ESTIMATION OF VELOCITY FUNCTION FOR TURKEY USING ENGLE-GRANGER TWO-STEP METHOD

A Thesis

Submitted to the Department of Economics
and the Institute of Economics and Social Sciences
of Bilkent University
In Partial Fulfillment of the Requirements
for the Degree of

MASTER OF ARTS IN ECONOMICS

By
Murat Ali YÜLEK
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Prof. Dr. Sübidey Togan

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

Assoc. Prof. Ümit Erol

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Approved for the Institute of Economics and Social Sciences

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ABSTRACT

ESTIMATION OF VELOCITY FUNCTION FOR TURKEY USING ENGLE GRANGER TWO-STEP METHOD

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MA in Economics

Supervisor: Prof. Dr. Sübidey Togan
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This study aims at estimating the velocity function for Turkey using quarterly data. Estimation is done using cointegration and error correction methods. This enabled incorporating short-term disequilibria moments in long run equilibrium.

The analysis starts with examination of level of integration of series in question. Then a number of cointegrating regressions are run. Cointegrated series are employed in different "lag-rich" error correction formulations. Finally using a general to specific approach, parsimonious models are reached dropping insignificant regressors.

Key words : Cointegration, level of integration, stationarity, error correction model, reparameterisation, adaptive expectations, auto-regressive distributed lag model, vector auto-regression.

ÖZET

HIZ FONKSİYONUN TÜRKİYE İÇİN ENGLE-GRANGER İKİ-BASAMAKLI METODUYLA TAHMİNİ

Murat Ali Yülek

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Bu çalışmada Türkiye için 3 aylık veriler kullanılarak hız fonksiyonunun tahmin edilmesi amaçlanmaktadır. Tahminde, eş-bütünleşme (cointegration) ve hata-düzeltme (error correction) yöntemleri kullanılmıştır. Bu yöntemlerin ana özelliği uzun dönem denge yapısını saklı tutarken, kısa dönem sapmalarını açıklayabilmeleridir.

Analize, kullanılan veri dizilerinin bütünleşme derecelerinin (level of integration) test edilmesiyle başlanmaktadır. Bundan sonra eş-bütünleşme regresyonları (cointegrating-regressions) yapılmakta ve eş-bütün seriler değişik hata-düzeltme modellerinde denenmektedir. Başlangıçta, zengin bir gecikmeli-değişken yapısına sahip alan modeller genelden-basite yaklaşımıyla önemsiz değişkenler atılarak basitleştirilmektedir.

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I. INTRODUCTION

This study is devoted to the estimation of velocity function under broad and narrow definitions of money (M1, M2) for Turkey, using Error Correction Methods.

The study first covers theoretical background of velocity functions and Error Correction Methods that are employed. Then results of empirical estimations are reported. In the study, a Cagan type money demand function that constitutes the basis for the velocity function which is estimated, is used. This, with certain modifications, led to a velocity function which had Income and Expected Loss (which in this study is the name used for minus of real interest rate) as the arguments. Expectations are assumed to form adaptively.

Estimation is made using Engle-Granger two-step method. In this approach, first a cointegrating regression is run. Then, assuming non-cointegration is rejected, residuals from this regression is used as error correction term in an appropriate error-correction model.

The organisation of the study is as follows: In the first section, theoretical background - namely derivation of velocity function, expectation formation and error correction methods- is briefed. Second section presents the empirical findings and results of diagnostic tests. Conclusions and recommendations for further study closes the thesis.

II. THEORETICAL BACKGROUND

1. Money Demand and Velocity Functions

The question of demand for money had been an ever-fresh topic for many researchers and theorists. To answer the question: why do people hold money balances? or put in a different way,what are the determinants of demand for money?, extensive empirical study has been done. However the subject is still a domain of substantial discussion.

Very briefly three main questions that still are under severe discussion are (*):

1) constraint that is imposed on money balances:
   - whether the appropriate constraint is wealth, income or a combination of the two.

2) importance of interest rates and price changes as arguments in the demand function.

3) definition of money to be used.

In this study, we don't want to get deeply involved in the discussions between different schools and instead follow a practical way to reach the velocity function which will be estimated.

(*) Meltzer (1963)

In a standard Cagan type money demand function which has is extensively used in empirical studies and whose theoretical consistency has been proved, main arguments are real income (y) and expected inflation (π) :

$$\frac{M^D}{P} = k\, y^{b}\, e^{-c} \quad \text{or} \quad \mathrm{Ln}\left(\frac{M^D}{P}\right) = a + b\ln y - c \;\ldots\; (1)$$

where $k = e^{a}$

The presence of expected inflation term in such a function is validated by the idea that, alternative cost of holding money in periods of rapid inflation, is simply expected price increases. We proceed however by modifying the above function by:

$$\frac{M^D}{P} = k\, y^{b}\, e^{-cEL} \quad \text{or} \quad \mathrm{Ln}\left(\frac{M^D}{P}\right) = a + b\ln y - cEL \;\ldots\; (2)$$

Here EL is used for "Expected loss" by which we mean:

$$EL = \pi - r \;\ldots\ldots\; (3)$$

where r is the nominal rate of return available from holding money (net of tax). r is naturally different for different definitions of money. The calculation to obtain r will be explained in the next section. As seen easily, EL is simply the minus of real interest rate.

From celebrated quantity theory which relates velocity to nominal income through money supply :

$$M^S v = py \;..............(4)$$

$$v = \frac{py}{M^s} \;........\;(5)$$

where :

M^s : money supply

v : velocity

p : price level

y : real income

Now if we keep the assumption of equilibrium in money market and hence replace M^S with M^D, we will obtain.

$$V = \frac{py}{M^D} \;.............\;(6)$$

Plugging in, what we have from our money demand equation, we reach :

$$V = \frac{y}{k\,y^{b}\,e^{-cEL}} = \frac{1}{k}\,y^{(1-b)}\,e^{cEL} \;...........\;(7)$$

Reparameterising this last relation will yield :

$$V = \lambda\, y^{\beta}\, e^{\gamma EL} \;..........\;(8)$$

and

$$\ln V = \mu \;\; \beta \ln y + \gamma\, EL \;.........\;(9)$$

This is the main model to be estimated in our study. However, as cointegration methods will be employed, different versions of (9) will be tried. (In this study V1 denotes velocity when M1 is used as money definition and V2 that for M2 namely, V1=Py/M1 and V2= Py/M2)

2. Derivation of Expected Loss Term

The Expected loss term consists of two components: expected inflation (π) nominal rate of return available from holding money (net of tax).

Expectations of inflation are supposed to form adaptively, adjusting to the difference between the rate of inflation and expected rate of inflation in the previous period.

In Togan (1987) this type of expectation, formation was fund to be preferable to alternative types, for Turkish data. The assumed adoptive expectation scheme can be formulated as follows (*)

$$\pi_t = \pi_{t-1} + \beta(\dot{p}_{t-1} - \pi_{t-1})$$
$$\dot{p}_t = \ln p_t - \ln p_{t-1}$$

where $\dot{p}$ represents rate of inflation
and ln p natural logarithm oh the price level

Working out the mathematics will yield : $\pi_t = \dot{p}_0 (1-\beta)^t + \beta \sum_{i=0}^{t-1} (1-\beta)^i \dot{p}_{t-i-1}$

at an instant t, where P_O denotes the inflation rate at t=0 has the limiting values (0,1). When ß equals 1 the scheme becomes

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(*) Togan (1987) pp 1986.

naive in the sense that expectations at a period equals the actual inflation rate at previous period (*).

Next the real rate of return available from holding money is calculated for M1 and M2 in the following manner :

M1: $r_{M1} = \frac{r_{DD} DD}{M1} (1-T)$

M2: $r_{M2} = \frac{r_{DD} DD + r_{TD} TD}{M2} (1-T)$

where DD: Demand Deposits
TD: Time Deposits
T: Tax rate on Interest Income

(In the above calculations, certificate of Deposits and Deposits at the Central Bank are not considered.)

3. Cointegration and Error Correction Methods

3.1. Integration, Stationary and Nonstationary Series

A recent contribution of Granger and Engle to the Error Correction literature is the celebrated relation between cointegration and error correction representations.

This relation takes its root from the theoretical-yet practically evidenced idea that certain pairs of series should be converging in the long run. Examples to these can be commodity prices in two countries open to trade or prices and wages in a country. The use of cointegration techniques applied to such

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(*) For a discussion on stability considerations of this scheme see Togan (1987), pp.1587 series first necessitates the explanation of basic time series definitions.

A single stationary time series with stochastic components has an infinite moving average representation as states Wald's theorem. This representation can generally be approximated by finite autoregressive moving average process. However, most of the economic time series are not stationary. Following is the celebrated integration definition by Granger :

Definition 1 (Integration): A series with a deterministic component which has a stationary, invertible ARMA representation after differencing d times is said to be integrated of order d, denoted $x_t \sim I(d)$.

For d=0 the series is stationary and for d=1 the change is stationary. A time series like :

$$X_t = \mu_1 X_{t-1} + \theta_2 X_{t-2} + \quad + \theta_n X_{t-n} + u_t \; .....(1)$$

is either stationary or non-stationary. The latter is further subdivided into an explosive process or a unit root process. A familiar example to unit root processes is random walk process, which can be represented as follows:

$$x_t = x_{t-1} + e_t$$

where e_t is white noise.

The main characteristics of I (0) and I (1) processes are as follows : (duplicated from YOSHIDA 1990)

TABLE : 1

Attributes of I(0) series	Attributes of I(1) series
Fluctuate irregularly around and frequently intersect their mean.	Tend to have wider swings. As sample size increase, probability of their returning to the same value approaches zero.
Since the effect of a shock (u_i) in each period weakens over time, I(0) variables do not diverge far from their mean or trends.	At least part of shock in each quarter has long-lasting effects : $x_t = x_{(t-1)} + e_t = x_o + \sum_{i=1}^{t} e_i$
The mean $\bar{x}$ and variance s^2 calculated from observed data are unbiased and consistent estimators of the true mean and variance.	Average $\bar{x}$ and variance s^2, calculated from observed data are often biased. (When $T \to \infty$ random walk has neither particular mean value nor finite variance)
Relatively accurate estimates of coefficients can be estimated by applying an ordinary regression. The estimates are known to follow a t-distribution.	In small samples, a regression including I(1) variables may well yield very erroneus results. Estimates are often biased. (cointegration is an exception and they do not follow a t-distribution.

As is stated in table 1, when a regression involves one or more I (1) series, the statistics like coefficient of determination or t values no longer have simple text book distribution in majority of cases and they lead the econometrician to incorrect inferences. It is only possible for samples of I (0) series to provide unbiased estimates of the population mean and variance. Therefore conventional methods of estimation will lead to incorrect estimates when applied to one or more I (1) series. This fact which has long been known in statistics could gain practical importance only after Dickey-Fuller (1979) who introduced first tests to be used to determine the degree of integration of series.

3.2. Cointegration

Second familiar definition comes below : (Granger 1981)

<u>Definition</u> <u>(Cointegration):</u> The components of the vector x_t are said to be cointegrated of order d, b, denoted $x_t \sim I$ (d,b) if

(i) all components of x_t are I (d)

(ii) there exists a vector α $(\neq 0)$ so that $Z_t = \alpha' X_t \sim I(d-b), b>0$

The vector α is called the co-integrating vector.

Much of the literature concentrate on the case where d=b=1 in which case, components are integrated of order 1 and error is white noise. If such Z_t has zero mean, it will frequently cross zero line and will not drift too far from it.

If x_t has N components such that N>2, α becomes a "cointegrating vector" which need not be unique.

3.3. Error Correction and Cointegration

Error correction mechanisms have been used widely in economics. Early examples are Sargan (1964) and Phillips (1957). Currently, the studies on the subject are gradually shifting towards the utilization of cointegration methods in estimating models in a manner that is theoretically discussed in this section.

Error correction per se says that the disequilibrium in one point in time is gradually corrected. Excess supply of a certain crop this year might for example be the result of the balance last year. Successful application of the method are inter-alia DHSY (1978), Hendry and von Ungern-Sternberg (1980), Currie (1981), Dawson (1981).

These models make use of rich lag structures including lagged dependent variables to capture true dynamic structure of the model. As a more general model they intrinsically include the long-run equilibrium while allowing short-run disequilibria, like classical econometric models. Error correction models use economic theory in assigning the components of the model.However they incorporate a rich lag structure which is not the case for the classical econometric models.

Definition 3 (Error Correction Representation, Granger,1987)

A vector time series representation x_t has an error correction representation if it can be expressed as :

$$A(B)(1-B)X_t = -\mu z_{t-1} + u_t$$

Where U_t = Stationary multivariate disturbance

A (B) is such that A(O)=I, A(1) has all elements finite, and $z_T = \alpha X_T$ $X \neq 0$ by rearrangement, older lags of the error term (z) can be shown to appear as explanatory variables.

Following theorem without proof which appeared in Granger (1983) establishes the required relationship between error correction mechanisms and cointegration :

Theorem 1, Granger Representation Theorem:

Let x_t be such that all (N) components are I(1) so that change in each component is zero mean, purely stochastic stationary process. Then the following will be the multivariate Wald representation of the system :

$(1 - B)\ x_t = C(B)\ \varepsilon_t$ .... (1)

which should be taken to mean that both sides will have the same spectral matrix.

If X_t is cointegrated with d=b=1 with co-integrating rank r, then:

(1) C(1) is of N-r

(2) There exists a vector ARMA representation

$A\ (B)\ X_t = d(B)\varepsilon_t$................(2)

with the properties that A(1) has rank d(B) is a scalar lag polynomial with d(1) finite and $A(0) = I_N$. When d(B) =1, this is a vector autoregression.

(3) There exist Nxr matrices, μ, α' of rank r such that,

$$\alpha' C(1) = 0$$

$$C(1)\mu = 0$$

$$A(1) = \mu\alpha'$$

(4) There exists an error correction representation with $z_t = \alpha' X_t$ an rx1 vector of stationary random variables:

$$A^*(B)(1-B)X_t = -\mu z_{t-1} + d(B)\varepsilon_t \text{ .... } (3)$$

with $A^*(0) = I_N$

(5) The vector z_t is given by:

$$z_t = K(B)\varepsilon_t \text{ ...... } (4)$$

$$(1-B)z_t = -\alpha'\mu z_{t-1} + J(B)\varepsilon_t \text{ .... } (5)$$

where K(B) is an rxN matrix of log polynomials given by $\alpha' C^*(B)$ with all elements of K(1) finite with rank r, and det $\det(\alpha'\mu) > 0$.

(6) If a finite vector autaregressive representation is possible, it will have the form given by (2) and (3) above with d(B)=1 and both A(B) and $A^*(B)$ as matrices of finite polynomials.

3.4. A Digression: Auto-Regressive Distributed Lag Model (AD) and ECM

Let's briefly denote simple univariate AD, Partial Adjustment, Distributed Lag, and Autoregressive models:

A simple AD Model=

$$x_t=\beta_0+\beta_1 x_{t-1}+\beta_2 y_t+\beta_3 y_{t-1}+u_t \quad \ldots(1)$$

Now imposing the restriction $\beta_3=0$ we pass to a simple Partial Adjustment Model=

$$x_t=\beta_0+\beta_1 x_{t-1}+\beta_2 y_t+u_t \quad \ldots(2)$$

Next, imposing $\beta_1 = 0$ to (1), we have a simple distributed lag model=

$$x_t=\beta_0+\beta_2 y_t+\beta_3 y_{t-1}+u_t \quad \ldots(3)$$

Finally, imposing $\beta_2 = \beta_3 = 0$ we have a first order Auto-regressive Model=

$$x_t=\beta_0+\beta_1 x_{t-1}+u_t \quad \ldots(4)$$

As seen, AD model can be considered as a general model which has - as special cases-other 3 models.*

Following simple but effective lines in Yoshida (1990), ECM is established from an AD model via " reparameterisation" as follows=

let: $\beta_1 = 1+a$, $\beta_2 = b$, $\beta_3 = -(b+ka)$

so that (1) takes the form

$$x_t=\beta_0+(1+a)x_{t-1}+by_t+(ak+b)y_{t-1}+u_t$$

and subtract x_{t-1} from both sides to have after rearrangement.

$$\Delta x_t=\beta_0+\beta\Delta y_t+a(x_{t-1}-ky_{t-1})+u_t \quad \ldots(6)$$

The term $x_{t-1} - ky_t$ is the error correcting term. It is said that in the log-run, $x_{t-1} - ky_{t-1} = 0$ so that the equilibrium is restored, However a certain proportion of error EC_t, which is=

$$EC_t = x_t - ky_t$$

is corrected at time instant t+1, at times of disequilibrium. By doing this, EC Model becomes a dynamic model allowing for disequilibrium, at times and equilibrium at others. The ECM representation (6) is a linear transformation of AD Model, therefore it shares the characteristics of AD Models.

3.5. Engel-Granger two-step Method

In a regression like=

$$x_t=\beta_0+\beta_1 y_t+u_t \ldots\ldots(7)$$

if one or more I(1) variables are used, the regression is considered as spurious. However, Stock (1987) prooved that if x_t and y_t are cointegrated, estimates of coefficients in (7) is far more precise than an ordinary LS estimation. The reason is that in an ordinary LS estimation between I(0) variables, convergence of coefficients to their true values is realized only at larger samples. However when two or more cointegrated I(1) series are regressed, convergence is maintained even at small sample sizes. This phonemenon is called " super-consistency", For proof one can refer to Stock (1987).

Two step method of Engel and Granger utilizes super-consistency to achieve consistent estimates. The method proceeds as follows:

1) Using the " cointegrating regression",

$$x_t=\beta_0+\beta_1 y_t+u_t$$

an estimate $\hat{\beta}_1$ is found. Then Error Correction Term (EC) is calculated:

$$EC_t = x_t - \beta_1 y_t - \beta_0$$

2) The ECM is estimated in an equation like:

$$\Delta x_t = \lambda_0 + \lambda_1 \Delta y_t + \lambda_2 EC_{t-1} + u_t$$

As can be seen by careful eyes, EC is simply the residuals from cointegrating regression.

3.6. Empirical Estimation Procedure

The estimation procedure that is employed in this study consists of three stages:

1) Testing the level of integration of series
2) Testing for cointegration
3) Construction, estimation and Testing the EC models.

Testing for level of integration:

To test level of integration ADF and DF tests were used:

The two tests proceed as follows:

DF Test:

In original DW test following regression is run:

$$x_t = -\alpha x_{t-1} + u_t$$

where t is trend.

Then $\hat{\alpha}-1 / se(\hat{\alpha})$ is compared with provided critical values, with Ho: random walk. However a simpler version without any difference in the characteristics of the test is running the following:

$$\Delta x_t = -\beta x_{t-1} + u_t$$

and comparing $\hat{\beta}$ directly with the critical values.

Null hypothesis is taken as non-stationarity of the series, if t value for β exceeds critical value in the table, Ho is rejected, thus supporting a trend-stationary process.

ADF Test:

Following ADF regression is run:

$$\Delta x_t = -\alpha x_{t-1} + \sum_{i=1}^{4} \beta_i \Delta X_{t-1} + u_t$$

The estimate $\hat{\alpha}$ is than compared with the critical values provided in the previous section.

Testing For Cointegration:

In line with Granger (1987) following tests can be used to test cointegration between series:

CRDW Test:

DW statistic of cointegrating regression (Cointegrating Regression DW-henceforth CRDW) is compared to the CRDW critical values, which are provided at the end of the section :

$$y_t = \sum_{i=1}^{N} \alpha_i x_{i,t} + C + u_t$$

Where N is the number of total cointegrated variables minus 1

and x_i are cointegrated variables to y_t.

The null hypothesis is taken as follows:

H_o : non-cointegration

If the CRDW exceeds critical value, Ho is rejected, in favour of cointegration:

DF Test:

The residuals U_t from cointegrating regression are regressed as:

$$\Delta u_t = -\Omega u_{t-1} + \varepsilon_t$$

The minus of estimate $\hat{\Omega}$ is compared to critical values which are provided at the end of the section.

ADF Test:

The residuals U_t are regressed as:

$$\Delta u_t = -\alpha u_{t-1} + \sum_{i=1}^{4} \beta_i \Delta u_{t-1} + \varepsilon_t$$

The minus of estimate $\hat{\alpha}$ is than compared to the critical values with Ho:non-cointegration. If ADF statistic exceeds critical value, Ho is rejected in favour of co-integration.

TABLE : 2

Critical Values for ADF, DF and CRDW Tests

2 variable Case

	1 %	5 %	10 %
CRDW	0,511	0,386	0,322
DF	4,07	3,37	3,03
ADF	3,77	3,17	2,84

3 Variable Case

	1 %	5 %	10 %
CRDW	0,488	0,367	0,308
ADF	3,89	3,13	2,82

The first table is duplicated from Granger and Engel (1987) whereas the second from Hall (1986) who obtained it upon request, from also professor Granger.

All three tests are built on Monte-Carlo studies.

There are discussions on whether to include a trend and coustant in the regression. In our study we contend with ADF and DF tests without a trend and constant.

3.7. Construction and Estimation of EC Models

As the cointegration regression in the following form is run:

$$y_t = c + \alpha_1 x_{1,t} + \alpha_2 x_{2,t} + \ldots + u_t$$

detecting cointegration, an EC model can be constructed tentatively in the following manner:

$$\Delta y_t = c + \sum_{i=0}^{N} \beta_i \Delta x_{1,t-i} + \sum_{i=0}^{N} \Omega_i x_{2,t-i} + \ldots + \sum_{i=1}^{N} \psi_i EC_{t-i} + u_t$$

where EC represents residuals from cointegrating-regression.

n should be determined tentatively but for the case of quarterly data, n= 4~ 6 is said to be sufficient unless important explanatory variables are omitted.

The insignificant regressors are then dropped with a general-to-simple approach. Gradual reduction of number of explanatory variables also involves checking of residual autocorrelation and other testing criteria which will be considered in the next section.

3.8. Validity Tests

There are a number of tests used to check the validity of models in this study. The resulting test values are reported together with the critical values. The theoretical aspects of there tests are explained briefly in this section. All of the tests to be mentioned below are provided by PC-GIVE including the critical valves.

1. Goodness of Fit= R^2

2. DW

The DW test which is most useful when testing white noise against random walk residuals is biased towards 2, when lagged dependent variables are used as explanatory variables; hence towards not detecting autocorrelation. In the case where lagged dependent variables are used as regressors, Durbin's h test or LM test are recommended.

3. LM Test:

The Lagrange-Multiplier Test for r^{th} order auto-correlation is distributed as λ^2 (r) in large sample. Ho is taken as no autocorrelation. In PC Give F-Form (Harvey (1981)) is used as test statistic. Nevertheless, in our study DW statistic is reported.

4. Normality $\lambda^2(2)$ Test: (Jargue and Bereu, 1980)

This test is employed against normality of residuals in line with J., and B.(1980). The statistic follows a λ^2 distribution with two degrees of freedom under the null hypothesis of normal residual distribution. If statistic exceeds the critical value (which is 5,99 at α =0,05) normality is rejected.

5. Heteroscedasticity :

$\lambda^2(F)$ is a test statistic for residual heteroscedasticity developed by White (1980).It follows an F distribution of(2k-2,T-3k+1) degrees of freedom under the null of homoscedasticity, where T is the number of observations and k is the number of explanatory variables excluding constant term. If F-statistic exceeds the critical value, homoscedasticity is rejected.

6. CHOW Test:

Familiar Chow Test (Chow, 1960) has been developed to test parameter constancy. It aims at detecting structural change or significant changes of coefficients between residual variance of the sample period and that of forecast period. The test statistic CH follows an F distribution with (n, T-k) under the null of no structural change (T = number of observations, k = number of eplonatory variables, n= length of out-of-sample period).

III. EMPIRICAL STUDY ON ESTIMATION OF VELOCITY FUNCTIONS

1. Determination of Level of Significance

To determine the level of integration of the series in question which is the first step in the estimation of velocity function using Engle Granger Two-step Method, ADF and DF regressions without a constant and trend were run. Next, to reinforce our inferences, ADF and DF regressions were run for the differenced series. Results are tabulated below.

TABLE : 3

DF and ADF Statistics for the Series

Series	DF	ADF
ln y	-0.30	-2,76
ln v1	-0,11	-0,01
ln v2	1,70	1,81
Δln y	6,07	23,40
Δln v1	5,58	5,91
Δln v2	5,65	3,79
EL(M1, ß=0.3)	1,76	1,76
ΔEL(M1, ß=0.3)	7,29	7,87
EL(M1, ß=0.5)	2,04	2,34
ΔEL(M1, ß=0.5)	6,29	4,72
EL(M1, ß=1.0)	2,66	2,83
ΔEL(M1, ß=1.0)	4,88	4,88
EL(M2, ß=0.3)	-0,72	-0,06
ΔEL(M2, ß=0.3)	3,91	3,20
EL(M2, ß=0.5)	-0,36	0,17
ΔEL(M2, ß=0.5)	4,10	3,68
EL(M2, ß=1.0)	0,38	0,48
ΔEL(M2, ß=1.0)	5,93	6,39

Here:

V1 = Py / M1 .... Velocity when M1 is used as monetary base
V2 = Py / M2 .... Velocity when M2 is used as motetary base
EL(Mi, ß=1) ....Expected loss when Mi (i=1,2) is used and coefficient of adaptation is 1.

From table (3) it is clearly seen that series lny, lnv1 and lnv2 are all I(1) as the levels are non-stationary and first differenced series are stationary. For these series, plottings of series also support non stationarity.

The expected loss series also present evidence for non-stationarity. However the plottings of series for M1 are dubious. This can be the result of lack of power of tests as approaches 1. We nevertheless consider both cases (stationarity and non-stationarity) when doing our empirical analysis in the next section.

2. Testing for Cointegration

The two main cointegrating regressions that were in question were that involving lnv1 and lny and that involving lnv2 and lny. However, as the possibility of non-stationarity of expected loss series also existed, the following cointegrating regression were run :

I - Narrow Money :

I - 1 $\ln V1_t = a + \beta \ln y_t$

I - 2 $\ln V1_t = a + \beta \ln y_t + \gamma EL_{M1,\beta=0.3}$

I - 3 $\ln V1_t = a + \beta \ln y_t + \gamma EL_{M1,\beta=0.5}$

I - 4 $\ln V1_t = a + \beta \ln y_t + \gamma EL_{M1,\beta=1.0}$

II - Broad Money :

II - 1 $\ln V2_t = a + \beta \ln y_t$

II - 2 $\ln V2_t = a + \beta \ln y_t + \gamma EL_{M2,\beta=0.3}$

II - 3 $\ln V1_t = a + \beta \ln y_t + \gamma EL_{M1,\beta=0.5}$

II - 4 $\ln V1_t = a + \beta \ln y_t + \gamma EL_{M1,\beta=1.0}$

The coefficients, CRDW, ADF and DF statistics are reported in Table (4).

All of the regressions pass CRDW test, however II-2 and II-3 fail in both DF and ADF tests, therefore they are considered as non-cointegrated. In I-3 and I-4 coefficients of expected loss series, and in II-1 all of the coefficients are insignificant.

The relations which have no problem in providing healthy test statistics and significant coefficients are I-1, I-2 and II-4. In I-2 and II-4 DF statistic fails however both CRDW and ADF tests provide supporting evidence in favor of cointegration and consequently the null of non-cointegration was considered as rejected.

TABLE 4
Cointegrating Regressions

EQN	CONS	ln y	EL(Mi,f=.3)	EL(Mi,f=.5)	EL(Mi,[illegible]=1.0)	CRDW	DF	ADF
I-1	-3.39	1.05				0.44	3.13	4.90
	(-7.32)	(9.39)						
I-2	-3.77	1.13	0.58			0.55	2.76	3.42
	(-7.30)	(9.30)	(2.08)					
I-3	-3.69	1.11		0.42		0.51	2.68	3.58
	(-7.10)	(8.80)		(1.54)				
I-4	-3.65	1.1			0.34	0.45	2.55	3.71
	(-7.00)	(8.80)			(1.36)			
II-1	0.25	0.011				0.72	2.86	3.60
	(0.36)	(0.07)						
II-2	-2.19	0.65	1.58			0.54	1.88	2.12
	(-4.47)	(5.30)	(8.69)					
II-3	-1.97	0.59		1.50		0.53	2.25	2.19
	(-4.27)	(5.06)		(8.83)				
II-4	-1.65	0.51			1.31	0.60	2.34	3.47
	(-3.3)	(4.10)			(7.50)			

Figures in paranthesis are t-values

3. EC Formulation Of the Model

In this study, three approaches to tackle the problem of Error Correction Formulation have been adopted. The description of these three approaches and the estimated models are reported below:

1) Ordinary General-to-Specific Approach :

In this approach, for each of the successful cointegration relations developed in the previous section, a simple, lag-rich model was adopted. The change of dependent variable was regressed on four lags of each cointegrated variable and dependent variable and also of Error Correction term which is simply the residuals from cointegrating regression. The results are presented in table (5).

TABLE : 5

Estimation Results for the First Approach

EQN

1 $$\Delta \ln v1_t = 0.002 + 0.86\,\Delta \ln y_t + 0.34\,\Delta \ln y_{t-3} - 0.24\,EC_{t-4}$$
$$(0.27)\quad(16.6)\quad(6.17)\quad(-3.44)$$

2 $$\Delta \ln v1_t = -0.012 + 0.22\,\Delta \ln v1_{t-1} + 0.32\,\Delta \ln v1_{t-2} + 0.50\,\Delta \ln y_{t-3} + 1.06\,\Delta \ln y_{t-4} - 0.90\,\Delta EL_{t-4} - 0.15\,EC_{t-2}$$
$$(-1.18)\quad(2.22)\quad(2.71)\quad(4.04)\quad(10.96)\quad(-2.85)\quad(-1.77)$$

3 $$\Delta \ln v2_t = -0.12 + 0.16\,\Delta \ln v2_{t-2} + 0.69\,\Delta \ln y_t - 0.25\,\Delta \ln y_{t-1} - 0.32\,\Delta \ln y_{t-2} - 0.24\,\Delta EL_{t-2} - 0.24\,\Delta EL_{t-4} - 0.42\,EC_{t-2}$$
$$(-2.45)\quad(1.78)\quad(11.05)\quad(-5.93)\quad(2.83)\quad(-1.77)\quad(-2.46)\quad(-8.24)$$

EQN	σ	R^2	DW	LM	$\lambda^2(2)$	$\lambda^2(F)$	CHOW
1	0.048	0.90	2.19	0.13/2.73*	0.50	0.38/2.53*	0.65/2.31*
2	0.045	0.93	1.72	0.76/2.78*	0.47	0.71/2.53*	1.35/2.41*
3	0.027	0.97	2.22	1.69/2.80*	0.62	0.47/2.74*	1.27/2.46*

(*)CRITICAL VALUES.(CRITICAL VALUE FOR $\lambda^2(2)$ TEST 5.99)

These parsimonious models were reached using a general-to-specific approach, by dropping insignificant variables. When multicollinearity problem was encountered, problem causing variable(s) was dropped paying attention not to cause misspecification errors. All of the three models were found satisfactory. Each of the models has one significant lag of Error Correction Term.

A second check was made concerning this approach by estimating a free (unrestricted) dynamic model by relaxing the coefficient restrictions imposed by prior cointegrating regressions I-1, I-2, and II-4. In these models, the change of dependent variable was regressed originally on :

1) Four lags of change of dependent variable
2) Four lags of changes of each variable present in cointegrating regression and
3) First lags of levels of each variable (including dependent) present in cointegrating regressions.

In table (6) the results of these estimations and, error correction term obtained by normalizing for a unit coefficient on velocity term, are reported.

TABLE : 6

Unrestricted Dynamic Model for the First Approach

EQN. NO

1 $\Delta \ln v1_t = -0.88 + 0.35\, \Delta \ln v1_{t-1} + 0.21\, \Delta \ln v1_{t-3} + 0.86\, \Delta \ln y_t - 0.43\, \Delta \ln y_{t-1}$
(-2.30) (2.52) (1.95) (8.69) (-2.57)
$-0.22 \ln v1_{t-1} + 0.27 \ln y_{t-1}$
(-2.48) (2.45)

2 $\Delta \ln v1_t = -0.52 + 0.25\, \Delta \ln v1_{t-3} + 0.36\, \Delta \ln v1_{t-4} + 0.70\, \Delta \ln y_t + 059\, EL_{t-1} + 0.59 EL_{t-2}$
(-0.97) (3.15) (2.69) (5.00) (2.34) (1.99)
$-0.66 EL_{t-4} - 0.18 \ln v1_t - 0.32 EL_{t-1} 0.27 \ln y_{t-1}$
(-1.90) (-1.75) (-1.44) (1.16)

3 $\Delta \ln v2_t = -0.71 + 0.49 \Delta \ln v2_{t-1} + 0.27\, \Delta \ln v2_{t-2} + 0.38 \Delta \ln v2_{t-3} + 0.48 \Delta \ln y_t + 0.54\, \Delta \ln y_{t-4}$
(-2.46) (4.17) (2.51) (4.70) (3.25) (3.79)
$-0.85\, \Delta EL_{t-1} - 0.87\, \Delta EL_{t-2} - 0.39\, \Delta EL_{t-3} - 0.39 \Delta EL_{t-4} + 1.02\, EL_{t-1} + 0.25 \ln y_{t-1} - 0.74 \ln v2_{t-1}$
(-3.33) (-3.20) (-1.90) (-2.73) (4.46) (3.08) (-5.07

REG. NO	IMPLIED EC TERM
1	$\ln v1 = 3.95 + 1.18 \ln y$
2	$\ln v1 = -2.94 - 1.78\, EL + 0.94 \ln y$
3	$\ln v2 = -0.96 + 1.38\, EL + 0.33 \ln y$

Comparing the implied error correction terms obtained from free-unresticted model with those in section IV-2, we see that first and third regressions are very close to I-1 and II-4, we also see that the lagged levels in free regressions in these two models are all significant. In the second free regression, coefficient of EL term is much different than second cointegrating regression although signs of regressors are in accordance in both of the regressions.

Finally to close this section, we can conclude that at least for I-1 and II-4 the cointegrating regressions are validated by the unrestricted models.

2) In the second approach the simple cointegration regression I-1 which relates Lnv1 to Lny is converted to an EC formulation in which change in Lnv1 is regressed on four lags of change in Lny, error correction term and lagged dependent variable and to this, is added-as a new regressor- expected loss term:

$$\Delta \ln V1_t = \sum_{i=1}^{4} \mu_i \Delta \ln V_{t-i} + \sum_{i=1}^{4} \mu_i \Delta \ln y_{t-i} + \sum_{i=1}^{4} EC_{t-i} + EL$$

This regression is run for each of the three EC series. The approach is again general to specific so that insignificant regressors are dropped to reach a final simpler model.

This has been tried only for narrow velocity (v1) as it was seen that for broad money velocity and real income not cointegrated.

Hall in his 1986 article utilized this approach to place expected inflation term in the final model without any lags and reported a coefficient of 1.04 (t: 6,0) for this particular term.

When the same approach was used, the results are obtained as follows:

TABLE : 7.

Estimation Results for the Second Approach

EQN. NO

1

$$\Delta \ln v1_t = \underset{(0.95)}{0.0099} + \underset{(1.79)}{0.23} \Delta \ln v1_{t-4} + \underset{(5.50)}{0.23} \Delta \ln y_t + \underset{(3.97)}{0.27} \Delta \ln y_{t-3} \underset{(-3.75)}{-0.26} EC_{t-4} \underset{(-1.24)}{-0.20} EL$$

2

$$\Delta \ln v1_t = \underset{(0.84)}{0.08} + \underset{(1.72)}{0.21} \Delta \ln v1_{t-4} + \underset{(6.04)}{0.69} \Delta \ln y_t + \underset{(4.33)}{0.27} \Delta \ln y_{t-3} \underset{(-3.77)}{-0.27} EC_{t-4} \underset{(-1.22)}{-0.18} EL$$

3

$$\Delta \ln v1_t = \underset{(-2.25)}{-0.002} + \underset{(4.67)}{0.23} \Delta \ln y_{t-3} + \underset{(13.51)}{0.75} \Delta \ln y_{t-4} \underset{(-2.66)}{-0.19} EC_{t-3} \underset{(-1.69)}{-0.19} EL$$

The diagnastic test results for each of the models are tabulated bellow:

TABLE : 8

Diagnostic Test Results for the Second Approach

EQN	σ	R^2	DW	LM	$\lambda^2(2)$	$\lambda^2(F)$	CHOW
1	0.047	0.92	1.86	0.87/2.76*	0.58	0.55/2.45*	0.47/2.37*
2	0.047	0.92	1.82	0.86/2.76*	0.60	0.59/2.45*	0.46/2.37*
3	0.047	0.91	2.05	0.15/2.74*	1.06	0.47/2.45*	0.68/2.34*

(*)CRITICAL VALUES.(CRITICAL VALUE FOR $\lambda^2(2)$ TEST 5.99)

Such regressions can only provide unbiased estimates if all the series are I (0), added to the standard assumptions (this was discussed before). It should therefore be reminded that these three models were developed assuming that ADF and DF tests for stationarity of EL series provided biased estimates and that EL series are I (0). However as seen from the tables, in non of the models have EL series, significant coefficients.

3) Lastly, we wished to try a yet approach that was used in section 6 of Engle-Granger (1987). In this approach, first a Vector Auto-Regression (VAR) of change in dependent variable over changes in dependent and independent variables present in each cointegrating regression, is realized. The significant regressors are then employed in an error correction

formulation together with a constant and first lag of level of Error Correction term.

Results are tabulated in Table (9).

TABLE : 9

VAR Estimates

$$\Delta \ln v1_t = \underset{(-1.34)}{-0.67} + \underset{(1.76)}{0.28}\,\Delta \ln v1_{t-1} + \underset{(1.28)}{0.20}\,\Delta \ln v1_{t-2} + \underset{(0.77)}{0.11}\,\Delta \ln v1_{t-3}$$

$$- \underset{(-0.041)}{0.008}\,\Delta \ln v1_{t-4} - \underset{(-2.23)}{0.46}\,\Delta \ln y_{t-1} - \underset{(-1.10)}{0.26}\,\Delta \ln y_{t-2} + \underset{(2.95)}{0.72}\,\Delta \ln y_{t-4}$$

$$- \underset{(-1.78)}{0.21}\,\ln v1_{t-1} + \underset{(1.48)}{0.22}\,\ln y_{t-1}$$

$$R^2=0.92 \quad \sigma=0.051 \quad DW=1.99$$

$$\Delta \ln v1_t = \underset{(-0.84)}{-0.51} + \underset{(1.00)}{0.18}\,\Delta \ln v1_{t-1} + \underset{(0.68)}{0.12}\,\Delta \ln v1_{t-2} + \underset{(0.48)}{0.075}\,\Delta \ln v1_{t-3} + \underset{(0.66)}{0.13}\,\Delta \ln v1_{t-4}$$

$$- \underset{(-1.23)}{0.51}\,\Delta \ln y_{t-1} - \underset{(-1.02)}{0.38}\,\Delta \ln y_{t-2} \underset{(-0.30)}{0.13}\,\Delta \ln y_{t-3} + \underset{(1.33)}{0.49}\,\Delta \ln y_{t-4} + \underset{(1.00)}{0.33}\,\Delta EL_{t-1}$$

$$+ \underset{(1.59)}{0.54}\,\Delta EL_{t-2} + \underset{(1.04)}{0.39}\,\Delta EL_{t-3} - \underset{(-1.99)}{0.84}\,\Delta EL_{t-4} - \underset{(-1.24)}{0.15}\,\ln v1_{t-1} + \underset{(0.98)}{0.16}\,\ln y_{t-1} - \underset{(-0.57)}{0.16}\,EL_{t-1}$$

$$R^2=0.95 \quad \sigma=0.046 \quad DW=1.60$$

$$\Delta \ln v2_t = \underset{(-2.52)}{-1.05} + \underset{(2.96)}{0.46}\,\Delta \ln v2_{t-1} + \underset{(1.69)}{0.33}\,\Delta \ln v2_{t-2} + \underset{(0.98)}{0.21}\,\Delta \ln v2_{t-3} - \underset{(-1.07)}{0.22}\,\Delta \ln v2_{t-4} - \underset{(-1.50)}{0.46}\,\Delta \ln y_{t-1}$$

$$- \underset{(-1.73)}{0.53}\,\Delta \ln y_{t-2} - \underset{(-0.88)}{0.31}\,\Delta \ln y_{t-3} + \underset{(2.12)}{0.74}\,\Delta \ln y_{t-4} - \underset{(-3.15)}{1.09}\,\Delta EL_{t-1} - \underset{(-2.63)}{0.98}\,\Delta EL_{t-2}$$

$$- \underset{(-1.02)}{0.29}\,\Delta EL_{t-3} - \underset{(-1.31)}{0.25}\,\Delta EL_{t-4} - \underset{(-4.02)}{0.76}\,\ln v1_{t-1} + \underset{(2.92)}{0.33}\,\ln y_{t-1} + \underset{(3.99)}{1.13}\,EL_{t-1}$$

$$R^2=0.98 \quad \sigma=0.030 \quad DW=1.63$$

In the first model $\ln Y_{t-3}$ term was dropped because of multicollineárity problems. The original model which included this term, didn't have any significant regressors but had a goodness of fit measure of 0,92. By dropping $\ln Y_{t-3}$ four variables become significant.

Estimations of EC models using the significant regressors of VAR models (except lagged levels) and results of diagnostic tests are presented in tables (10) and (11).

The second model yields highly insatisfactory results ($\sigma=0.14, R^2=0.16$) and it fails in error autocorrelation test. Others however pass all the tests. In the first model, error correction term is insignificant. The signs are in accordance with theory.

TABLE : 10

Estimation Results for the Third Approach

EQN. NO

1 $$\Delta \ln v1_t = \underset{(1.09)}{0.0095} + \underset{(2.76)}{0.38}\,\Delta \ln v1_{t-1} - \underset{(-4.31)}{0.56}\,\Delta \ln y_{t-1} + \underset{(10.30)}{0.71}\,\Delta \ln y_{t-4} - \underset{(-1.59)}{0.13}\,EC_{t-1}$$

2 $$\Delta \ln v1_t = \underset{(-0.13)}{-0.0034} - \underset{(-0.29)}{0.28}\,\Delta EL_{t-4} + \underset{(2.25)}{0.62}\,EC_{t-1}$$

3 $$\Delta \ln v2_t = \underset{(-3.12))}{-0.023} + \underset{(1.86)}{0.12}\,\Delta \ln v2_{t-1} + \underset{(16.82)}{0.87}\,\Delta \ln y_{t-4} - \underset{(-2.82)}{0.51}\,\Delta EL_{t-1} - \underset{(-1.99)}{0.32}\,\Delta EL_{t-2} - \underset{(-4.76)}{0.43}\,EC_{t-1}$$

TABLE : 11

Diagnostic Test Results for the Third Approach

EQN	σ	R^2	DW	LM	$\lambda^2(2)$	$\lambda^2(F)$	CHOW
1	0.049	0.90	2.23	0.41/2.74*	0.73	0.48/2.45*	0.83/2.34*
2	0.14	0.16	1.68	14.49/2.71*	1.86	1.56/2.74*	0.83/2.28*
3	0.042	0.94	1.32	1.25/2.76*	0.51	0.83/2.45*	1.31/2.37*

(*)CRITICAL VALUES.(CRITICAL VALUE FOR $\lambda^2(2)$ TEST 5.99)

4. Evaluation of Approaches

Velocity for narrow money seems cointegrated with real income (all in log-linear form). All the test statistics are at the safe side and all the regressors (constant and real income) are significant. When expected loss with M1, ß= 0.3 is also considered, velocity seems also cointegrated with this term added to real income. DF statistic is in favor of non-cointegration this time. As there exists the possibility that expected loss series may not be non-stationary, DF statistic may reveal the truth and these latter variables may really not be cointegrated. The last cointegrating relation that is defected is the one relating velocity for M2 to real income and expected loss series for M2, ß= 1,0. For all the other relations, both DF and ADF are suggesting non-cointegration.

The unrestricted EC regressions were used to check contegrating-relations. For the first and third relations, the coefficients obtained in unrestricted regression, when normalized for unit coefficient at velocity terms, provided very close estimates to cointegrating regressions. This is in accordance with the theory of cointegration.

When, level of EL variables for different ßs, are used as one of the regressors in EC model, built on the first cointegrating-relation (v1 ~ y), it was seen that this term was always insignificant. Highest t value that was obtained was for ß=1,0 (t= 1,69). This was done to see what would happen if EL series for M1, were really stationary. In such a case, in a regression including changes of other variables and level of EL, all regressors would be I (0) and coefficients would be unbiased.

When VAR is first employed, it was seen that for the first regression, $\hat{\sigma}$ was lower in AD model than that in VAR model (0,049 vs 0,051). However error correction term in this regression is insignificant (t= 1,59). For the second regression there were substantial problems, LM test indicated autocorrelation, $\hat{\sigma}$ was too high (0,14) and R^2 too low (0,16). In the third regression, though $\hat{\sigma}$ is slightly higher than VAR model, we had all the regressors significant and all the diagnostic tests passed.

IV. CONCLUSIONS AND SUGGESTIONS FOR FURTHER STUDY

In this study we aimed at estimating the velocity function for Turkey. We employed a recent procedure which still needs to be developed, especially when critical values are concerned. We have obtained however satisfactory inferences albeit certain dubious point, that took place.

It was found that, cointegrations of velocity for M1 with real income and of velocity for M2 with real income and EL for M2, β =1.0 were strongly evidenced by test statistics and auxilliary unrestricted regressions. The error correction models built on contegrating regressions had significant EC terms.

EC models built on VAR models provided similar test statistics (except second model). The significant regressors however one of different lags.

The Error Correction models that are built on first and third approaches therefore can be considered as satisfactory.

In future studies using the same scheme, EL term may be divided into its two components π and r (cancelling the restriction that the coefficients of the two are the same) and cointegration between these variables could be sought. As the interest rates are "nearly free" for a very short time, it can be difficult to use a "step" interest rate series Therefore r series can altogether be omitted in studies, till we can obtain a consideraby-long free interest series.

Next suggestion is to consider interest rates to foreign currency deposits, exchange rates, stock market coefficient of variation (or any other appropriate measure) gold priceseries etc. to be present in velocity function. There are thought to affect money demand and hence velocity in a country of high inflation.

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VI. DATA SOURCES

Quarterly Income: Calculated by Ercan UYGUR, Fatih ÖZATAY of CB of Turkey

Interest rates : From "Interest Rates in Turkey",Unpublished Expert Thesis by Zeynep ADA; SPO

M1, M2,Demand and Time Deposits: From CB of Turkey

Prices: From State Statistical Institute of Turkey

Data Matrix

		Re-Y	P68	M1	M2	EL(M1,0.3)
				266.540	317.000	.000
1979	1	45.830	9.065	288.780	344.000	.070
1979	2	55.440	10.893	323.730	387.000	.081
1979	3	61.550	12.273	360.610	439.000	.107
1979	4	45.530	14.197	416.850	498.000	.106
1980	1	44.800	19.830	446.350	536.000	.113
1980	2	51.780	23.493	490.55[illegible]	588.000	.174
1980	3	61.360	24.720	574.300	690.000	.158
1980	4	48.160	28.189	654.880	803.000	.119
1981	1	46.590	30.806	660.540	877.000	.116
[illegible]	2	54.200	31.733	[illegible]	1009.000	.100
1981	3	[illegible]	33.917	811.370	1208.000	.072
1981	4	49.960	35.934	824.590	1337.000	.063
1982	1	47.830	38.825	879.410	1589.000	.054
1982	2	55.660	41.194	915.200	1749.000	.054
1982	3	65.800	43.286	1037.080	1979.000	.050
1982	4	55.130	44.616	1173.900	2245.000	.042
1983	1	50.150	50.292	1261.080	2442.000	-.051
1983	2	57.710	52.744	1325.300	2548.000	-.033
1983	3	67.470	55.252	1439.630	2735.000	-.039
1983	4	56.520	60.413	1601.420	2948.000	-.043
1984	1	53.530	67.617	1526.990	3306.000	.041
1984	2	59.950	80.345	1599.300	3723.000	.055
1984	3	71.710	86.470	1748.770	4130.000	.084
1984	4	60.430	94.423	1908.580	4626.000	.073
1985	1	53.760	106.392	1998.180	5254.000	.069
1985	2	63.970	115.533	2140.930	5947.000	.077
1985	3	76.620	118.371	2505.920	6807.000	.072
1985	4	63.800	130.673	2653.040	7382.000	.050
1986	1	58.750	142.270	2747.190	8025.000	.056
1986	2	69.560	149.259	3083.970	8794.000	.038
1986	3	83.360	154.133	3563.670	9474.000	.023
1986	4	67.310	164.614	3929.720	10340.000	.008
1987	1	62.680	177.104	4390.910	11196.000	.007
1987	2	73.630	193.466	4796.360	11924.000	.012
1987	3	87.840	205.557	5666.190	13218.000	.020
1987	4	75.560	229.713	6261.020	14368.000	.017
1988	1	67.270	282.404	6751.920	15469.000	-.070
1988	2	77.070	322.601	6968.400	16376.000	-.071
1988	3	91.870	348.866	8248.730	18525.000	.016
1988	4	73.820	402.181	8906.770	22140.000	.066

.EXPLANATIONS:

Re-Y : REAL GNP in BILLIONS OF TL
P68 : WSPI FOR TURKEY (1968=1.00)
M1 : M1 MONEY STOCK in BILLIONS OF TL
EL (Mi,l) : EXPECTED LOSS SERIES CALCULATED FOR Mi MONEY DEFINITION (i=1,2)
AND FOR BETA VALUES l (l=0.3, 0.5, 1.0)

Data Matrix

		EL(M1,0.5)	EL(M1,1.0)	EL(M2,0.3)	EL(M2,0.5)	EL(M2,1.0)
1979	1	.070	.070	.057	.057	.057
1979	2	.088	.106	.068	.075	.093
1979	3	.128	.168	.093	.114	.154
1979	4	.116	.104	.093	.103	.090
1980	1	.123	.130	.100	.109	.117
1980	2	.220	.318	.161	.207	.305
1980	3	.177	.147	.142	.161	.128
1980	4	.101	.025	.101	.084	.008
1981	1	.105	.107	.051	.040	.042
1981	2	.084	.064	.016	.001	-.020
1981	3	.045	.005	-.043	-.070	-.110
1981	4	.044	.043	-.071	-.091	-.092
1982	1	.038	.033	-.103	-.118	-.123
1982	2	.046	.053	-.113	-.121	-.114
1982	3	.042	.036	-.118	-.126	-.131
1982	4	.034	.026	-.126	-.134	-.142
1983	1	-.063	-.076	-.155	-.166	-.179
1983	2	-.026	.012	-.135	-.128	-.090
1983	3	-.040	-.057	-.122	-.123	-.140
1983	4	-.048	-.057	-.124	-.129	-.138
1984	1	.044	.061	-.172	-.168	-.152
1984	2	.065	.085	-.171	-.161	-.140
1984	3	.107	.147	-.156	-.133	-.093
1984	4	.077	.047	-.187	-.183	-.212
1985	1	.069	.061	-.205	-.205	-.212
1985	2	.082	.093	-.206	-.201	-.170
1985	3	.070	.058	-.208	-.210	-.222
1985	4	.034	-.001	-.222	-.238	-.273
1986	1	.053	.073	-.217	-.220	-.200
1986	2	.037	.040	-.202	-.203	-.200
1986	3	.016	-.001	-.199	-.206	-.223
1986	4	-.003	-.020	-.183	-.194	-.211
1987	1	.002	.011	-.173	-.178	-.169
1987	2	.012	.020	-.161	-.161	-.153
1987	3	.025	.036	-.145	-.141	-.129
1987	4	.017	.009	-.147	-.147	-.155
1988	1	-.062	-.041	-.223	-.215	-.194
1988	2	-.042	.017	-.231	-.201	-.143
1988	3	.033	.026	-.184	-.167	-.174
1988	4	-.067	-.098	-.348	-.349	-.380

EXPLANATIONS:

EL (Mi,l) : EXPECTED LOSS SERIES CALCULATED FOR Mi MONEY DEFINITION (i=1,2)
AND FOR BETA VALUES l (l=0.3, 0.5, 1.0)

DATA MATRIX
INTEREST RATES AND TAX RATE ON INTEREST INCOME

		DEMAND DEPOSITS	ONE YEAR	TAX RATE
1979	1	3%	12%	20%
	2	3%	12%	20%
	3	3%	12%	20%
	4	3%	12%	20%
1980	1	3%	12%	20%
	2	3%	12%	20%
	3	5%	15%	20%
	4	5%	15%	20%
1981	1	5%	38%	25%
	2	5%	42%	25%
	3	5%	50%	25%
	4	5%	50%	25%
1982	1	5%	50%	25%
	2	5%	50%	25%
	3	5%	50%	25%
	4	5%	50%	25%
1983	1	20%	40%	20%
	2	20%	40%	20%
	3	20%	35%	20%
	4	20%	35%	20%
1984	1	5%	47%	10%
	2	5%	47%	10%
	3	5%	49%	10%
	4	5%	52%	10%
1985	1	5%	52%	10%
	2	5%	52%	10%
	3	5%	52%	10%
	4	5%	50%	10%
1986	1	5%	49%	10%
	2	9%	46%	10%
	3	10%	45%	10%
	4	10%	40%	10%
1987	1	10%	39%	10%
	2	10%	38%	10%
	3	10%	38%	10%
	4	10%	38%	10%
1988	1	27%	47%	10%
	2	36%	52%	10%
	3	22%	52%	10%
	4	35%	72%	10%