NEURAL NETWORK SIMULATION OF THE INDUSTRIAL PRODUCER PRICE INDEX DYNAMICAL SERIES

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Abstract
This paper is devoted the simulation and forecast of dynamical series of the economical indicators. Multilayer perceptron and Radial basis function neural networks have been used. The neural networks model results are compared with the econometrical modeling.

1 Introduction
The construction of models of economic systems is now an indispensable tool for the theoretical and practical economy. Models are being built for the purpose of a retrospective analysis, and prediction of the behavior of the economic system. Currently, in addition to traditional methods of constructing mathematical models of economic systems and processes the modern methods including the neural networks technology have been developed. Neural networks can solve problems that not solved by traditional methods, they are able to successfully solve the problem, based on incomplete, noisy, distorted information. In recent years the macroeconomic indicators dynamic series simulation is particularly relevant due to the instability of the national economies as a result of sluggish global economic and financial crisis. The price index is one of the most important macroeconomic indicators, widely used in the analysis of the economy. Industrial producer price index (PPI) is determined on the observation of changes in these prices by recording the prices of representative goods. Application of neural networks in research, along with the traditional econometric models caused by the presence in the economic indicators dynamic series of complex dependencies, undetectable by conventional econometric methods and the possibilities to compare neural network forecast values with econometric simulation data. Industrial producer price index dynamical series have been studied over a range from January 2003 to February 2013. The forecasted values of PPI have been obtained for 2013. Study of the levels of the dynamical series in a larger time interval can identify a trend in the PPI and obtain the forecast values of levels for the following year.

2 The methodology and results of the study
Study the dynamics of the PPI are based on statistical data of the National Statistical Committee of the Republic of Belarus [1] in the period from January 2003 to February 2013. Calculations were performed using the STATISTICA 8.0 package with the
application of neural networks, as well as in the econometric model with multiplicative exponential smoothing. The dynamical series levels simulation with neural networks is reduced to the choice of architecture and power of neural networks and the initial data for its training. In work the multilayer perceptron MLP (multilayer perceptron), mainly used in the problems of prediction and classification, together with the radial basis function RBF (Radial Basis Function) neural networks have been applied to simulate the dynamical series. Simulation results were taken from the neural network model data with the lowest standard deviations of the observed values. Neural network model results are compared with the results of econometric model. Decomposition of time series levels using a multiplicative model [2] assumes that each level of a time series can be represented as a product of the trend (T), seasonal (S) and random (E) component \( Y = T \cdot S \cdot E \). Model selection caused by changes in amplitude or structure seasonality. Construction of the model includes a number of successive actions, including the calculation of the values of the seasonal component S (Seasonal Factors), removing the seasonal component of a series of baseline data and getting an alignment \( T \cdot E \) (Adjusted Series), calculation of the values of the trend component T, the calculation of the random components of E, as well as the calculation of the values obtained model \( T \cdot S \) (Smoothed Series) with predicted data. Figures 1 - 2 show the results of modeling of dynamic time series of PPI levels using neural networks and econometric multiplicative model.

![Figure 1: Chain PPI for the period from January 2003 to February 2013 and the results of the neural network and econometric modeling with forecast data for 2013](image)

The dynamic series of chain PPI show a sharp 15-20 percentage points increase for the second half of 2011 and the gradual decrease of growth on average 1.3 percentage points per month in the 4th quarter of 2012 and January-February 2013. Econometric modeling using a multiplicative model with exponential smoothing provides forecast data at the end of 2013 and in January-February 2014, indicating a further decrease in
prices index grew to the level of an average of 0.94 percentage points per month (Fig. 1). Neural network modeling of dynamical series of PPI using radial basis function RBF 1-65-1 neural network with 65 neurons in the hidden layer, as shown in Fig. 1, more accurately reflects the changes of the statistical curve of the time series of PPI and predicts to reduce the growth of prices in the third and fourth quarter of 2013 to an average of 0.1 points per month. Forecast results obtained using neural networks and econometric modeling shows a trend to reduce price increases in the second half of 2012 and early 2014. The discrepancy between the results of neural network RBF 1-65-1 modeling with baseline statistics (standard deviation of 2.33) is somewhat better than in the case of the econometric model (standard deviation of 3.23). Fig. 2 shows the modeling results of the base PPI dynamic series as a percentage of the level in December 2002.

![Graph showing base PPI from January 2003 to February 2013 and results of neural network and econometric modeling with forecast data for 2013]

Figure 2: The base PPI from January 2003 to February 2013 and the results of the neural network and econometric modeling with forecast data for 2013

The dynamics of base PPI to December 2002 shows a sharp rise in prices in the second half of 2011, replaced by a flat areas of price increases in 2012. The curve rather monotone and allows to apply neural network modeling based on the architecture of multilayer perceptron MLP. Fig. 2 shows the results of MLP neural network simulation. Model values are practically identical with the original data time series, but the predicted values show two alternative scenarios. The neural network MLP 12-24-1 predicted values show almost horizontal section of the whole period of 2013 with weak price trends downward. Alternative predicted values behavior of the base PPI is shown in the neural network MLP 12-54-1 modeling and finds a sharp decline to the level of the reference period, and in some cases, significantly (by 300 percentage points) below
the base level. Fig. 2 shows the curve to compare the results of econometric modeling. The results of the neural network simulation presented in Figures 1 and 2 show two alternative scenarios for 2013. The first variant of the forecast follows from the results of the multilayer perceptron MLP 12-24-1 and of the radial basis function RBF 1-65-1 neural network simulation. Industrial producer prices in the Republic of Belarus little change during 2013, remaining at the same level, and thus, the first scenario shows the stabilization of industrial producer prices in 2013. The second alternative variant of the forecast follows from the results of the neural networks MLP 12-54-1 modeling and shows a sharp drop in prices, which may be related to a possible denomination of national currency. There is also a variant of the forecast of the econometric model, according to which in 2013 is expected to further very strong growth in industrial producer prices with the possible stabilization of prices in 2014.

3 Conclusion

Neural network simulation of the PPI time series with multilayer perceptron MLP neural networks identifies two variants of predicted values for 2013. First is the price stabilization and second is their sharp decline. Option prices stabilize during 2013 confirmed by data of radial basis function RBF neural networks as that feature is the absence of local minima. However, the option of a sharp decrease in prices can be considered a possible in terms of denomination of the national currency. Predicted values from the econometric multiplicative model with exponential smoothing show a further increase in prices during 2013 and the stabilization of prices in 2014, which also can not be excluded from the scenario of possible developments of price change.

References
