МЕНЕДЖМЕНТ

UDC 338.2

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METHODOLOGICAL APPROACH TO PREDICTING PRODUCER PRICES FOR PETROLEUM PRODUCTS

Urgency of the research. *Every day, scientists solve problems in economics. To find, which action leads to the expected result with the smallest losses and risks, it's necessary to predict the further development of events.*

Target setting. *The most widespread problem is the allocation of resources. To make proper calculations and right decisions of distribution, the science of economic theory exists.*

Actual scientific researches and issues analysis. *The studies of Khaikin S. and Callan R. are the most famous among the studies of foreign authors. Yakhyaeva G. E. investigated the theory of neural networks. Matviychuk A. V. suggested a methodical approach to forecasting financial time series with the use of neural networks.*

Uninvestigated parts of general matters defining. *At the moment about 200 methods of estimation are being used, but in practice only a few of them are used.*

The research objective. *The study of each criterion takes a lot of time on preparation of data for the study and careful verification of the original data. For this, it is necessary to choose the correct methodology for developing a forecast to identify the problems to be solved.*

The statement of basic materials. *In this article, the stages of research and prediction are considered of wholesale prices for petroleum products, a methodological approach is proposed in order to evaluate the accuracy of forecasting using neural networks, based on an algorithm with linear partial descriptions of the method of group accounting of the argument.*

Conclusions. *The proposed methodological approach to estimating the accuracy of forecasting using neural networks shows that neural networks allow us to obtain reliable predictions. However, the data on which the training took place had a high degree of similarity among itself, therefore the proposed methodological approach on the one hand does not pretend to be "universal" in forecasting for different sectors of the Ukrainian economy, since different industries have their own characteristics. On the other hand, it can become universal and will allow us to obtain reliable forecasts when taking into account modern features of the development of the Ukrainian economy.*

Keywords: *forecasting; sample; neural networks; GMDH; error.*

УДК 338.2

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МЕТОДОЛОГИЧЕСКИЙ ПОДХОД К ПРОГНОЗИРОВАНИЮ ОПТОВЫХ ЦЕН НА НЕФТЕПРОДУКТЫ

Актуальность темы исследования. *Ежедневно общество сталкивается с проблемами экономики. Чтобы определить какие из действий приведут к желаемому результату с наименьшими потерями и рисками, необходимо прогнозировать дальнейшее развитие событий.*

Постановка проблемы. *Возникает проблема выбора правильной методологии и методов прогнозиро-вания, которые позволят обеспечить необходимое качество прогноза.*

Анализ последних исследований и публикаций. *Исследования Хайкина С. и Каллана Р. являются наиболее известными среди исследований зарубежных авторов. Яхьяева Г. Э. исследовала теорию нейронных сетей. Матвийчук А. В. предложил методический подход к прогнозированию финансовых временных рядов с применением нейронных сетей.*

Выделение неисследованных частей общей проблемы. *В данный момент используется около 200 методов прогнозирования, но на практике широко применяется значительно меньшее их количество.*

Постановка задачи. *Исследование каждого критерия прогнозирования занимает большое количество времени, в связи с подготовкой данных для проведения исследования и тщательной проверкой исходных данных. Для этого необходимо выбрать правильную методологию и методы прогнозирования.*

Изложение основного материала. *В статье рассмотрены этапы исследования и прогнозирования оптовых цен на нефтепродукты, предложен методологический подход к оценке точности прогнозирования с использованием нейронных сетей, на основе алгоритма с линейными частными описаниями метода группового учёта аргументов.*

Выводы. *Предложенный методологический подход к оценке точности прогнозирования с использованием нейронных сетей показывает, что нейронные сети позволяют получать достоверные прогнозы. Однако данные, на которых происходило обучение, имели высокую степень схожести между собой, поэтому предложенный методологический подход с одной стороны не претендует на роль «универсального» в прогнозировании для разных отраслей экономики Украины, так как различные отрасти промышленности, имеют свои особенности. С другой стороны он может стать универсальным и позволит получать достоверные прогнозы при учете современных особенностей развития экономики Украины.*

Ключевые слова: *прогнозирование; риск; оптовая цена; нейронные сети; МГУА; погрешность.*

DOI: *10.25140/2410-9576-2018-2-2(14)-147-153*

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Urgency of the research. In the forecast, fuel prices in Ukraine are based on the following. In all commodity markets in 2018, a 5 percent increase is expected. This means that oil will trade 5% higher than it is currently trading. At the same time, it is necessary to take into account the predicted devaluation of not less than 10% and the inflation factor. Thus, the price of oil products in 2018 will increase. However, Ukraine has a reserve to prevent a strong price increase.

Target setting. A problem of choosing the right methodology and methods of forecasting, which will ensure the necessary quality of the forecast, is arising.

Actual scientific researches and issues analysis. Noteworthy statement of the Nobel Prize winner P. Samuelson "economic theory is nothing but the science of society choosing ways of exploiting and consuming scarce resources for the production and distribution of different goods now and in the future for the consumption of various individuals and groups of society" [1].

However, only with the help of economic theory it is impossible to accurately solve the problem of predicting the size of scarce resources. To solve it, it is necessary to turn to the sphere of forecasting [2; 3; 4].

Analysis of literature [2-5; 6; 9] showed that the basis of projection is statistical methods and decision theory. However, at the moment, much less attention has been paid to alternative approaches of the prediction problem, such as the theory of neural networks. Studies by Khaikin S. [7] and Callan R. [8] are the most famous among the studies of foreign authors. Yakhyaeva G. E. [3] investigated the theory of neural networks. Matviychuk A. V. [4] suggested a methodical approach to forecasting financial time series with the use of neural networks. Posokhov I. M. suggested a methodical approach to the predictive assessment of the effectiveness of management of internal risks of interaction between corporations of industrial enterprises of railway transport on the basis of the use of neural networks.

Uninvestigated parts of general matters defining. At the moment about 200 methods of estimation are being used, but in practice only a few of them are used.

The research objective. The study of each criterion takes a lot of time on preparation of data for the study and careful verification of the original data. For this, it is necessary to choose the correct methodology for developing a forecast to identify the problems to be solved.

The statement of basic materials. It is necessary to develop a methodology for forecasting wholesale fuel products prices and to estimate the accuracy of the forecast with the help of neural networks.

Proceeding from the definition of the problem, it becomes clear that the accuracy of forecasting data – especially in economics and industrial production – is a very relevant task, the solution of which will reduce the loss of material resources, due to the manifestation of economic risks.

The problems solved by the theory of neural networks are numerous [10]. One of them is the task of forecasting.

This study attempts to develop a methodological approach to forecasting based on neural networks of Hebb, Rosenblatt and Hamming. The resulting forecast is constructed as a synthesis, using an algorithm with linear partial descriptions of the method of group accounting of arguments.

Analysis of many public reports of various companies, the following restrictions on input and output data was identified:

- Samples should have a number of measurements more than 1000 points;
- The sampling frequency is the same and is one day;
- The number of elements of the prediction sample (the time for which the forecast is made) should not exceed 2.5% of N. This restriction is imposed in connection with a very intensive increase in the error of the results for each subsequent forecast.

The first stage of this methodological approach is the choice of economic characteristics, which will be estimated.

As input samples, we take data on wholesale purchasing prices of fuel from Zakarpat-Nefteproduct Mukachevo (LLC "Market") during 2006-2016.

The second stage – it is the presentation of the prediction problem as a problem of classifying objects.

This stage includes splitting the sample into blocks, determining the conditions for the termination of training and the conditions for generating images and classes (splitting the sample into behavioral areas that are easily amenable to interpolation and have smaller order than the sample size).

Conditions of aborting study – are responsible for aborting the education of the method's point. The criterion is the requirement to minimize the deviation from the input data. Also, one should take into

account the non-learning ability of the system. Therefore, it is necessary to establish the threshold value of the epochs in the study of neural networks, when it is achieved, it is necessary to perform the "rollback" of the epochs, to the minimum error. In this work, it was not necessary to implement this, since all 3 neural networks were successfully trained on the given samples.

Input blocks are represented by input data of neural networks (a kind of input layer). The number of input blocks is equal to the number of neurons on the first layer of the neural network.

Classes are compiled by dividing the samples into subsamples, the number of which is greater than the number of neurons in the first layer. Next, a pair of adjacent subsamples is input. Further, four sets of neighboring subsamples are submitted, and so to the original sample N. If the neural network recognizes the subsample as the smallest, then the forecast will be based on this sample. If the behavior is recognized as a group of 4 minimum time series, then, therefore, the forecast will continue for this site. The worst case is when a sample of size N is recognized, then the forecast will have the greatest forecast error.

The third stage of this methodological approach consists in the selection of neural networks. During the process of research the following neural networks were considered: elementary Hebb's neural network [7; 8]; two-layered Rosenblatt's perceptron [7; 8]; Hamming's neural network [4].

The authors used the MatLab package. In the present implementation, the process of initializing a plurality of coefficients is fully automated.

In the Hebb's neural network, groups of m bipolar or binary neurons A1,..., Am (Figure 1) were used, which allow significantly increased the capabilities of the neural network and recognized up to 2m different values. This architecture was used to recognize only m different values, giving each of them a single output at the output of one A-element (the outputs of the rest should take the value "-1" for bipolar neurons or "0" for binary ones).

A single-layer neural network with binary neurons, shown in Fig. 1, was trained using an algorithm based on Hebb's rule.

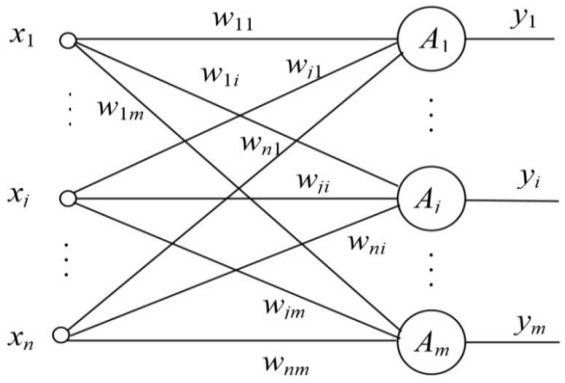

Fig. 1. Hebb's neural network

The result of using the neuron network perceptron is shown in Fig. 2.

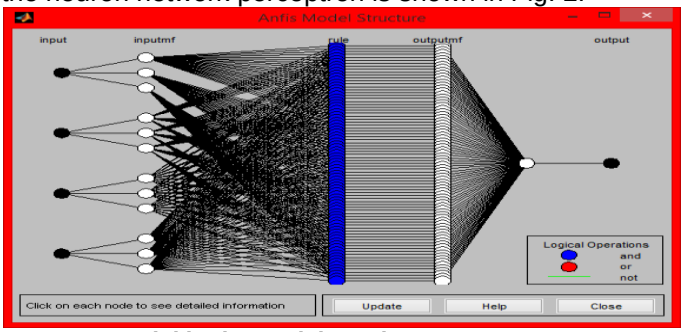

Fig. 2. Generated perceptron model in the Matlab package

Further a neural Hamming's network was used, the scheme of which is shown in Fig. 3.

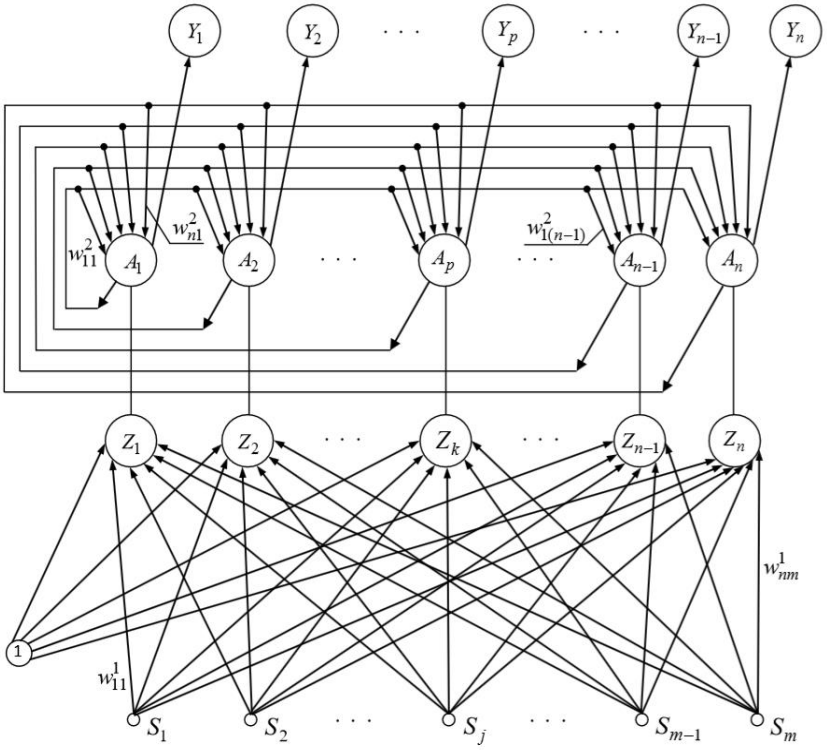

Fig. 3. Hamming's neural network

The fourth stage of the methodological approach of the study is the generalization and compilation of the general model estimation system. The model of the methodological estimation system proposed by the authors is shown in Fig. 4.

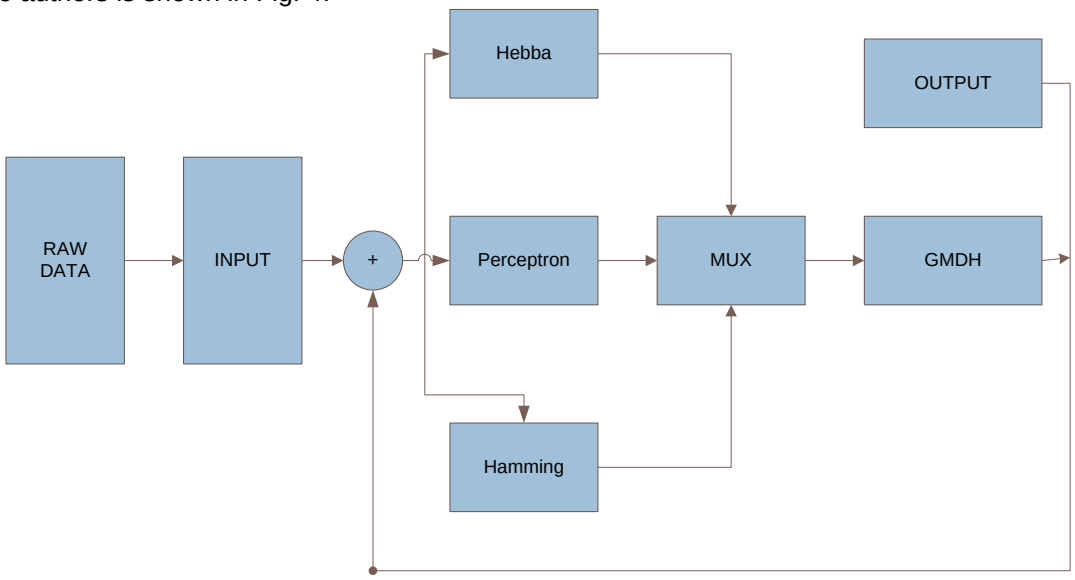

Fig. 4. Model of the forecasting system
Proposed by the authors

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The fifth stage of the given methodological approach is the synthesis of the results of each neural network in the form of a weighted average based on the GMDH algorithm. The sixth stage the given methodological approach is directly testing the previously based on collected data. The sample size is defined as 2000 (approximately 5 years and 6 months). The sample rate is 1 day. The number of such samples is 1 for studying, 9 for predicting the studied networks. The prediction is conducted for 48 days. Fig. 5 shows the estimation of the errors of each of the neural networks and the result of using the GMDH algorithm with linear descriptions.

The forecast results shown in Fig. 5 show an average prediction error of less than 5%.

As conclusions about each of the neural networks, it can be noted that the neural network of Hamming gives more optimistic forecasting results, despite the error of the order of 0.05%. Perceptron shows pessimistic results, which is not very good, because preparing for the projected risks, you can lose the opportunity to receive more revenue and, thus, incur losses. Hebb's neural network showed results intermediate to Perceptron and Hemming.

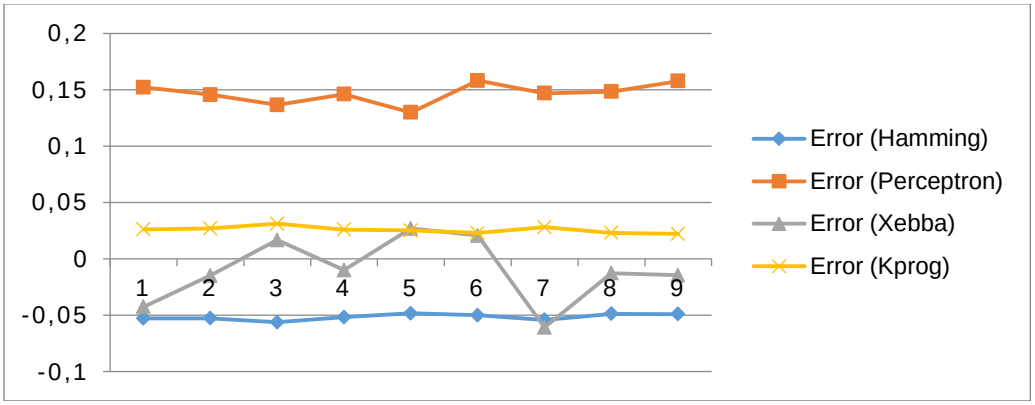

Fig. 5. Relative errors in forecasts
Proposed by the authors

The result shown in Fig. 6 demonstrates that the values of each of the 48 error values have a very wide spread. Also the error in the Hebb's network changes its sign (i.e., in certain cases it gives an optimistic, in some gives a pessimistic forecast) that is not suitable for synthesizing the criteria with using GMDH. In Fig. 6 and Fig. 7, the result of the estimates for 2 time series is presented (we had 9 time series in total, based on Fig. 3). We presented 2 of 9 time series. They clearly illustrate the fact that forecasts have approximately the same error.

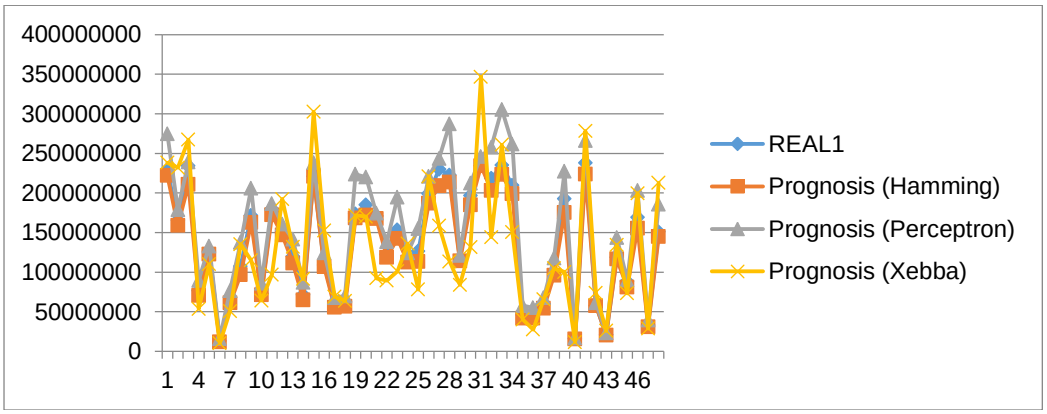

Fig. 6. Forecast of 48 values for sample number 1
Proposed by the authors

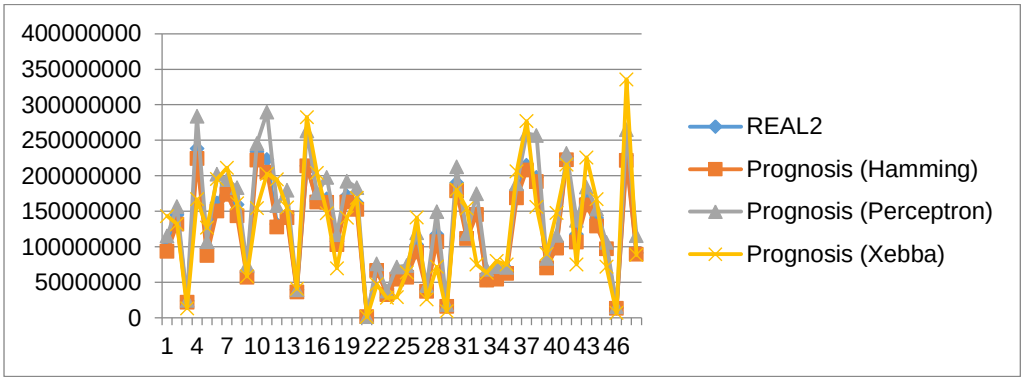

Fig. 7. Prediction for 48 points for sample number 2
Proposed by the authors

Conclusions. The proposed methodological approach shows that neural networks work very well with forecasting and can be synthesized into one resulting forecast, which is built on the results of prediction using several neural networks. The element of novelty is the using synthesis in the application of three neural networks of Hebb, Hamming, and Rosenblatt in the methodological approach for the construction of forecasts in conjunction with the approach of GMDH to obtain estimates of the weighted relative errors of the resulting forecast.

The methodological approach which developed by the authors is a modern view on the regularities in the formation of prices for petroleum products, complementing and developing existing methods. It allows application in various sectors of the economy because of its universality, taking into account modern features of the development of the Ukrainian economy.

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Received for publication 01.03.2018

Бібліографічний опис для цитування :

Posokhov, I. M. Methodological approach to predicting producer prices for petroleum products / I. M. Posokhov, N. A. Gorenko, V. V. Chelak // Науковий вісник Полісся. – 2018. – № 2 (14). Ч. 2. – С. 147-153.

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