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Use of extrapolation to forecast the working capital in the mechanical engineering companies

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Abstract. The purpose of the article is to study the method of extrapolation, highlighting the effectiveness of the financial activity of JSC «ZAZ» and for its future development. In the process of analyzing and exploring the scientific work of many scientists, effectiveness of using the extrapolation method for predicting performance was determined. As a result of research in the article analyzes the financial position of the enterprises of mechanical engineering in modern conditions, the efficiency of working capital in recent years determined. The feasibility of using the method of extrapolation in terms of instability of the market economy was investigated and proved. The forecast of working capital and total sales was made.

It is offered to use in research the linear correlation coefficient of the pair, the method of least deviation, t – Student's criterion. Data obtained on the basis of the forecast enables businesses to improve their performance, to compete at a high level with other entities to establish a system of sales, to avoid crises in the future, increase profits and develop programs to reduce costs. Prospects for further research in this area will improve and develop an integrated system of economic methods on prediction performance of engineering enterprises based on current market position and variability of the environment.

Key words: Method of extrapolation, trend, coefficient of linear correlation, mean approximation error.

INTRODUCTION

In modern conditions of Ukraine's economy development, the problem of using planning elements and forecasting in the mechanical engineering is attracting considerable attention, ensuring of their economic security and determination of their effectiveness based on mathematics. That refers to the use of economic-mathematical methods and models for solving problems of planning. Structural changes that occur in a market economy of Ukraine positively influence on the development of individual enterprises. This contributed to the increase of production and sales. However, these changes have a positive impact on only a small part of enterprises while other companies still have a large amount of unresolved problems. It is important for them to develop the production process and sales, to win key positions in the domestic market, to attract foreign investment and establish business relations with foreign partners. Solution of these tasks requires introduction of modern forecasting and planning methods in the mechanical engineering, great part among which has forecasting output (sales) production by extrapolating trends, which is important in the present circumstances and complexity of economic processes.

MATERIALS AND METHODS

In the scientific literature [1, 2, 3] it is fairly well described both forecasting methods, based on the simulation of the processes under study, and extrapolation techniques for available information. Issues related to the use in practice of economic forecasting methods have been the research objects of scientists and economists: M. M. Magomedov, V. P. Bozhko, I. J. Karatseva [4], V. V. Vitlinskiy [2], V. A. Kasyanenko [3], G. O. Kramarenko [5], P. V. Krivulya [6], Y. V. Sherstennykov [7], Alieksieiev O., Belyayeva. M. [21] and others whose work analyzed forecasting methods, modeling and planning of economic processes, sales in a competitive market and the variability of the environment.

It should be noted that in the development process and methods of forecasting, modeling, studying growth, extrapolation, averages a significant contribution to the statistics made the following scientists: S. S. Gerasimenko [8], I. I. Eliseєva [9], A. M. Erin [10], A. S. Kazinets [11], G. V. Kovalevskiy [12], B. G. Litvak [13], I. S. Paskhaver [14], E. M. Chetyrkin [15], R. A. Shmoilova [16], and these issues even in philosophy analyzed and considered L. A. Mikeshina [17].

As you can see, the use of the extrapolation method in current conditions, especially in the mechanical engineering, forecasting of working capital and sales, the absence of the forecast to improve financial stability, solvency and business activity – has not lost its relevance today and requires more detailed further research, the possibility of using foreign experience in domestic practice for enterprises in different sectors, including engineering. The level of studying the existing problems and the extent of their decision resulted in the choice of topic and definition of its purpose.

Based on these circumstances, the purpose of the article is to apply the method of extrapolation on the mechanical engineering sector, highlighting the effectiveness of the financial activity of JSC «ZAZ» working capital and total sales forecasting. It is considered the specific use of the extrapolation method in the mechanical engineering. The problem is that without use of forecasting methods, it is impossible to determine the volume of sales, profits and potential effectiveness accurately in the whole. Having reliable forecast would improve financial stability, solvency, competition, reduction of costs and management of inventory [4, 6, 18].

RESULTS

In an unstable world economy development there is a need to predict the amount of working capital, the possible size of sales and calculate future income and expenses in the mechanical engineering. This issue is very relevant for both domestic and foreign enterprises, as there is no single method accurately determined for planning and forecasting performance engineering enterprises. Therefore, the phase of planning margin, gross and net profit various methods can be used: extrapolation method, the method of direct calculation, regulatory method, the method of «CVP»; method of forming a target profit, cash flow forecasting method, the method of factorial design.

This study focuses on the comparative characteristics, the problem of forecasting of the indicators of working capital and volume of goods sold, and also identifying the common features of extrapolation method for planning and forecasting the profits of the enterprise to determine the appropriateness and effectiveness of the application of this method in future studies.

The method of extrapolation is based on the results of trend analysis of margin, gross and net operating income dynamics for prior periods and consists of identifying the «trend line», which allows predicting the amount of data indicators. However, this method of planning the operating profit is the least accurate because it does not account the changes in factors that affect it. This method can be used only for preliminary planning stage (when operating plans are not yet formed), and only for a short forecast period (month, quarter) [19].

Different experts may give their interpretation of this method, and they also vary the certainty related to this approach. However, its effectiveness is proved, therefore it can't be excluded while predicting. Extrapolation method allows understanding the situation well and imagining how the events will develop.

The use of this method is rather difficult because it requires processing a huge number of economic indicators. The amount of information is enormous. In order to be the most effective, we have to make vertical and horizontal coordination.

To apply this method in the mechanical engineering or other organizations, first of all, support from the administration at all levels, from the highest to field managers or leaders of specific departments is need.

Also, you must rebuild the peculiarities of new information perception, so you can explore your past and move them to the future prospects. Extrapolation is intrinsically valid with the method of control, which provides a deep analysis of all the data, and then they can already be carried forward.

When drawing up the forecast plan equity analysis acts as the main form of pre-plan for economic research enterprise is a tool for the prediction and assessment of the expected results. The sequence of perspective analysis is this:

1) defines the terms of General indicators that characterize perspective on the basic directions of economic activity;

2) the system of General indicators supplemented with necessary personal or specific indicators;

3) set the sequence of the analysis of indicators, based on the main lines of communication between the relevant groups of indicators.

Among the methods of economic analysis used in forecasting equity, a significant role belongs to the qualitative and substantive aspects in the auxiliary role of quantitative methods of analysis, that is, holding a forecast analysis methods are used pair and linear correlation, methods of analysis of dynamic series, spectral analysis, extrapolation methods of dynamic rows etc.

Extrapolation methods are used in a relatively stable development of the company (or individual indicators of its activity) or in the presence of seasonal or cyclical fluctuations with a distinct trend. As «the trend» we should understand long trend of economic indicators in economic forecasting. If the development of indicators

of financial and economic activities in previous periods are characterized by considerable uncertainty and significant fluctuations in financial performance, their extrapolation in future periods is not possible, and thus it is impractical to use appropriate methods [19].

As the «trend extrapolating» we should understand the continuation of the extension revealed in the analysis of trends beyond constructed on the basis of empirical data series speakers. The most developed among the forecasting methods is considered to be the extrapolation method, which is based on the distribution the future trends of the past [3, p. 71].

Using extrapolation in predicting the financial condition of the company we will make an assumption about the direct link existence between working capital and sales, which can be expressed by a simple factor (ratio of net capital to sales) or equation communication [5, p. 628] :

$$Y = a + bx. \quad (1)$$

where: a – constant of net working capital; b – regression coefficient, which reflects the degree of circulating capital dependence of from sales.

Let us consider this method at JSC «ZAZ» (table 1) [20].

We can demonstrate the dependence of working capital from sales graphically (fig. 1).

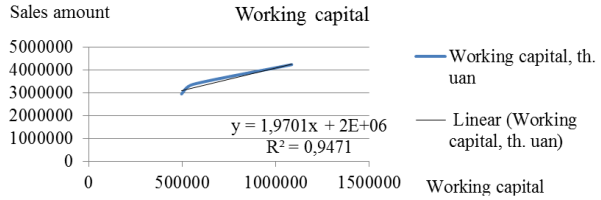

Fig. 1. Dynamics of working capital JSC «ZAZ» in 2009–2011 years

Calculation of linear correlation with statistic function CORREL in Microsoft Excel, confirms the density of communication between two signs, characterized by linear dependence of working capital from sales – 0,9731.

Since the correlation coefficient is calculation is based on a small number of source data, you need to check it out on the base of probability t – Student's criterion [1, 4]:

$$t=0,973191*1/(1-0,9471)=18,39\ldots>3 \quad (2)$$

Since the value obtained is greater than 3, the coefficient of linear correlation is to be recognized as essential. Further we will express the signs dependence with the line equation (1). To find the parameters a and b we use statistic function of Microsoft Excel. For a – function INTERCEPT (value _y; value _x) and for b – SLOPE (value _y; value _x). Thus, the volume of sales dependence on the working capital can be imagined as a regression equation:

$$y=1,9701x+2E+06.$$

From the equation it implies that if the company will increase the amount of working capital to 529617 USD. from the last quarter, sales volume will be:

$$У=1,9701*(529617+1085305)+2000000+6=$$
$$=5181564 \text{ USD}.$$

In our case of pair linear regression can be used a statistic function FORECAST (value _y; value _x), where x – variable for which to be a forecast. This value 5181564 UAN corresponds to previously calculated by solving the regression equation.

A prerequisite for the use of this method is the prediction of the constancy of the factors that make a trend detected, but a fundamental point – identifying the trend typical for the dynamic rate under the research.

In theory and practice, there are different ways of calculating the trend. One is the method of the least deviation. If there is a steady linear dependence of the investigated parameter (x) value on the time interval (t), it is advisable to identify the trend and to build straight, described by a linear regression formula 1.

Parameters a and b of trend equation are chosen so that the actual sum of squared deviations of rate x_t from the theoretical values, that describes a straight line should be minimal :

$$f(a,b) : \sum_{t=1}^{m} (x_t - (a + bt))^2 \rightarrow \min. \quad (3)$$

where: m – the set of analyzed dynamic rate periods; x_t – the value of the studied parameters; t – time interval; a, b – the unknown parameters of the trend equation.

On the base of mathematical transformations we obtain algorithms for calculating the parameters a and b:

$$b = x = \frac{12\sum_{t=1}^{m} tx_t - 6(m+1) - \sum_{t=1}^{m} x_t}{m(m^2-1)}, \quad (4)$$

$$a=(1/m)\sum_{t=1}^{m} x_t - b((m+1)/2). \quad (5)$$

Table 1. Calculation of derived data for the financial condition of the JSC «ZAZ» forecasting

Years	Working capital, th. UAN (x)	Volume of sales, th. UAN(y)	x*y	x^2	y^2
2009	495902	2952243	1,464E+12	2,4592E+11	8,7157E+12
2010	555688	3370840	1,8731E+12	3,09E+11	1,1363E+13
2011	1085305	4239725	4,60E+12	1,18E+12	1,7975E+13
Total	2136895	10562808	7,9386E+12	1,7326E+12	3,8054E+13

Table 2. The calculation of basic data for forecasting the financial condition of the JSC «ZAZ»

№ c/p	Working capital, th. UAN	Absolute growth	Volume of sales, th. UAN	Absolute growth
2009	495902		2952243	
2010	555688	59786	3370840	418597
2011	1085305	529617	4239725	868885
2012	1033276	-52029	4202425	-37300
2013	1131510	98233,8	4417005	214580
2014	1229744	98233,8	4631586	214580
2015	1327978	98233,8	4846166	214580
2016	1426212	98233,8	5060746	214580
2017	1524446	98233,8	5275327	214580

The advantage of this method is an ability to determine the needs of the enterprise in net working capital (after calculation of the above mentioned factors predicted sales) [2]. The disadvantage of this method is taking into account only the factor of sales and the level of demand for net working capital in the short term depend on the duration of inventory turnover, accounts receivable and payable, the level of business activity and more. From the rate of capital's turnover also depends its profitability and as a result – the liquidity, solvency and financial stability of the company.

Let us determine the projected performance for an improved method of least deviation using the information contained in the table 2 and construct fig. 2, which shows the extrapolation of working capital and total sales.

Let us forecast the cost of working capital from the table 2. Empirical data on the values of the studied parameters assume for x_t. The sum of these figures for the three periods that make up the dynamic rates, is equal to 2136895 thousand (495902+555688+1085305). The total value will be t_{xt} 4863193 thousand (1*495902+2*555688+3*1085305). Substituting the appropriate values in the formula for calculating the parameters of the linear regression, we obtain: b = 98233,83; a = 640341,02. The desired function of the line that describes the trend will take the following form: x_t = 640341,02+98233,83t.

Thus, the predictive value of the indicator revenue in 2017 year will amount to 1524445,52 thousand (640341,02+98233,83*9) and observed positive changes in this indicator, which is confirmed by fig. 2. Similarly, it is possible to forecast the next period.

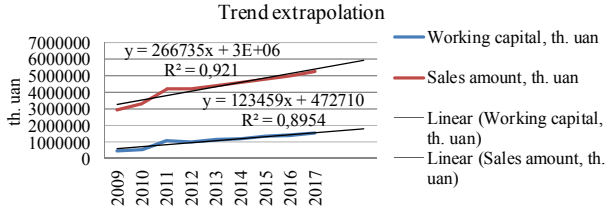

Fig. 2. Extrapolation of the trend of working capital and proceeds from the sale of JSC «ZAZ» in 2009–2017 years

Analyzing the data table 2 and fig. 2 let us turn to identifying the future volume of sales. It is characterized by the following indicators: x_t is 10562808 thousand (2952243+3370840+4239725); t_{xt} = 22413098 thousand (1*2952243+2*3370840+3*4239725); b = 214580,3; a = 3344104. The direct to the volume of sales has the form: x_t = 3344104+214580,3t. Predictive value tends to increase: in 2015 it will amount 4846165 thousand, 2016 – 5060746 thousand, and in 2017 held an increase of 214580,33 thousand compared to the year 2016 [19].

For use as a tool of trend prediction must numerically evaluate the parameters (coefficients) of equations (a_0, a_i) [19]. Options equation determined by the method of least squares:

$$\sum(y_t - \overline{y_t})^2 = \min. \quad (6)$$

In equation (6) variables y_t, and $\overline{y_t}$ are known quantities and parameters of equation (a_0, a_i) – are unknown quantities. For their definition the derivatives from expression (6) must equate to zero for each initial setting separately. After appropriate transformations we obtain a system of normal equations for linear trend equation :

$$\sum y_t = a_0 n + a_i \sum t$$
$$\sum y_t t = a_0 \sum t + a_i \sum t^2. \quad (7)$$

where: a_0, a_i – unknown quantities; n – number of periods; t – time interval.

Quality is measured by the equation system performance. The most important indicator for the evaluation of each equation is the pair correlation coefficient – for linear equations and pair correlation ratio – for all non-linear equations that reflect the closeness of the connection between the effective rate (function) and the factorial sign (argument).

Linear correlation coefficient of the pair for the equation ($y_t = a_0 + a_1 t$) is calculated as :

$$r = (n\sum yt - \sum y \sum t) : \sqrt{n\sum t^2 - (\sum t)^2 * n\sum y^2 - (\sum y)^2}. \quad (8)$$

where: n – number of periods; y – the specified value (working capital); t – time interval.

The conclusions about distress communications can be made of the following parameters:

$r \le 0,5$ – weak link;

$0,7 \ge r \ge 0,5$ – communication medium;

$r \ge 0,7$ – relationship strong.

In addition to distress communications for evaluating the adequacy equation real process are the following indicators:

1. The average error of approximation :

$$\varepsilon=1/n\sum\left|\frac{y_t-\overline{y_t}}{y_t}\right|100, \quad (9)$$

where: n – number of periods; y_t – working capital in thousand UAH; $\overline{y_t}$ – working capital is calculated based on the equation.

2. The average deviation between the actual and estimated values of the function :

a) absolute :

$$\sigma_{абс}=\sqrt{\sum(y_t-\overline{y_t})^2}:(n-1), \quad (10)$$

where: n – number of periods; y_t – working capital in thousand UAH; $\overline{y_t}$ – working capital is calculated based on the equation.

b) relative :

$$\sigma_{відн}=\sqrt{\sum((y_t-\overline{y_t}):y_t)^2}:(n-1)100. \quad (11)$$

where: n – number of periods; y_t – working capital in thousand UAH; $\overline{y_t}$ – working capital is calculated based on the equation.

3. The average deviation between the actual and estimated values of the function:

a) absolute :

$$\Delta_{абс}=\sum\left|y_t-\overline{y_t}\right|:n. \quad (12)$$

where: n – number of periods; y_t – working capital in thousand UAH; $\overline{y_t}$ – working capital is calculated based on the equation.

b) relative – is defined in the same way with the indicator, calculated by formula (9).

The smaller the values calculated according to formulas (9-12), the higher is the quality of the selected equation. The maximum level is set independently, based on knowledge, experience, feature data analyzed as there are no evidence-based recommendations on these matters.

In table 3, with the example of an amount of working capital for 9 years, we show the order of parameters calculating the statistical characteristics of a linear equation in accordance with the above formulas.

Similarly, on the same principle, that is based on pre-calculated intermediate data and statistical parameters are determined the characteristics of other equations, including quadratic.

Substituting the obtained in tab. 3 (gr. 3-10) intermediate calculation data into the appropriate formula, we can calculate the required values.

Parameters of equation (a_0, a_1) we can calculate on the basis of equations in (7):

$$\begin{cases}9809=9\times1+45\times2;\\56449=45\times1+285\times2.\end{cases}$$

By implementing the system of equations, we get: a_0=473,2; a_1=123,4.

Linear correlation coefficient of the pair in (8) is:

r=(9*56449-45*9809)/√(9*285–45^2)*(9*11710967–9809)=0,946.

The volume of output, calculated from the equation we can get, if the value of the argument (time t) is successively substituted for each year.

Based on the estimated parameters of equation (a_0, a_1) linear equation can be written as follows: $\overline{y_t}$ = 473,2+123,4t.

Substituting equation at the specified value of t for the first year (t = 1), we calculated the value of output in 2012 (table 3) – 966,8 thousand, in 2013 – 1090,2 thousand, in 2014 – 1213,6 thousand and so on up to 2017 – 1583,8 thousand, that there is a positive trend in this indicator.

The average error of approximation in (9) is – 10,05%. Since the error is less than 15%, then this equation can be used as a trend. The average deviation between the actual and estimated values of the function:

а) absolute in the formula (10) =
=√106594,16/(9–1)=115,43;

б) a relative in the formula (11) =
=√0,186/(9–1)*100=1,52%.

Table 3. Data on the dynamics of working capital of the enterprise and the calculation of intermediate parameters to determine the parameters and statistic characteristics of the equation $y = a_0 + a_1 t$

№ i/o	Working capital, th. UAN Y_t	t^2	y^2	y_t*t	Working capital, calculated on the base of equation yt_{cep}	$\lvert y_t-yt_{cep}\rvert$	$(y_t-yt_{cep})^2$	$(y_t-yt_{cep})/y_t$	$((y_t-yt_{cep})/y_t)^2$
2009	496	1	246016	496	596,6	100,6	10120,36	0,203	0,041
2010	556	4	309136	1112	720	164,00	26896,00	0,295	0,087
2011	1085	9	1177225	3255	843,4	241,60	58370,56	0,223	0,050
2012	1033	16	1067089	4132	966,8	66,20	4382,440	0,064	0,004
2013	1132	25	1281424	5660	1090,2	41,80	1747,240	0,037	0,001
2014	1229	36	1510441	7374	1213,6	15,400	237,160	0,013	0,0002
2015	1328	49	1763584	9296	1337	9,00	81,00	0,007	0,00
2016	1426	64	2033476	11408	1460,4	34,40	1183,360	0,024	0,001
2017	1524	81	2322576	13716	1583,8	59,80	3576,040	0,039	0,002
Sum	9809	285	11710967	56449	-	732,80	106594,16	0,904	0,186

The average deviation between the actual and estimated values of the function:

а) absolute in the formula (12) = 732,8/9 = 81,42 thousand UAH;

б) the relative is defined as was observed earlier, the same average error of approximation is 10,05 %, respectively.

Proposed indicators for assessing the quality of the equation do not contradict each other. Which is better to use is at the discretion of the expert. In general, we can say that the constructed equation is characterized by high and reliable performance, and also confirms the previously made predictions about the growth of working capital of JSC «ZAZ» until 2017 year and has even more positive dynamics.

CONCLUSIONS

Summing up the above, one can draw the following conclusions. The research examined the extrapolation method and its specific application in the mechanical engineering. It should be noted that this method can be used for forecasting of working capital and the volume of sales in the mechanical engineering. A forecast for several years makes it possible to assess the financial situation and create a plan of development, establish relationships with partners, improve the technical equipment to attract foreign investment. This method allows modeling the volume of sales based on market fluctuations and especially price changes, consumer demand for the products of new advanced car models. Further development of the results will be towards developing an integrated system of economic methods of performance indicators prediction based on existing market position and variability of the environment.

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