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TEST OF THE MONETARY MODEL FOR THE CASE OF RUSSIA, 1992–1993 AND GERMANY 1991-1993

Irina S. SEMENOVA and Andreas WÖRGÖTTER

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"TEST OF THE MONETARY MODEL FOR THE CASE OF RUSSIA, 1992–1993 AND GERMANY 1991–1993"

Irina S. SEMENOVA
University of Bath, UK

Andreas WÖRGÖTTER
Department of Economics, IAS, Vienna

Bestellungen: Institut für Höhere Studien
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Test of the Monetary Model for the Case of Russia, 1992-1993 and Germany 1991-1993.

Irina S. Semenova

I. Introduction

The aim of the author was to compare the recent evidence for the classical flexible-price monetary model of the long-run exchange rate determination for two different types of economies: a developed economy and one undergoing transition. In particular, in this paper the monetary exchange rate model is tested for the Russian case, for the period January 1992 - February 1994, and for the case of Germany during 1991 - 1993, that is, after the economic unification took place. The problem was to try to find an existing standard methodology which could explain the exchange-rate phenomena in the Russian economy since the moment of price liberalisation in January 1992, and to compare the results of the modelling to those for a "standard" market economy. German case have been chosen for this comparison as one of the most often studied in the literature on exchange rate economics. Moreover, during the period of the inflation in 1920-23 the conditions of the German economy could have been partly similar to the case of the Russian inflation today.

It is argued sometimes that in the situation of rapidly changing prices, the monetary approach becomes more valid. It can better explain the main factors determining the long-term exchange rate. One should take into account that the Russian case is specific because of the deformed interrelations in the economy in transition. During the period studied it could be already considered as a market economy, even though a lot of parts of a market environment had been not developed, like the market for non-money assets, for instance, which can be considered as a significant one only since the end of 1992. The simple flexible-price version of the monetary approach seems to be more suitable in this case than, for example, portfolio balance approach. The other essential feature of the Russian economy is high rate of inflation during the studied period. Therefore, implementing the standard approach to a non-standard economy like Russian may require certain adjustment to the existing reality.

The paper will proceed as follows. Section 2 gives a theoretical description of the classical monetary approach to long-run exchange-rate determination. This part includes a description of the model and modifications done. Section 3 presents the data sets and the empirical evidence. Section 4 gives conclusions.

II. The Monetary Approach

The monetary model

The monetary approach explains the long-run nominal exchange rate in terms of relative national money supply and demand. It relies on the assumptions of continuous purchasing power parity (PPP) and the existence of stable money demand functions for the domestic and foreign economies. It can be stated as follows:

$$e = a + b(m-m^*) - c(y-y^*) + d(R-R^*) \qquad \textbf{(1)}$$

Where **e** is the logarithm of the nominal exchange rate, which may be assumed to depend on the **m**'s and **y**'s which are logs of money supply and real income, and **R**'s which are levels of interest rates. Foreign variables are denoted by an asterisk.

One of the first tests of the above equation was conducted by Frenkel (1976) for the German mark/US dollar exchange rate over the period 1920-23. Since this period corresponds to the German hyperinflation, Frenkel argued that domestic monetary effects will overwhelmingly dominate the exchange-rate equation, and, thus, the domestic income variable and even foreign variables could be dropped, and attention focused simply on the effects of German money growth and the expected inflation.

There are three formulations of the monetary exchange rate model - the flexible-price, sticky price and real interest differential specifications. Equation (1) represents the first one, which was also the first to be formulated and tested. Even the latest developments of the model are more complicated and the assumptions are more flexible, the last period evidence is not so supportive of the monetary model. The studies of interwar period and of next one until the late 1970s were largely supportive of this approach. In particular Dornbush (1979) studying flexible-price model and Frankel (1979) studying real interest differential model of the mark-dollar exchange rate both obtained results which can be considered as good explanation. However, if the sample period is extended, the ability of the model to track the exchange rate is worsening. In many reports after 1978 few coefficients were correctly signed, the equations had poor explanatory power as measured by the coefficient of determination, and residual autocorrelation was a problem (MacDonald and Taylor, p.11).

Nevertheless, the monetary model seems to be the better approach for the case of Russia. The other main view of exchange rate determination - the portfolio balance approach - hardly can be applied to the Russian economy, where in 1992 there was almost no market for securities. The other reason for testing this particular approach is high inflation in Russia during the 1992 -1993. Due to rapidly growing prices Russian case could be close to one studied by Frenkel.

The interest rate is assumed to be equal to expected inflation in the Interest Rate Parity condition under PPP. In the flexible-price model the change in the interest differential and the expected change in the exchange rate, both of which reflect inflationary expectations, are interchangeable. However, in case of Russia an interest rate could not be considered as perfect indicator of inflationary expectations until 1993. Two interest rates which are available for the period 1992-1993 are: the Central Bank of Russia refinance rate and the interbank credits rate. The structure of credits changed significantly during this period, therefore it is difficult to choose a rate which is representative during all the period studied. The CBR refinance rate, being settled from above, could be hardly considered as a perfect market indicator. Therefore in order to reflect the inflationary expectations in the model the inflation rate differential has been used. Expected inflation is assumed to be equal to current inflation. Thus, the exchange-rate equation can be written:

$$e = a + b(m-m^*) - c(y-y^*) + d(i-i^*) \qquad (2).$$

Description of the Data

The above models have been tested using a data set with 26 monthly observations, from January 1992 to February 1994 for the case of Russia. Data for the US indicators (M2, interest rate, CPI, industrial production) have been taken from different issues of the IMF *International Financial Statistics*. The source of the Russian macroeconomic indicators was *Russian Economic Trends*, Monthly Updates, April 20, 1993 and December 20, 1993. Most of the indicators presented here are given by Goskomstat (The State Committee for Statistics). The information on exchange rates is published regularly in *Commersant Weekly* (1992 data) and *Commersant Daily* (1993-1994 data).

The classical monetary long-run exchange-rate model deals with money supply, income and expected inflation variables. The choice of the macroeconomic indicators for both countries was made taking into consideration the possibility of their comparison between two countries, so that the methodology of obtaining these indicators should be the same or at least relatively close for the USA and Russia. Therefore M2 stands for money supply, and real industrial production is taken as national income variable. The change of CPI rate is used as the rate of inflation. Treasury Bill Rate is used as the US interest rate, in case of Russia the CBR refinance rate is taken.

The expected inflation is assumed to be equal to current inflation rate, as it was mentioned above. Actually the inflationary expectations for Russia varied during the analysed period. In order to trace this one could use several different models for different periods and cut the two-year one into shorter periods. But this may lead to unreliable statistical outcome because the data set in such a case will be not sufficient for the regression analysis.

For the test of the German mark/dollar rate case the sources of data were different ussues of *International Financial Statistics.* For the money supply term seasonally adjusted M2 is taken for both countries, all other variables are similar to US variables in the previously discussed test.

As the currency conversion in Germany took place on July 1990, it may be reasonable to assume a certain adjustment period, several months at least. During the second half of 1990 the effects of the economy division into western and eastern parts seem to be strong enough and may affect the results of the analysis. The model is tested for the three-year period starting in January 1991. The last observation is January 1994, therefore 37 monthly observations are used for the analysis, with the exchange rate set on the last day of each month. Full samples are presented in the Appendix.

Empirical evidence

For the case of ruble/dollar exchange rate equations (1) and (2) were tested using OLS regression. Full regression outputs for four versions are given in Table 1.

TABLE 1.

ESTIMATES OF THE EXCHANGE RATE EQUATION RUBLE/DOLLAR EXCHANGE RATE

	Cons-tant	**(m-m*)**	**(y-y*)**	**(i-i*)**	**(R-R*)**	**F(3,22)**	**Adj. R square**	**Root MSE**
1. Equation (2) with inflation rates. No lags.	5.633 (0.081)	0.912 (0.057)	1.035 (0.396)	0.004 (0.001)	-	366.3	0.977	0.133
2. Equation (2) with inflation rates. Lagged **m**	5.769 (0.083)	0.879 (0.053)	0.930 (0.373)	0.003 (0.001)	-	399.66	0.980	0.127
3. General equation with interest rates. No lags	5.922 (0.144)	0.957 (0.107)	0.770 (0.693)	-	-.003 (002)	145.52	0.945	0.207
4. Cochrane-Orcutte procedure; general equation with interest rates and lagged **m**	6.031 (0.077)	1.016 (0.051)	0.430 (0.339)	-	-.004 (.0009)	580.32 *	0.987	0.105

* **F-statistics** in the case 4 is for 20 degrees of freedom: F(3,20)

Standard errors of the coefficients are given in brackets.

It can be mentioned that the formulation which includes inflation rates as inflationary expectations term has better explanatory power than the classical formulation with the interest rate differential (see items 1 and 3 above). It is also worth mentioning that adding a one-month lag to the money differential improves the model (item 2 compared with item 1 shows better coeffissients and general charateristics of the model).

Cases 1 and 2 (Equation (2)) with and without one-month lag in the money differential) presented in the Table 1 are illustrated by the graphs 1 and 2 which are given below.

Running the regression for the residuals one can obtain the result demonstrating a strong dependence of **u[t] and u[t-1].** It means that first-order serial correlation exists. In order to avoid this it is possible to run Cochrane-Orcutt regression. This have been done for the Equation (1) which included lagged money differential. This test gave the best result from the point of view of the performance of the model. However, the income differential coefficient is insignificant and the interest differential coefficient is negative in this case.

The coefficient on the money supply variable is close to unity in all cases, but is not exactly unity as suggested by the theoretical model. It turns to be 0.879 minimum and 1.016 maximum for different versions of the equation.

The income variable *y* is wrong signed and insignificant for most versions of the model. One could argue that monetary factors contributes more to the weakness of ruble than sustained decrease in real production which has taken place in the Russian economy during all the transition period.

TABLE 2

ESTIMATES OF THE EXCHANGE RATE EQUATION
GERMAN MARK/DOLLAR EXCHANGE RATE

	Cons-tant	**(m-m*)**	**(y-y*)**	**(R-R*)**	**F(3,33)***	**Adj. R-square**	**Root MSE**
1. Equation (1) No lags	0.767 (0.437)	0.134 (0.369)	0.129 (0.439)	-0.036 (0.009)	7.62	0.355	0.048
2. Equation (1) lagged **m**	1.489 (0.296)	0.729 (0.245)	0.857 (0.318)	-0.048 (0.008)	12.52	0.489	0.043

* The critical value for the F(3,33) at 5% significance level is approximately 8.61.

The performance of the flexible-price monetary model in the case of Germany is not so good as in the case above. Even though this model seems to explain the trend of the exchange rate. The results of testing Equation (1) for the German mark/dollar exchange rate are presented in Table 2.

It is obvious that the results of the first test are not supportive of the monetary model in form of Equation (1). F-statistics is 7.62 which is below the 5 % critical value, equal approximately to 8.61. This suggests that the model is misspecified. All coefficients apart from the interest differential are insignificant. However, if the money differential in the Equation (1) is replaced with the lagged one, the results of the test suggest that the monetary model can explain the changes in the German mark/dollar exchange rate. One month lag is used here as in the case for the ruble/dollar exchange rate.

Graphs 4 and 5 present predicted by the model and actual values of the exchange rate for the end of each month. One can mention that the trend of the exchange rate is predicted relatively well, even some sharp increases and decreases in the German mark rate are reflected by the curve of predicted values, for instance, the drop in December 1992. All coefficients are significant, however only the money differential coefficient is signed correctly. Nevertheless, the explanatory quality of the model is significant, as suggested by the F-statistics which is equal to 12.52 and therefore exceeds the critical value of 8.61. The coefficient of determination is close to 0.5 in this test which could be considered as a good result for this particular case.

Conclusions

The monetary model in the flexible-price formulation, adjusted to the case of Russia during the 1992-1993 is valid. The results of the test of the similar model for the case of German mark/US dollar exchange rate are less supportive of the model, even though the model does work in case of certain adjustment. For both economies the tendency of exchange-rate changes is predicted well by the model.

The main results of the regression analysis are as follows.

- The main contribution to the current ruble-to-dollar exchange rate is made by the changes of the money supply in Russia. Interest rate as a variable reflecting inflationary expectations seems to be not a better choice for the model in comparison with the inflation rate. This could be caused by the specific conditions of the transitionary economy with high inflation.
- The income variable turns out to be signed incorrectly and even insignificant because monetary effects prevail, and it could be removed from the model, as suggested by Frenkel for an economy overcoming hyperinflation.

- The first-order serial correlation is a problem for both Russian and German dollar exchange rates. Cochrane-Orcutt procedures being used allows us to avoid this problem.
- The regression model can be improved significantly by using one-month lag in money supply variables for both Russian and German cases.
- The interest differential coefficient turns to be negative for both tests.

The monetary approach explains the main factors determining the exchange rate rather well for the economy in transition. Money supply dynamics have the most important influence, and the inflation rate contributes through the two channels, mentioned below. First, current inflation affects inflationary expectations of the market participants and, second, it is a type of anchor for the policy of the CBR as the main player in the Russian exchange market.

For the developed economy the explanatory power of the monetary model is relatively lower, however, if lags in the monetary variables are used, it does predict the tendencies of main changes in the exchange rate. The volatility of the exchange rate is much bigger in the developed economy, than in the Russian economy. Some factors which are not specified in the model may contribute to the changes in the mark/dollar exchange rate as well.

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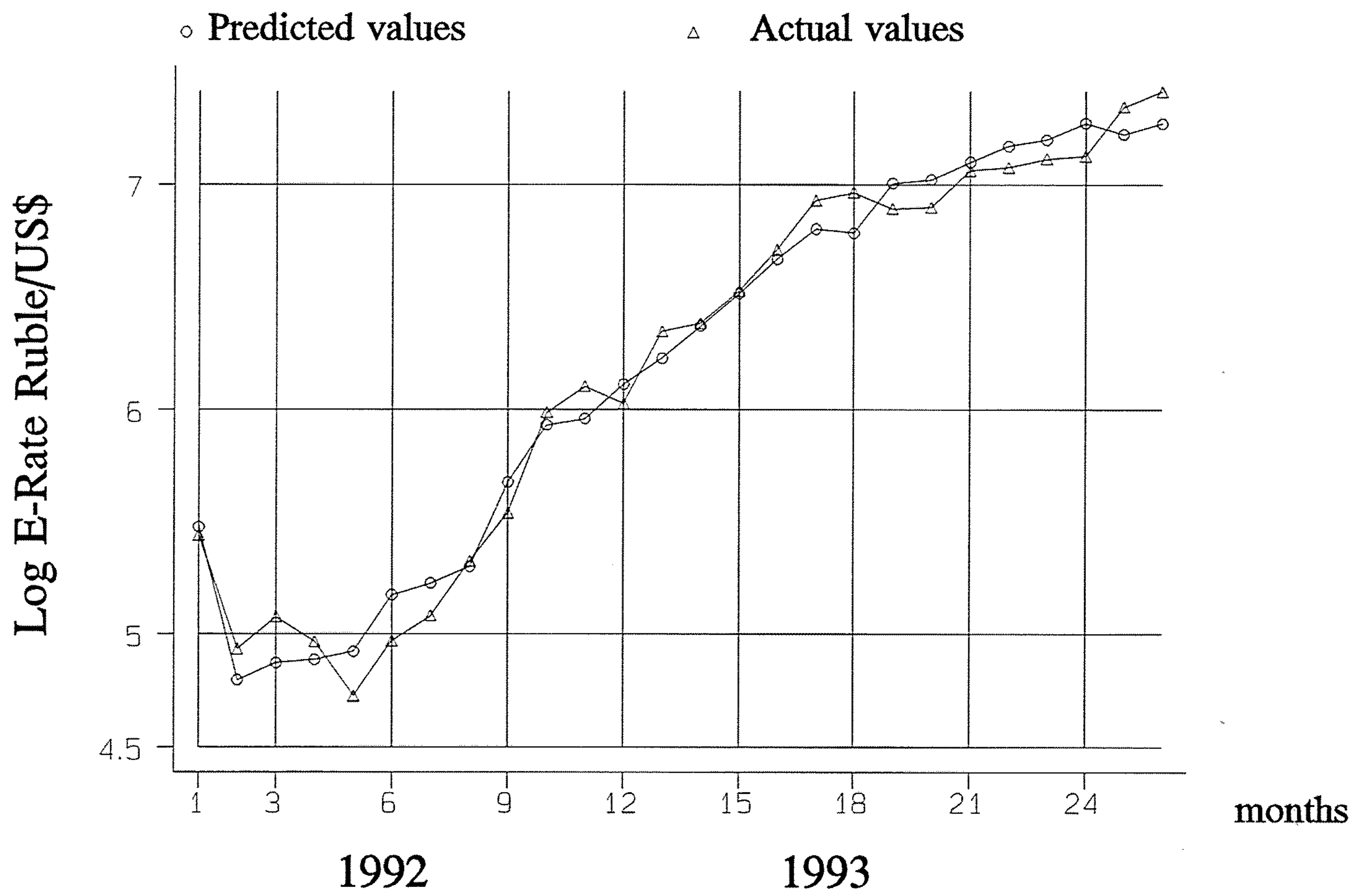
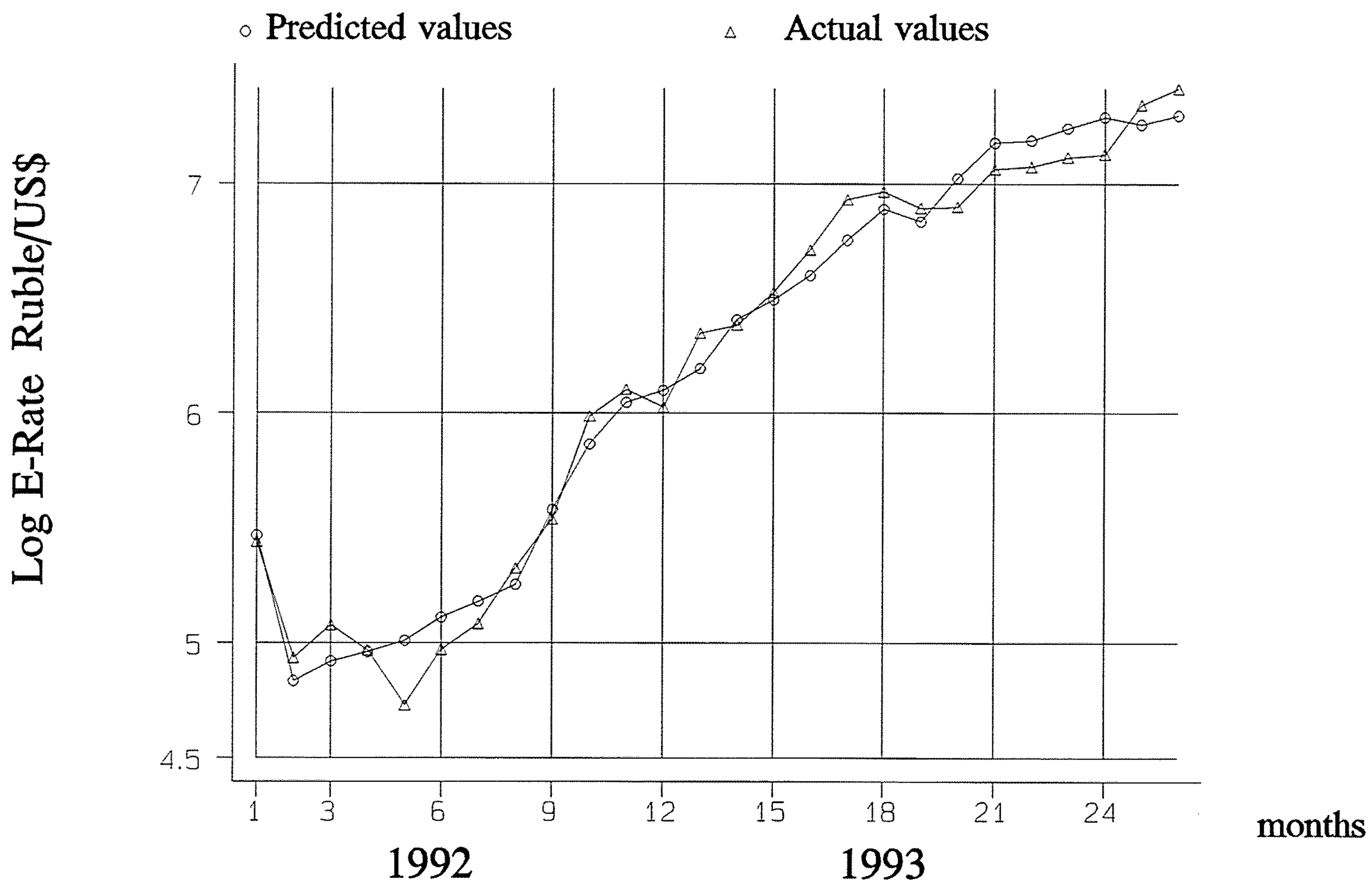
APPENDIX

Graph 1



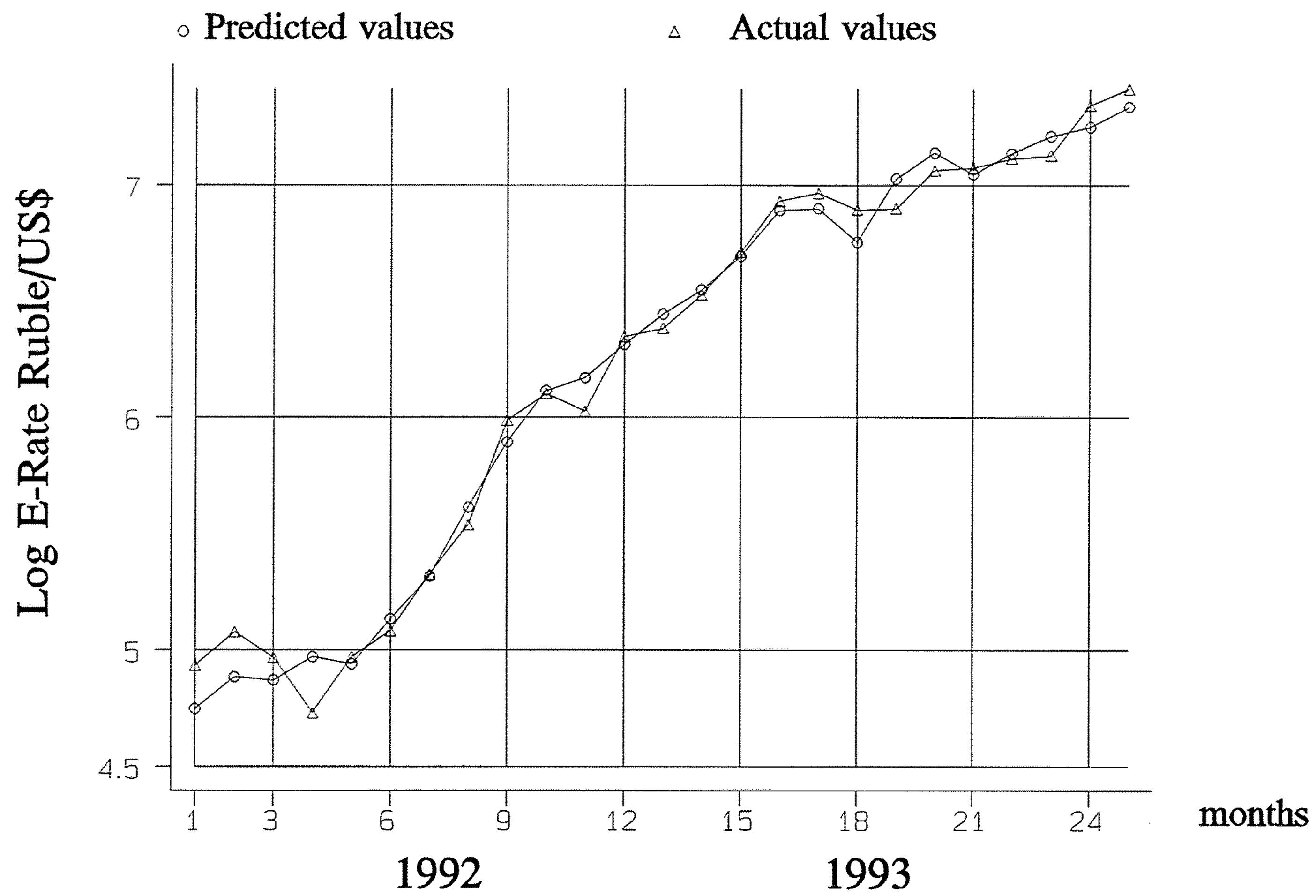
Monetary Model of Exchange Rate Ruble/US$ Using CPI

Graph 2



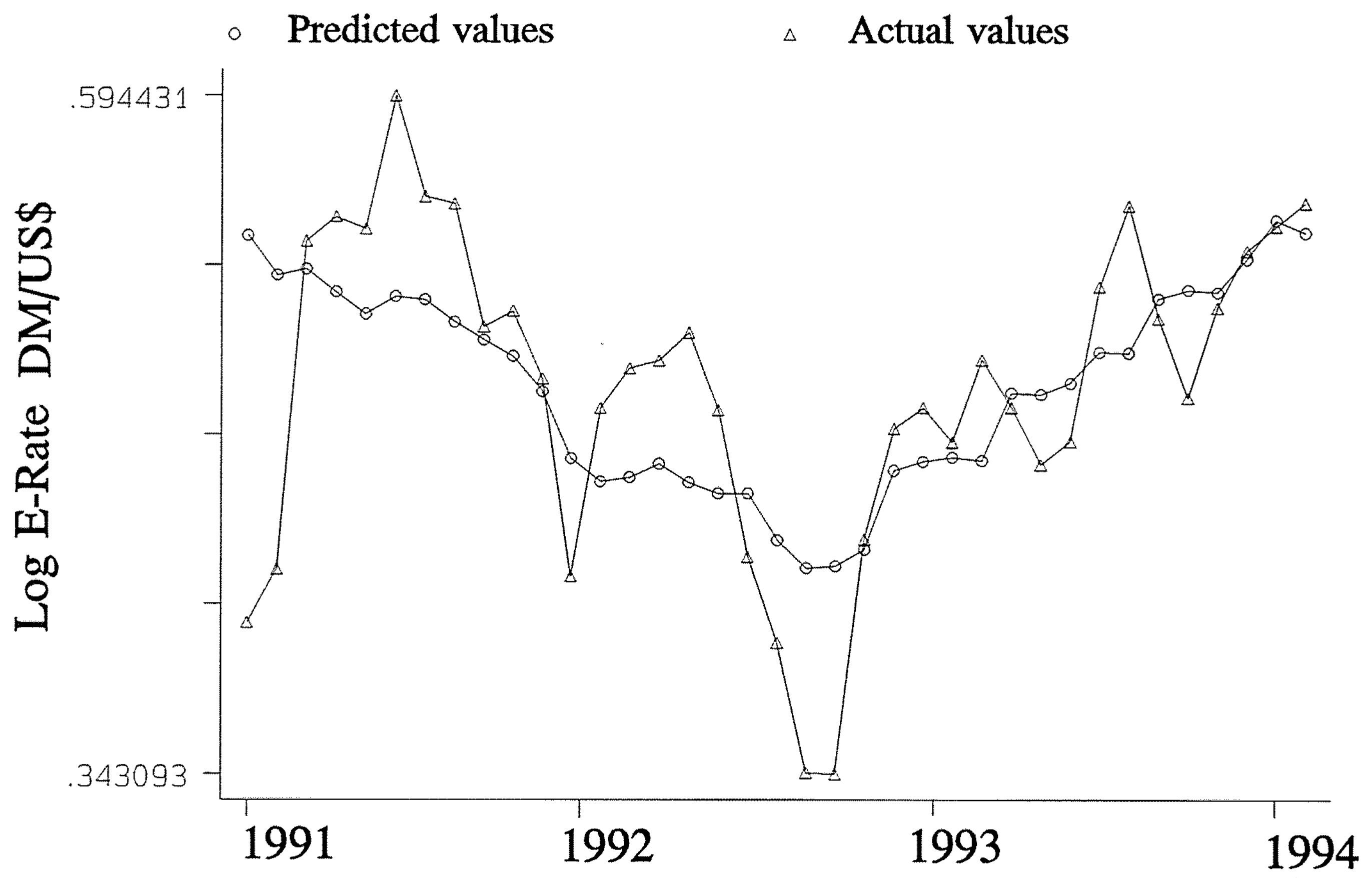
Model of Exchange Rate Ruble/US$ Using CPI and Lagged m^R-m^{US}

Graph 3



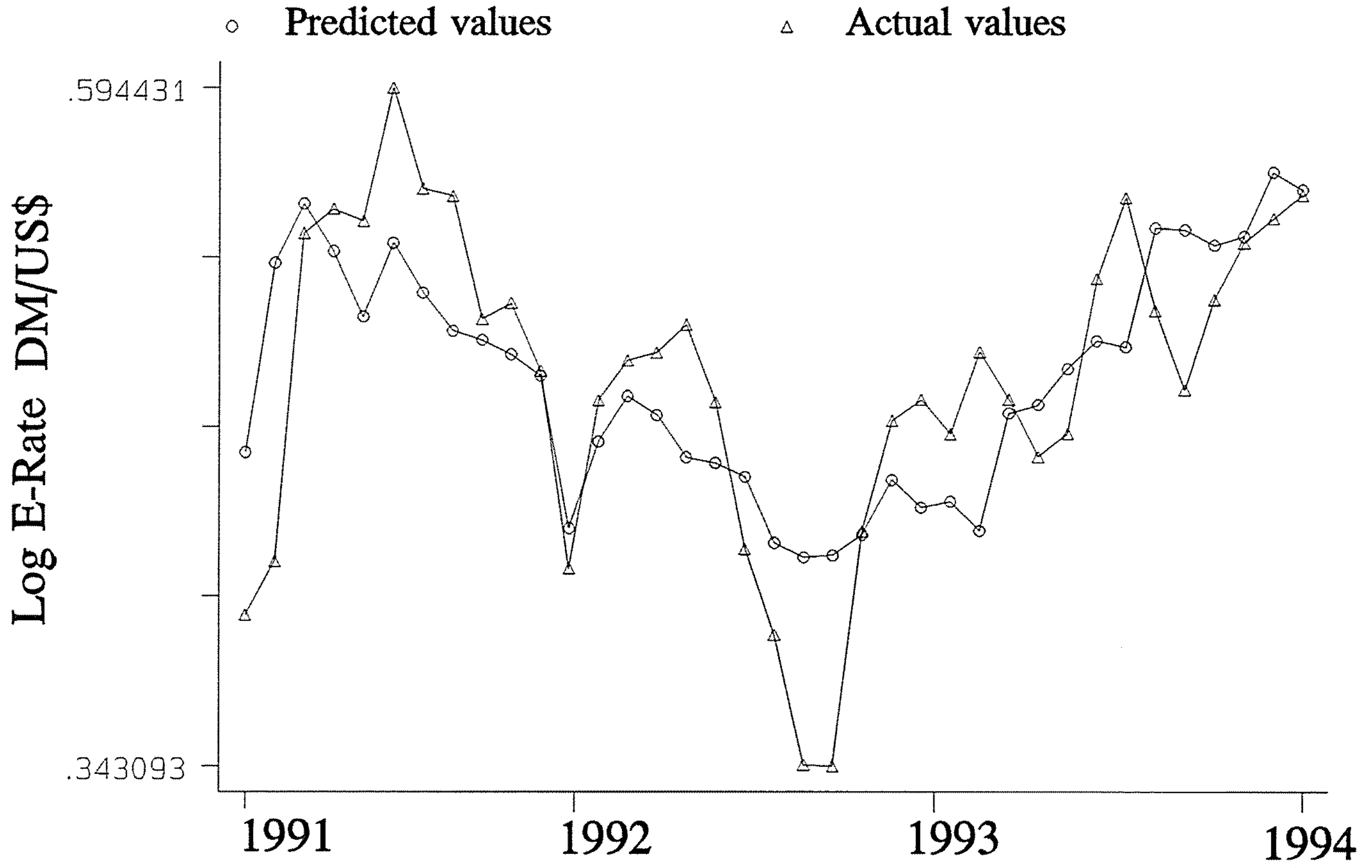
'Corced' Model of Exchange Rate Ruble/US$ With Interest Rates and Lag in $m^{R}-m^{US}$

Graph 4



Simple Monetary Model of Exchange Rate DM/US$

Graph 5



Monetary Model of Exchange Rate DM/US$ With Lagged $m^G - m^{US}$

DATE	Exchange Rate DM/$	Money Supply Seasonally Adjusted	Treasury Bill Rate	CPI	Industrial production Seasonally Adjusted
01M91	1,49	953,7	8,2	108,8	122,1
02M91	1,5202	964,8	8,2	109,1	119,9
03M91	1,717	968,1	8,2	109	121,5
04M91	1,7325	968,5	8,2	109,5	121,1
05M91	1,7247	978,2	8,2	109,9	120,4
06M91	1,812	982,7	8,2	110,5	123,9
07M91	1,7458	996	8,2	111,5	121,8
08M91	1,7408	1004,2	8,2	111,5	119,8
09M91	1,6631	1008,4	8,2	111,7	120,4
10M91	1,6731	1016,7	8,2	112	120,6
11M91	1,6318	1022,9	8,2	112,5	121,1
12M91	1,516	1035,2	8,3	112,6	116,3
01M92	1,6137	1051,5	8,5	113,1	122,4
02M92	1,6378	1060,1	8,5	113,8	124
03M92	1,6427	1071,8	8,5	114,2	121,7
04M92	1,6598	1084,5	8,5	114,5	120,8
05M92	1,6128	1089,5	8,5	115	120,8
06M92	1,527	1098,7	8,5	115,2	119,2
07M92	1,479	1113,4	8,6	115,2	119,1
08M92	1,4097	1120,1	8,7	115,4	118,8
09M92	1,4093	1154,2	8,7	115,7	119
10M92	1,537	1153	8,2	116,1	116,1
11M92	1,6015	1155,8	7,6	116,7	114,2
12M92	1,614	1148,6	7,5	116,8	111,8
01M93	1,5935	1152,3	7,4	118,1	111,1
02M93	1,643	1157,9	7,2	118,6	109,8
03M93	1,6143	1176,4	6,7	119	111,2
04M93	1,5802	1184	6,6	119,4	110,5
05M93	1,594	1190,3	6,6	119,8	110,8
06M93	1,6882	1204,1	6,4	120	110,8
07M93	1,7397	1215,4	6,3	120,2	109,9
08M93	1,6683	1215,6	5,8	120,2	111,9
09M93	1,6199	1222,6	5,7	120,3	111,6
10M93	1,6753	1227,7	5,7	120,6	111,2
11M93	1,711	1237,1	5,4	120,9	109,9
12M93	1,7263	1265,5	5,1	121,1	111,4
01M94	1,7414	1281,6	5,1	122,2	109,7

DATE	Money supply M2	Money supply Seasonally Adjusted	Treasury Bill Rate	CPI	Industrial production Seasonally Adjusted
01M91	3358,5	3353,7	6,3	125,1	111,8
02M91	3363,4	3369	5,9	125,3	110,8
03M91	3392,5	3386,2	5,9	125,5	110,1
04M91	3414,9	3396	5,7	125,7	110,6
05M91	3392,4	3407,2	5,5	126	111,6
06M91	3411,7	3416,2	5,6	126,4	112,5
07M91	3414,7	3415,9	5,6	126,6	113,2
08M91	3413,3	3417	5,4	127	113,2
09M91	3407,6	3418,1	5,2	127,5	113,7
10M91	3417	3422,5	5	127,7	113,7
11M91	3438,4	3435,8	4,6	128,1	113,3
12M91	3457,9	3445,8	4,1	128,2	112,6
01M92	3456	3451	3,8	128,3	111,8
02M92	3462,3	3467,7	3,8	128,8	112,4
03M92	3489,4	3486,3	4	129,5	112,8
04M92	3498,9	3481,9	3,8	129,6	113,3
05M92	3467,4	3482,1	3,7	129,8	114,2
06M92	3473,4	3477,8	3,7	130,3	113,8
07M92	3478,1	3480,7	3,3	130,6	114,7
08M92	3484,1	3489,4	3,1	130,9	114,4
09M92	3486,7	3496,6	3	131,3	114,2
10M92	3504,6	3507,5	2,8	131,8	115
11M92	3517,4	3510,5	3,1	132	115,8
12M92	3527,6	3509	3,2	131,9	116,2
01M93	3508,3	3502,8	3,1	132,5	114,6
02M93	3484,2	3494,2	2,9	133	115,2
03M93	3495,8	3494,8	3	133,5	115,4
04M93	3515,2	3498	2,9	133,8	115,8
05M93	3507,3	3521,9	3	134	115,5
06M93	3524,4	3528,7	3,1	134,2	115,9
07M93	3529,8	3533,5	3	134,2	116,2
08M93	3528,6	3535,7	3	134,6	116,4
09M93	3533,2	3543,6	3	134,9	116,8
10M93	3543,1	3545,1	3	135,4	117,5
11M93	3564,9	3556,2	3,1	135,5	118,7
12M93	3585,7	3563,1	3,1	135,5	119,5
01M94	3576,5	3569,8	3	135,9	120

RUSSIAN DATA

DATE	Ruble/ Dollar Exchange Rate	% change of CPI	Money Supply M2 bln.rubles	Industrial production Seas.Adj. Dec 91=100	Refinance rate CBR
Dec-91	169,2	12,1	960	100	20
Jan-92	230	245	1046	98	20
Feb-92	139	38,3	1204	98	20
Mar-92	160,3	29,8	1369	98	20
Apr-92	143,6	21,6	1506	94	50
May-92	113	12	1641	94	50
Jun-92	144	18,6	2093	94	80
Jul-92	161,2	11	2668	83	80
Aug-92	205	9	3422	72	80
Sep-92	254	12	4515	80	80
Oct-92	398	23	5722	81	80
Nov-92	447	26	6038	79	80
Dec-92	414,5	25	7140	80	80
Jan-93	572	26	8447	75	80
Feb-93	593	25	9300	80	100
Mar-93	684	20	10890	82	100
Apr-93	823	19	13400	80	100
May-93	1024	18	15961	78	100
Jun-93	1060	20	16200	76	140
Jul-93	987	22	22204	71	170
Aug-93	992,5	26	25119	64	170
Sep-93	1169	23	25926	68	180
Oct-93	1184	20	28700	68	210
Nov-93	1231	16	31101	67	210
Dec-93	1247	13	34589	67	210
Jan-94	1548	18	37828	58	210
Feb-94	1659	11	38500	60	210

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