Extrapolation of indicators of monitoring of activity of industrial enterprises for an estimation of steady competitiveness

Abstract. The article is devoted to monitoring and analysis of the competitive position of industrial enterprises (on the example of enterprises of Kryvyi Rih region). It also presents a forecast of sustainable competitiveness based on the extrapolation of monitoring the performance of the enterprise, models and comparative analysis of the competitive position of the enterprise. There are also built analytical dependencies of an enterprise competitive position on corresponding influence factors for Kryvyi Rih region enterprises on the basis of extrapolation. There is performed a comparative analysis of predicted factors influencing competitiveness of mining enterprises. The following main components of the impact on sustainable competitiveness are analyzed: sales volume, net profit, market share, intensity of competition in the industry, market share of the researched enterprise and market leader share. The discrete time series have been identified for the first time. The applied extrapolation method has enabled determining forecast values of factors influencing the competitive position of an enterprise. The obtained results have been used practically in management activities at corresponding enterprises when making strategic decisions. The use of monitoring and discrete time series will allow to assess the competitive position of the enterprise and the relevant factors of influence.

Keywords: monitoring, indicator, enterprise, extrapolation, competitiveness, forecast

1 Introduction

1.1 Problem statement and its topicality substantiation

Current market conditions of industrial enterprises functioning require careful management as a means of not only surviving but also their further development. At the present stage of economic development, establishment and efficient use of certain competitive advantages facilitate accelerated development of production forces, scientific and technological progress, intensification of relations between countries' economies. Extrapolation of the enterprise's condition as "one of the most widely spread means of short-term forecasting of economic phenomena" (hereinafter courtesy translation) [1, 2] is one of pledges of achieving corresponding goals. In its wide meaning, extrapolation is known to be "a forecasting method that consists in studying stable trends of past and current processes and phenomena development and extending them into the future" [3,4]. Narrowly defined, extrapolation is determination of function values beyond the series using a series of the function data. In forecasting, extrapolation is applied to studying time series. There exist various methods of forecasting extrapolation which can be divided into complex and simple ones. Simple methods are based on the assumption that absolute values of levels, the average series level, the average absolute growth, the average growth rate are relatively stable in the future. Complex methods provide for spotting the main trend, i.e. application of analytical relations describing the trend. Methods of this group can be divided into analytical and adaptive [6 - 8].

The characteristic feature of extrapolation in the narrow meaning is that it can lean heavily on a rather small amount of data, this being often connected with properties of processes under study. When it comes to industrial enterprises, data volumes are not large as a rule, this being primarily explained by information being provided in the form of discrete time series with the time interval of one year. Due to this, application of mathematical statistics methods and conclusions while extrapolating is not reasonable and results in considerable errors. When making this kind of calculations, it is reasonable to base on point forecasts as determination of interval forecasts requires mathematical statistics methods. That is why, it is considered viable to extrapolate with the help of thorough studies of data features. Moreover, experts' opinions must be taken into account while analyzing forecasting data. The Ukrainian society information processes require comprehensive forecasting of enterprises' activity results in order to provide their corresponding competitiveness. Competitiveness of the enterprise potential provides for gaining profits due to new opportunities on the basis of studies of uncertainty factors and consideration of various risks. Extrapolation allows for expansion of regularities of

basic indicators formation beyond the current time interval and provision of scientific substantiation for efficient decision-making. The article aims to study and determine a competitive position and prospective forecasting of competitiveness on the basis of extrapolation of enterprise activity indicators with the necessary accuracy.

1.2 Analysis of the latest researches and publications

Processes of transformation of production activities at enterprises require forecasting competitiveness and development on the whole. Economic policies of enterprises should be transparent and forecast.

In scientific literature there are many works devoted to forecasting results of enterprise activities. Forecasting methods and models are studied in works by L.I. Brovko. O.A. Chepiha [9] where the essence of financial forecasting is substantiated and its methods and stages are determined. T.A. Vasyl'ieva, V.O. Kas'ianenko and L.S. Zakharkina [10] analyze efficiency of measures for governmental stimulation of innovative activities and study dynamics of budgeting innovative activities and transfer of technologies by strategic priorities. O. Zhuk investigates issues of revenue forecasting and its place in activities of an enterprise and performs extrapolation-based forecasting of the enterprise's earnings [11].

Works [12-14] demonstrate that calculating forecast financial and economic indicators is important for developing a scientifically substantiated strategy of providing competitiveness and enhancing the financial condition of an enterprise in the future. [15] investigates the essence and importance of financial forecasting for establishing sustainable financial development of enterprises in Ukraine and determines priority factors of influence of forecast values on managerial decision-making to minimize financial risks of an enterprise. Forecasting modeling is dealt with in [16-18] which consider main business trends in both Ukrainian and foreign markets. [19, 20] pay attention to methods of analyzing competitive advantages that enable measuring and forecasting competitiveness of industrial enterprises, assessing their competitiveness increase potential, studying the most appropriate directions of its increase. The most common indicators used as the most important characteristics of the competitiveness level are dealt with and strategies for adequate response to market volatility are presented in [21]. The authors of [22] suggests the system for evaluating both the level of development and efficiency of a country's industry and model their influence on the social and economic development. In [23], return on fixed assets of Ukraine's agriculture is modeled applying extrapolation and forecast values of the indicator are calculated. Research by Yu.A. Hajbura and L.A. Zahnitko determines prospective forecasting of economic indicators and the mechanism of using the obtained results in strategic management of an enterprise [24]. In [25-27], the authors state that economic forecasting consists in determining and studying principles, the structure, relations and mechanisms of social and economic processes. However, despite a great number of scientific works, the problem of analyzing and forecasting results of activities of industrial enterprises remains of relevance [28].

2 RESULTS

The actual market share in the total sales volume of particular products is one of the most common manifestations of the degree of competitive goals achievement. It reflects important results of competition and shows the degree of the dominance of the enterprise on the market.

The competitive position of the j-th enterprise on the market $[M_{KP_{j(t)}}]$ at the time moment t=t_i can be determined as follows [29, 30]:

$$M_{KP_{j(t)}} = \{d_{1j}(t), d_{2j}(t), d_{3j}(t)\}\ t=t_i$$

where $d_{1j}(t)$ is the indicator describing a market share of the j-th enterprise in the strategic zone of economic activities at the time moment $t=t_i$;

$d_{2j}(t)$ is the indicator describing competitive intensity in the industry of the j-th enterprise;

$d_{3j}(t)$ is the indicator describing the position of the j-th enterprise in relation to the leader of the industry.

The market share of the *j*-th enterprise in the z-th industry

$$d_1 = \frac{V_{ij}}{V_{iz}}$$

where V_{iz} is the sales volume of the *i*-th products of all enterprises-competitors in the z-th industry.

Intensity of competitiveness of the *i*-th products in the z-th industry, (d_2).

$$d_2 = \frac{V_{i1}+V_{i2}+V_{i3}+V_{i4}}{V_{iz}}$$

where V_{i1}, V_{i2}, V_{i3}, V_{i4} are the sales volume of the *i*-th products of the first, second, third and fourth enterprises in the z-industry respectively.

The market share of the enterprise under analysis to the z-th industry leader relation, (d_3):

$$d_3 = \frac{V_{ij}}{V_{i1}},$$

where V_{i1} is the sales volume of the *i*-th products of the enterprise-leader in z-th industry.

The status of the j-th enterprise is specified by a number of indicators characterizing this or that component. Thus, the next set is established in this way [29, 30]:

$$V_j = (V_{1j}, V_{2j}, \dots, V_{nj}),$$

where V_{ij} is the volume of the *i*-th products sold by the j-th enterprise, $i = \overline{1,n}$,

n is the number of product types, $j = \overline{1,m}$, $m -$ is the number of enterprises.

The initial data is presented as the matrix V=(V_{ij}). As the indicators under consideration may be of different dimensions, they should be standardized. For this, the following formula is used:

$$z_{ij} = \frac{V_{ij}-\overline{V_j}}{s_j}$$

where $\overline{V_j} = \frac{1}{n}\sum_{i=1}^{n} V_{ij}$ is the average value of the sales volume of the i-th products of the *j*-th enterprise,

$s_j = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(V_{ij} - \bar{V}_j)^2}$ –is the standard deviation of the sales volume of the i-th products of the *j*-th enterprise.

Next comes creation of the competitive status reference P_0.

To receive the competitive status reference P_0, all characteristics are divided into stimulants and destimulants.

Stimulants are indicators positively influencing and stimulating the competitive status of the enterprise, and destimulants are indicators with the contrary properties. Let us denote corresponding indicators for the j-th enterprise as sets

$$I_{sj} = \left\{z_{1_j}^{(s)}, \dots, z_{l_j}^{(s)}\right\} \text{ – stimulants,}$$

$$I_{dj} = \left\{z_{(l+1)_j}^{(d)}, \dots, z_{(n-l)_j}^{(d)}\right\} \text{ – destimulants,}$$

where l_j –is the number of indicators-stimulants of the $j-$ th enterprise,

$(n-l)_j$ – is the number indicators-destimulants of the $j-$ th enterprise.

The reference is the point of a multidimensional space created in the following way: among indicators-stimulants there are chosen data with the maximum values, among indicators-destimulants data with the minimum values are chosen:

$$P_0 = \left(z_{01}, \dots, z_{0p}, z_{0,p+1}, \dots, z_{0n}\right)$$

where $z_{0i} = \max\limits_{1 \le j \le m} z_{i_j}^{(s)}$, $(i = 1, \dots, p)$,

$$z_{0i} = \min_{1 \le j \le m} z_{i_j}^{(d)}, \quad (i = p+1, \dots, n).$$

Then quality is evaluated in the form of a summarizing indicator which is the resultant of all characteristics.

The quantitative evaluation of the competitive status level is determined as Euclidean distance to the point reference P_0

$$C_{i0} = \sqrt{\sum_{k=1}^{n}(z_{ik} - z_{0k})^2}$$

Then the average of the distance between points

$$\overline{C_0} = \frac{1}{n}\sum_{i=1}^{n} C_{i0}$$

and the mean-square deviation

$$S_0 = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(C_{i0} - \bar{C}_0)^2}$$

are determined.

The value C_0 is calculated by the formula:

$$C_0 = \overline{C_0} + 2S_0$$

And the integrated indicator is found in the following way:

$$d_i = 1 - \frac{c_{i0}}{c_0}.$$

This indicator is a quantitative evaluation of the competitive status level for every enterprise by the given set of components. It enables determining the lifecycle stage of the enterprise at a particular time moment. Then the obtained data is ranked and interpreted.

Relevant studies and calculations have been performed for mining enterprises of Ukraine.

The status of enterprises was evaluated according to the suggested methods applying the following indicators [29, 30]:

- the market share of the enterprise on the product market (d_1);
- competitive intensity in the industry (d_2);
- the market share of the enterprise under study to that of the market leader relation (d_3) [29, 30].

At the first stage of evaluating the competitive status at Ukrainian mining enterprises, the most important components of the earlier enterprise competitive status evaluation are analyzed. The enterprises chosen are located in various parts of Ukraine. As enterprises of Kryvyi Rih dominate the industry, the priority is given to them. The following enterprises were chosen: the PJSC "Inhulets GZK", the PJSC "Central GZK", the OJSC "Southern GZK" the OJSC "Northern GZK", the PJSC "KZRK", the PJSC "Evraz Sukha Balka" and the OJSC "Poltava GZK".

The following sets of the competitive status reference for each enterprise under consideration are as follows:

P_1=(0.864; 1; 0.93; 1; 1;1); P_2=(0.864; 0.862; 0.937; 0.687; 0.819; 0.894);

P_3=(0.859; 0.838; 0.954; 0.712; 0.827; 0.831);

P_4=(1; 0.852; 1; 0.818; 0.949; 0.894); P_5 =(0.764;0.567; 0.254;0.657;0.753;0.812);

P_6 = (0.568; 0.357; 0.127; 0.538; 0.624; 0.745);

P_7 =(0.754; 0.421; 0.354; 0.657; 0.785; 0.875)

From these the quantitative evaluation of the competitive status level or the quality level C_0 is calculated for each enterprise under analysis:

$C_{01} = 2.26$, $C_{02} = 3.17$, $C_{03} = 2.87$, $C_{04} = 1.80$, $C_{05} = 3.50$, $C_{06} = 3.99$, $C_{07} = 3.58$

Thus, the average distance between points $\overline{C_0}$ =3.023 and the mean-square deviation S_0 = 0.718 [31-33].

Calculation of the integrated indicator *d* for each of the mentioned enterprises is the final step. This indicator is a quantitative evaluation of the competitive status level by the given set of components. Every enterprise has its own specific features without consideration of which the required accuracy of extrapolation cannot be achieved. This refers to the full extent to mining and concentration enterprises of Ukraine. The process of choosing the appropriate alternative involves creative analytical work. Economic and analytical analysis of the choice of alternative development of the enterprise contains the relevant stages, which include not only methods, models, a balanced system of monitoring indicators, but also intellectual components.

Table 1 presents indicators of the competitive position of the PrJSC "KZRK" [34, 35].

To determine specificity of the indicators in Table 1 as time series, let us present them graphically. Analysis of the graphs in Fig. 1 demonstrates periodicity of sales volumes and net profits within the period under review.

Table 1

Competitive position indicators, PJSC "KZRK"

Indicators \ Years	2013	2014	2015	2016	2017	2018
Sales volume, 000 UAH	1127259	2111434	1227289	3108511	4291290	3289691
Net profit, 000 UAH	174530	1050379	200835	1196743	1743515	772156
Share on product market (d_1)	0.040	0.073	0.072	0.105	0.070	0.060
Competitive intensity in industry (d_2)	0.864	0.862	0.937	0.687	0.819	0.894
Enterprise market share to that of market leader relation (d_3)	0.095	0.222	0.161	0.370	0.265	0.162

Note: calculated on the basis of [34, 35]

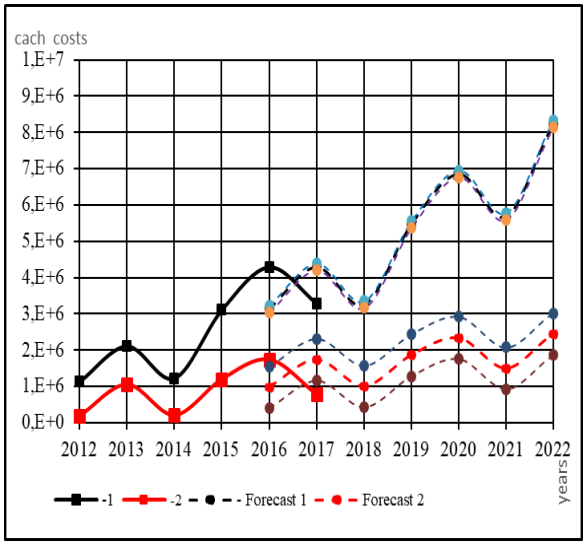

Fig. 1. Sales volume, 000 UAH – 1; net profit, 000 UAH – 2 (PrJSC "KZRK")

Note: developed by the authors.

The graphs in Fig. 2 a), b), c) KZRK" on time respectively present dependency of indicators d_1, d_2, d_3 of the competitive position forecast of the PrJSC "

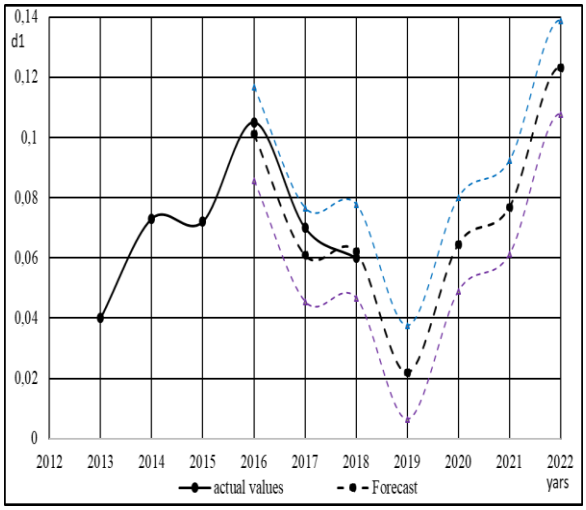

Fig. 2 a) Dependency of the competitive position indicator d_1 of the PrJSC "KZRK" on time

Note: developed by the authors

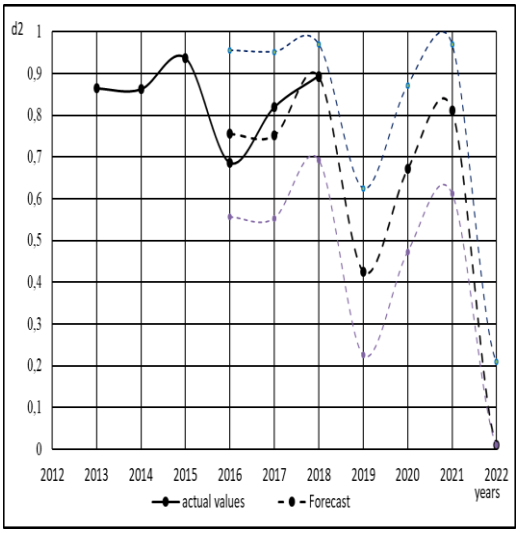

Fig. 2 b) Dependency of the competitive position indicator d_2 of the PJSC "KZRK" on time

Note: developed by the authors

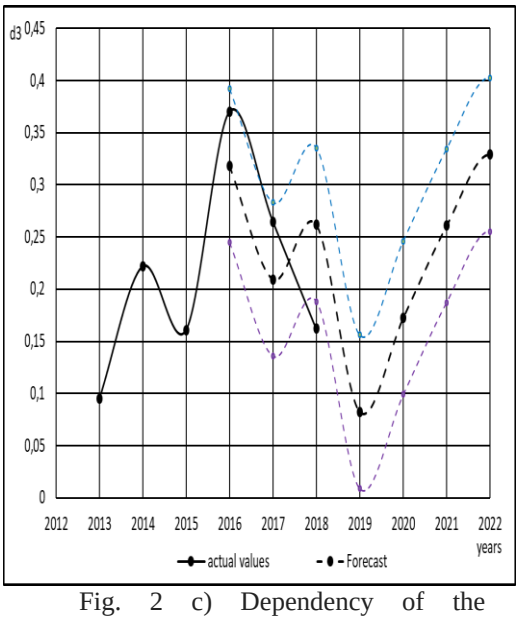

Fig. 2 c) Dependency of the competitive position indicators d_3 of the PrJSC "KZRK" on time

Note: developed by the authors

Analysis of the graphs in Fig. 1 and 2 a), b), c) shows that the given discrete time series are stochastic linear processes [36-38]. At the first stage of evaluating the competitive status at Ukrainian mining enterprises, the most important components of the earlier enterprise competitive status evaluation are analyzed. The

enterprises chosen are located in various parts of Ukraine. As enterprises of Kryvyi Rih dominate the industry, the priority is given to them. The following enterprises were chosen: the PJSC. The strategy for the development of mining enterprises provides for the feasibility of calculating a system of monitoring indicators to ensure sustainable competitiveness of the enterprise. The system of indicators must contain the characteristics of the enterprise. It is advisable to monitor the values of indicators that are essential in determining the external environment

This enables their presentation as the regression of the current deviation of the time series from the earlier deviation average

$$\tilde{x}_t = \gamma_0 + \gamma_1 \tilde{x}_{t-1} + \gamma_2 \tilde{x}_{t-2} + \cdots + a_t, \qquad (1)$$

where $\tilde{x}_{t-k} = x_{t-k} - \bar{x}$,

$\bar{x}$ – is the time series average value,

γ_0, γ_1, γ_2, …are the numerical coefficients, a_t –is the residual error.

It is observed that for the graphs in Fig. 1 and 2 the most appropriate model of a time series looks like

$$\tilde{x}_t = \gamma_0 + \gamma_1 \tilde{x}_{t-3} + a_t \qquad (2)$$

Coefficients in formula (2) are determined by the least square method through minimization of the sum of squared deviations by the coefficients γ_0, γ_1

$$S(\gamma_0, \gamma_1) = \sum_{k=3}^{5} \left(\tilde{x}_{t_k} - \gamma_0 - \gamma_1 \tilde{x}_{t_k-3}\right)^2, \qquad (3)$$

Table 2 presents results of identification of discrete time series based on the data from Table 1.

Table 2.

Results of discrete time series identification

Indicators of competitive position, PrJSC "KZRK"	Mathematical model of discrete time series
Sales volume, 000 UAH	$x_{t_k} = 1814521 + 1.175 \cdot x_{t_k-3}$
Net profit, 000 UAH	$x_{t_k} = 824949 + 0.868 \cdot x_{t_k-3}$
Share on product market (d_1)	$x_{t_k} = 0.15 - 1.22 \cdot x_{t_k-3}$
Competitive intensity in industry (d_2)	$x_{t_k} = -0.858 + 1.868 \cdot x_{t_k-3}$
Enterprise market share to that of market leader relation (d_3)	$x_{t_k} = 0.402 - 0.858 \cdot x_{t_k-3}$

Note: developed by the authors

Fig. 1 and 2 a), b), c) present forecast results up to 2022 of indicators of the competitive position of the PrJSC "KZRK". Analysis of the given graphs only enables determining the qualitative character of the forecast due to limited data. Besides, it should be noted that the forecast for 2021 and up is based on the previous one, this affecting its accuracy. In its turn, the forecast structure remains unchanged and is proved by the wavelike character of the graphs.

Monitoring indicators of other GOKs were calculated similarly to the identification of discrete time series for PrJSC "KZRK". Analysis of the presented mathematical models of discrete time series shows their similarity. This enables the conclusion about similar qualitative behavior of forecast indicators in terms of competitive positions of the other GZKs, their wavelike character in particular.

3 CONCLUSIONS

The obtained results enable the following conclusions: modeling and comparative analysis of the competitive position of an industrial enterprise, identification of discrete time series form the basis for determining forecast indicators of enterprises' competitiveness applying extrapolation with the view of making efficient strategic managerial decisions. The work has analyzed main components of influence on competitiveness: the sales volume, the net profit, the market share, competitive intensity in the industry, the market share of the enterprise under study to that of the market leader relation. The work states that it is possible to obtain relevant forecasts of a qualitative character due to a limited volume of initial data.

Analytical dependences on the competitive position of the enterprise and the corresponding factors of influence for the enterprise are constructed. For the first time, the identification of discrete time series was obtained. The application of the extrapolation method allowed to determine the predicted values of factors influencing the competitive position of the enterprise. The results of the study were used in the practice of managers of relevant enterprises in making effective decisions in the system of strategic management. The use of identification of discrete time series will allow to carry out the corresponding estimation of a competitive position of the enterprise and the corresponding factors of influence. At present, the company needs significant investments in the renewal of fixed assets, introduction of modern technologies and so on.

Various disturbances of the internal and external environments of mining companies require appropriate adjustments to strategies. Transformations of the environment require editing and an appropriate strategic management process. That is, the process of strategic management is in constant dynamics. The enterprises of the Kryvyi Rih iron ore basin have real opportunities for further development of their economic potential. Thus, the process of strategic management is in constant dynamics. Economic and analytical assessment of competitive status is a tool, the use of which allows managers to obtain the basic characteristics of the

production activities of the enterprise to invest in the most profitable or promising areas of development.

References

1. Govkivska T. Scientific Bulletin of Ugorod National University. **19 (1)**, 146–151 (2018)
2. Sehida, K. Problems of continuing geographical education and cartography. **24,** 109-116 (2016)
3. Beridze, T. M. *Statistical monitoring in the enterprise strategic management system: monograph*. (Kremenchuk, Ukraine, 2016)
4. Beridze, T.M. Serebrenykov, V.M. and Lokhman N.V. Ekonomika ta suspil'stvo **15** (2018), , http://www.economyandsociety.in.ua/index.php/journal-15 Accessed 2020/10/20. Accessed 2020/10/15
5. Box G. E. P., Jenkins G. M., and Reinsel G. C. *Time series analysis: Forecasting and control. — 3rded*. (NJ, USA, 1994).
6. Eykhoff P. *System Identification* (Moscow, Russia, 1975)
7. B.L., Kalman R.E. Regelungstechnik. **14,** 545-548 (1966)
8. *Time series analysis* (2016). https://github.com/lanit-tercom-school/analyzeme/wiki/ Accessed 2020/10/17. Accessed 2020/10/14
9. Brovko, L. I. and Chepiha, O. A. Efektyvna ekonomika **11** (2015), http://www.economy.nayka.com.ua/?op=1&z=4520 Accessed 2020/10/14. Accessed 2020/10/11
10. Vasyl'ieva, T. A. Kas'ianenko, V. O., and Zakharkina, L. S Black Sea Economic Studies. **40**, 23-29 (2019).
11. Zhuk, O. Scientific blog (2015), https://naub.oa.edu.ua/2015 прогнозування-прибутку-підприємства/ Accessed 2020/10/14. Accessed 2020/10/11
12. Kuz'mina, O.M. Pecherytsia, Yu.S. and Hryschuk, L.V. Young scientist. **1(28).** 89-93 (2016)
13. Chandler A. *Strategy and structure*. (Boston, USA, 1962)
14. Hamel G., and Prahalad C. K. *Competing for the future*. (Boston, USA, 1984)
15. Hajbura, Yu. A. and Zahnitko, L. A. Economy and society.**9,** 968-974 (2017).
16. Sych, O.A. and Kalichak, I.I. A young scientist. **№ 2 (42**), 333-339 (2017).
17. Hamilton P. *Time Series Analyses*, (Princeton, USA, 2001)
18. Kharris R., Sollis R. *Applied time series Modeling and forecasting.* (Moscow, Russia, 2003)
19. Savyts'ka, O. M. Perminova, S. O. and Omel'chenko, Ya. V. Efficient economy**. 1** (2018). http://www.economy.nayka.com.ua/?op=1&z=6049 Accessed 2020/10/17. Accessed 2020/10/14
20. Sharko, V. V. Scientific Bulletin of Mukachevo State University. **2(4).** 120-125 (2015).
21. Khaustova, V. Ye.. *Industrial Policy in Ukraine: Formation and Forecasting* (Kharkiv. Ukraine, 2015)
22. Nuzhna, O. Yu. and Pyrih, S. O. Economic forum **2**, 35-41 (2015)
23. Hajbura, Yu.A. and Zahnitko, L.A. Economy and society **9,** 968-974 (2017), http://economyandsociety.in.ua/ journal/9_ukr/167.pdf Accessed 2020/10/17. Accessed 2020/10/14
24. Biau G., Bleakley k., Gy¨orfi L., Ottucs´ak G. J. Nonparametric Stat. **22(3),** 297–317 (2010).
25. Hyndman R. J., Athanasopoulos G. Forecasting. *Principles and practice*., https://www.otexts.org/book/fpp: (Melbourne, Australia, 2018)
26. Hajbura, Yu.A. and Zahnitko, L.A. Economy and society**. 9,** 968-974 (2017), http://economyandsociety.in.ua/ journal/9_ukr/167.pdf Accessed 2020/10/28. Accessed 2020/10/21
27. Johnston, J. *Econometric Methods*. (London, England, 1984)
28. Beridze, T.M. Lokhman, N.V. and Pasichnyk, N.V. *Investment activity of industrial enterprises: practical experience*. (Kremenchuk. Ukraine, 2017)
29. Ponomarenko, V. S. and Hontareva, I. V. *Methodology of complex evaluation of enterprise development efficiency* (Kharkiv Ukraine, 2015)
30. Trydied, O. M. and Dziebko, I. P. Problems of Theory and Methodology of Accounting, Control and Analysis, 1(19), 376-382. (2015).
31. Lokhman, N. Serebrenikov, V. Beridze, T. Cherep, A. and Dashko, I. Bulletin of the National Mining University. **2,** 179-189 (2020)
32. Beridze, T.M. Lokhman, N.V. and Pasichnyk, N.V. *Investment activity of industrial enterprises: practical experience*. (Kremenchuk. Ukraine, 2017)
33. Beridze, T.M. Lokhman, N.V. and Pasichnyk, N.V. *Investment activity of industrial enterprises: practical experience*. (Kremenchuk. Ukraine, 2017)
34. SMIDA (n.d.). Account of information services. Reports of enterprises. Retrieved from http://smida.gov.ua/. Accessed 2020/10/17. Accessed 2020/10/1
35. State Statistics Service of Ukraine (n.d.). Retrieved from http://www.ukrstat.gov.ua/ Accessed 2020/10/17. Accessed 2020/10/14
36. Astrom K.J. *Lectures on the identification Problem - The Least Squares Method*. (Lund Institute of Technology, 1968)
37. Durbin J.Royal Stat. **22.** 139-153 (1960)
38. Strejc V. Kybernetika. **13**, 83-105 (1)