

## MODELING OF FORECASTING OF THE FIRM FINANCIAL INDICATORS PERFORMANCE

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**Abstract.** The modeling of forecasting of the firm financial indicators performance by means of extrapolation method on the basis of polynomial function is carried out in the article. The authors empirically prove that the polynomial trend accurately reflects the dynamics of the firm's revenue with the seasonal nature of sales. For forecasting revenue, characterized by seasonal dynamics, the article developed an algorithm for constructing a model. For the purpose of approbation of the author's forecasting algorithm, the revenue forecast was modeled according to quarterly reports of Plant of Electrical Installation Products (PEIP) TatelectromontazhJSC for the period 2014 – 2016. Based on the obtained modeling results, the authors proved that modeling with the use of a polynomial trend provides a high-quality forecast of the dynamics of the firm's revenue in the conditions of a dynamically changing external environment. The proposed method for forecasting the revenue of PEIP TatelectromontazhJS Callows you taking into account the impact of changes in the macroeconomic environment. The results of logical modeling also confirm the reliability of the results of the constructed forecast model. Practical implementation of the proposed modeling methodology revealed the following features. First, to compile a forecast, it is necessary to accurately identify the duration of the season; Secondly, if there is enough data, the method gives a good approximation and can be effectively used in forecasting the sales volume with the seasonal component.

**Keywords:** additive forecasting model, multiplicative prediction model, polynomial trend, seasonal and cyclical fluctuations

## 1. INTRODUCTION

Forecasting of the financial indicators performance is the basis for identifying some trends in the firm development in a dynamic changing of the external and internal environment, as well as finding the rational solutions to ensure the necessary stability of its position in the market (Murata, Turner, Rae, & Le, 2000). The forecasting methods are widely used for analysis and development of the concepts for the development of the firm production, financial and sales systems, in particular for market environment research and sales forecasting.

At present, the management of firms is experiencing a shortage of analytical and forecasting tools, reliable models and methods of forecasting, providing a vision of global challenges and account for the macroeconomic situation.

## 2. METHODS

The mathematical methods of forecasting are used to obtain quantitative estimates of the prospects for economic development (Ivanter, 1985). The econometric models based on the processing of financial reporting information, as well as on the estimates of individual variables and their parameters obtained by expert analysis are the most widely used (Guichard, & Rusticelli, 2011). The forecasting of the firm financial indicators performance includes the extrapolation method based on the polynomial function. The polynomial trend quite accurately reflects the dynamics of the firm revenue with a seasonal nature of sales (Koshechkin, 2001).

The list of seasonal goods is quite wide. In forecasting, the term "season" is applicable to any systematic fluctuations. The fluctuation cycle can vary considerably in duration. Modeling of cyclical fluctuations of seasonal nature is carried out by means of calculation of the autocorrelation ratios of the series levels. Quantitatively, the autocorrelation can be measured using the linear correlation ratios between the levels of the original time series and the levels of this series shifted by a specified number of steps in time. The set of such ratios, depending on the delay lag, forms an autocorrelation function. The lag at which the autocorrelation function reaches its maximum, as a rule, corresponds to the cycle value in the time series. The analysis of values of the autocorrelation function allows us making a conclusion that there is a periodicity of four quarters (one year) in the time series under study.

The simplest approach is to calculate the values of seasonal component by the moving average method and construct an additive or multiplicative time series model that includes three components: trend (T), seasonal (S) and eventual (E), - integrated, respectively, by the addition or multiplication operations.

The model choice is based on the analysis of the structure of seasonal fluctuations. If the fluctuation amplitude is approximately constant, it is constructed an additive model. If the amplitude of seasonal fluctuations increases or decreases with time, it is constructed a multiplicative model.

The additive model of the forecast F can be represented in the form of the Equation 1:

$$F = T + S + E \quad (1)$$

The use of multiplicative models is due to the fact that the value of seasonal component represents a certain share of trend value in some time series. These models can be represented by the Equation 2:

$$F = T \times S \times E \quad (2)$$

The additive model is characterized by an almost constant seasonal variation, while it increases or decreases in the multiplicative model. To forecast the product sales volume that is seasonal, the following algorithm for constructing the forecast model is proposed (Koshechkin, 2001):

1. Determination of the best trend for approximating the dynamics of actual data.

2. Aligning the initial series levels using the moving average method through the following iterations (Eliseeva, 2002):

a) sequential summation of the series levels for every four quarters with a shift for one quarter and determining the conditional annual sales volume;

b) finding the moving averages by dividing the sums obtained by 4, so that the resulting equalized values no longer contain the seasonal component;

c) bringing the obtained values into correspondence with the actual moments of time, i.e. finding the centered moving averages as arithmetic mean of two consecutive moving averages.

3. Estimation of the seasonal component S as the difference between the actual levels of the series and

the centered moving averages (Ermolaev & Mirolyubova, 2006). For this it is necessary to find the average for each quarter (for all years) of estimates of the seasonal component  $S_i$ .

The seasonal component models usually assume that the seasonal impacts are cancelled over the period. In the additive model, this is expressed in the fact that the sum of seasonal component values should be zero over all quarters. Therefore, the obtained seasonal component values need to be adjusted. For this, the correction factor (K) and the adjusted seasonal component values are calculated in sequence as the difference between its average estimate and the correction factor:

$$K = (\sum S_i) / N \quad (3)$$

1. Elimination of the seasonal component influence by subtracting its value from each level of the original time series (Ermolaev & Mirolyubova, 2006).

$$T+E = Y-S \quad (4)$$

where:

T – model trend value,

E – eventual component,

Y – actual value of revenue,

S – seasonal component.

2. Analytic alignment of the series (T + E) with the help of a polynomial trend.

6. Calculation of model errors as the difference between actual values and calculated model values.

7. Modeling of the final forecast of sales volume using the exponential smoothing methods. This makes it possible to level out the lack of adaptive models, namely, to take into account new macroeconomic parameters.

$$F_{pr t} = a F_{f t-1} + (1-a) F_{m t} \quad (5)$$

where:

$F_{pr t}$  – forecast value of sales volume;

$F_{f t-1}$  – actual value of sales volume in the previous year;

$F_{m t}$  – model value;

a – smoothing constant

$$a [7] = 2 / (n+1) \quad (6)$$

where:

n – number of observations included in the smoothing interval.

### 3. RESULTS AND DISCUSSION

Let us test the modeling algorithm on the quarterly revenue data of PEIPTatelectromontazhJSC for the period from 2014 to 2016, when revenue shows a pronounced seasonal character with an increasing trend (Figure. 1).

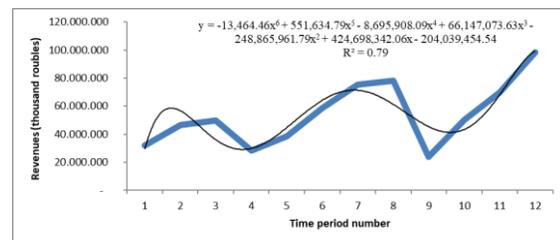


Figure. 1. - Dynamics of revenue for 2014-2016 years.

The seasonal component estimation is calculated for each time series according to the Equation 7 (Zabrodskaia, n. d):

$$S_0 = Y - T \quad (7)$$

where:

$S_0$  – seasonal component estimation;

Y – actual value of the time series of revenue;

T – trend value of revenue.

The results of seasonal component calculation are shown in Table 1.

Table 1. Determination of the seasonal component

No.	Period	Revenue (Y), thousand roubles.	The trend value (T)	Estimation of the seasonal component (S0)
1	30.03.2013	28,033,690	29,782,261.60	- 1,748,571.60
2	30.06.2013	28,294,181	56,726,029.86	- 28,431,848.86
3	30.09.2013	38,006,940	36,096,010.88	1,910,929.12

4	31.12.2013	25,721,957	29,882,363.14	- 4,160,406.14	1	2,298,199	-6,090,559.76	-21,561,895.64	-25,354,256.00	-8,451,418.67	-8,452,722.83
1	30.03.2014	32,080,461	29,782,261.60	2,298,199.40	2	-10,078,012	-5,389,879.10	6,922,828.94	-8,545,062.02	-2,848,354.01	-2,849,658.17
2	30.06.2014	46,648,018	56,726,029.86	- 10,078,011.86	3	13,604,918	4,263,089.84	1,446,546.40	19,314,554.36	6,438,184.79	6,436,880.62
3	30.09.2014	49,700,929	36,096,010.88	13,604,918.02	4	-1,434,802	16,900,566.22	-865,350.46	14,600,413.62	4,866,804.54	4,865,500.38
4	31.12.2014	28,447,561	29,882,363.14	- 1,434,802.02					Amount	5,216.65	0.00
5	30.03.2015	38,630,830	44,721,389.76	- 6,090,559.76					K	1,304.16	
6	30.06.2015	58,771,395	64,161,274.10	- 5,389,879.10							
7	30.09.2015	75,496,494	71,233,404.16	4,263,089.84							
8	31.12.2015	78,229,852	61,329,285.78	16,900,566.22							
9	30.03.2016	23,821,149	45,383,044.64	- 21,561,895.64							
10	30.06.2016	50,282,346	43,359,517.06	6,922,828.94							
11	30.09.2016	69,494,476	68,047,929.60	1,446,546.40							
12	31.12.2016	98,295,817	99,161,167.46	- 865,350.46							

Then a model error is calculated. There are the values of the series levels obtained as a result of model construction at the first step. For this, the seasonal component value S is added to the levels T (Table 3).

Table 3. Calculation of the values of the time series levels

No.	Period	The value of the series levels ((T + S, deviation from the mean level)	(T+S) ^2
1	30.03.2014	21,329,538.77	454,949,224,140,957.00
2	30.06.2014	53,876,371.69	2,902,663,426,479,460.00
3	30.09.2014	42,532,891.50	1,809,046,859,634,390.00
4	31.12.2014	34,747,863.52	1,207,414,018,972,560.00
5	30.03.2015	36,268,666.93	1,315,416,200,879,310.00
6	30.06.2015	61,311,615.93	3,759,114,247,948,400.00
7	30.09.2015	77,670,284.78	6,032,673,138,324,670.00
8	31.12.2015	66,194,786.16	4,381,749,714,326,900.00
9	30.03.2016	36,930,321.81	1,363,848,668,991,000.00
10	30.06.2016	40,509,858.89	1,641,048,667,288,020.00
11	30.09.2016	7,484,810.22	5,547,986,954,007,170.00
12	31.12.2016	104,026,667.84	10,821,547,621,203,600.00
		Amount (T+S) ^2	41,237,458,742,196,500

In the second step, the absolute model errors are calculated. For the additive model, the calculation of absolute errors is made by the Equation 4.

Further, the root-mean-square error of the model is determined by dividing the sum of squares of the absolute errors obtained by the sum of squares of the deviations of series levels from their mean level. The root-mean-square error of the model (E) is equal to 0.018 or 1.8% (745,604,715,234,681 / 745,604,715,234,68 = 0.018). The value of the error obtained makes it possible to state that the constructed model approximates well the actual data and is a tool for constructing the high-quality forecasts.

At the final step, the final revenue forecast is modeled using the exponential smoothing methods, which allows taking into account a possible future

The value of seasonal component (S) is calculated for each quarter separately by the Equation 8:

$$S = Si - K \quad (8)$$

where:

S – value of seasonal component of one quarter (only 4 values of the seasonal component for the first, second, third and fourth quarters);

Si – average quarterly estimate of the seasonal component;

K – correction factor.  $K = 15,649.96 / 12 = 1,304.16$

The average quarterly estimate of the seasonal component is calculated by the Equation 9:

$$Si = \sum S0y / N \quad (9)$$

where:

Si – average quarterly estimate of the seasonal component;

(S0y – S0) – seasonal component estimate, y - belonging to one quarter;

N – number of years K of one quarter observation.

The calculation results of the average quarterly estimate for each quarter are presented in Table 2, column 6.

Table 2. Results of the calculation of the average seasonal component

No.	2014	2015	2016	Total (S0y))	Average rating (Si)	Seasonal component (S)
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change in the dynamics on which the trend model is based. The essence of this amendment is that it neutralizes the lack of adaptive models, namely, allows taking into account new trends emerging.

The smoothing constant is equal to 0.4 ( $2/(4 + 1)$ ), i.e. the trends of the past years are taken into account when calculating the forecasted result. The results of the sales forecast are presented in Table 4.

The starting point of the time series is the last reporting period - the quarterly data of the actual revenue for 2016, which is assigned the first, second, third and fourth ordinal numbers of the time series, therefore the sequence number of the forecast values of the time series will continue this numbering.

Table 4. Forecast revenue figures for 2017-2018, thousand roubles.

No.	Period	$F = T + S \pm E$	E	$F_{pr t} = a F_{t-1} + (1-a) F_{m t}$
5	30.03.2017	36,268,666.93	655,765.17	30,896,200.66
6	30.06.2017	61,311,615.93	1,108,560.79	56,234,771.48
7	30.09.2017	77,670,284.78	1,404,338.01	73,557,358.47
8	31.12.2017	66,194,786.16	1,196,852.24	78,317,087.15
	<b>Total</b>	<b>232,992,630.97</b>	<b>4,212,684.524</b>	<b>239,005,417.76</b>
9	30.03.2018	36,930,321.81	667,728.39	34,516,673.35
10	30.06.2018	40,509,858.89	732,449.15	46,799,823.93
	30.09.2018	74,484,810.22	1,346,742.20	74,113,829.52
12	31.12.2018	104,026,667.84	1,880,881.52	93,742,835.56
	<b>Total</b>	<b>255,951,658.76</b>	<b>4,627,801.26</b>	<b>249,173,162.36</b>

Thus, based on the results of the constructed forecast model, it can be concluded that the sales revenue will fall by 2% in 2017 and it will grow by 4% compared to 2016 and by 3% compared to 2016 in 2018.

The proposed methodology for constructing the forecast model is quite simple and, as the results of many studies show, is effective. However, even with the use of software calculations, this method cannot be used without conducting a preliminary "expert" analysis (Koshechkin, 2001).

Taking into account the fact that when forecasting the financial results of the firm activities, a comprehensive analysis of the current situation and the emerging trends of development is necessary,

the results of the forecast model obtained through the application of economic and mathematical calculations should be compared with the results of the expert evaluation in order to obtain a reliable and maximally reasonable image of the forecast period. As an expert evaluation, it is proposed to rely on the results of financial analysis and logical modeling (Downes, Drew & Ollivaud, 2003). Within the framework of logical modeling, it is planned to analyze the dynamics of the forecast indicator (sales revenue) for the most accessible number of previous reporting periods (Table 5).

Table 5. Dynamics of revenue for 2012 - 2016, thousand roubles.

Time indicator	2012	2013	2014	2015	2016
<b>Revenue</b>	158,625,703	120,056,768	156,876,969	251,128,571	241,893,788

According to Table 5, it is seen that the cycle period (Girouard, & André, 2005) is 3 years. The cycle starting point is 2012. Revenue has the maximum value for this cycle in this year. There is a decline in 2013. This year is the crisis year of the cycle. Further, there is an increase in revenue in 2014, the revenue in 2014 is close to the indicator value in 2012, but does not reach it. Based on the identified nature of revenue changes, a slight fall in revenue is forecasted in 2017, and a sharp rise - in 2018, which is inherent in the beginning of a new cycle (Figure. 2).

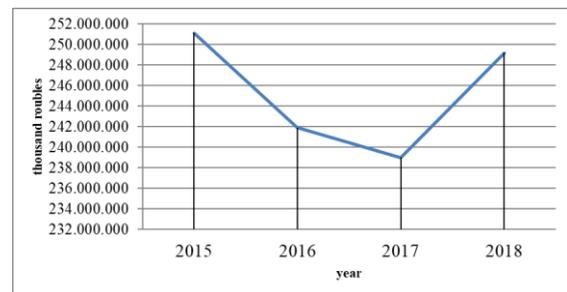


Figure. 2 - Revenue dynamics of PEIPTatelectromontazhJSC, thousand roubles

#### 4. SUMMARY

To predict the revenue volumes from the sale of products, we introduced an algorithm in the article that allows taking into account the influence of seasonal and cyclic components, while a polynomial trend line of the sixth degree was used to improve the accuracy of data approximation. The polynomial function of the time series dependence allows us taking into account the influence of seasonal component, and the use of the sixth degree enables us to approximate the data as accurately as possible and to take into account all factors affecting the results of activities in the previous reporting periods. As an "expert evaluation" we suggested to use the method of logical modeling, which confirmed the reliability of the results calculated by the economic-mathematical model. Practical application of the algorithm proposed was tested on the example of financial results of PEIPTatelectromontazhJSC, which allowed obtaining a fairly accurate and justified result for the forthcoming reporting period. Thus, the presented algorithm can be applied in practice when planning and developing the optimization of the firm activities, which has a seasonal and cyclical nature of demand.

## 5. CONCLUSIONS

The prerequisites for the development of a forecast model based on the use of a polynomial trend are due to the need to take into account both the internal and external factors (Koutsogeorgopoulou, 2000), which have a significant impact on the firm revenue. The proposed method of forecasting the firm financial indicators performance allows taking into account the impact of changes in the macroeconomic indicators.

The results of logical modeling confirm the reliability of results of the constructed forecast model. The account of external factors will allow revealing the dependence nature for the development of administrative decisions with the purpose of minimization (maximization) of certain indicators.

Practical implementation of this method has revealed the following features:

- 1) we need to know exactly the season duration to make a forecast;
- 2) the use of a polynomial trend instead of a linear one allows significantly reducing the model error;

- 3) if there is a sufficient amount of data, the method gives a good approximation and can be effectively used in forecasting the sales volume.

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