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Forecasting the price dynamics in the markets – benchmark prices (using the example of the interbank credit market and the bond market)

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Abstract

This article proposes an algorithm for forecasting benchmark prices in the markets – price targets, an example of forecasting the average interest rate of BID on the interbank credit market of Ukraine for operations in the national currency for a period of 1 month. For the calculation, data for October-November 2015 and May-June 2016 were adopted, since during these periods a sharp and predictable change in this rate was observed. The results of calculations showed that the proposed approach to the forecast of interest rates on the interbank market should be used when forecasting price dynamics in other markets – benchmark prices.

Keywords: banks services pricing, pricing method, market – price reference point, combined method of pricing.

JEL Classification: G12, G13, G21.

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Introduction

Increased competition in markets and dynamic changes in the market conditions of individual market segments necessitate the expansion of a range of pricing methods. Today, market methods dominate (focused on prices of direct competitors and average market prices), whereas cost methods and value methods (oriented to the utility of services for the consumer) are used much less. When pricing market entities often focus on the so-called "markets – benchmark prices", to which they have access and information about the conjuncture on which they have full, so the question of adequate forecasting of the price dynamics on them becomes very relevant.

For financial institutions and banks in the role of markets – benchmark prices are most often the interbank market, bond market, internal capital market of integration associations (financial conglomerates and banking groups): national and foreign; Forex market.

To select the most effective method for forecasting price dynamics on the market – benchmark prices, it is necessary to determine the set of factors that affect it. If factors of interest rate formation in the interbank credit market and factors of general fluctuations in yield on the bond market are predominantly common within the country, then pricing factors in the domestic capital markets of financial conglomerates and internal capital markets of banking groups can often be formed only in these domestic markets, and therefore the corresponding set of factors can vary considerably depending on the period and the particular domestic market.

In periods of economic stability, when the market situation – benchmark prices remains stable, determining the price and calculating the permissible range of its fluctuations is not a problem. However, in the event that the price in the markets – benchmark prices reaches the upper (or lower) permissible limit of price fluctuations, management should decide whether to change the price or keep it at the same level. The corresponding decision should be made on the basis of forecasts of future price fluctuations in the markets – benchmark prices. To solve this problem, statistical methods are used that have proved their adequacy in forecasting macroeconomic indicators.

Our study of a number of models of forecasting macroeconomic series in the framework of the analysis of time series allows us to conclude that it is inexpedient to select models of this class for forecasting price dynamics in the markets-price benchmarks after the price leaves for the permissible limits of its fluctuations,

since this class of models forms forecasts on the basis of previous values of the variable. If the variable in the previous periods was relatively stable, and in the last one it suffered significant fluctuations, the time series analysis models in any case will predict the further stability of the variable, leaving it at the same level, as this class of models calculates the forecast values based on the tendency of a number of previous values, and significant fluctuations in the last period will be considered as an accident. Despite this, to solve the task, an approach that considers the factors that cause significant price fluctuations in the markets – benchmark prices – is necessary.

Literature review

Chris Strickland [1] described the different approaches and different models that have been developed to value interest rate-dependent securities, providing a survey of pricing procedures which are based on mathematical models of the term structure. It can be viewed as a reference for the different interest rate models with explicit representations, where they exist, for prices of derivative instruments and an an analysis of their respective advantages and disadvantages.

D. Brigo and F. Mercurio [2] considered the evolution of the methods of pricing for a bank rate from modeling suggested by no-arbitrage discounting to Volatility smile extensions of Forward market-rates models.

A. Blanchard [3] study interest rate models and their accuracy in the pricing of common structured products. He specifically focus on the Hull-White model, which was first established in the article John Hull and Alan White [4]. His goal was to study this model, calibrate it on market prices, and derive prices for the most commonly traded products. In particular, A. Blanchard [3] investigates whether it gives a satisfying description of real financial market prices.

J.Hull and A.White [4] showed that the one-state-variable interest-rate models of Vasicek [5] and Cox, Ingersoll, and Ross [6] can be extended so that they are consistent with both the current term structure of interest rates and either the current volatilities of all spot interest rates or the current volatilities of all forward interest rates. The extended Vasicek model is shown to be very tractable analytically. The authors compared option prices obtained using the extended Vasicek model with those obtained using a number of other models.

John Hull and Alan White [7] compared different approaches to developing arbitrage-free models of the term structure and presented a numerical procedure that can be used to construct a wide range of one-factor models of the short rate that are both Markov and consistent with the initial term structure of interest rates.

The construction is explicit for the lognormal LIBOR and swap "market models", the former following Musiela and Rutkowski [8]. F. Jamshidian [9] are discussed and appropriate practical models suggested for primary examples of LIBOR and swap derivatives.

T. Björk [10] published materials; appendices on measure theory, probability theory, and martingale theory; and a new chapter on the martingale approach to arbitrage theory, which cover the binomial model, a general one period model, stochastic integrals, differential equations, portfolio dynamics, arbitrage pricing, completeness and hedging, parity relations and delta hedging, the martingale approach, incomplete markets, dividends, currency derivatives, barrier options, stochastic optimal control, bonds and interest rates, short rate models, forward rate models, and LIBOR and swap market models.

Methods and data

To form the methodology for forecasting interest rates on the interbank credit market, it is necessary to determine the factors that today have a decisive influence on the price situation on the interbank credit market. The main list of factors for the formation of this type of rates, which is accumulated in theoretical works on this topic, largely coincides with the list of factors shaping the price of banking services. However, after examining the opinions of banking practitioners in Ukraine about fluctuations in interest rates on the interbank credit market during 2015 and the first half of 2016, it was concluded that the factors of the recent fluctuations in the market situation are the balance of funds on correspondent and transit accounts of banks, the Ukrainian hryvnia rate to the US dollar on the interbank foreign exchange market of Ukraine and the volume of government government bonds on the National Bank of Ukraine of domestic state loan.

Given this list of determinants of price fluctuations in the interbank credit market and the goal for achieving which it is necessary to form an approach, namely, forecasting the future behavior of prices in the interbank

credit market, the following list of indicators for predicting the interest rate in the interbank credit market during the period t (Y_1):

- balance of funds on correspondent and transit accounts of banks during the period t-$_1$(X_1);
- weighted average rate on the interbank foreign exchange market in the period t-$_1$(X_2);
- volume of domestic government loan bonds, which is owned by banks during the period t-$_1$(X_4);
- average weighted interest rate on the interbank credit market in the period t-$_1$(X_3).

The last indicator was added to the list of factors that need to be included in the model, based on the fact that it demonstrates the dynamics of the development of this market and indicates the weighted average cost of resources in the market, taking into account the corresponding resources of the National Bank of Ukraine. The inclusion of a weighted average interest rate on the interbank credit market makes it possible to predict interest rates in the interbank market based on its latest values, while including in the regression dependence the main factors that can change its level. In addition, as can be seen from the above list of indicators, in order to solve the required task of forecasting interest rates, the value of independent variables for the previous period will be included in the regression dependence, since the formation of interest rates on the interbank market occurs in conditions when the relevant specialists have only the data for the previous business day, since the data for the current day will be generated in the evening or the next business day. As an interest rate of the interbank credit market, the average BID interest rate on the interbank credit market of Ukraine for transactions in the national currency for a period of 1 month was chosen.

The methodology of forecasting interest rates in the interbank credit market is developed as follows:

1) smoothing the data needed to build the model;

2) constructing a model of linear regression dependence based on smoothed data;

3) predicting the future dynamics of independent variables based on one of the methods of smoothing time series;

4) the formation of predictive values of the effective indicator.

So, the first step in solving this task is to smooth out the historical data of the effective and independent variables, which is necessary in order to minimize the influence on the regression dependence of side noise and randomness, which can reduce its quality. However, to solve the problem of smoothing the input data, first of all, it is necessary to fix the problem of choosing the smoothing method, because to date in statistics this direction is represented by a set of methods, each of which under different conditions can have more accurate values. To select the most optimal method for smoothing time series, we performed the smoothing of the data we needed by several methods: smoothing using the Holt method, Fourier smoothing, exponential smoothing, smoothing by the usual moving average method; smoothing by the Spencer method.

Results

During 2015 and the first half of 2016, a sharp increase in the average interest rate of BID on the interbank credit market of Ukraine for operations in the national currency for a period of 1 month occurred 2 times: in October 2015 and May 2016, and therefore to test the effectiveness of the proposed approach to forecasting the interest rate on interbank market, the corresponding two regression models were constructed reflecting the cause-effect relationships of these fluctuations. So in the period from 29.09.2015 to 26.10.2015, the average interest rate of BID on the interbank credit market of Ukraine on operations in the national currency for a period of 1 month increased from 11.5% to 24.0% (see Table 1 in Appendix).

As a result of smoothing the time series of data on the dynamics of the average interest rate of BID on the interbank credit market for resources in the national currency for a period of 1 month and the factors that affect its fluctuations were identified. To determine the optimal method, it is necessary to compare the results of each smoothing with each other (Table 2 in Appendix).

As Table 2 shows among the methods of smoothing time series of interest rate data in the interbank market and factors affecting its fluctuations, the most acceptable is the Spencer's method, which showed the smallest errors and the highest determination coefficient for all variables simultaneously, and therefore it is expedient to construct a linear regression model using the data exactly smoothed by this method.

Investigating the dynamics of the effective and independent variables, it can be seen that during the same period in 2015 and the first half of 2016, the same factors have a different impact on the average interest rate of BID on the interbank credit market of Ukraine for operations in the national currency for a period of 1 month. Starting from the end of the first quarter of 2015 and almost to the end of the year the amount of balances on correspondent and transit accounts of banks showed a gradual downward trend, as a result of which the average interest rate of BID on the interbank credit market of Ukraine for operations in the national currency gradually grew between these indicators. With the beginning of 2016, the amount of balances on correspondent and transit accounts of banks began to decrease sharply, while the average interest rate of BID on the interbank credit market of Ukraine, which had declined after a certain period of time, stopped its decline and stopped at 8-9%, and from the gradual restoration of the balance of funds on correspondent and transit accounts of banks fell to the level of 5%.

However, at the end of the second quarter of 2016 the interest rate under study increased sharply, while the balances of correspondent and transit accounts of banks did not demonstrate the corresponding dynamics, which means that it was possible to conclude that in this period of time the crucial role in interest rate fluctuations in the interbank credit market played another factor. In our opinion, such a factor could be a weighted average rate on the interbank foreign exchange market. This confirms the above hypothesis that the growth of the average interest rate of BID on the interbank credit market of Ukraine on operations in national currency at the end of the second quarter of 2016 is most likely due to the growth of the weighted average rate on the interbank foreign exchange market of Ukraine, which indicates a direct link between them.

Despite the fact that the average interest rate of BID on the interbank credit market of Ukraine for operations in the national currency for a period of 1 month will be the resultant variable in the constructed model, it is advisable to build a linear regression dependence based on the corresponding number of working days. In other words, since usually a month is 4 calendar weeks, corresponding to 20 working days, in our opinion, to determine the linear regression dependence, with the subsequent purpose of building on its basis a forecast on the dynamics of interest rates in the interbank credit market, it is reasonable to take as a basis for calculating the data for the last 20 business days.

In defining the regression dependence, the values of the effective indicator will be taken in the period t, and the independent t-1, since our regression dependence assumes that to determine the interest rate in the interbank market in the current period, it is necessary to focus on the dynamics of its basic drivers in the previous period. The construction and analysis of the linear regression model were performed using MS Excel and the XLSTAT add-in (Figure 1, see in Appendix).

As the data presented in Figure 1, three of four factors showed a moderate or strong relationship with the outcome. Of course, the strongest connection with the average interest rate of BID on the interbank credit market of Ukraine for operations in the national currency for a period of 1 month in the period t showed such a factor as the weighted average interest rate on the interbank credit market in the period *t*-1, is quite expected, since noted above, it is necessary that the the previous values of the weighted average interest rate were starting point of the interest rate forecast in the interbank market. However, it should be noted that the balance of funds on correspondent and transit accounts of banks in the previous period and the weighted average rate on the interbank foreign exchange market of Ukraine in the previous period showed a moderate relationship.

As a result of the analysis, the following linear regression equation was obtained:

$$Y_{1(t)} = -1069.388 + 0.309X_{1(t-1)} + 1.310X_{2(t-1)} + 0.967X_{3(t-1)} + 0.323X_{4(t-1)}, \quad (1)$$

where $Y_{1(t)}$ – the average interest rate of BID on the interbank credit market of Ukraine for operations in the national currency for a period of 1 month in the period *t*;

$X_{1(t-1)}$ – balance on correspondent and transit accounts of banks during the period *t*-1;

$X_{2(t-1)}$ – weighted average rate on the interbank foreign exchange market of Ukraine in the period *t*-1;

$X_{3(t-1)}$ – weighted average interest rate on the interbank credit market in the period *t*-1;

$X_{4(t-1)}$ – the volume of domestic government loan bonds, which is owned by banks during the period *t*-1.

To assess the statistical significance of the regression equation obtained, it is necessary to study the regression statistics. As shown in Figure 3, the coefficient of multiple correlation is 0.994, which indicates a very strong connection of the entire set of factors with the resultant sign. In addition, an important indicator from the point of view of forecasting interest rates in the interbank market on the basis of the regression dependence obtained is the value of the mean square error (MSE) equal to 0.126, which is insignificant, and consequently this regression dependence is quite stable within the period under review.

Uncorrected multiple determination coefficient is 0.994 and estimates the proportion of the variation of the effective characteristic as a result of the action of independent variables in the overall variation of the result. In this regression dependence this share is 99.4% and indicates a very high degree of conditionality of the variation of the average interest rate of BID in the interbank credit market by the variation of the factors identified by us.

Corrected multiple determination coefficient specifies the density link , considering the degrees of freedom of the total and residual dispersions. In the regression equation obtained, the adjusted multiple determination coefficient indicates a very high (more than 99%) determination of the result by the indicated drivers.

In addition, the value of the Fisher's F-test, which gives an estimate of the reliability of the regression equation as a whole and the density index for this model, for the regression dependence obtained, is 584.441. This value is much higher than the tabulated value (4.619), and therefore the received regularity is not accidental, but formed under the influence of significant factors, i.e. the statistical significance of the entire equation and the indicator of the density link – the coefficient of determination – are confirmed.

It should be separately noted that although the correlation matrix depicted in Figure 1 shows that not all independent variables have a close relationship with the final variable, but the above tools for constructing the regression model also make it possible to analyze the cases in which one or more independent variables are excluded from the linear regression model, the results of the corresponding calculations allow us to conclude that it is the inclusion of all selected independent variables that makes it possible to obtain the most approximative results of the linear regression (Figure 2, see in Appendix).

As shown in Figure 2, it is possible to investigate the relationship between a set of independent variables and the final variable by means of XLSTAT and see which particular set of factors makes it possible to construct the most accurate regression dependence. Based on the results of such an analysis, we can conclude that the inclusion of all selected factors in the regression dependence gives a high adjusted coefficient of determination and less standard deviation. For example, excluding such an independent variable from the model as a weighted average rate on the interbank foreign exchange market of Ukraine in the previous period raises the standard error by 0.025, and the inclusion of only the weighted average interest rate on the interbank credit market in the previous period and the volume of domestic government bonds owned by banks in the previous period raises the standard error of 0.237.

In addition, Figure 2 allows us to evaluate the standardized coefficients of the linear regression equation obtained. Since the standardized coefficients of linear regression can be compared with each other, it can be concluded that the weak influence on the average interest rate of BID on the interbank credit market of Ukraine on operations in the national currency for a period of 1 month from 29.09.2015 to 26.10.2015 was such a factor as the balance of correspondent and transit accounts of banks in the previous period, and the strong one – the weighted average interest rate in the interbank credit market in the previous period, fully corresponds to the one for resolving which was based on this dependence, namely, forecasting the interest rate on the interbank credit market based on the previous conjuncture of this market, adjusting these values for changes in the main factors that cause fluctuations in this interest rate.

In conclusion, it should be noted that, as the graph shown in Figure 2, all findings were very close to the actual ones, which further confirms the statement about the reliability of the model, and hence the possibility of forming on its basis predictive values close to real.

Thus, having determined the regression dependence on the basis of which it is possible to construct the interest rate forecast for the nearest periods, the next step is the formation of the forecast of independent variables and the determination based on them of the forecast values. As the results of smoothing showed, some methods allow us to predict the values of independent variables quite accurately, and therefore one of the already used methods of data smoothing can be used as a forecasting tool. As evidenced by the data presented in Table 2, all methods except the Fourier method showed results very close to the actual ones, and the Spencer's method

demonstrated the best results of smoothing, however, in our opinion, this method can not calculate the forecast data quite correctly, since in its calculation it is oriented not only to the past values of the series, but also the future ones, and therefore, to form the predicted values of the independent variables, it is expedient to choose the following method with the best indicators – the moving average with period 5.

Forcasted values of independent variables and the forecast of the average interest rate of BID on operations in the national currency for a period of 1 month calculated on their basis is presented in Table 3.

Table 3. Forecast of average interest rate BID on the Ukrainian banking credit market for transactions in the national currency in line for 1 month for the period from October 27, 2015 to November 2, 2015

Date	Predictive values of independent variables				Forecast interest rate BID	Actual interest rate BID
	X_1	X_2	X_3	X_4		
26.10.2015	14.82	800.58	23.10	56.93	-	-
27.10.2015	13.63	800.55	22.31	56.97	24.80	24.50
28.10.2015	13.61	800.56	22.51	56.99	23.64	24.00
31.10.2015	13.64	800.56	22.73	56.99	23.85	24.00
01.11.2015	13.82	800.57	22.84	56.99	24.07	27.00
02.11.2015	13.91	800.57	22.86	56.98	24.24	25.00

As Table 3 shows, in general, the projected interest rates of BID allow us to conclude that this price in the market in the forecasted period will balance around 24%, which means that the interest rate is the benchmark for pricing for banking services that takes into account the risks of volatility in the market – the benchmark price will be amount to 21.5%. As evidenced by the data given in Table 3, this price level fully corresponds to the real fluctuations in the interbank market, and therefore can be adopted as a benchmark for pricing for banking services. Thus, the proposed methodology for forecasting interest rates in the interbank market is effective and can be used in the framework of the proposed approach of using markets – benchmark prices in pricing for banking services.

To exclude the randomness factor in checking the effectiveness of the proposed methodology for forecasting interest rates in the interbank market, this method was also used for the period from 27.04.16 to 29.05.16. The initial data for constructing the linear regression model are given in Table 4 (see in Appendix).

As evidenced by the data given in Table 4, during the analyzed period the average interest rate of BID on the interbank credit market of Ukraine for operations in the national currency for a period of 1 month kept at the same level of about 5%, and at the end of the month it grew more than twice, and therefore it is necessary to build a forecast of the future dynamics of the target interest rate (Figure 3, see in Appendix).

The results of the regression analysis presented in Figure 3 show that the coefficients for independent variables for the linear regression equation constructed for the period from 29.04.16 to 31.05.16 differ from those that were constructed for the period from 29.09.2015 to 26.10.2015, and this confirms the hypothesis that at different time intervals various factors are the determining factors for the change in interest rates in the interbank market. Separately, it should be noted that the coefficients of correlation of independent variables to the effective ones changed significantly, all of them, except for the weighted average interest rate in the interbank credit market in the previous period, increased significantly, which also indicates that for the period under consideration the influence of the factors included in the dependence for accounting for possible sharp fluctuations in interest rates in the interbank market as a result of changes in the values of their main drivers.

As a result of the analysis, the following linear regression equation was obtained.

$$Y_{1(t)} = 287.610 - 0.201X_{1(t-1)} - 0.441X_{2(t-1)} + 0.583X_{3(t-1)} + 1.072X_{4(t-1)}, \quad (2)$$

As shown by the regression statistics depicted in Figure 5, this dependence is not random, and this set of independent variables determines the value of the effective variable by 98%. The criterion of the Fisher's F-test comprises 250.915 and indicates the reliability of the regression equation obtained and the corresponding density index.

Conclusions and discussion

Thus, the proposed approach to forecasting interest rates on the interbank market is effective. To verify this forecast, this forecast was twice tested on actual data, and the corresponding test results showed that it can be

used to predict price dynamics in the market-a price benchmark. In our opinion, the proposed approach to forecasting interest rates in benchmark markets needs to be tested not only at possible rates – benchmark prices of the interbank credit market, but also in the bond market, since these two markets are generally available markets – benchmark prices. In order to build the necessary forecasting methodology, it is suggested to choose the average weighted rate of yield for eurobonds of domestic banks in circulation in the bond market as a price guide, since this rate can be chosen as a benchmark for interest rates on long-term deposits in foreign currency.

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Appendix

Table 1. Initial data for constructing a linear regression model for determining the influence of the main factors on the average interest rate of BID on the interbank credit market of Ukraine on operations in the national currency for a period of 1 month in the period from 29.09.2015 to 26.10.2015

Date	Average interest rate BID	The components of the linear regression equations are smoothed by the Spencer method				
		Y_1	X_1	X_2	X_3	X_4
28.09.2015	-	-	14.116	799.830	9.116	60.481
29.09.2015	11.500	11.507	14.934	799.898	9.534	59.445
30.09.2015	13.500	11.877	15.026	800.081	10.397	58.670
03.10.2015	12.000	11.719	15.495	800.055	10.448	57.375
04.10.2015	13.000	12.273	15.635	800.158	10.997	56.445
05.10.2015	10.500	12.324	15.631	800.116	11.367	55.512
06.10.2015	11.333	12.854	14.766	800.171	12.242	55.308
07.10.2015	14.000	13.367	14.565	800.237	12.848	55.137
10.10.2015	15.500	14.030	13.599	800.317	13.728	55.346
11.10.2015	14.500	14.435	13.386	800.576	14.065	55.677
12.10.2015	15.500	14.979	13.245	800.845	14.069	55.822
13.10.2015	15.000	15.109	13.700	800.964	13.724	56.014
14.10.2015	14.500	15.308	13.754	801.116	13.648	56.214
17.10.2015	15.500	15.737	13.899	801.058	14.187	56.264
18.10.2015	17.000	16.640	13.849	800.843	15.434	56.392
19.10.2015	17.000	17.742	13.371	800.800	17.341	56.538
20.10.2015	19.000	19.323	13.114	800.511	19.456	56.824
21.10.2015	21.000	20.779	13.289	800.514	21.035	56.956
24.10.2015	22.500	22.062	13.300	800.502	22.166	56.973
25.10.2015	24.000	23.196	14.227	800.588	22.432	56.773
26.10.2015	24.000	23.887	-	-	-	-

Table 2. Comparison of the results of smoothing the final and independent variables by different methods

Smoothing method	Quality indicators	Y_1	X_1	X_2	X_3	X_4
Holt's method	SSE	503.689	1228.107	149.779	1232.276	230.931
	MSE	1.419	3.459	0.422	3.471	0.651
	R^2	0.961	0.723	0.960	0.875	0.982
Fourier method	SSE	6253.806	5043.104	3659.203	7799.783	7010.831
	MSE	17.469	14.087	10.221	21.787	19.583
	R^2	0.520	-	0.032	0.212	0.455
Exponential smoothing	SSE	497.318	1151.585	132.316	1191.628	232.537
	MSE	1.393	3.226	0.371	3.338	0.651
	R^2	0.962	0.742	0.965	0.880	0.982
Usual moving average	SSE	485.384	1012.035	96.632	1438.105	200.461
	MSE	1.352	2.819	0.269	4.006	0.558
	R^2	0.963	0.775	0.974	0.855	0.984
Spencer's method	SSE	198.711	436.852	48.438	616.670	80.690
	MSE	0.554	1.217	0.135	1.718	0.225
	R^2	0.985	0.903	0.987	0.938	0.994

Confidence interval (%): 95
Tolerance: 0,0001
Model selection: Best model / Adjusted R2
Min variables: 2 / Max variables: 4

Correlation matrix:

Variables	X1	X2	X3	X4	Y1
X1	**1,000**	-0,646	-0,641	0,161	-0,640
X2	-0,646	**1,000**	0,482	-0,489	0,513
X3	-0,641	0,482	**1,000**	-0,252	0,991
X4	0,161	-0,489	-0,252	**1,000**	-0,191
Y1	-0,640	0,513	0,991	-0,191	**1,000**

Model parameters:

Source	Value	Standard error	t	Pr > |t|	Lower bound (95%)	Upper bound (95%)
Intercept	-1069,388	258,645	-4,135	0,001	-1620,677	-518,098
X1	0,309	0,151	2,043	0,059	-0,013	0,632
X2	1,310	0,319	4,105	0,001	0,630	1,990
X3	0,967	0,026	36,508	< 0,0001	0,911	1,024
X4	0,323	0,070	4,633	0,000	0,175	0,472

Goodness of fit statistics:

Observations	20,000
Sum of weights	20,000
DF	15,000
R2	0,994
Adjusted R2	0,992
MSE	0,126
RMSE	0,355
MAPE	1,750
DW	1,453
Cp	5,000
AIC	-37,182
SBC	-32,203
PC	0,011

Figure 1. Results of regression analysis of the factors of fluctuation of interbank interest rates from 29.09.2015 to 26.10.2015

Summary of the variables selection:

No. of variables	Variables	MSE	R2	Adjusted R2	Mallows' Cp	Akaike's AIC	Schwarz's SBC	Amemiya's PC
2	X3 / X4	0,237	0,986	0,983	17,936	-26,068	-23,081	0,016
3	X2 / X3 / X4	0,151	0,992	0,990	7,175	-34,270	-30,287	0,011
4	X1 / X2 / X3 / X4	0,126	0,994	**0,992**	5,000	-37,182	-32,203	0,009

The best model for the selected selection criterion is displayed in blue

Standardized coefficients:

Source	Value	Standard error	t	Pr > |t|	Lower bound	Upper bound
X1	0,066	0,032	2,043	0,059	-0,003	0,135
X2	0,129	0,031	4,105	0,001	0,062	0,196
X3	1,000	0,027	36,508	< 0,0001	0,942	1,059
X4	0,114	0,025	4,633	0,000	0,062	0,166

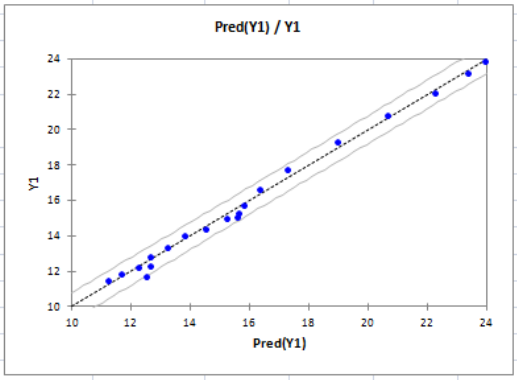

Figure 2. Additional indicators regression analysis of fluctuations in interbank interest rates for the period from 29.09.2015 to 26.10.2015

Table 4. Initial data for constructing a linear regression model for determining the influence of the main factors on the average interest rate of BID on the interbank credit market of Ukraine on transactions in the national currency for a period of 1 month in the period from 28.04.16 to 31.05.16

Date	Average interest rate BID	Components of the linear regression equation are smoothed by the Spencer's method				
		Y_1	X_1	X_2	X_3	X_4
28.04.2016	-	-	18.623	803.423	4.938	67.816
03.05.2016	4.750	4.875	18.215	803.301	4.842	67.870
04.05.2016	5.000	4.955	18.337	803.242	4.428	67.965
07.05.2016	5.000	4.966	18.258	803.094	3.961	68.023
08.05.2016	5.000	4.993	18.813	803.047	3.558	68.138
10.05.2016	5.000	5.006	19.186	803.027	3.397	68.260
11.05.2016	5.000	5.008	19.892	803.128	3.368	68.494
14.05.2016	5.000	5.006	20.325	803.335	3.449	68.652
15.05.2016	5.000	5.003	20.741	803.602	3.548	68.833
16.05.2016	5.000	4.994	20.976	803.912	3.599	68.989
17.05.2016	5.000	4.983	20.854	804.234	3.654	69.079
18.05.2016	5.000	4.950	20.972	804.663	3.665	69.209
21.05.2016	5.000	4.869	20.250	805.011	3.685	69.299
22.05.2016	5.000	4.767	19.912	805.499	3.815	69.430
23.05.2016	5.000	4.788	18.920	805.979	4.225	69.492
24.05.2016	5.000	5.081	18.254	806.282	5.223	69.462
25.05.2016	5.500	5.944	17.308	806.724	7.159	69.369
28.05.2016	5.500	7.065	16.611	807.028	9.206	69.289
29.05.2016	7.500	8.413	16.028	806.995	11.259	69.392
30.05.2016	11.000	9.623	15.648	807.225	12.842	69.962
31.05.2016	13.000	10.635	-	-	-	-

	A	B	C	D	E	F	G	H	I	J
1	Confidence interval (%): 95									
2	Tolerance: 0,0001									
3	Model selection: Best model / Adjusted R2									
4	Min variables: 2 / Max variables: 4									
5										
6	Correlation matrix:								Goodness of fit statistics:	
7										
8	Variables	X1	X2	X3	X4	Y1			Observations	20,000
9	X1	**1,000**	-0,592	-0,866	-0,175	-0,826			Sum of weights	20,000
10	X2	-0,592	**1,000**	0,764	0,863	0,770			DF	15,000
11	X3	-0,866	0,764	**1,000**	0,496	0,986			R2	0,985
12	X4	-0,175	0,863	0,496	**1,000**	0,552			Adjusted R2	0,981
13	Y1	-0,826	0,770	0,986	0,552	**1,000**			MSE	0,056
14									RMSE	0,237
15	Model parameters:								MAPE	3,061
16									DW	0,725
17	Source	Value	Standard error	t	Pr > |t|	Lower bound (95%)	Upper bound (95%)		Cp	5,000
18	Intercept	287,610	103,286	2,785	0,014	67,460	507,760		AIC	-53,279
19	X1	-0,201	0,117	-1,714	0,107	-0,451	0,049		SBC	-48,301
20	X2	-0,441	0,152	-2,902	0,011	-0,765	-0,117		PC	0,025
21	X3	0,583	0,056	10,324	< 0,0001	0,463	0,703			
22	X4	1,072	0,326	3,289	0,005	0,377	1,768			

Figure 3. Results of regression analysis of fluctuations in interbank interest rates in the period from 29.04.16 to 31.05.16