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FORECASTING OF THE BUSINESS CONFIDENCE INDEX OF UKRAINE ON THE BASIS OF NEURAL NETWORKS TECHNOLOGIES

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The paper is dedicated to the one of the leading economic indicators – business confidence index (BCI). This indicator characterizes the state of the economy and the business situation in the country. Future changes in business cycles and economic prospects can be determined on its basis, since the business confidence index is associated with the concept of economic cycles. The index enables to identify and predict crisis phenomena that occur in the economy and develop possible options for overcoming them. The author's vision of the stages of forecasting the business confidence index based on neural network technologies is proposed. The paper studies the dynamic of the Ukrainian business confidence index over the past eleven years (2008-2019). A system of socio-economic indicators that have an impact on the business confidence index was formed. Based on the correlation coefficients, the degree of their relationship with business confidence index was established, and only those that had a high degree of relationship were selected. Based on the selected socio-economic indicators, the business confidence index forecast for the next period was developed. For forecasting, which based on neural network technologies, the quarterly values of the growth rates of the selected indicators were taken as initial data. It is established that the obtained forecast completely repeats the trend of the initial time series. Forecast error is equal to 4% that demonstrates the high quality of the obtained results. The obtained forecasting results indicate that in the forecast period the business confidence index of Ukraine will decrease by 3,12% compared with the previous period. The predicted values of the business confidence index make it possible earlier than other macroeconomic indicators to predict changes in the country's business climate.

ПРОГНОЗУВАННЯ ІНДЕКСУ ДІЛОВИХ ОЧІКУВАНЬ УКРАЇНИ НА ОСНОВІ НЕЙРОННИХ ТЕХНОЛОГІЙ

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Ключові слова:
прогноз, нейронна мережа, модель, валовий внутрішній продукт, індекс ділових очікувань, аналіз, бізнес ситуація, економіка.

Розглянуто один із випереджаючих економічних індикаторів – індекс ділових очікувань (business confidence index, BCI). Цей показник характеризує стан економіки та бізнес ситуації країни. На його основі можна визначати майбутні зміни ділових циклів та економічні перспективи, оскільки його пов'язують з концепцією економічних циклів. BCI дає змогу виявляти та прогнозувати кризові явища, які відбуваються в економіці та розробляти можливі варіанти виходу із них. Запропоновано авторське бачення етапів прогнозування індексу ділових очікувань на основі нейромережевих технологій. Досліджено динаміку BCI вітчизняної економіки за останні одинадцять років (2008-2019). Сформовано систему соціально-економічних показників, які здійснюють вплив на BCI. На основі коефіцієнтів кореляції встановлено ступінь їх зв'язку з BCI та відібрано лише ті, які мають високий рівень зв'язку. На основі відібраних соціально-економічних показників було побудовано прогноз значення BCI на наступний період. Для прогнозування індексу BCI для української економіки було застосовано нейромережеві технології, у якості вихідних даних було обрано квартальні значення темпів зростання відібраних показників. Установлено, що отриманий прогноз повністю повторює тенденцію вихідного часового ряду. Помилка прогнозу становить 4%, що свідчить про високу якість отриманих результатів. Результати прогнозування свідчать про те, що в прогнозному періоді значення індексу BCI в Україні зменшиться на 3,12% порівняно з попереднім періодом та складе 115,96. Прогнозні значення індексу ділових очікувань дають змогу раніше за інші макроекономічні показники передбачати зміни бізнес-клімату країни.

Statement of the problem

At the current stage of economic development, researchers are placing greater emphasis on studying of various socio-economic indicators that would characterize the changes taking place in the economic space. One of these indicators is the business confidence index, which allows both analysing the current state of the economy and tracking the peaks and downturns of the economic cycle. Also, it should be noted that on the basis of the business confidence index, it is possible to predict the direction of changes in the business cycle that may occur in the next period and assess the business situation in the country.

The business confidence index refers to leading indicators that provide an opportunity for early detection of economic changes, as it is published by the National Bank of Ukraine quarter earlier than the information of State Statistics Service of Ukraine on macroeconomic indicators. Given this data, the indicator is very valuable for the analysis of the economic situation in the country and requires qualitative research. Therefore, forecasting the index of business confidence is one of the urgent tasks of the economy, which requires a solution.

Analysis of recent studies and publications

Theoretical and practical aspects of the formation of an index of business confidence have been investigated in many foreign and Ukrainian researchers. Helder Ferreira de Mendonça and André Filipe Guedes Almeida [1] have considered the issue of building a confidence index based on the inflation target of Brazil. Researchers have established that the impact of the credibility of monetary policy on business confidence is significant for decision making by enterprises. In paper [2], an extraordinary approach to the generation of local business confidence indices and an analysis of local intersectoral relations based on textual data from newspaper articles was proposed. S. Feuerriegela та J. Gordon [3] include business confidence index in the set of macroeconomic indicators with the aim of reflecting the general German economic climate and the forecast of macroeconomic indicators is built using the semantic path model. In the collective monograph [4], various interpretations of the business activity of the enterprise are considered and the conclusion is drawn that simultaneously with the microeconomic approach, an integrated approach to the study of this category is also being developed through an attempt to combine the business activity of individual business entities with the business activity of the economy as a whole. The system of indicators that characterize the general economic development of the country refers to external sources of information for generating business activity indicators and is the basis for analysing and predicting the environmental conditions of the entity's functioning when developing a comprehensive policy for managing business activity and identifying reserves for its increase, focusing on industry average indicators. In paper [5], a group of economic indicators that affect business activity is proposed based on cross-correlation analysis into three groups: lagging, coincident and leading indicators. The existing scientific papers do not fully reflect the current views of researchers regarding the forecasting of business confidence index. Therefore, in spite of a significant number of scientific publications, the issue of business confidence index forecasting remains insufficiently disclosed.

Objectives of the article

The purpose of the article is to forecast the index of business confidence of Ukrainian enterprises on the basis of a system of socio-economic indicators that have a significant relationship with the business confidence index using neural network technologies.

The main material of the research

In the scientific economic literature, the business confidence index is understood as a complex numerical assessment that reflects the efficiency of using available resources and the state of the economy as a whole. In Ukraine, the business confidence index is determined by the National Bank of Ukraine [6] in accordance with the recommendations of the Organization for Economic Cooperation and Development (OECD). The National Bank of Ukraine has been conducting quarterly surveys regarding business confidence of enterprises since 2006 and calculates an aggregate index of survey results — an index of business confidence, which is based on the expectations of enterprises regarding their development prospects in the next 12 months, in particular regarding the financial and economic situation, volume of sales, investment and employment. The business confidence index is calculated as the average value of response balances [7].

The forecasting of the business confidence index was carried out on the example of the Ukrainian economy over the past eleven years (2008-2019). To form a system of socio-economic indicators that affect the business confidence index of enterprises of Ukraine [6], the official statistical data of the site "Trading Economics" [8] was used. The authors proposed a methodological approach to forecasting BCI based on neural network technologies, which is presented in Figure 1.

In accordance with the proposed methodological approach, the first stage is the formation of a system of socio-economic indicators that characterize the business situation in the country under study. Based on the analysis of scientific papers, the authors made the assumption that the business confidence index (BCI) is affected by a set of socio-economic indicators, such as: growth rate of Changes in Inventories, GDP Annual Growth Rate, Producer Price, Unemployment Rate, growth rate of Consumer Spending, growth rate of Steel Production, growth rate of Export and growth rate of Import. Accordingly, the authors formed an array of input data for the country under study (Ukraine). The outgoing data for forecasting are the time series of quarterly growth rates of economic indicators over the past eleven years (1^{st} quarter of 2008 – 1^{st} quarter of 2019).

At the second stage, the degree of connection between the selected socio-economic indicators and the BCI is checked. The degree of connection is established using the correlation coefficient, if its value is greater than 0,7, and then this indicator will be used in the future when predicting BCI. All other indicators whose correlation coefficient are less than 0,7 are not considered.

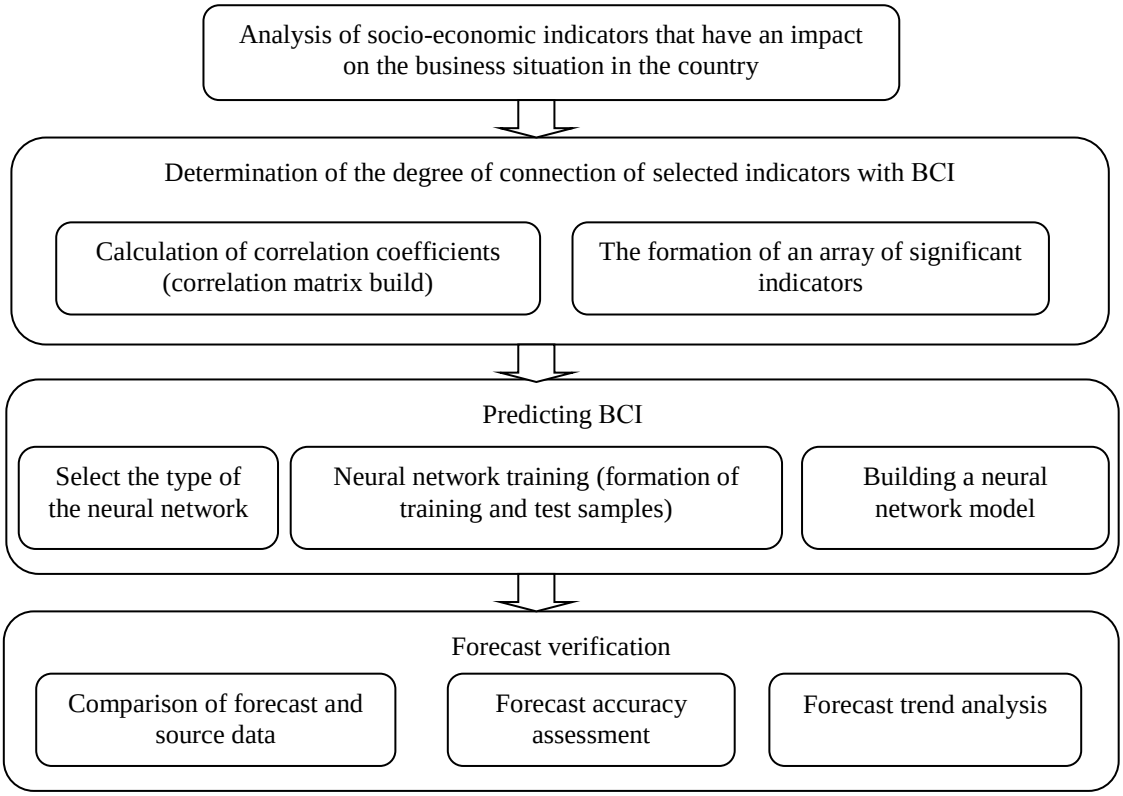

Fig. 1. Stages of developing the BCI forecast based neural network technologies
Source: *developed by the authors*

In accordance with the results of the correlation analysis, it was found that significant indicators that affect the level of business confidence of Ukrainian enterprises (BCI) are indicators such as: GDP Annual Growth Rate, growth rate of Export and growth rate of Import (Table 1). It is these indicators that have a correlation coefficient with the business confidence index greater than the threshold value of 0,7 and based on them, the further forecasting of the business confidence index of enterprises of Ukraine will be carried out.

Table 1 – Correlation matrix

Socio-economic indicators	The degree of connection of selected indicators with BCI
Changes in Inventories	0,228177
GDP Annual Growth Rate	0,860089
Producer Price	0,081755
Unemployment Rate	-0,44299
Consumer Spending	0,42668
Steel Production	0,549649
Export	0,759519
Import	0,786822

Source: *calculated by the authors*

We will implement forecasting the business confidence index of Ukrainian enterprises by two methods: using neural network technologies and based on regression analysis. Forecasting based on neural network technologies consists of such steps as selecting the type of neural network and the method of its training, and then testing the neural network and its launch to develop predictive values. For a predictive neural network, the number of inputs depends on the generated array of the training sample, and there is only one output – the BCI value.

All calculations were carried out on the basis of the analytical platform Deductor Studio Academic 5.3 [9], which allows you to perform all the steps of data mining from their loading and visualization to building and evaluating the quality of finished models. The forecasting procedure, first of all, provides for the construction of a neural network model, determination of confidence intervals and comparison of forecast values of BCI with real ones.

The time period for analysis is 45 values (1st quarter of 2008 - 1st quarter of 2019). The training set consists of 89% of the data (40 values, time period between 1st quarter of 2008 and 4th quarter of 2017), and the test set – 11% of data (5 values, time period between 1st quarter of 2018 and 1st quarter of 2019). According to the results of the correlation analysis, three indicators for predicting the BCI of Ukraine, which influence the business confidence index, were chosen: GDP Annual Growth Rate (GDP_AGR_Ukraine), Export (Exports_Ukraine) and Import (Imports_Ukraine). An artificial neural network consists of one hidden layer, which contains two

neurons, and one output layer (business confidence index). The number of variables in the input layer corresponds to the number of selected economic indicators for modelling, i.e. tree. Thus, to predict BCI, used the neural network of the type [3–2–1] (Fig. 2).

The activation function of the hidden layer is the sigmoid function. This type of function is often used for modelling and the outgoing values of such a function continuously fill the range from 0 to 1 [8]. The learning algorithm is the back-propagation error algorithm (Back-Propagation) with a learning rate of 0,1. The difference between the reference and the real output of the network is less than 0,05 (learning rate). The number of learning iterations is 10000.

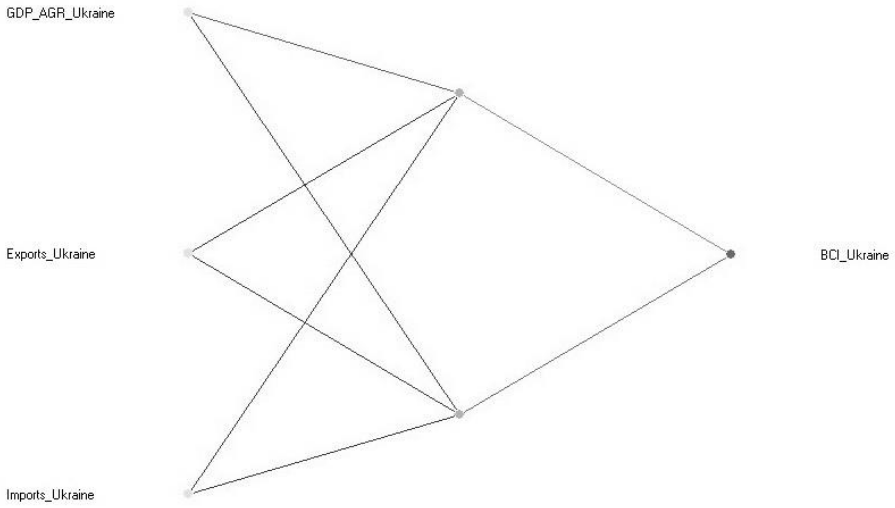

Fig. 2. General view of a neural network of the type [3–2–1]
Source: *calculated by the authors*

The next step is the analysis of the results – establishing the accuracy and quality of the developed forecast. The quality of the forecast is determined on the basis of confidence intervals and is visually displayed on the dispersion diagrams, which are shown in Fig. 3 and. Fig. 4.

From the dispersion diagram, it can be seen that the predicted values of BCI do not exceed 5% confidence interval, that is, we can conclude that the neural network models obtained are qualitative.

Average and maximum errors train and test sets for model are not exceed the recognition error threshold (0,05), which evidenced that the resulting neural network model can be used to predict the index of business confidence of the country's enterprises. Absolute percentage error also evidenced about high forecasting quality, since it is not exceed 10% (Table 2).

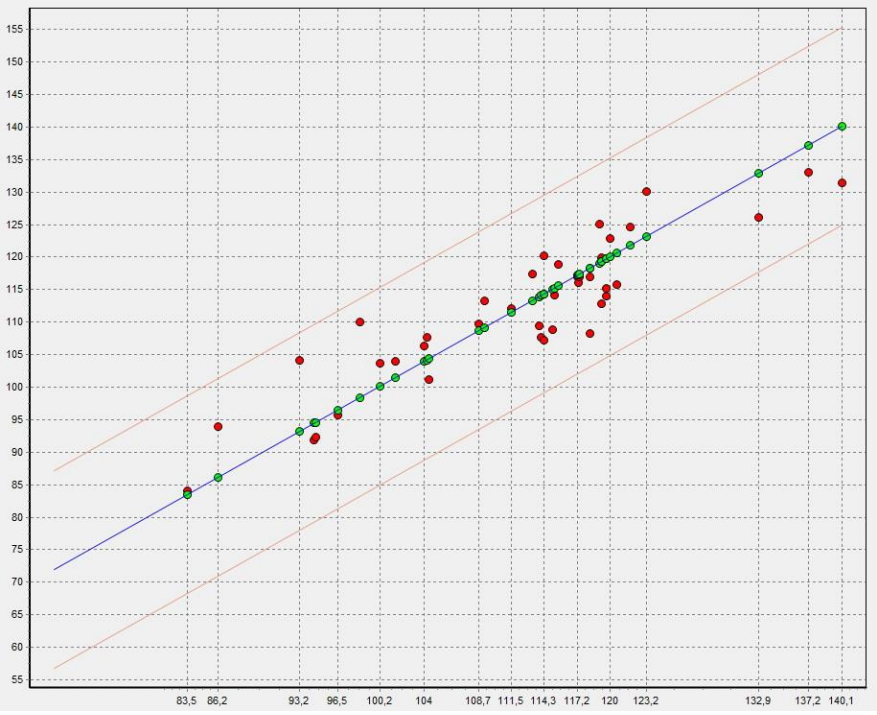

Fig. 3. Dispersion diagram of the train set of the neural network
Source: *calculated by the authors*

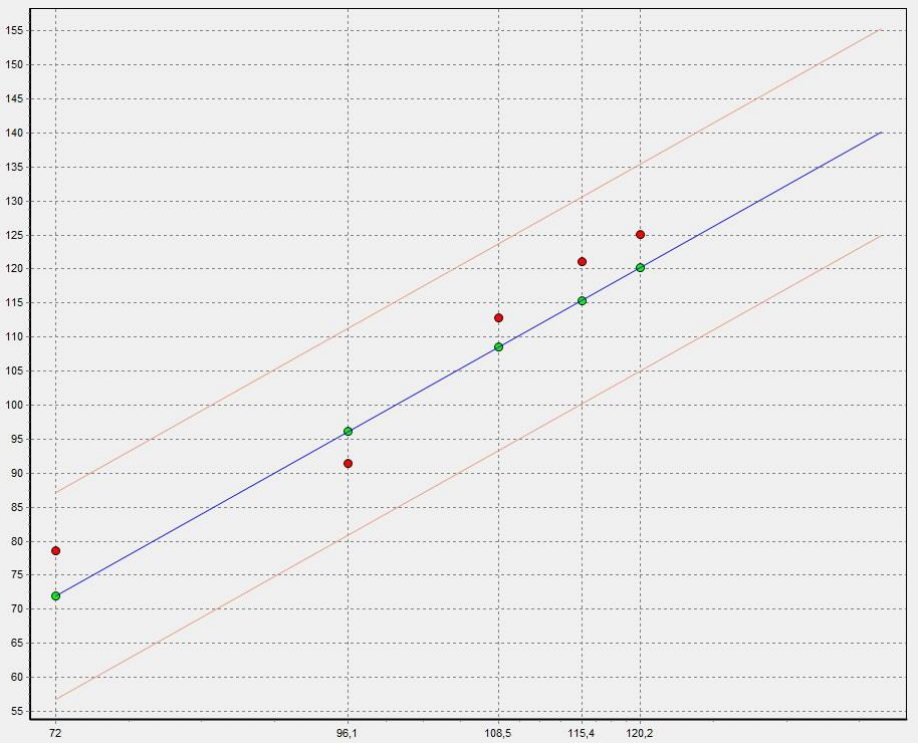

Fig. 4. Dispersion diagram of the test set of the neural network
Source: *calculated by the authors*

Table 2 – Measures of the forecast set

Measures	Value of the measure
Average error of the train set	0,0085
Maximum error of the train set	0,0426
Average error of the test set	0,0088
Maximum error of the test set	0,0138
Absolute percentage error (MAPE), %	4

Source: *calculated by the authors*

Using the worked out a neural network model, we construct the forecast of the business confidence index for the Ukrainian enterprises for the 2nd quarter of 2019. This forecast was made using the "What - If" tool of the analytical platform Deductor Studio Academic 5.3. The forecast result is shown in Fig. 5.

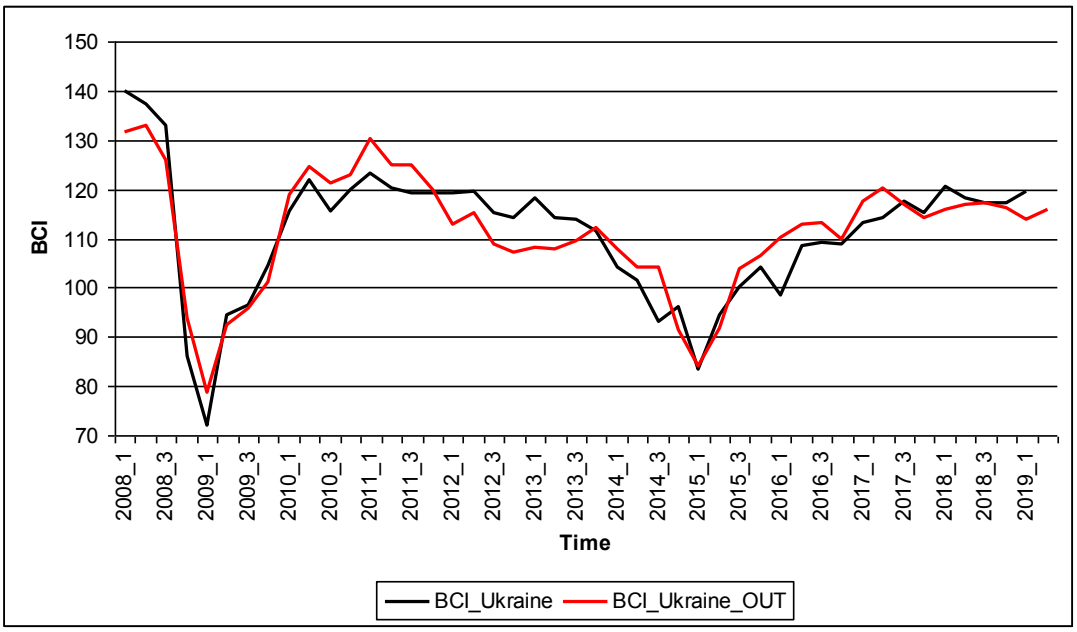

Fig. 5. The result of forecasting the business confidence index based on neural network technologies
Source: *calculated by the authors*

Figure 5 shows that starting from the 2nd quarter of 2016 there has been an increase in the economic activity of the Ukrainian economy by an average of 1.7%. Based on a visual analysis of the real and forecast values of the business confidence index, we can conclude that the obtained forecasts completely repeat the trends of the original time series. The forecast value of the business confidence index of Ukrainian enterprises in 2nd quarter 2019 decrease by 3.12% compared to 1st quarter 2019 (from 119,7 to 115,96). The decline in the value of BCI is associated with an increase in the rate of growth in exports by 57,2% (from 7,37 in 1st quarter of 2019 to 3,16 in 2nd quarter of 2019). However, the value of the business confidence index is more than 100, which indicates the continued growth trend in economic activity in the 2nd quarter of 2019.

Conclusions

The paper discusses the forecasting of the business situation in Ukraine based on the use of an appropriate indicator – the business confidence Index (BCI), which determines the effectiveness of the country's economy and its development prospects. The advantages of the indicator are the fact that it has a proactive publication nature; therefore, it is valuable for forecasting the macroeconomic state of the country.

Since neural network technologies today are characterized by broad research capabilities, such as: ability to change its behaviour depending on external influences, high reliability. Considering this the BCI forecasting is proposed to be carried out by phased construction of a neural network model with the possibilities of its training. Based on the results of testing the proposed methodological approach, the time series of quarterly values of the BCI indicator of Ukraine for the period 2008-2019 was predicted to take into account the influence of significant socio-economic indicators, such as: GDP Annual Growth Rate, growth rate of Export and growth rate of Import. It was found that the forecast that was obtained using neural network technologies has high accuracy and such that is within the confidence interval. It is proved that in the next period the value of the BCI will be 115,96, which will indicate the retention trends of economic activity in Ukraine. The obtained forecast indicators serve as the basis for making managerial decisions both at the level of economic entities and at the macro level. Based on them, economic development strategies are formed, and the prospects for the overall business situation in the country are substantiated.

References

1. de Mendonca, H. F., & Almeida, A. F. G. (2018) Importance of credibility for business confidence: evidence from an emerging economy. Empirical Economics, Retrieved from https://doi.org/10.1007/s00181-018-1533-5.
2. Sakaji, H., Kuramoto, R., Matsushima, H., Izumi, K., Shimada, T., & Sunakawa, K. (2019) Financial Text Data Analytics Framework for Business Confidence Indices and Inter-Industry Relations. Proceedings of the First Workshop on Financial Technology and Natural Language Processing (FinNLP@IJCAI 2019), Macao, China, August 12. (pp. 40-46).
3. Feuerriegela, S., & Gordon, J. (2019) News-based forecasts of macroeconomic indicators: A semantic path model for interpretable predictions. European Journal of Operational Research, vol. 272, no. 1, 162-175. Retrieved from https://doi.org/10.1016/j.ejor.2018.05.068.
4. Kashchena, N.B., Horoshanska, O.O., Polova, T.V., Prokopova, O.V., Harkusha, N.M., Rudenko, I.V. et al. (2016). Dilova aktyvnist pidpryiemstva: sutnist ta metodyka analizu [Business activity of the enterprise: the essence and methods of analysis]. Kharkiv: Vydavnytstvo Ivanchenka I.S. [in Ukrainian].
5. Bilan, Y., Gavurova, B., Gedek, S. & Tkacova, A. (2017) The Composite Coincident Indicator (CCI) for business cycles. Acta Polytechnica Hungarica, vol. 14, no. 7, 71-90. Retrieved from https://doi.org/10.12700/APH.14.7.2017.7.5.
6. National bank of Ukraine: Business expectations of enterprises. https://bank.gov.ua Retrieved from https://bank.gov.ua/control/uk/publish/ category?cat_id=58374 [in Ukrainian].
7. Los, V., Ocheretin, D. (2019) Prediction of Business Confidence Index Based on a System of Economic Indicators. Proceedings of the Selected Papers of the 8th International Conference on Monitoring, Modeling & Management of Emergent Economy (M3E2-EEMLPEED 2019) Odessa, Ukraine, May 22-24, 2019. CEUR Workshop Proceedings, vol. 2422, 237-248. Retrieved from http://ceur-ws.org/Vol-2422/paper19.pdf.
8. Tradingeconomics.com: 20 million indicators from 196 countries. https://tradingeconomics.com. Retrieved from https://tradingeconomics.com.
9. Paklin, N. B., & Oreshkov, V. I. (2013) Biznes-analitika: ot dannyh k znanijam [Business Analytics: From Data to Knowledge]. Saint Petersburg: Piter [in Russian].
10. Callan, R. (1999) The Essence of Neural Network. New Jersey: Prentice Hall.