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Forecasting the Us Dollar Exchange Rate Using Excel Using Brown's Linear Model

Dotsent, Mambetov J. I., Master's student, Azimova C.K
Osh Technological University named after. M.M. Adysheva

Docent, Makhkamov G. U.
Namangan engineering-construction institute

Abstract: The US dollar exchange rates in Kyrgyzstan for the last 19 months (03.2023-09.2024) were obtained and a forecast for the next twentieth month was made. The forecast was made using the Brown linear model. Calculations were made in Excel.

Key words: US dollar exchange rate, Brown's linear model, adaptive model, econometrics.

Econometric model is the basic concept of econometrics [1-3]. Using econometric model, it is possible to make analysis and forecasting on statistical data. Brown model is often used for forecasting cash flows and securities. Here the exponential smoothing method is considered. In this model, the forecast is made by averaging the levels in the initial given line.

Problem statement and solution.

Let us consider the initial time series, which contains 19 levels of observation of this indicator Y(t) (US dollar exchange rates in Kyrgyzstan. The data were obtained based on the best exchange rates posted on the “Exchange Rates” page on the Banks.kg portal):

Table No. 1

03.23	04.23	05.23	06.23	07.23	08.23	09.23	10.23	11.23	12.23
87,32	87,43	87,51	87,07	87,35	87,78	88,55	88,8	88,6	89,23
01.24	02.24	03.24	04.24	05.24	06.24	07.24	08.24	09.24	10.24
88,81	89,37	89,48	89,36	87,56	87,15	85,63	85,4	84,18	?

Let's use the adaptive forecasting scheme.

We will make the forecast in stages.

Forecasting using Brown's double exponential smoothing method:

Stage 1. We will obtain initial estimates of the parameters for the first five points (Table No. 1) using the least squares method (LSM) according to the formulas:

$$A_1 = \sum \left[\left(t - t_{cp}\right) \cdot \left(Y(t) - Y_{cp}\right)\right] \Big/ \sum \left(t - t_{cp}\right)^2, \qquad (1)$$

$$A_0 = Y_{cp} - A_1 \cdot t_{cp}, \qquad (2)$$

Where t_{cp} — average value of the "time" factor;

$У_{cp}$ — average value of the indicator under study.

We solve equations (1) and (2) in Excel. First, we enter the dollar exchange rates for the first 5 months, i.e. for March, April, May and June 2023, on a new Excel sheet (see Figure 1).

	A	B	C	D	E	F
1	t	Y(t)	(t-tcp)^2	Y(t)-Ycp	t-tcp	(Y(t)-Ycp)(t-tcp)
2	1	87,32				
3	2	87,43				
4	3	87,51				
5	4	87,07				
6	5	87,35				
7	tcp=3	Ycp=87,34				

Figure 1. Data entered.

We calculate using the formulas shown in Figure 1. As a result, using formula (1), (2) we can determine A1, A0. The calculation results are shown in Figure 2.

	A	B	C	D	E	F
1	t	Y(t)	(t-tcp)^2	Y(t)-Ycp	t-tcp	(Y(t)-Ycp)(t-tcp)
2	1	87,32	4	-0,02	-2	0,04
3	2	87,43	1	0,09	-1	-0,09
4	3	87,51	0	0,17	0	0
5	4	87,07	1	-0,27	1	-0,27
6	5	87,35	4	0,01	2	0,02
7	tcp=3	Ycp=87,34	10	0	0	-0,3
8						
9			**A1=**	**-0,03**		
10			**A0=**	**87,43**		
11						

Figure 2. Estimation of initial values of model parameters

Step 2: Let's take k=*1* . α smoothing parameter equal to 0.5.

Substituting into the trend equation t =1, we find: $Y_p(1) = 87{,}43 - 0{,}03 \cdot 1 = 87{,}4.$

Forecast error: $e(1) = Y(1) - Y_p(1) = -0{,}08.$

Step 3: Adjusting the coefficients taking into account errors:

$$A_1(t) = A_1 + (1-\beta)^2 e(t),$$

$$A_0(t) = A_0 + A_1 + (1-\beta^2)e(t).$$

In the conditions of the problem α = 0,5. Respectively β = 1-α=0,5.

Let's use the Data Analysis package in Excel:

$A_1(1) = D2 + (1-0,5)^2 * F3,$

$A_0(t) ==\ C2 + D2 + (1-0,5^2) * F3.$

The calculation results are shown in Figure 3.

	A	B	C	D	E	F
1	t	$Y(t)$	A_0	A_1	$Y_p(t)$	$e(t)$
2			87,43	-0,03		
3	1	87,43	87,394	-0,032	87,4	-0,008
4						
5						

Figure 3.

Step 4: The next forecast is made based on the latest adjusted coefficients (Figure 4):

$Y_p(2) = C3 + D3 = 87,29,$

$e(2) = Y(2) - Y_p(2) = B4 - E4 = 0,14.$

	B	C	D	E	F
1	$Y(t)$	A_0	A1	$Y_p(t)$	e(t)
2		87,43	-0,03		
3	87,32	87,34	-0,05	87,4	-0,08
4	87,43	87,395	-0,015	87,29	0,14

Figure 4.

Step 5: We make another forecast when t=3:

$Y_p(3) = C4 + D4 = 87,38,$

$e(2) = Y(2) - Y_p(2) = B4 - E4 = 0,13$

The results are shown in Figure 5.

	B	C	D	E	F
1	$Y(t)$	A_0	A1	$Y_p(t)$	e(t)
2		87,43	-0,03		
3	87,32	87,34	-0,05	87,4	-0,08
4	87,43	87,395	-0,015	87,29	0,14
5	87,51	87,4775	0,0175	87,38	0,13

Figure 5.

The procedure continues until the last observation. By copying cells B5-E5 and substituting into the following cells, we obtain forecasts for the following months.

Step 21: Let's make a forecast for the next two time periods (2024, October, November, see Figure 6):

$Y_p(20) = C21 + D21 = 83{,}45,$

$Y_p(21) = C21 + D2 * 2 = 82{,}6.$

	B	C	D	E	F
1	*Y(t)*	A_0	A1	$Y_p(t)$	e(t)
2		87,43	-0,03		
3	87,32	87,34	-0,05	87,4	-0,08
4	87,43	87,395	-0,015	87,29	0,14
5	87,51	87,4775	0,0175	87,38	0,13
6	87,07	87,1763	-0,0888	87,495	-0,425
7	87,35	87,2844	-0,0231	87,0875	0,2625
8	87,78	87,6503	0,10656	87,2613	0,51875
9	88,55	88,3517	0,30484	87,7569	0,79313
10	88,8	88,7641	0,3407	88,6566	0,14344
11	88,6	88,7262	0,21449	89,1048	-0,5048
12	89,23	89,1577	0,28682	88,9407	0,2893
13	88,81	88,9686	0,12819	89,4445	-0,6345
14	89,37	89,3017	0,19649	89,0968	0,27318
15	89,48	89,4845	0,19194	89,4982	-0,0182
16	89,36	89,4391	0,11282	89,6765	-0,3165
17	87,56	88,058	-0,3852	89,5519	-1,9919
18	87,15	87,2807	-0,5159	87,6728	-0,5228
19	85,63	85,9137	-0,7996	86,7648	-1,1348
20	85,4	85,3285	-0,7281	85,1141	0,28587
21	84,18	84,2851	-0,8332	84,6004	-0,4204
22				83,4519	
23				82,6187	0

Figure 6.

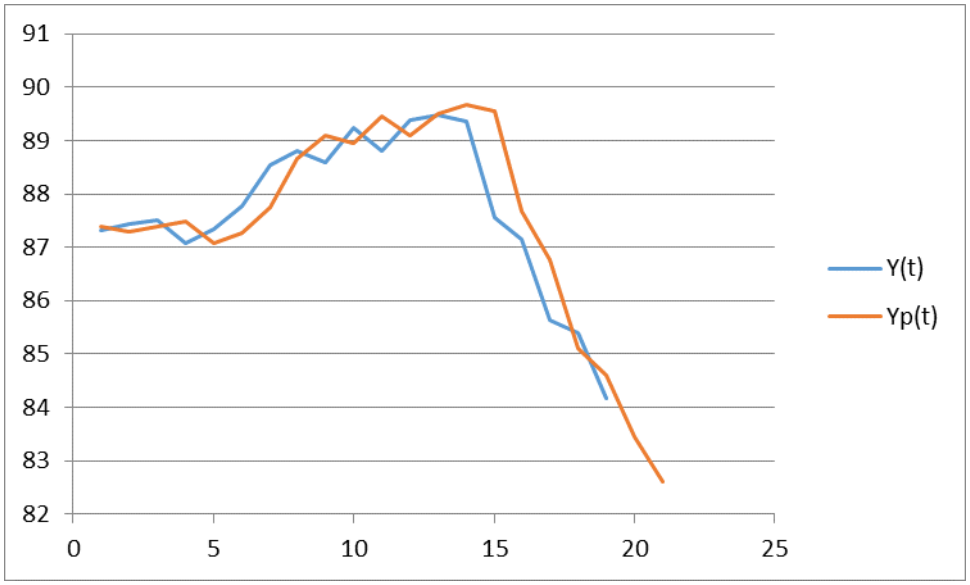

Figure 7. 1. Results of approximation and forecasting using the adaptive Brown model (the smoothing parameter is 0.5).

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