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## **Conflict of Exchange Rates**

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# Econometrics of Exchange Rate

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Conflict between economic interests of two or more countries can take place in the inflation prone floating exchange regime and thus affect monetary policies of each other. This paper tries to examine whether the exchange rates of the currencies of the industrial countries are affecting India's currency and making the Reserve Bank of India (RBI) intervene in the foreign exchange market. It is found that limitation of RBI data is a major factor constraining the progress of research on the above kind of conflict.

## 1. Introduction

The experiences of the international monetary system since 1973 till now have lead to a floating exchange rate system, whereby the present leading currencies of the world like European Economic and Monetary Union's euro, Japan's yen, Great Britain's pound sterling and International Monetary Fund's SDR (special drawing rights) follow the floating exchange rate system and the currencies of the transition economies follow a mix of fixed and flexible exchange systems. From October 1975 India has pegged rupee against the basket of above five currencies and in August 1994, the final step in a three-year long process since late 1991 towards current account convertibility was taken by acceptance of the obligations under Article VIII of the IMF, under which India is committed to forsake the use of exchange restrictions on current international transactions as an instrument in managing the balance of payments<sup>1</sup>. Economic theory tells that RBI has to intervene in the foreign exchange market by purchase/sale of foreign exchange assets in terms of above five currencies in order to control/prevent fluctuations in the external value of rupee vis-à-vis above five currencies so as to maintain external balance in terms of a sound balance of payment position and internal balance in terms of a suitable trade off between inflation and unemployment<sup>2</sup>.

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<sup>1</sup> Until very recently rupee had been pegged to a basket of five currencies. Data on the movement of sixth currency are too scarce to facilitate research.

<sup>2</sup> As per economic theory an appreciation in rupee is supposed to make exports more costly and imports more expensive. This phenomenon reduces world demand for India's output and increases India's demand for imports thereby adding to net foreign exchange outflow and at the same time allowing imports to supplant their domestic counterparts in a liberalized trade regime. A depreciation in rupee is supposed to do the reverse adding to net foreign exchange inflow. The experiences of the countries following a floating exchange rate system between 1966 and 1972 show that this system allows international divergence in inflation rates. It is also found that high inflation countries tend to have weaker currencies than their low inflation neighbors. Further, most of the difference in depreciation rates is due to inflation differences, making purchasing power parity a major factor causing long run nominal exchange rate variability. Experiences show that a central bank cannot be indifferent to its currency's value in the foreign exchange market. After 1973 central banks repeatedly intervened in the foreign currency market to alter exchange rates.

## 2. Issues to be addressed

1. What is the pattern of movement over the years since 1976-77 till 2002-03 of the of rupee values of above currencies?
2. What is the pattern of changes over the years during the above period of RBI's net foreign exchange assets position?
3. Do the changes in values of industrial countries' currencies in terms of rupee make the RBI intervene in the foreign exchange market?

### (i). Objective of the paper

Intellectual exercise in form of application of multivariate regression model to the time series data is the objective of the paper. In course of going through successive steps of analysis starting from test of stationarity of time series data up to examination of residuals with a view to detecting heteroscedasticity problem, the paper seeks some meaningful implications of limitation of RBI data on its foreign exchange market intervention facing the economists (Ghosh 2002).

### (ii). Collection and nature of data

Data is collected from RBI publications and therefore it is a secondary data<sup>3</sup>. RBI publishes data on its international operations in gold, SDR and other foreign currencies in form of a composite variable called 'Net Foreign Exchange Assets (NFEA)' and the exchange rates of the five foreign currencies to which rupee is linked in form rupee values of these individual currencies. Exchange rate of a currency, say dollar, in terms of rupee is denoted by D/R, which means the value of dollar in terms of rupee. We have taken data on NFEA and these five exchange rates – dollar/rupee (D/R), mark/rupee

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<sup>3</sup> Any time series data has an underlying stochastic process. A stochastic process is called stationary if its mean and variance are constant over time and the value of covariance between two time periods depends only on the lag between the two time periods and not on the time of calculation of covariance.

There are two key concepts in time series analysis:

- i. Trend stationary process (TSP): If in the regression  $Y_t = a + bt + u_t$ , error term  $u_t$  is stationary then  $Y_t = a + bt + u_t$  represents a TSP.
- ii. Difference stationary process (DSP): If  $Y_t$  is generated as  $Y_t - Y_{t-1} = c + u_t$ , where  $c$  is a constant and  $u_t$  is stationary then the process is called a DSP.

The consequence of a non-stationary time series data is that it makes least square estimators inconsistent and diagnostic statistics like  $t$  and  $F$  statistics do not have their standard limiting distributions. As a consequence of this the regression coefficient of an explanatory variable may appear significantly different from 0 though it is not truly a determinant of the dependent variable. Stationarity is checked through, among others, Augmented Dicky-Fuller Unit Root Test (Gujarati 1995).

(M/R), yen/rupee (Y/R), SDR/rupee (SDR/R) and pound sterling/rupee (PS/R). After January 1, 1999, euro has replaced mark. Except mark/rupee, all other five variables are found non-stationary at the first difference.

### **(iii). Research methodology**

The methodology of research is econometric modeling supplemented by software packages. The stationarity test is conducted in 'EViews' and rest of the analysis is conducted in 'Analysis Tool Pack'.

## **3. Steps in analysis of data**

### **Step 1**

We conduct augmented Dickey-Fuller unit root tests for first and second differences in all of exchange rate variables and NFEA variable. NFEA data is nonstationary in the first difference unit root test at 1% level of significance because the computed value of  $|t|$  is less than 1% and 5% critical Mackinnon values for rejection of the hypothesis that the series is stationary, whereas it is more than all critical Mackinnon values in the second difference. For dollar/rupee the computed  $|t|$  value is below 1% and 5% critical values, but above 10% critical values and above all critical values for 2<sup>nd</sup> difference unit root test. For pound/rupee and yen/rupee, the computed  $|t|$  values are below 1% critical value but above 5% and 10% critical values and above all critical values for 2<sup>nd</sup> difference unit root test. For SDR/rupee, the computed  $|t|$  value is above all critical values in the 1<sup>st</sup> difference unit root test. For mark/rupee and balance of payments, the computed  $|t|$  values are above all critical values in the first difference unit root test. So second difference unit root test is not required for mark/rupee. In short at all levels of significance NEFA is stationary at first difference, SDR stationary at first difference, Y/R stationary at second difference, PS/R stationary at second difference, M/R stationary at first difference, D/R stationary at second difference.

### **Step 2**

There are three preconditions for success of the regression model:

1. If we work with time series data it should be stationary. A stationary series is free of autocorrelation. We deduct the value of each period value from the value of the preceding period for all variables except mark/rupee in order to make them stationary. This takes care of autocorrelation problem also. We do the same for mark/rupee also in order to conform it to the proposed multivariate regression model.
2. The independent variables should be free of multicollinearity. In order to avoid the problem of multicollinearity we check the correlation matrix between the exchange rates and it is found strong positive correlation exists between exponentials of changes in all exchange rates except between those in dollar/rupee and mark/rupee. So we take only these two variables for as independent variables. We could have taken balance of payments variable as an independent variable, but theoretically it is influenced by exchange rate fluctuations and thus could lead to multicollinearity problem if included in the set of independent variables along with the exchange rates (Delurgio 1998).

3. The residuals should be free of heteroscedasticity. They should not show any patterns when plotted against the values of independent variables and the estimated values of the dependent variable. Existence of heteroscedasticity of the residuals problem can be examined after estimating the model.

### Step 3

Again there is a difference between the levels of the units of the dependent variable - change in NFEA and those of the independent variables - changes in all exchange rates. In order to wipe out this difference we apply exponential operator to the values of all independent variables.

### Step 4

We propose the model:

$\Delta NFEA = c + m_1 e^{\Delta(D/R)} + m_2 e^{\Delta(M/R)} + u$ ,  $u$  is the error term,  $c$  is the constant term,  $m_1$  and  $m_2$  are coefficient parameters,  $e^{\Delta(D/R)}$  is the exponential value of the change in dollar/rupee and  $e^{\Delta(M/R)}$  is the exponential value of the change in mark/rupee.

## 4. Result, interpretations and conclusion

Following are the results of the analysis and followed by interpretations and conclusion:

1. There is no correlation between dollar/rupee and mark/rupee, because, perhaps, the European Economic and Monetary Union's monetary policy maintains independence of the monetary policy of United States, while Japan and Great Britain link their currencies to dollar and IMF to gold to which, dollar is in turn linked (Krugman 2000).
2. When plotted against independent variables and the estimated dependent variable, residuals do not exhibit any patterns and hence can be inferred to be free of heteroscedasticity problem.
3. Changes in the exchange rates dollar/rupee and mark/rupee could not explain changes in NFEA, perhaps because, NFEA includes information not only on RBI's intervention in dollar and mark, but also on the same in pound sterling, yen and SDR. RBI does not publish data separately on its interventions in dollar and mark. The results of regression analysis are displayed in the appendix.

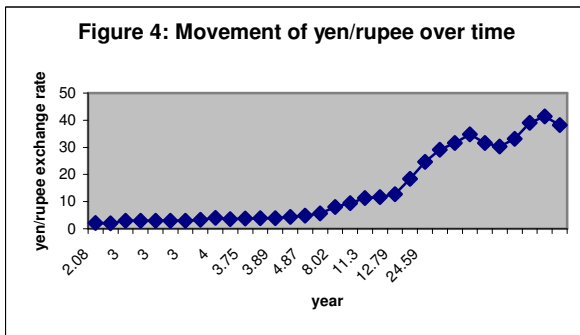
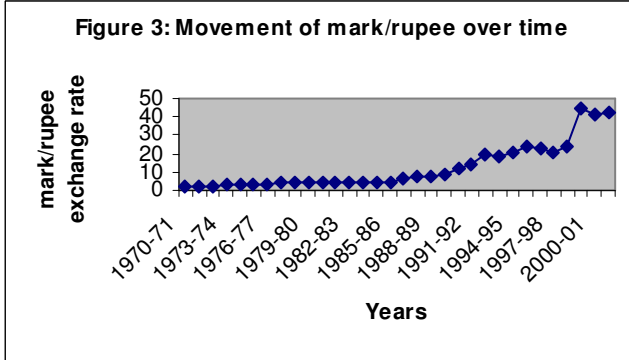
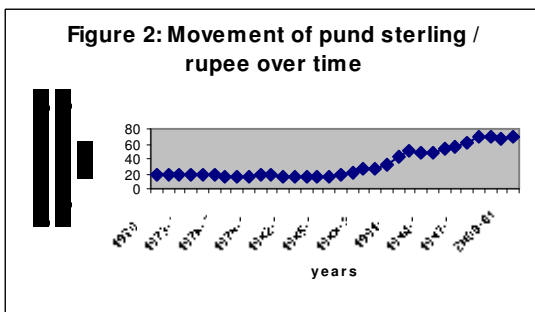
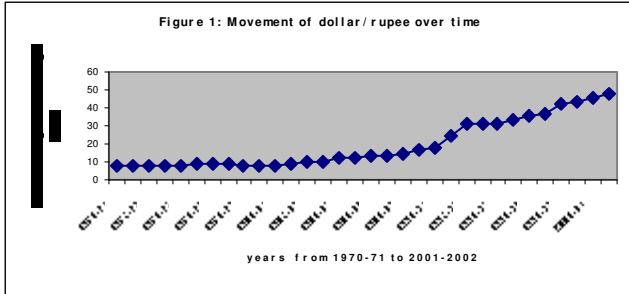
We conclude that unless RBI publishes details of its foreign exchange operations in terms of net assets in individual foreign currencies, it would be difficult to ascertain the impact, if any, of monetary policies of US and EMS on the monetary policy of RBI.

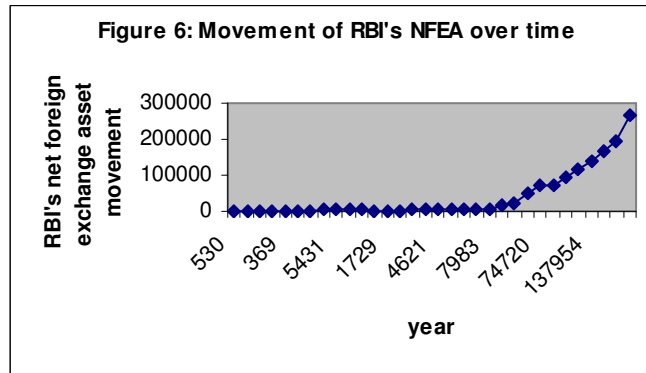
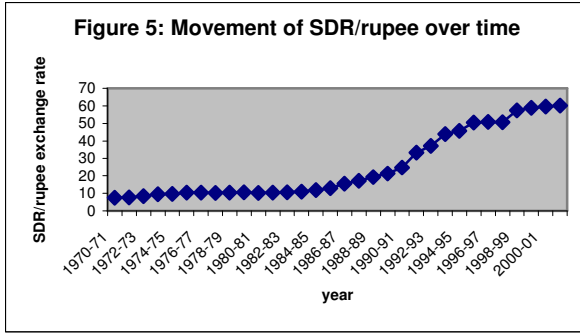
## 9. References

1. Ghosh S (2002): 'RBI Intervention in the Forex Market', *Economic and Political Weekly*, June 15, Volume 37, No 24, p 2333-48
2. Delurgio S A (1998): *Forecasting Principles and Applications*, Irwin McGraw-Hill, Boston, 1<sup>st</sup> edition, Chapter 3
3. Gujarati D N (1995): *Basic Econometrics*, McGraw-Hill, New York, 3<sup>rd</sup> Edition, Chapter 21
4. Krugman P R (2000): *International Economics, Theory and Policy*, Addison Wesley Longman, Singapore, 5<sup>th</sup> edition, Chapters 18-20

5. Reserve Bank of India (2003): *Handbook of Statistics on Indian Economy*, Reserve Bank of India, Mumbai

**Appendix**





**Table 1: Modified RBI Data**

Year	EXP(Change in NFEA)	EXP(Change in dollar/rupee)	EXP(Change in PS/R)	EXP(Change in M/R)	EXP(Change in Y/R)	EXP(Change in SDR/R)
1970-71						
1971-72	78	0.91879	1.15998	1.49182	0.96079	1.18946
1972-73	-39	1.22373	1.27354	1.55659	2.6117	2.20141
1973-74	92	1.12468	1.76526	0.95839	1	2.54798
1974-75	-292	1.15986	1.20226	1	1	1.25282
1975-76	555	2.0995	1.2893	0.66584	1	2.09782
1976-77	1675	1.34313	1.20322	0.05961	1	0.9859
1977-78	1933	0.67591	1.22753	0.8658	1.39097	0.82737
1978-79	899	0.6983	1.46844	1.71018	1.95424	1.31128
1979-80	-43	0.8788	1.28621	5.41515	0.65705	1.06396
1980-81	-613	0.82837	0.75262	2.33778	1.1853	0.72921
1981-82	-2069	2.88377	0.72123	0.24793	1.20925	1.17081
1982-83	-977	2.00913	1.1044	0.37757	0.95123	1.25533
1983-84	-105	1.96207	0.98039	0.48763	1.63232	1.45893
1984-85	1275	4.70488	1.04865	0.5766	1.63232	2.69743
1985-86	842	1.41383	1.76403	7.24202	2.117	2.69231

1986-87	880	1.72168	5.70704	9.25811	11.0232	12.4784
1987-88	795	1.20635	3.0144	20.3891	4.01485	5.33133
1988-89	785	4.55352	1.91363	33.4048	6.61937	8.50879
1989-90	-133	8.73642	2.83715	3.75092	1.43333	8.21942
1990-91	1915	3.64589	10.4114	503.257	3.09566	32.2881
1991-92	10855	686.015	24.2811	11802.9	284.291	5374.39
1992-93	3809	480.631	143.008	9611.35	468.717	40.813
1993-94	28775	2.04766	0.42853	0.01134	91.8356	849.629
1994-95	23298	1.03365	4.31199	5.02638	12.4797	6.71605
1995-96	-628	7.77723	24.4737	34.1752	24.7395	108.419
1996-97	20725	7.76868	0.62195	55.2573	0.0386	1.50531
1997-98	21073	5.28514	0.14042	105.573	0.27557	0.80872
1998-99	22064	135.071	24.9756	5046.75	17.0321	933.929
1999-2000	27926	3.53283	8.9E+08	1.35053	374.84	4.1396
2000-01	31295	10.5034	0.0366	0.10038	10.4291	1.84485
2001-02	66794	7.44468	2.00953	2.15265	0.03971	1.95248

**Table 2: RBI Data**

<b>Year</b>	<b>NFEA</b>	<b>D/R</b>	<b>PS/R</b>	<b>M/R</b>	<b>Y/R</b>	<b>SDR/R</b>
1970-71	530	7.5578	18	2.049	2.08	7.5
1971-72	608	7.4731	18.4	2.1974	2.04	7.6735
1972-73	569	7.675	18.8425	2.4392	3	8.4626
1973-74	661	7.7925	18.8	3.0075	3	9.3979
1974-75	369	7.9408	18.8	3.1917	3	9.6233
1975-76	924	8.6825	18.3933	3.4458	3	10.3642
1976-77	2599	8.9775	15.5733	3.6308	3	10.35
1977-78	4532	8.5858	15.4292	3.8358	3.33	10.1605
1978-79	5431	8.2267	15.9658	4.22	4	10.4315
1979-80	5388	8.0975	17.655	4.4717	3.58	10.4935
1980-81	4775	7.9092	18.5042	4.1875	3.75	10.1777
1981-82	2706	8.9683	17.1096	3.8607	3.94	10.3354
1982-83	1729	9.666	16.1356	3.96	3.89	10.5628
1983-84	1624	10.34	15.4174	3.9402	4.38	10.9405
1984-85	2899	11.8886	14.8668	3.9877	4.87	11.9328
1985-86	3741	12.2349	16.8467	4.5553	5.62	12.9232
1986-87	4621	12.7782	19.0722	6.297	8.02	15.4472
1987-88	5416	12.9658	22.0872	7.4004	9.41	17.1208
1988-89	6201	14.4817	25.5959	8.0494	11.3	19.2619
1989-90	6068	16.6492	26.9179	9.0922	11.66	21.3684



1990-91	7983	17.9428	33.139	11.4351	12.79	24.8431
1991-92	18838	24.4737	42.5151	14.6248	18.44	33.4325
1992-93	22647	30.6488	51.6858	19.5877	24.59	37.1415
1993-94	51422	31.3655	47.2064	18.7403	29.11	43.8863
1994-95	74720	31.3986	48.8211	20.2017	31.6341	45.7908
1995-96	74092	33.4498	52.3526	23.3993	34.8425	50.4768
1996-97	94817	35.4999	56.3646	22.9244	31.5879	50.8858
1997-98	115890	37.1648	61.024	20.9613	30.299	50.6735
1998-99	137954	42.0706	69.5505	24.1792	33.1341	57.5129
1999-2000	165880	43.3327	69.851	44.7909	39.0606	58.9335
2000-01	197175	45.6844	67.5522	41.4832	41.4052	59.5459
2001-02	263969	47.6919	68.3189	42.1811	38.179	60.215

**Table 3: Correlation Matrix**

	<i>Column 1</i>	<i>Column 2</i>	<i>Column 3</i>	<i>Column 4</i>	<i>Column 5</i>
Column 1	1				
Column 2	0.982628	1			
Column 3	-0.0518	-0.05841	1		
Column 4	0.716813	0.707145	0.537714	1	
Column 5	0.805832	0.757667	-0.04458	0.394724	1

*Column 1:* EXP(Change in dollar/rupee)

*Column 2:* EXP(Change in PS/R)

*Column 3:* EXP(Change in Mark/Rupee)

*Column 4:* EXP(Change in Yen/Rupee)

*Column 5:* EXP(Change in SDR/Rupee)

**Table 4**

**SUMMARY OUTPUT**

<i>Regression Statistics</i>	
Multiple R	0.24134
R Square	0.05825
Adjusted R Square	-0.009
Standard Error	15197.9
Observations	31

**ANOVA**

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	2	4E+08	2E+08	0.86589	0.43164

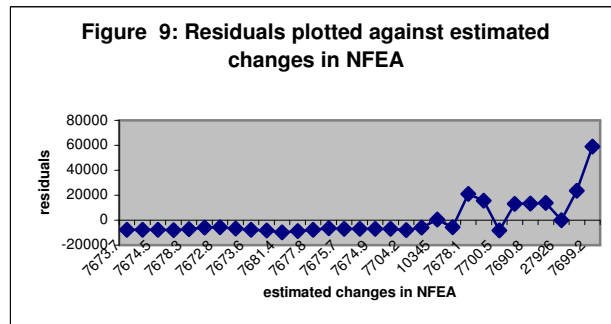
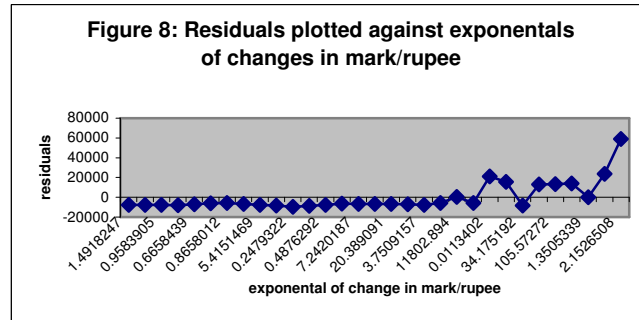
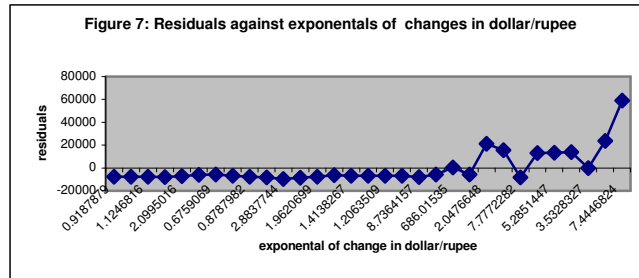
Residual	28	6.5E+09	2.3E+08
Total	30	6.9E+09	

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
Intercept	7670.15	2907.23	2.6383	0.01345	1714.94	13625.3	1714.94	13625.3
X Variable 1	3.89849	18.7615	0.20779	0.8369	-34.533	42.3297	-34.533	42.3297
X Variable 2	2.3E-05	1.7E-05	1.30848	0.20135	-1E-05	5.8E-05	-1E-05	5.8E-05

### RESIDUAL OUTPUT

<i>Observation</i>	<i>Predicted Y</i>	<i>Residuals</i>
1	7673.73	-7595.7
2	7674.92	-7713.9
3	7674.53	-7582.5
4	7674.67	-7966.7
5	7678.33	-7123.3
6	7675.38	-6000.4
7	7672.78	-5739.8
8	7672.87	-6773.9
9	7673.57	-7716.6
10	7673.37	-8286.4
11	7681.39	-9750.4
12	7677.98	-8655
13	7677.79	-7782.8
14	7688.49	-6413.5
15	7675.66	-6833.7
16	7676.86	-6796.9
17	7674.85	-6879.8
18	7687.9	-6902.9
19	7704.2	-7837.2
20	7684.36	-5769.4
21	10344.6	510.431
22	9543.88	-5734.9
23	7678.13	21096.9
24	7674.18	15623.8
25	7700.47	-8328.5

26	7700.43	13024.6
27	7690.75	13382.3
28	8196.72	13867.3
29	27926	0.00084
30	7711.09	23583.9
31	7699.17	59094.8



**ADF test of first difference with intercept for NEFA**

ADF Test Statistic	0.37948580	1% Critical Value*	-
	0486		3.6660666
			1797
		5% Critical Value	-
			2.9626554
			3832
		10% Critical Value	-
			2.6200111
			5799

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

Augmented Dickey-Fuller Test Equation  
 Dependent Variable: D(NFEA,2)  
 Method: Least Squares  
 Date: 10/06/05 Time: 10:56  
 Sample(adjusted): 1971-72 to 2001-02  
 Included observations: 30 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(NFEA(-1))	0.06747322	0.177801722	0.379485800	0.7071901
	89111	29	486	08103
C	1781.59089	2212.330901	0.805300371	0.4274323
	669	2	533	5404
R-squared	0.00511687	Mean dependent var		2223.8666
	835062			6667
Adjusted R-squared	-	S.D. dependent var		10146.528
	0.03041466			1262
	17083			
S.E. of regression	10299.6739	Akaike info criterion		21.381952
	886			5725
Sum squared resid	2970331959	Schwarz criterion		21.475365
	.63			7313
Log likelihood	-	F-statistic		0.1440094
	318.729288			72771
	588			
Durbin-Watson stat	2.19314315	Prob(F-statistic)		0.7071901
	459			08103

**ADF test of second difference with intercept for NEFA**

ADF Test Statistic	-	1% Critical Value*	-
	5.76747189		3.6752420
	76		4413
		5% Critical Value	-
			2.9664542
			2271
		10% Critical Value	-
			2.6220132
			4541

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

Augmented Dickey-Fuller Test Equation  
 Dependent Variable: D(NFEA,3)  
 Method: Least Squares

Sample(adjusted): From 1973-74 to 2001-02  
 Included observations: 29 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(NFEA(-1),2)	-	0.235119627	-	3.9127574
	1.35604584	12	5.767471897	434e-06
	199		6	
C	2687.85113	1889.953881	1.422178163	0.1664248
	964	04	5	99853
R-squared	0.55196933	Mean dependent var		1228.1379
	4394			3103
Adjusted R-squared	0.53537560	S.D. dependent var		14796.863

	6039		9552
S.E. of regression	10086.0399	Akaike info criterion	21.342164
	647		2669
Sum squared resid	2746661458	Schwarz criterion	21.436460
	.55		5311
Log likelihood	-	F-statistic	33.263732
	307.461381		0897
	871		
Durbin-Watson stat	1.73053350	Prob(F-statistic)	3.9127574
	255		434e-06

#### ADF test of first difference with intercept for D/R

ADF Test Statistic	-3.241432	1% Critical Value*	-3.6661
		5% Critical Value	-2.9627
		10% Critical Value	-2.6200

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(D\_R01,2)

Method: Least Squares

Sample(adjusted): From 1972-73 to 2001-02

Included observations: 30 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(D_R01(-1))	-0.537575	0.165845	-3.241432	0.0031
C	0.752937	0.356094	2.114432	0.0435
R-squared	0.272857	Mean dependent var		0.069740
Adjusted R-squared	0.246888	S.D. dependent var		1.811502
S.E. of regression	1.572059	Akaike info criterion		3.806990
Sum squared resid	69.19832	Schwarz criterion		3.900403
Log likelihood	-55.10484	F-statistic		10.50688
Durbin-Watson stat	1.959254	Prob(F-statistic)		0.003066

#### ADF test of second difference with intercept for D/R

ADF Test Statistic	-6.5569696395	1% Critical Value*	-3.67524204413
		5% Critical Value	-2.96645422271
		10% Critical Value	-2.62201324541

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(D\_R01,3)

Method: Least Squares

Date: 10/06/05 Time: 10:58

Sample(adjusted): 1972-73 to 2001-02

Included observations: 29 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(D_R01(-1),2)	-1.22918024126	0.187461633779	-6.5569696395	4.94530774691e-07
C	0.081516370338	0.339636160077	0.240010870219	0.812134716255
R-squared	0.614251828256	Mean dependent var		-
Adjusted R-squared	0.599964858932	S.D. dependent var		0.0217517241379
				2.88865992097

S.E. of regression	1.82702919659	Akaike info criterion	4.10973165268
Sum squared resid	90.1269635002	Schwarz criterion	4.20402791682
Log likelihood	-57.5911089639	F-statistic	42.9938508533
Durbin-Watson stat	2.184118596	Prob(F-statistic)	4.94530774691e-07

**ADF test of first difference with intercept for M/R**

ADF Test Statistic	-5.702266	1% Critical Value*	-3.6661
		5% Critical Value	-2.9627
		10% Critical Value	-2.6200

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(M\_R01,2)

Method: Least Squares

Sample(adjusted): From 1972-73 to 2001-02

Included observations: 30 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(M_R01(-1))	-1.073543	0.188266	-5.702266	0.0000
C	1.429460	0.776743	1.840325	0.0763
R-squared	0.537311	Mean dependent var		0.018317
Adjusted R-squared	0.520787	S.D. dependent var		5.825472
S.E. of regression	4.032697	Akaike info criterion		5.691088
Sum squared resid	455.3540	Schwarz criterion		5.784501
Log likelihood	-83.36632	F-statistic		32.51583
Durbin-Watson stat	2.028368	Prob(F-statistic)		0.000004

**ADF test of first difference with intercept for PS/R**

ADF Test Statistic	-	1% Critical Value*	-
	3.47575443		3.6660666
	815		1797
		5% Critical Value	-
			2.9626554
			3832
		10% Critical Value	-
			2.6200111
			5799

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(PS\_R01,2)

Method: Least Squares

Sample(adjusted): From 1972-73 to 2001-02

Included observations: 30 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(PS_R01(-1))	-	0.173090757	-	0.0016789
	0.60162096	539	3.475754438	6972658
	8718		15	

C	1.00594475	0.639760188	1.572377853	0.1270960
	22	813	13	25157
R-squared	0.30141235	Mean dependent var	0.0122233	
	0619		333333	
Adjusted R-squared	0.27646279	S.D. dependent var	3.6852884	
	1713		502	
S.E. of regression	3.13474285	Akaike info criterion	5.1873118	
	376		2106	
Sum squared resid	275.145157	Schwarz criterion	5.2807249	
	258		7984	
Log likelihood	-	F-statistic	12.080868	
	75.8096773		9143	
	159			
Durbin-Watson stat	1.88930032	Prob(F-statistic)	0.0016789	
	311		6972658	

**ADF test of second difference with intercept for PS/R**

ADF Test Statistic	-6.36182537571	1% Critical Value*	-3.67524204413
		5% Critical Value	-2.96645422271
		10% Critical Value	-2.62201324541

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(PS\_R01,3)

Method: Least Squares

Sample(adjusted): From 1973-74 to 2001-02

Included observations: 29 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(PS_R01(-1),2)	-1.21209814915	0.190526787136	-6.36182537571	8.20134464509e-07
C	-0.693723207787	0.00855898223903	-0.990246865583	
			0.0123377481724	
R-squared	0.599838880971	Mean dependent var	0.10424137931	
Adjusted R-squared	0.585018098785	S.D. dependent var	5.79733964582	
S.E. of regression	3.73459337912	Akaike info criterion	5.53962702682	
Sum squared resid	376.574068099	Schwarz criterion	5.63392329095	
Log likelihood	-78.3245918888	F-statistic	40.4728221111	
Durbin-Watson stat	2.12727921642	Prob(F-statistic)	8.20134464509e-07	

**ADF test of first difference with intercept for Y/R**

ADF Test Statistic	-	1% Critical Value*	-
	2.87309610		3.6660666
	558		1797
		5% Critical Value	-
			2.9626554
			3832
		10% Critical Value	-
			2.6200111
			5799

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

Augmented Dickey-Fuller Test Equation  
 Dependent Variable: D(Y\_R01,2)  
 Method: Least Squares

Sample(adjusted): From 1972-73 to 2001-02  
 Included observations: 30 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(Y_R01(-1))	- 0.179945261		- 0.0076699	
	0.51700002	036	2.873096105	5873675
	87		58	
C	0.57149765	0.444663441	1.285236421	0.2092393
	0955	943	64	76285
R-squared	0.22768594	Mean dependent var		-
	155			0.1062066
				66667
Adjusted R-squared	0.20010329	S.D. dependent var		2.3084476
	6606			2974
S.E. of regression	2.06460502	Akaike info criterion		4.3520954
	445			0159
Sum squared resid	119.352629	Schwarz criterion		4.4455085
	396			6036
Log likelihood	-	F-statistic		8.2546812
	63.2814310			3188
	238			
Durbin-Watson stat	1.42002396	Prob(F-statistic)		0.0076699
	945			5873675

**ADF test of second difference with intercept for Y/R**

ADF Test Statistic	-	1% Critical Value*	-
	4.15680643		3.6752420
	185		4413
		5% Critical Value	-
			2.9664542
			2271
		10% Critical Value	-
			2.6220132
			4541

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

Augmented Dickey-Fuller Test Equation  
 Dependent Variable: D(Y\_R01,3)  
 Method: Least Squares

Sample(adjusted): From 1973-74 to 2001-02  
 Included observations: 29 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(Y_R01(-1),2)	- 0.213142210		- 0.0002919	
	0.88599091	917	4.156806431	47216954
	3239		85	
C	- 0.440460728		- 0.7297869	
	0.15372641	19	0.349012763	36129



	6148		93
R-squared	0.39023067	Mean dependent var	-
	854		0.2265793
			10345
Adjusted R-squared	0.36764662	S.D. dependent var	2.9804524
	9597		24
S.E. of regression	2.37007512	Akaike info criterion	4.6301924
	694		4446
Sum squared resid	151.665914	Schwarz criterion	4.7244887
	898		0859
Log likelihood	-	F-statistic	17.279039
	65.1377904		7118
	446		
Durbin-Watson stat	1.73924478	Prob(F-statistic)	0.0002919
	611		47216954

**ADF test of first difference with intercept for SDR/R**

ADF Test Statistic	-	1% Critical Value*	-
	3.68720068		3.6660666
	753		1797
		5% Critical Value	-
			2.9626554
			3832
		10% Critical Value	-
			2.6200111
			5799

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(SDR\_R01,2)

Method: Least Squares

Sample(adjusted): From 1972-73 to 2001-02

Included observations: 30 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(SDR_R01(-1))	-	0.176115828	-	0.0009655
	0.64937440	339	3.687200687	81294034
	3338		53	
C	1.14309584	0.501015044	2.281559915	0.0303201
	196	308	1	081245
R-squared	0.32684943	Mean dependent var		0.01652
	3445			
Adjusted R-squared	0.30280834	S.D. dependent var		2.6046526
	1782			6258
S.E. of regression	2.17483297	Akaike info criterion		4.4561212
	038			6099
Sum squared resid	132.437156	Schwarz criterion		4.5495344
	574			1976
Log likelihood	-	F-statistic		13.595448
	64.8418189			9102
	148			
Durbin-Watson stat	2.25303861	Prob(F-statistic)		0.0009655

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