for Four Alternative Specifications (1976-1988)  
With Parameters Estimated for 1963-75 Period

Case:	q <sup>*</sup>	$\chi^2(q)$	Marginal Significance	At 99% Hypothesis
A	5	11.2	0.048	Not Rejected
B	5	15.2	0.001	Rejected
C	5	9.8	0.081	Not Rejected
D	8	11.7	0.165	Not Rejected

\*  
Number of Independent Restrictions

Next, to compare the out of sample forecasting performances, the estimates of  $\lambda$  and  $\eta$  in 1963-75 period, and the money growth, interest rate and income growth parameters for the 1976-88 period

<sup>7</sup>It is assumed by most rational expectations models that people are aware of the new policy rule as soon as it is in tact. Whether the rule is announced beforehand or whether it is felt by the individuals is an issue not much discussed in empirical studies.

are used to calculate the parameters of the inflation process implied for this period by the restrictions of Table 8<sup>8</sup>. The root mean square forecast errors (RMSE) are reported on Table 8<sup>9</sup>. For comparison, the RMSE of adaptive expectations for  $\beta=1$  which is the public's RMSE under case A is also presented. Quite interestingly, case A results are superior to all other cases in forecasting inflation. Figures 1 and 2 show the paths of forecasted and realized inflation rates for cases A and C respectively. A common observation in all cases, is that explaining and forecasting money growth is much more easier by this model which may be an implication of exogeneity of inflation during the investigated time interval (Figures 3 and 4).

Table 8  
Root Mean Squared Forecast Errors of Inflation  
(1976-88 Period)

Case:	RMSE	Parameter Values Used	
		$\eta$	$\lambda$
A.	0.116	1.39	0.79
B.	0.151	1.00	-1.07
C.	0.148	0.50	3.05
D.	0.141	1.33	1.53
Naive*	0.152	-	-

\* Adaptive Expectations ( $\beta=1$ ) is identical to previous period's realized inflation rate.

<sup>8</sup> The estimation of policy processes were done seperately for each case under its own restrictions.

<sup>9</sup> The forecasts are "static" in the sense that the past realized vaues are used to forecast current values.

Figure 1

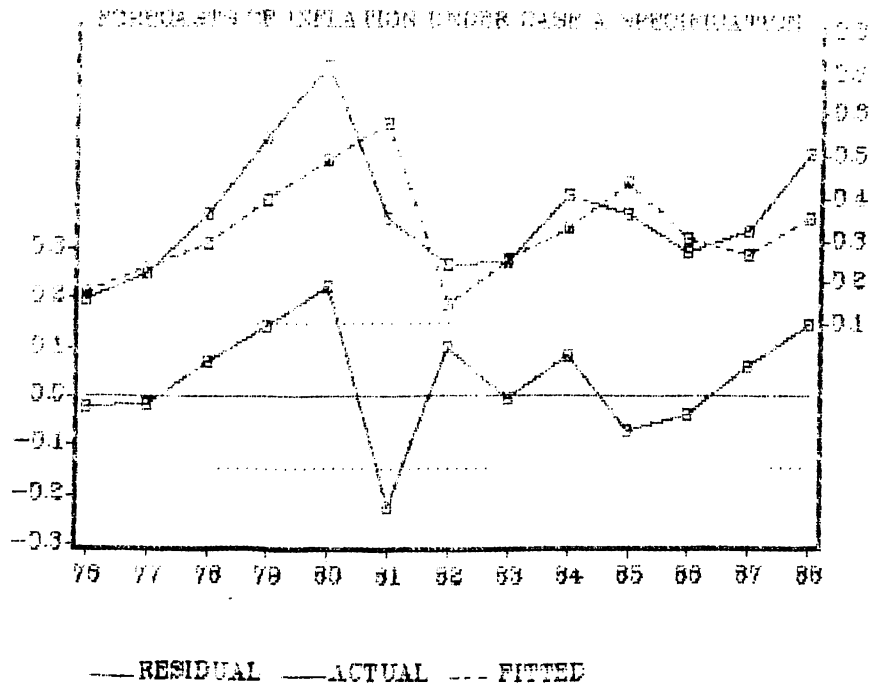
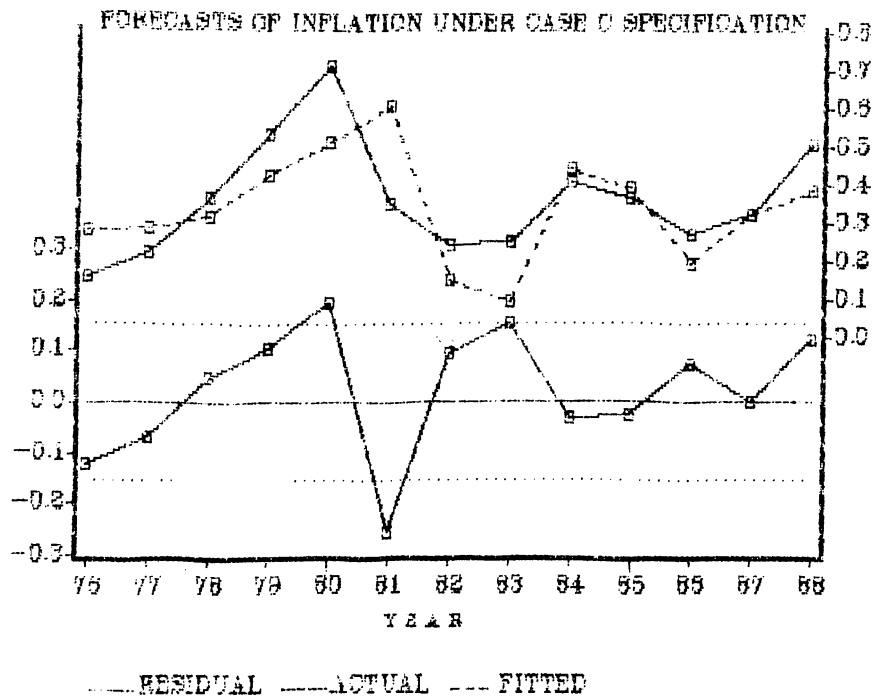
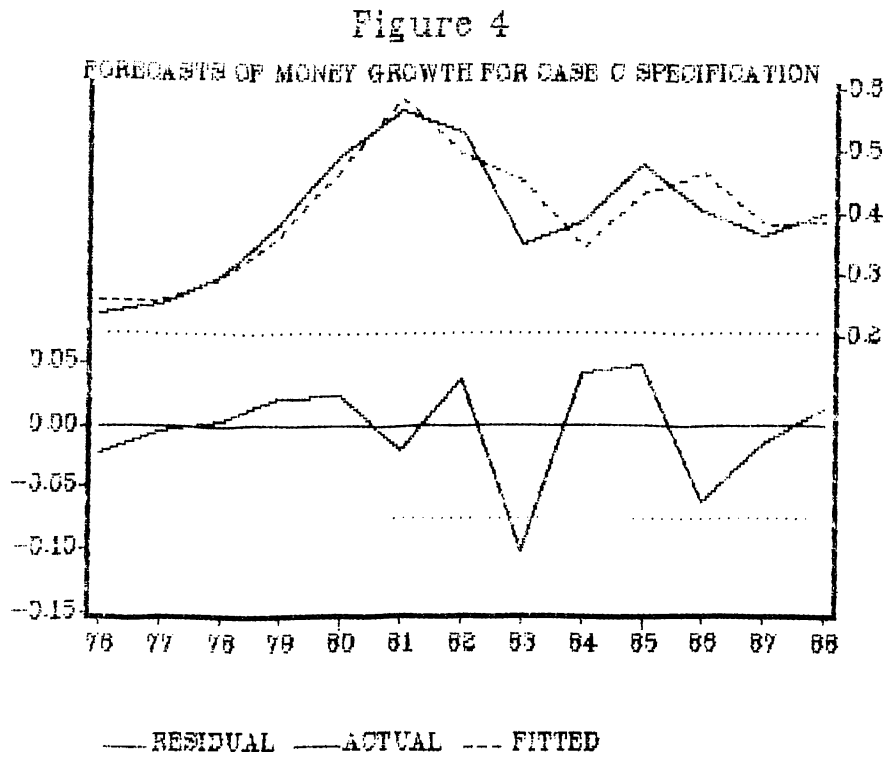
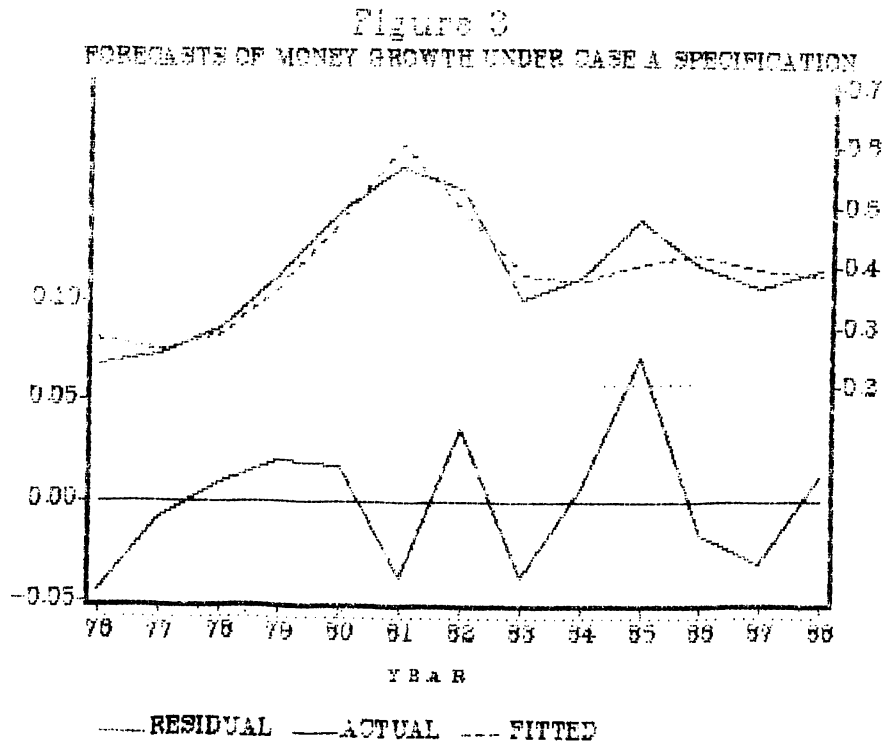


Figure 2







## V. Conclusions

This paper looked for evidence of policy dependence in expectations of inflation in Turkey. The time period investigated is one in which interest rates are not allowed to move together with expected inflation, hence the effect of expected inflation rate on real money balances becomes emphasized.

The data on price, money, income and interest rates for Turkey in 1963-88 period does not provide strong evidence on the existence of policy dependence in inflation expectations of the agents in the context of the rational expectations imbedded money demand function. An adaptive expectations specification fits the data better and the so constructed model has the best forecasting performance.

However when the data is separated to two time periods, it is seen that the rational expectations models fit better in the second period.

Another finding of this study is that, the less informed cases where the agents are assumed to possess only the previous period's information, in general seem to be more valid as compared to more informed cases.

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