Igor Mikhailovich Posokhov
PhD, Professor
National Technical University
"Kharkiv Polytechnic Institute"
dglaz04@mail.ru

Irina Alekseevna Herashchenko
c.e.s., Associate Professor,
National Technical University
"Kharkiv Polytechnic Institute"

SECTION 31. Economic research, finance, innovation, and risk management.

QUASI ADAPTIVE PREDICTION BEHAVIOR OF THE EXCHANGE RATE AT THE EXAMPLE OF THE MARKET FOREX

Abstract: It is proposed an econometric model and an algorithm of Quasi adaptive forecasting the exchange rate on the FOREX market, based on the modeling a sign of uncertainty of the forecast.
Key words: Exchange rate, a sign of uncertainty, an econometric model, quasi-adaptive prediction.
Language: English
Citation: Posokhov IM, Herashchenko IA (2016) QUASI ADAPTIVE PREDICTION BEHAVIOR OF THE EXCHANGE RATE AT THE EXAMPLE OF THE MARKET FOREX. ISJ Theoretical & Applied Science, 08 (40): 23-26.
Soi: http://s-o-i.org/1.1/TAS-08-40-5   Doi: crossref http://dx.doi.org/10.15863/TAS.2016.08.40.5

Econometric models in the FOREX market are widely used [1, P. 814]. The traditional view of such models – regression equation or a system of econometric equations. Such models provide acceptable accuracy and have good predictive quality [2, P. 348]. It should be noted that the choice of form of the regression equation is more important than the estimation of its parameters. Subsequent studies revealed that the regression equations are convenient, if you are dealing with data that is monotonically increasing or decreasing [2, pp. 362-373]. If the data are characterized by large fluctuations, the use of regression equations are not so effective, because it leads to errors in excess of 20% for short-term forecasts. A number of studies indicated that the data used in the regression equations (prices, incomes, exchange rates, etc.) are non-stationary dynamics [3]. Exchange rate inconstancy may be characterized non-stationary mean and variance in the number of adjacent intervals. Checking for the presence (absence) of non-stationary time series, characterizing the dynamics of quotations currency pair may be carried out by inspections null hypotheses regarding the equality of means and variances on several adjacent intervals [3].

Ignoring the problems of non-stationary causes that parametric tests (in particular, t-test and F-test) are unreliable and may lead to erroneous results. But in spite of these limitations, completely abandon the regression equations is inappropriate, since under certain circumstances they are the most effective.

An important aspect is the consideration of the behavior of traders in the FOREX market as a whole. This mass behavior of market participants according to the law of large numbers can lead, firstly, to a certain dominant logic and, secondly, to provide information about the direction of the exchange rate dynamics, its acceleration or deceleration. For example, if the exchange rate tends to fall, it is likely that the currency can buy that has a chance to lead to an increase in the exchange rate. There may be situations of mass offers exchange rate. One cannot ignore the scale of the account of the dynamics of the exchange rate (minutes, hours, days, etc.).

The unsolved part of the problem of creating and using econometric models to predict the behavior of the exchange rate lies in the fact that in certain models explicitly take into account only information on the previous points in time. Despite the fact that in this situation using the adaptive model of interest to create versions of models that involve more information, in particular, carried out accounting errors in the distribution of the signs of the exchange rate forecast of changes (this is the essence of quasi-adaptive prediction).

The aim is to develop econometric models and forecasting the behavior of exchange rates, as well as providing advice on the use of models.

Suppose X_{t_1}, ... X_{t_2} - time series of successive observations of the behavior of the exchange rate, $(t_2 - t_1)$ - the length of the test section of the series. The challenge is to identify more or less stable dependency t-th observation from

the past and using information on such dependencies, the construction of the exchange rate forecast estimates on (t2 + 1)-th time. It`s [3, p. 340] considered a similar statement.

Adaptive prediction models use direct information on the dynamics of the number of levels of the exchange rate and the corresponding parameter adaptation. An example is the classic model of exponential smoothing [2, C. 17].

After analyzing a number of randomness and obtaining information about the behavior of a number it is already possible to make an attempt to predict the specificity of the problem [4, 6-10]. It is connected, firstly, with the choice of a model class and, secondly, with the selection or the creation of a specific model of the selected class. This should be reduced sufficiently weighty argument with respect to the selection.

The task of building quasi-adaptive prediction the behavior of the exchange rate is to obtain a forecast of the exchange rate estimates, which are based on forecast errors of the mark registered predictive assessments and minimize the sum of squared prediction error estimates.

According to quasi-adaptive prediction we understand predictive estimates, which take into account the forecast accuracy the predictive assessment of the sign of uncertainty.

In case the behavior of the exchange rate situation has its own characteristics, which is based on the method of quasi-adaptive prediction. They are in the account of the behavior of the bulk of traders in the FOREX market.

It`s supposed the following scheme of constructing the forecast exchange rate estimates presented with time series $X = \{X_t\}_{t=t_1}^{t_2}$.

1. It`s done the assessment $\hat{a}_{1,0}, \hat{a}_{2,0}$ to initial values of coefficients $a_{1,0}$ и $a_{2,0}$. The initial array is the interval of the time series $\{X_t\}_{t=t_1}^{t_2}$ exchange rate.

First for X applies the method of least squares. It`s obtained an expression $\hat{X}_t = \hat{\beta}_0 + \hat{\beta}_1 t$.

For $t = 0$ supposed

$$a_{1,0} = \beta o, \qquad (1)$$

$$a_{2,0} = \beta 1, \qquad (2)$$

2. For $t = t_1, \dots, t_2$ calculated assessments $\hat{a}_{1,t}, \hat{a}_{2,t}$ of coefficients according to relations (3), (4).

$$\hat{a}_{1,t} = \alpha_1 X_t + (1 - \alpha_1)(\hat{a}_{1,t-1} + \hat{a}_{2,t-1}) + \alpha_3 f(e_t, e_{t-1}), \quad (3)$$

$$\hat{a}_{2,t} = \alpha_2(\hat{a}_{1,t} - \hat{a}_{1,t-1}) + (1 - \alpha_2)\hat{a}_{2,t-1}, \quad (4)$$

where

$$f(e_t, e_{t-1}) = \widetilde{Sign}(\Delta e_t)\, |\Delta e_t|, \quad (5)$$

$$\widetilde{Sign}(\Delta e_t) = Sign(\widehat{m}_t, k_{t-1}), \quad (6)$$

$$\Delta e_t = e_t - e_{t-1}, \quad (7)$$

$$\widehat{m}_t = Sign(\hat{S}_{t-1}) = \begin{cases} +1, \hat{S}_{t-1} > \varepsilon_S \\ 0, |\hat{S}_{t-1}| \le \varepsilon_S \\ -1, \hat{S}_{t-1} < -\varepsilon_S \end{cases}, \quad (8)$$

$$S_t = \alpha m_t + (1 - \alpha)S_{t-1}, \quad (9)$$

$$m_t = k_t k_{t-1}, \quad (10)$$

$$k_t = \begin{cases} +1, if\ \Delta e_t > \varepsilon_e \\ 0, if\ |\Delta e_t| \le \varepsilon_e \\ -1, if\ \Delta e_t < -\varepsilon_e \end{cases}. \quad (11)$$

The ratios used symbols $\alpha, \alpha_1, \alpha_2, \alpha_3, e_t, \varepsilon_S, \varepsilon_e$ have the following meanings:

$\alpha, \alpha_1, \alpha_2, \alpha_3$ – numerical model parameters that are changing between 0 and 1;

$e_t = X_t - \hat{X}_1(t - 1)$ – prediction error;

$\varepsilon_S, \varepsilon_e$ – sizes indifference intervals for exponential average S_t and the values of a number e_t.

In our opinion, εS parameter can be interpreted as the degree of desire (+1) (indifference (0) reluctance (-1)) a trader to buy up (wait, sell) currency.

3. For step of the forecast $\tau = 1$, time counts $t = t_1, \dots, t_2$ and initial values of $\alpha, \alpha_1, \alpha_2, \alpha_3$ calculated the initial predictive estimate $\hat{X}_\tau(t)$ of the time series X_t according to the formula (12)

$$\hat{X}_\tau(t) = A + \hat{a}_{1,t} + \hat{a}_{2,t}\tau. \quad (12)$$

4. Calculate the sum of squares of the forecast errors *SSE*:

$$SSE = \sum_{t_1}^{t_2} e_t^2. \quad (13)$$

5. In order to improve the quality of the forecast, parameter estimates are found the values of $A, \alpha, \alpha_1, \alpha_2, \alpha_3$, which minimize the SSE.

6. Steps 1-5 are repeated again. Stop.

The algorithm of the quasi-adaptive prediction has been applied to the construction of the forecast estimates of the exchange rate. The results of the algorithm are shown in pic. 1 (The data of the National Bank of Ukraine is used [5]).

It may be noted, at least three points.

Firstly, the model at an early stage during the first five days, adapted to the actual dynamics of the exchange rate.

Secondly, the model is following the course using the hypothesis that the exchange rate has never been stable, permanent. In other words, there is a condition (14):

$$\forall t_i, t_i + 1 \ \ X_{t_i} \neq X_{t_i+1}. \tag{14}$$

This condition provides an efficiency of the model using predictions of error signs.

Thirdly, this requirement, in turn, introduces an additional (small) error which, for example it is visible in the prediction on the 500th day.
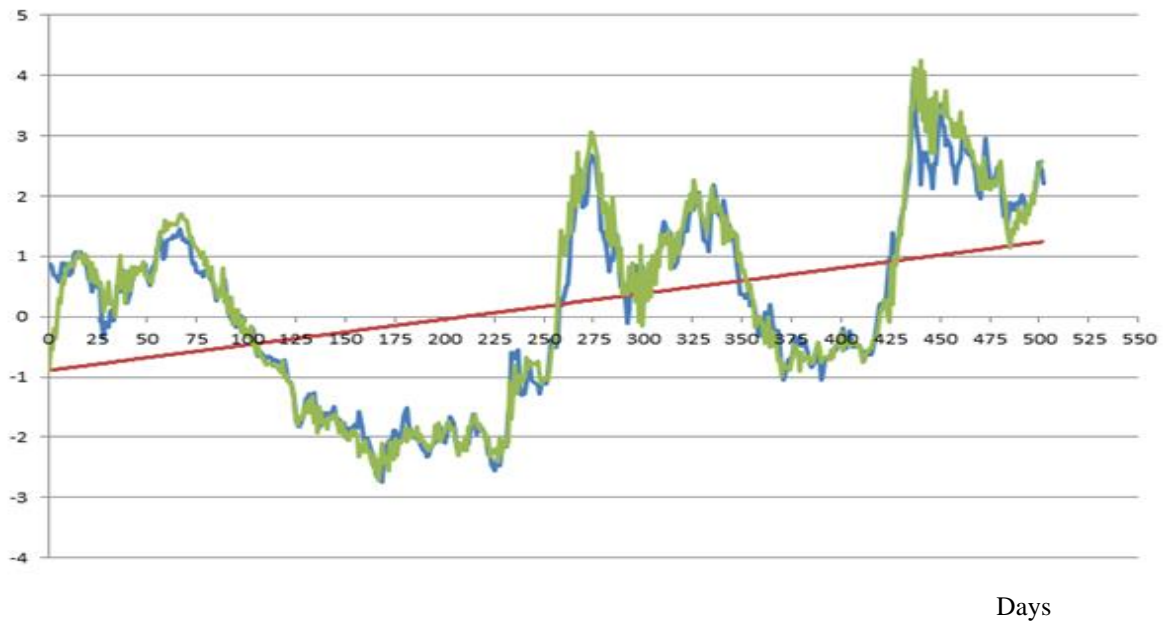
Exchange rate
25 UAH
to the dollar

Days

Figure 1 – Forward-looking assessment of the Exchange rate.

——— Exchange rate 25 UAH to the dollar ——— Interpolation
——— Linear regression

On the base of analyze pic.1 you can make the following conclusions.

Firstly, the three-parameter algorithm quasi-adaptive prediction works quite fine. That is, it is well interpolates the initial data, the current values and takes into account the possible trends in the predictions.

Conclusions and directions for further research.

The presented material makes it possible to affirm about the efficiency quasi-adaptive prediction algorithm. Directions of further researches may be:

a) improve the quality of the prediction by adjusting the sizes of the indifference intervals $\varepsilon_S, \varepsilon_e$;

б) finding the limits of the action of the algorithm;

c) the algorithm generalization in the direction of qualitative factors account;

d) the development of a universal program realization of the algorithm.

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