Vasilev, Aleksandar; Pavlov, Plamen; Rainov, Stefan; Kovatchev, Tsvetoslav

Research Report

Testing three models in international economics: The Purchasing Power Parity Model, the Interest Rate Parity Model and the Monetary Model: The case of the Turkish Lira and the US Dollar (1975-1999)

Testing three models in international economics: The Purchasing Power Parity Model, the Interest Rate Parity Model and the Monetary Model: The case of the Turkish Lira and the US Dollar (1975-1999)

Aleksandar Vasilev

Plamen Pavlov

Stefan Rainov

Tsvetoslav Kovatchev

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CONCISE PROJECT SUMMARY

The goal of this empirical project is to test the validity of three economic models – The General Monetary, The Purchasing Power Parity and The Interest Rate Parity models in Turkey – basing on quarterly data for the period 1975 – 1999. The project takes into account the serious economic shocks that hit the Turkish economy in 1979 and 1994.

Different models are created and the variables are tested for Significance, Serial Correlation, Unit Root and Cointegration. The tests used throughout the project are: Dickey Fuller, Augmented Dickey Fuller, Breusch-Godfrey LM Test for cointegration and Johansen Test.

The outputs of the tests are presented to support the conclusions made throughout the test. The basic findings made are that for Turkey the three models: The General Monetary Model, The Purchasing Power Parity Model and The Interest Rate Parity hold for the time period 1975 – 1999.

I. Introduction

Project goal:

The empirical project will test the validity of three alternative economic models that describe the behavior of the exchange rate of the Turkish Lira against the US dollar during the period from 1975 to 1999 including. The General Monetary Model describes the effects of changes in money supply on the exchange rate. The Purchasing Power Parity Model establishes the relationship between the inflation rate and the exchange rate. The Interest Rate Parity Model captures the effect of the change in relative interest rates on the exchange rate.

A Brief Overview Of The Turkish Economy

SOURCES: 2001 CIA WORLD FACTBOOK
BCSIA PUBLICATIONS

Turkey's dynamic economy is a complex mix of modern industry and commerce along with traditional agriculture that still accounts for nearly 40% of employment. It has a strong and rapidly growing private sector, yet the state still plays a major role in basic industry, banking, transport, and communication. Textiles and clothing is the most important industry and the major exporter.

The years considered in the project include the so-called second oil price shock in 1979. It had a significant impact on the Turkish economy. The shock affected the macroeconomic variables: GDP, unemployment, inflation, and thus changed the overall structure of the Turkish economy.

In recent years the economic situation has been marked by erratic economic growth and serious imbalances. Real GNP growth has exceeded 6% in most years, but this strong expansion was interrupted by sharp declines in output in 1994 and 1999. Meanwhile the public sector fiscal deficit has regularly exceeded 10% of GDP - due in large part to the huge burden of interest payments, which account for more than 40% of central government spending, while inflation has remained in the high double-digit range.

Perhaps because of these problems, foreign direct investment in Turkey remains low - less than $1 billion annually. Prospects for the future are improving, however, because the Ecevit government since June 1999 has been implementing an IMF-supported reform program, including a tighter budget, social security reform, banking reorganization, and accelerated privatization. As a result, the fiscal situation is greatly improved and inflation has dropped below 40% - the lowest rate since 1987.

II. Variables used

Dummy Variables

Basing on the data about the Turkish economy we will use two dummy variables:

- D 79 - The effect of oil price shocks
  (1975 - 1978) = 0
  (1979 - 1999) = 1
- D 94 - The recession of 1994
  (1975 - 1993) = 0
  (1994 - 1999) = 1

The data used throughout the analysis are quarterly, for the period years 1975 and 1999. Data are defined as follows:

- NER - Nominal exchange rate (TRL/ USD)
- M1 - Money supply (Turkey)
- P_TUR - Price index (Turkey)
- INT_TUR - Discount Rate (Turkey)
- P_USA - Price index (USA)
- INT_USA - Discount Rate (USA)

The variables computed and included in the models are:

- LOGNER - Logarithm on the nominal exchange rate
- DLOGNER = LOGNER - LOGNER1
- LOGM1 - Logarithm of the Money Supply
- DLOGM1 = LOGM1 - LOGM1_1
- LOGP_TUR - Logarithm price index Turkey
- LOGP_USA - Logarithm price index USA
- LOGDIFP = LOGP_TUR - LOGP_USA
- LOGDIFP1 = LOGP_TUR1 - LOGP_USA1
- DLOGDIFP = LOGDIFP - LOGDIFP1
- SRADJPPP = LOGDIFP1 - LOGNER1
- LOGINT_TUR - Logarithm Discount Rate Turkey
- LOGINT_USA - Logarithme Discount Rate USA
- LOGDIFINT = LOGINT_TUR - LOGINT_USA
- LOGDIFINT1 = LOGINT_TUR1 - LOGINT_USA1
- DLOGDIFINT = LOGDIFINT - LOGDIFINT1
- SRADJIRP = LOGDIFINT1 - LOGNER1
- SRADJM1 = LOGM1_1 - LOGNER1

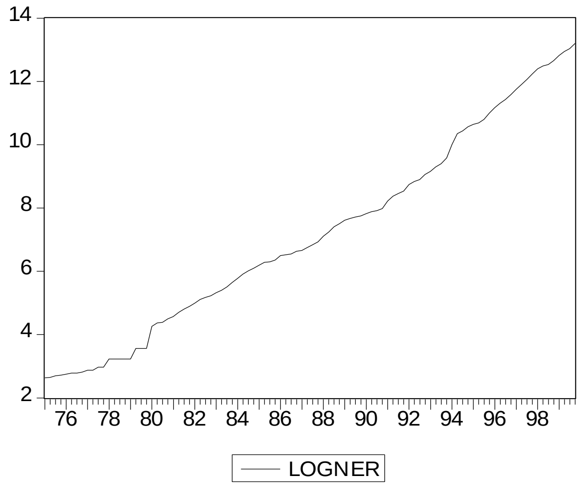
III.Tests

1. Purchasing power parity

Unit Root Test

A. Unit Root Test on LOGNER

From the graph it can be seen that the data on LOGNER is non-stationary with a time trend.



UNIT ROOT LOGNER

Ho: $\rho=1$ => Unit Root Exists
Ha: $\rho<1$ =>No Unit Root Exists

ADF Test Statistic	-1.411951	1% Critical Value*	-4.0550
		5% Critical Value	-3.4561
		10% Critical Value	-3.1536

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LOGNER)
Method: Least Squares
Date: 12/11/02 Time: 20:24
Sample(adjusted): 1975:4 1999:4
Included observations: 97 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOGNER(-1)	-0.038829	0.027500	-1.411951	0.1613
D(LOGNER(-1))	0.068762	0.102908	0.668191	0.5057
D(LOGNER(-2))	-0.106975	0.103115	-1.037430	0.3023
C	0.132105	0.049781	2.653701	0.0094
@TREND(1975:1)	0.005115	0.002992	1.709598	0.0907

R-squared	0.098650	Mean dependent var	0.108253
Adjusted R-squared	0.059461	S.D. dependent var	0.095859
S.E. of regression	0.092965	Akaike info criterion	-1.863012

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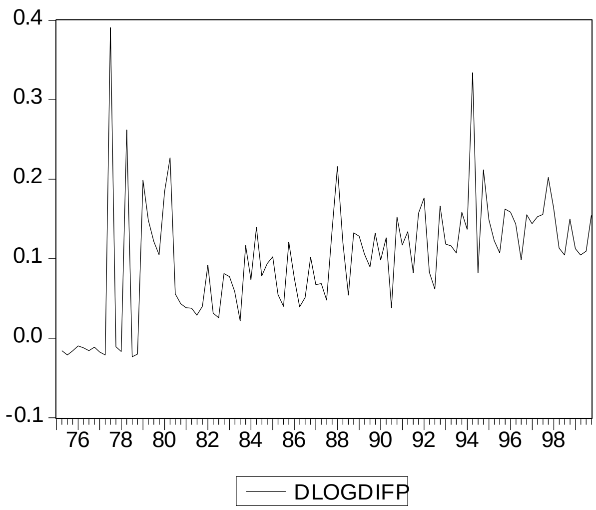
Sum squared resid	0.795113	Schwarz criterion	-1.730295
Log likelihood	95.35610	F-statistic	2.517292
Durbin-Watson stat	1.945619	Prob(F-statistic)	0.046605

Performing the Augmented Dickey-Fuller Unit Root Test, we conclude that there is a unit root because at 5% level of significance t > t*

B. Unit Root Test on LOGDIFP

From the graph it can be seen that the data on LOGDIFP is non-stationary with a time trend.



UNIT ROOT LOGDIFP

Ho: $\rho=1$ => Unit Root Exists

Ha: $\rho<1$ => No Unit Root Exists

ADF Test Statistic	-1.232996	1%	Critical Value*	-4.0550
		5%	Critical Value	-3.4561
		10%	Critical Value	-3.1536

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LOGDIFP)
Method: Least Squares
Date: 12/11/02 Time: 20:56
Sample(adjusted): 1975:4 1999:4
Included observations: 97 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.

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LOGDIFP(-1)	-0.019643	0.015931	-1.232996	0.2207
D(LOGDIFP(-1))	-0.024489	0.102568	-0.238760	0.8118
D(LOGDIFP(-2))	-0.073285	0.102457	-0.715276	0.4762
C	-0.122892	0.139839	-0.878815	0.3818
@TREND(1975:1)	0.003268	0.001670	1.956507	0.0534

R-squared	0.203642	Mean dependent var	0.102126
Adjusted R-squared	0.169018	S.D. dependent var	0.073345
S.E. of regression	0.066860	Akaike info criterion	-2.522266
Sum squared resid	0.411262	Schwarz criterion	-2.389548
Log likelihood	127.3299	F-statistic	5.881489
Durbin-Watson stat	1.961354	Prob(F-statistic)	0.000293

After performing the Dickey-Fuller Unit Root Test, we conclude that there is a unit root because t > t*

C. UNIT ROOT TEST ON DLOGNER AND DLOGDIFP

As both LOGNER and LOGDIFP are Random Walks we correct for that using differencing. Thus, we obtain DLOGNER and DLOGDIFP. We test the new variables for unit root.

UNIT ROOT FOR DLOGNER

ADF Test Statistic	-4.757838	1% Critical Value*	-4.0560
		5% Critical Value	-3.4566
		10% Critical Value	-3.1539

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LOGNER,2)
Method: Least Squares
Date: 12/11/02 Time: 20:28
Sample(adjusted): 1976:1 1999:4
Included observations: 96 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOGNER(-1))	-0.845012	0.177604	-4.757838	0.0000
D(LOGNER(-1),2)	-0.075456	0.140249	-0.538011	0.5919
D(LOGNER(-2),2)	-0.214651	0.102248	-2.099323	0.0386
C	0.058052	0.022617	2.566744	0.0119
@TREND(1975:1)	0.000675	0.000374	1.803991	0.0745

R-squared	0.509578	Mean dependent var	0.001535
Adjusted R-squared	0.488021	S.D. dependent var	0.128696
S.E. of regression	0.092085	Akaike info criterion	-1.881521
Sum squared resid	0.771656	Schwarz criterion	-1.747961
Log likelihood	95.31299	F-statistic	23.63861
Durbin-Watson stat	1.944519	Prob(F-statistic)	0.000000

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UNIT ROOT FOR DLOGDIFP

ADF Test Statistic	-4.451439	1% Critical Value*	-4.0560
		5% Critical Value	-3.4566
		10% Critical Value	-3.1539

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LOGDIFP,2)
Method: Least Squares
Date: 12/11/02 Time: 20:58
Sample(adjusted): 1976:1 1999:4
Included observations: 96 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOGDIFP(-1))	-0.795696	0.178750	-4.451439	0.0000
D(LOGDIFP(-1),2)	-0.219135	0.141737	-1.546061	0.1256
D(LOGDIFP(-2),2)	-0.294761	0.099180	-2.971979	0.0038
C	0.041361	0.015492	2.669797	0.0090
@TREND(1975:1)	0.000814	0.000319	2.548391	0.0125

R-squared	0.565447	Mean dependent var	0.001774
Adjusted R-squared	0.546346	S.D. dependent var	0.095482
S.E. of regression	0.064311	Akaike info criterion	-2.599506
Sum squared resid	0.376363	Schwarz criterion	-2.465946
Log likelihood	129.7763	F-statistic	29.60268
Durbin-Watson stat	2.059724	Prob(F-statistic)	0.000000

In both cases there is no unit root as t > t*. In this way we find out that both LOGNER and LOGDIFP exhibit I(1). On this basis we can now perform a cointegration test.

COINTEGRATION TEST

Ho: No Cointegration Exists

Ha: Cointegration Exists

We conduct a Cointegration Test on LOGNER and LOGDIFP. The test indicates that at 5% significance level we should reject the Ho of no cointegration.

Date: 12/11/02 Time: 21:00
Sample: 1975:1 1999:4
Included observations: 97
Test assumption: Linear deterministic trend in the data
Series: LOGNER LOGDIFP
Lags interval: 1 to 2

Eigenvalue	Likelihood Ratio	5 Percent Critical Value	1 Percent Critical Value	Hypothesized No. of CE(s)
0.141033	17.84870	15.41	20.04	None *

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0.031477	3.102331	3.76	6.65	At most 1

*(**) denotes rejection of the hypothesis at 5%(1%) significance level
L.R. test indicates 1 cointegrating equation(s) at 5% significance level

Unnormalized Cointegrating Coefficients:

LOGNER	LOGDIFP
0.017580	0.024214
-0.469132	0.495067

Normalized Cointegrating Coefficients: 1 Cointegrating Equation(s)

LOGNER	LOGDIFP	C
1.000000	1.377401	-2.456244
	(16.2671)	
Log likelihood	234.9569	

Our conclusion is that there is cointegration between the two variables. We should expect that the variables be related.

ERROR CORRECTION MODEL

We reformulate the model using DLOGNER and DLOGDIFP. We obtain the ECM equation:

$$DLOGNER = \beta_o + \beta_1 DLOGDIFP + \beta_2 SRADJPPP + Ut$$

Dependent Variable: DLOGNER
Method: Least Squares
Date: 12/11/02 Time: 21:10
Sample(adjusted): 1975:2 1999:4
Included observations: 99 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.556062	0.358381	1.551592	0.1241
DLOGDIFP	0.582252	0.124054	4.693519	0.0000
SRADJPPP	0.047500	0.033880	1.401985	0.1641

R-squared	0.186664	Mean dependent var	0.106703
Adjusted R-squared	0.169719	S.D. dependent var	0.095541
S.E. of regression	0.087056	Akaike info criterion	-2.014686
Sum squared resid	0.727567	Schwarz criterion	-1.936046
Log likelihood	102.7270	F-statistic	11.01618
Durbin-Watson stat	2.200884	Prob(F-statistic)	0.000049

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We check the significance of β_2 and it is not significant at the 10% significance level. Next we check for SC of the order AR(4).

Ho: $\rho_1 = \rho_2 = \rho_3 = \rho_4 = 0$
Ha: at least one is non-zero

Reject Ho iff p-value of Obs*R-squared < $\alpha = 0.05$. Since 0.014503<0.05, reject Ho. Therefore, we proved the existence of SC.

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	3.298560	Probability	0.014229
Obs*R-squared	12.41731	Probability	0.014503

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 12/19/02 Time: 20:27
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.189676	0.393703	-0.481776	0.6311
DLOGDIFP	0.022461	0.123780	0.181463	0.8564
SRADJPPP	-0.017537	0.037078	-0.472966	0.6374
RESID(-1)	-0.061545	0.113351	-0.542964	0.5885
RESID(-2)	-0.154273	0.106022	-1.455103	0.1490
RESID(-3)	0.227229	0.104301	2.178588	0.0319
RESID(-4)	-0.185264	0.106446	-1.740443	0.0851

R-squared	0.125427	Mean dependent var	-1.10E-16
Adjusted R-squared	0.068390	S.D. dependent var	0.086164
S.E. of regression	0.083165	Akaike info criterion	-2.067898
Sum squared resid	0.636310	Schwarz criterion	-1.884405
Log likelihood	109.3610	F-statistic	2.199040
Durbin-Watson stat	1.951590	Prob(F-statistic)	0.049975

We look at the p-values of the lagged residuals and note that only res(-3) is significant at 55 level of significance. So we have to respecify our model by including AR(3).

Dependent Variable: DLOGNER
Method: Least Squares
Date: 12/19/02 Time: 20:29
Sample(adjusted): 1976:1 1999:4
Included observations: 96 after adjusting endpoints

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Convergence achieved after 7 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.234785	0.567339	2.176451	0.0321
DLOGDIFP	0.626156	0.133981	4.673481	0.0000
SRADJPPP	0.111121	0.053167	2.090042	0.0394
AR(3)	0.334821	0.106381	3.147371	0.0022

R-squared	0.250448	Mean dependent var	0.109207
Adjusted R-squared	0.226006	S.D. dependent var	0.095898
S.E. of regression	0.084368	Akaike info criterion	-2.066487
Sum squared resid	0.654850	Schwarz criterion	-1.959639
Log likelihood	103.1914	F-statistic	10.24667
Durbin-Watson stat	1.956015	Prob(F-statistic)	0.000007
Inverted AR Roots	.69	-.35+.60i	-.35 -.60i

The coefficient β_2 is individually significant which shows that there is a SR adjustment towards the LR. This SR adjustment takes place at a rate of 11% per quarter, or 44% per year.

2. Interest Rate Parity

Unit Root Tests

A. Unit Root Test on LOGDIFINT

From the relevant graph it can be seen that the data on LOGDIFINT is non-stationary and has a time trend.

Unit Root Test on LOGDIFINT

Ho: ρ=1 => Unit Root Exists
Ha: ρ<1 => No Unit Root Exists

|ADF Test-Statistic|<|t – critical| => we cannot reject H_0 even at 10% level of significance.

⇨ there exists a unit root in LOGDIFINT

ADF Test Statistic	-1.656763	1% Critical Value*	-4.0550
		5% Critical Value	-3.4561
		10% Critical Value	-3.1536

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LOGDIFINT)
Method: Least Squares
Date: 12/19/02 Time: 21:20
Sample(adjusted): 1975:4 1999:4
Included observations: 97 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOGDIFINT(-1)	-0.063821	0.038521	-1.656763	0.1010

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D(LOGDIFINT(-1))	0.104805	0.105338	0.994943	0.3224
D(LOGDIFINT(-2))	0.061974	0.105893	0.585253	0.5598
C	0.049187	0.030436	1.616096	0.1095
@TREND(1975:1)	0.001514	0.001218	1.243401	0.2169

R-squared	0.039677	Mean dependent var	0.021438
Adjusted R-squared	-0.002076	S.D. dependent var	0.137120
S.E. of regression	0.137262	Akaike info criterion	-1.083680
Sum squared resid	1.733359	Schwarz criterion	-0.950963
Log likelihood	57.55848	F-statistic	0.950269
Durbin-Watson stat	1.982394	Prob(F-statistic)	0.438774

B. UNIT ROOT TEST ON DLOGDIFINT

We perform a Unit Root Test on the first difference of LOGDIFINT to check whether the data has become stationary, thus having no unit root.

Ho: Unit Root Exists
Ha: No Unit Root Exists

We see test statistic is less than the critical values at 1,5,10% of significance

⇨ we reject H_0 of unit root in the first difference of LOGDIFINT

⇨ LOGDIFINT is of I(1)

ADF Test Statistic	-5.327428	1% Critical Value*	-4.0560
		5% Critical Value	-3.4566
		10% Critical Value	-3.1539

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LOGDIFINT,2)
Method: Least Squares
Date: 12/19/02 Time: 21:22
Sample(adjusted): 1976:1 1999:4
Included observations: 96 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOGDIFINT(-1))	-0.923622	0.173371	-5.327428	0.0000
D(LOGDIFINT(-1),2)	-0.004543	0.144653	-0.031404	0.9750

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D(LOGDIFINT(-2),2)	0.022779	0.105674	0.215565	0.8298
C	0.038106	0.030712	1.240753	0.2179
@TREND(1975:1)	-0.000354	0.000517	-0.684829	0.4952

R-squared	0.460502	Mean dependent var	-0.001684
Adjusted R-squared	0.436788	S.D. dependent var	0.186508
S.E. of regression	0.139969	Akaike info criterion	-1.044107
Sum squared resid	1.782821	Schwarz criterion	-0.910548
Log likelihood	55.11716	F-statistic	19.41884
Durbin-Watson stat	1.980004	Prob(F-statistic)	0.000000

The results (t > t*) indicate that there is no unit root, so the LOGDIFINT variable has I(1).

From the results in the PPP case we already know that LOGNER has a unit root but DLOGNER does not. Consequently, LOGNER has I(1). Basing on this, we can conduct a cointegration test on LOGNER and LOGDIFINT.

COINTEGRATION TEST

Ho: No Cointegration Exists

Ha: Cointegration Exists

Date: 12/19/02 Time: 21:31
Sample: 1975:1 1999:4
Included observations: 97
Test assumption: Linear deterministic trend in the data
Series: LOGNER LOGDIFINT
Lags interval: 1 to 2

Eigenvalue	Likelihood Ratio	5 Percent Critical Value	1 Percent Critical Value	Hypothesized No. of CE(s)
0.089508	10.87255	15.41	20.04	None
0.018151	1.776860	3.76	6.65	At most 1

*(**) denotes rejection of the hypothesis at 5%(1%) significance level
L.R. rejects any cointegration at 5% significance level

Unnormalized Cointegrating Coefficients:

LOGNER	LOGDIFINT
0.034795	0.004477

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-0.067047	0.251370	

Normalized Cointegrating Coefficients: 1 Cointegrating Equation(s)

LOGNER	LOGDIFINT	C
1.000000	0.128680	-7.448692
	(2.41980)	
Log likelihood	154.5561	

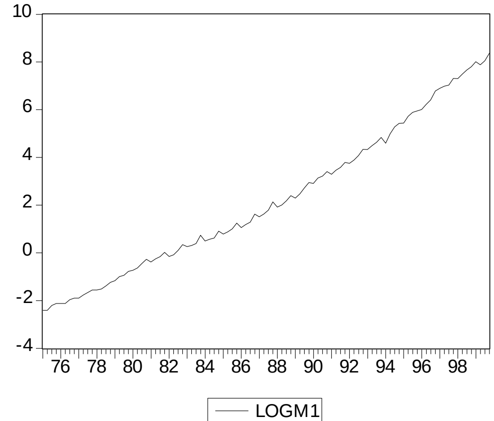
The Cointegration Test on LOGNER and LOGDIFINT shows that at the 5% significance level the Ho cannot be rejected, so the two variables are not cointegrated and an error correction model cannot be specified.

3. Monetary Approach

Unit Root Tests

A. UNIT ROOT TEST ON LOGM1.

From the graph we see that LOGM1 is non-stationary and there is a time trend.



Ho: Unit Root Exists
Ha: No Unit Root Exists

|ADF test statistic| < |t*| => we cannot reject H_0 => there is a unit root in LOGM1

ADF Test Statistic	-0.406566	1% Critical Value*	-4.0550
		5% Critical Value	-3.4561
		10% Critical Value	-3.1536

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LOGM1)
Method: Least Squares
Date: 12/19/02 Time: 21:41
Sample(adjusted): 1975:4 1999:4
Included observations: 97 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOGM1(-1)	-0.013029	0.032048	-0.406566	0.6853
D(LOGM1(-1))	-0.444664	0.101745	-4.370391	0.0000
D(LOGM1(-2))	-0.318338	0.100013	-3.182977	0.0020
C	0.069664	0.107565	0.647649	0.5188
@TREND(1975:1)	0.002954	0.003419	0.863828	0.3899

R-squared	0.240838	Mean dependent var	0.109024
Adjusted R-squared	0.207830	S.D. dependent var	0.134970
S.E. of regression	0.120128	Akaike info criterion	-1.350342

Sum squared resid	1.327635	Schwarz criterion	-1.217625
Log likelihood	70.49158	F-statistic	7.296545
Durbin-Watson stat	2.351543	Prob(F-statistic)	0.000038

B. UNIT ROOT TEST ON DLOGM1.

Ho: Unit Root Exists
Ha: No Unit Root Exists

We test the first difference of LOGM1 for unit root. The results show that there is no unit root as t < t*. We conclude that LOGM1 has I(1). We already know that LOGNER has a unit root and I(1) as DLOGNER has no unit root. Now we can conduct a Cointegration Test on LOGNER and LOGM1.

ADF Test Statistic	-13.70028	1% Critical Value*	-4.0560
		5% Critical Value	-3.4566
		10% Critical Value	-3.1539

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LOGM1,2)
Method: Least Squares
Date: 12/19/02 Time: 21:45
Sample(adjusted): 1976:1 1999:4
Included observations: 96 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOGM1(-1))	-2.794858	0.204000	-13.70028	0.0000
D(LOGM1(-1),2)	1.164660	0.151368	7.694218	0.0000
D(LOGM1(-2),2)	0.581982	0.088022	6.611817	0.0000
C	0.171646	0.024954	6.878474	0.0000
@TREND(1975:1)	0.002535	0.000406	6.249245	0.0000

R-squared	0.799697	Mean dependent var	0.002425
Adjusted R-squared	0.790892	S.D. dependent var	0.216962
S.E. of regression	0.099213	Akaike info criterion	-1.732413
Sum squared resid	0.895737	Schwarz criterion	-1.598853
Log likelihood	88.15583	F-statistic	90.82770

Durbin-Watson stat	1.493270	Prob(F-statistic)	0.000000

COINTEGRATION TEST

Ho: No Cointegration Exists

Ha: Cointegration Exists

The test shows that Ho is rejected at the 5% significance level so there is cointegration between LOGNER and LOGM1. This shows that the two variables are related.

Date: 12/19/02 Time: 21:47
Sample: 1975:1 1999:4
Included observations: 97
Test assumption: Linear deterministic trend in the data
Series: LOGM1 LOGNER
Lags interval: 1 to 2

Eigenvalue	Likelihood Ratio	5 Percent Critical Value	1 Percent Critical Value	Hypothesized No. of CE(s)
0.159273	22.94895	15.41	20.04	None **
0.061150	6.120626	3.76	6.65	At most 1 *

*(**) denotes rejection of the hypothesis at 5%(1%) significance level
L.R. test indicates 2 cointegrating equation(s) at 5% significance level

Unnormalized Cointegrating Coefficients:

LOGM1	LOGNER
0.256807	-0.218435
-0.438327	0.447298

Normalized Cointegrating Coefficients: 1 Cointegrating Equation(s)

LOGM1	LOGNER	C
1.000000	-0.850582	3.879939
	(0.06764)	
Log likelihood	168.6668	

`

ERROR CORRECTION MODEL

In order to correct the model we use DLOGNER and DLOGM1 and obtain the equation:

$$LOGNER = \beta o + \beta_1 DLOGM1 + \beta_2 SRADJM1 + Ut$$

Dependent Variable: DLOGNER
Method: Least Squares
Date: 12/19/02 Time: 21:51
Sample(adjusted): 1975:2 1999:4
Included observations: 99 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.520436	0.207073	2.513296	0.0136
DLOGM1	-0.033016	0.074474	-0.443319	0.6585
SRADJM1	0.082657	0.042171	1.960024	0.0529

R-squared	0.050263	Mean dependent var	0.106703
Adjusted R-squared	0.030477	S.D. dependent var	0.095541
S.E. of regression	0.094074	Akaike info criterion	-1.859646
Sum squared resid	0.849583	Schwarz criterion	-1.781006
Log likelihood	95.05248	F-statistic	2.540326
Durbin-Watson stat	1.671174	Prob(F-statistic)	0.084131

We run the regression and check the significance of β_2. At 10% level it is significant.

We test for SC. The results show that there is serial correlation because p-value of the LM test statistic obs*R^2 is smaller than 0.05.

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	3.240137	Probability	0.015553
Obs*R-squared	12.22454	Probability	0.015757

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 12/19/02 Time: 21:53
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.259349	0.236686	1.095752	0.2760
DLOGM1	0.005794	0.072314	0.080127	0.9363

SRADJM1	0.052343	0.048048	1.089398	0.2788
RESID(-1)	0.230360	0.109166	2.110175	0.0376
RESID(-2)	-0.017484	0.107737	-0.162287	0.8714
RESID(-3)	0.316755	0.101876	3.109223	0.0025
RESID(-4)	-0.085298	0.105765	-0.806490	0.4220

R-squared	0.123480	Mean dependent var	1.12E-17
Adjusted R-squared	0.066316	S.D. dependent var	0.093109
S.E. of regression	0.089968	Akaike info criterion	-1.910634
Sum squared resid	0.744677	Schwarz criterion	-1.727141
Log likelihood	101.5764	F-statistic	2.160091
Durbin-Watson stat	1.980819	Prob(F-statistic)	0.053929

We check the individual significance of the residuals and note that res(-1) and res(-3) are both significant at less than 5%. We include ar(1) and ar(3) and run a new regression which shows that ar(1) is insignificant at 10% => we keep only ar(3).

Dependent Variable: DLOGNER
Method: Least Squares
Date: 12/19/02 Time: 21:59
Sample(adjusted): 1976:1 1999:4
Included observations: 96 after adjusting endpoints
Convergence achieved after 6 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.582524	0.246778	2.360515	0.0204
DLOGM1	-0.056794	0.069246	-0.820173	0.4142
SRADJM1	0.093917	0.050271	1.868225	0.0649
AR(3)	0.284526	0.102771	2.768535	0.0068

R-squared	0.126738	Mean dependent var	0.109207
Adjusted R-squared	0.098262	S.D. dependent var	0.095898
S.E. of regression	0.091064	Akaike info criterion	-1.913727
Sum squared resid	0.762930	Schwarz criterion	-1.806879
Log likelihood	95.85890	F-statistic	4.450721
Durbin-Watson stat	1.647192	Prob(F-statistic)	0.005759
Inverted AR Roots	.66	-.33+.57i	-.33 -.57I

The coefficient of DLOGM1 is insignificant. However we choose to keep it in the model because of economic theory's sake.

So our final model is:

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$LOGNER = \beta o + \beta_1 DLOGM1 + \beta_2 SRADJM1 + ar(3) + u_t$

The coefficient of SRADJM1 is significant at the ten percent level, so we conclude that there is a short run adjustment of 9.4% per quarter towards a long run equilibrium.

FIRST SPECIFICATION OF THE MONETARY MODEL

We run the regression:

$LOGNER = \alpha + \beta_1 DLOGM1 + \beta_2 LOGM1 + \beta_3 LOGNER1 + \beta_4 D79 + \beta_5 D94$

Dependent Variable: LOGNER
Method: Least Squares
Date: 12/19/02 Time: 22:11
Sample(adjusted): 1975:2 1999:4
Included observations: 99 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.712660	0.189602	3.758720	0.0003
DLOGM1	-0.183017	0.067612	-2.706873	0.0081
LOGM1	0.135420	0.039564	3.422781	0.0009
LOGNER1	0.857164	0.039915	21.47471	0.0000
D79	0.120714	0.033312	3.623720	0.0005
D94	0.089398	0.036923	2.421234	0.0174

R-squared	0.999319	Mean dependent var	7.243198
Adjusted R-squared	0.999282	S.D. dependent var	3.141953
S.E. of regression	0.084172	Akaike info criterion	-2.053221
Sum squared resid	0.658895	Schwarz criterion	-1.895941
Log likelihood	107.6345	F-statistic	27291.41
Durbin-Watson stat	2.029622	Prob(F-statistic)	0.000000

We check the coefficients for individual significance and whether their signs match intuition. Then, we perform an LM Test to check for SC. The results indicate the existence of serial correlation. The quarterly nature of the data implies AR(4) which is also supported by the fact that only resid(-4) is the only significant at 5%.

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Breusch-Godfrey Serial Correlation LM Test:

F-statistic	2.533010	Probability	0.045760
Obs*R-squared	10.11854	Probability	0.038477

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 12/19/02 Time: 22:40
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.110362	0.216967	-0.508656	0.6123
DLOGM1	0.027933	0.068669	0.406770	0.6852
LOGM1	-0.022789	0.045339	-0.502647	0.6165
LOGNER1	0.022630	0.045829	0.493797	0.6227
D79	-0.002597	0.033194	-0.078249	0.9378
D94	0.000692	0.035790	0.019323	0.9846
RESID(-1)	0.018540	0.112645	0.164588	0.8696
RESID(-2)	-0.151800	0.109326	-1.388513	0.1684
RESID(-3)	0.154147	0.104239	1.478781	0.1427
RESID(-4)	-0.261630	0.104386	-2.506356	0.0140

R-squared	0.102208	Mean dependent var	1.75E-15
Adjusted R-squared	0.011420	S.D. dependent var	0.081996
S.E. of regression	0.081527	Akaike info criterion	-2.080230
Sum squared resid	0.591551	Schwarz criterion	-1.818096
Log likelihood	112.9714	F-statistic	1.125782
Durbin-Watson stat	1.966792	Prob(F-statistic)	0.353255

Next we correct for SC by adding ar(4).

Dependent Variable: LOGNER
Method: Least Squares
Date: 12/19/02 Time: 22:42
Sample(adjusted): 1976:2 1999:4
Included observations: 95 after adjusting endpoints
Convergence achieved after 6 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.700711	0.168732	4.152796	0.0001
DLOGM1	-0.191010	0.057925	-3.297556	0.0014
LOGM1	0.135313	0.035796	3.780148	0.0003

LOGNER1	0.857934	0.036050	23.79816	0.0000
D79	0.131062	0.030729	4.265111	0.0001
D94	0.082113	0.031547	2.602856	0.0108
AR(4)	-0.245269	0.104754	-2.341376	0.0215

R-squared	0.999300	Mean dependent var	7.434285
Adjusted R-squared	0.999252	S.D. dependent var	3.062441
S.E. of regression	0.083749	Akaike info criterion	-2.051149
Sum squared resid	0.617228	Schwarz criterion	-1.862968
Log likelihood	104.4296	F-statistic	20933.66
Durbin-Watson stat	1.970285	Prob(F-statistic)	0.000000

Inverted AR Roots	.50 -.50i	.50+.50i	-.50+.50i	-.50 -.50i

The coefficient of DLOGM1 is negative and significant at 1%. This is supported by economic theory, which states that MS and exchange rate move in opposite directions (as we increase MS the exchange rate falls and vice versa). The excessively high R^2_{adj} and the graphical analysis indicate that this is most probably a spurious regression. If this is the case, a test for unit roots in the variables should be conducted, their order of integration should be determined and the appropriate differencing should be applied to correct for the non-stationarity of the time series.

SECOND SPECIFICATION OF THE MONETARY MODEL

We can alternatively test the equation:

$$DLOGNER = \alpha + \beta_1 DLOGM1 + \beta_2 LOGNER1 + \beta_3 D79 + \beta_4 D94 + U_t$$

We perform the steps already described in the first specification. The two models are very similar and give the same results.

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IV. Conclusions

Testing the three models, we conclude that there is cointegration between the variables in the PPP and Monetary models, which indicates that these models hold in the case of the Turkish economy in the period between 1975 and 1999. The statistical tests fail to provide support for the IRP model because they indicate lack of cointegration between the interest rates of USA and Turkey and the net exchange rate. A reasonable explanation for this phenomenon is that people don’t view US and Turkish bank deposits as perfect substitutes, which may be caused by various political and macroeconomic factors.