# Polish macroeconomic indicators correlated-prediction with indicators of selected countries

Monika Hadaś-Dyduch[1]

**Abstract**

The aim of this article is to provide an estimate of the unemployment rate on the basis of copyright model. Polish unemployment rate forecast, based on a model based on multiresolution analysis and selected macroeconomic indicators of different countries. A characteristic feature of the model is to divide the ranks into sub-series with the corresponding time-shifted and dependence prediction depend on other macroeconomic indicators of selected countries.

The algorithm for the prediction of time series presenting macroeconomic indicators, based on neural networks and the wavelet analysis, wavelets Daubechies. However, the main feature of the algorithm is to divide the analyzed series into several partial under-series and prediction dependence of a number of other economic series with the appropriate sliding window of time.

***Keywords:*** *macroeconomic indicators, wavelets, the unemployment rate*

***JEL Classification:*** *G10, G19, E00*

## 1. Introduction

The aim of this article is to provide an estimate of the unemployment rate in Poland based on macroeconomic indicators of other countries. The forecast was based on copyright model. The algorithm for the prediction of time series presenting macroeconomic indicators, based on neural networks and the wavelet analysis, wavelets Daubechies. However, the main feature of the algorithm is to divide the analyzed series into several partial under-series and prediction dependence of a number of other economic series with the appropriate sliding window of time. The research was based on macroeconomic indicators of Belgium, the Czech Republic, Denmark, Germany, Greece and Austria. The data included in the study relate to the period 1995-2013. The study included the following macroeconomic indicators: unemployment, inflation, GDP, employment.

The greatest rate of employment among the countries included in the study, in the period 1995-2013, was in Belgium and the lowest in Greece (Fig. 1). The greatest rate of growth of GDP, among the countries included in the study, in the period 1995-2013, was in Poland – 3.04%, and the lowest in Germany (Fig. 3).

[1] Corresponding author: University of Economic in Katowice, Department of Statistical and Mathematical Methods in Economics, 1 Maja 50, 40-287 Katowice, Poland, e-mail: monika.dyduch@ue.katowice.pl.

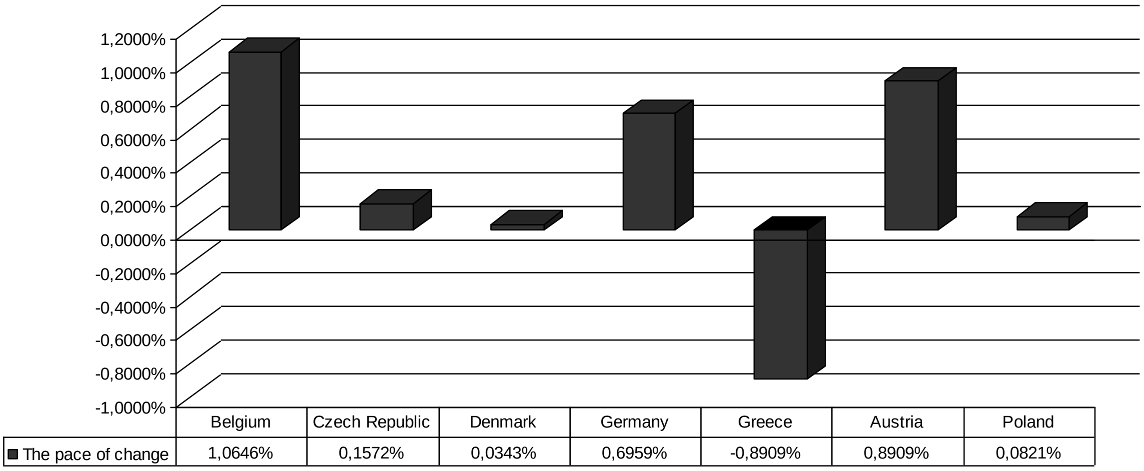


**Fig. 1.** The pace of changes in employment in 1995-2013 year.

Source: http://www.money.pl.

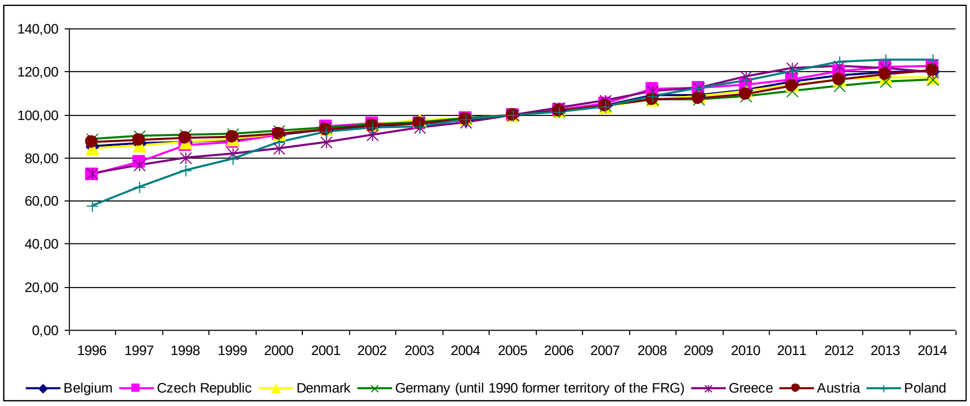


**Fig. 2.** Inflation.

Source: http://www.money.pl.

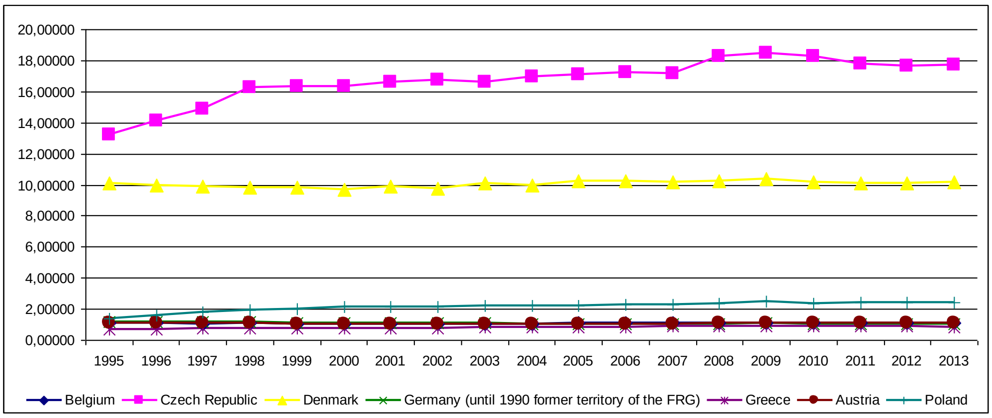


**Fig. 3.** GDP.

Source: http://www.money.pl.

## 2. Research methods – Description of copyright prediction model M.H-D

The proposed model time series prediction presenting macroeconomic indicators consists of six main stages: wavelet analysis, the selection of variables for the model, artificial neural network, inverse wavelet transform, forecast, error forecast (Hadaś-Dyduch, 2013, 2014, 2014a; Hadaś, 2006).

The first stage of the proposed model, shown in Figure 4, can be called a wavelet analysis. It aims to generate scaling functions and wavelets, in this case the Daubechies wavelets. Generated Daubechies wavelet is necessary in subsequent steps, particularily the stage in which the wavelet coefficients are determined for the series of the selected study. Generating scaling functions and wavelets begins with determining the value of the scaling function for integers, which is necessary to determine the value of this function across the field and then the Daubechies wavelets (Hadaś-Dyduch, 2013, 2014, 2014a).

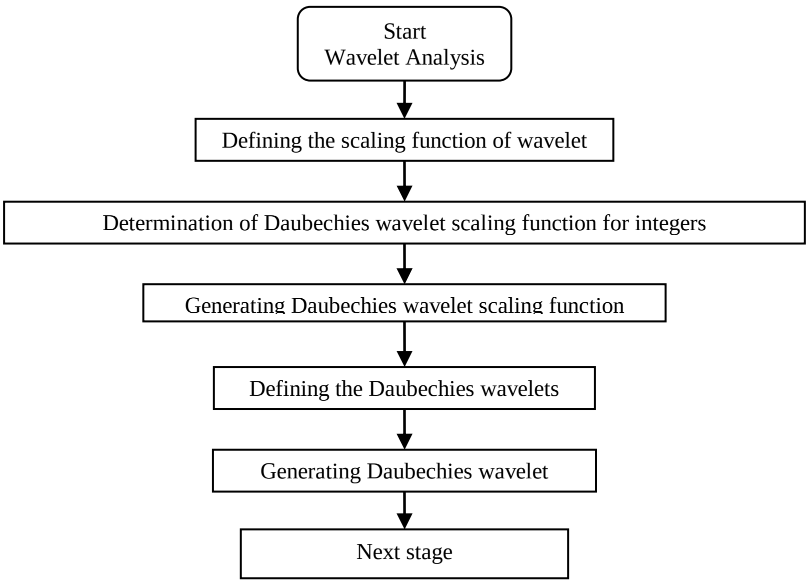


**Fig. 4.** Schematic of a first stage of the algorithm.

The second stage shown in Figure 5, the preparation stage, is mainly intended for time series study. During this stage we do all the operations that precede the process of building the model, including the standardization of time series. This step involves examining the accuracy and nature of raw data and their operationalization. If you need to make activities related to the transformation of data into a form suitable for processing. In addition, in order to obtain accurate results, each must be divided into series so-called under-series, samples with an even number of observations, number multiple of two.

Properly prepared ranks, actually under-series subject to the operation of wavelet transform, the advance fixing of the coefficients of wavelet transform. As a result, we obtain wavelet transform for each under-series, wavelet coefficients of selected under-series at different levels of resolution, which are necessary in learning process about artificial neural network (Hadaś-Dyduch, 2014, 2014a).

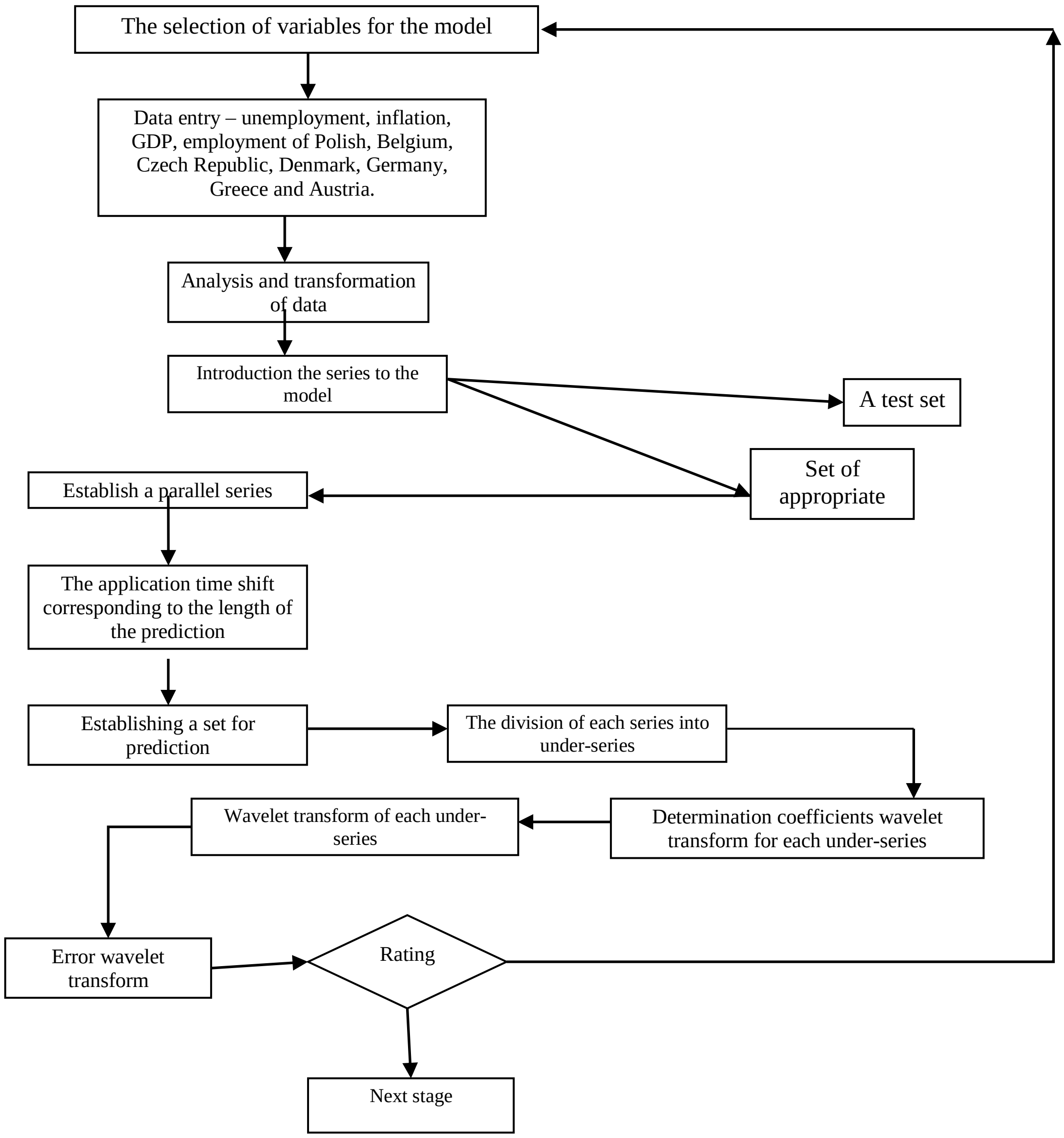


**Fig. 5.** Schematic of the second stage of the algorithm.

Source: The author's calculations.

In the next step we initialize the model of artificial neural network and execute accordingly to the diagram shown in Figure 6.

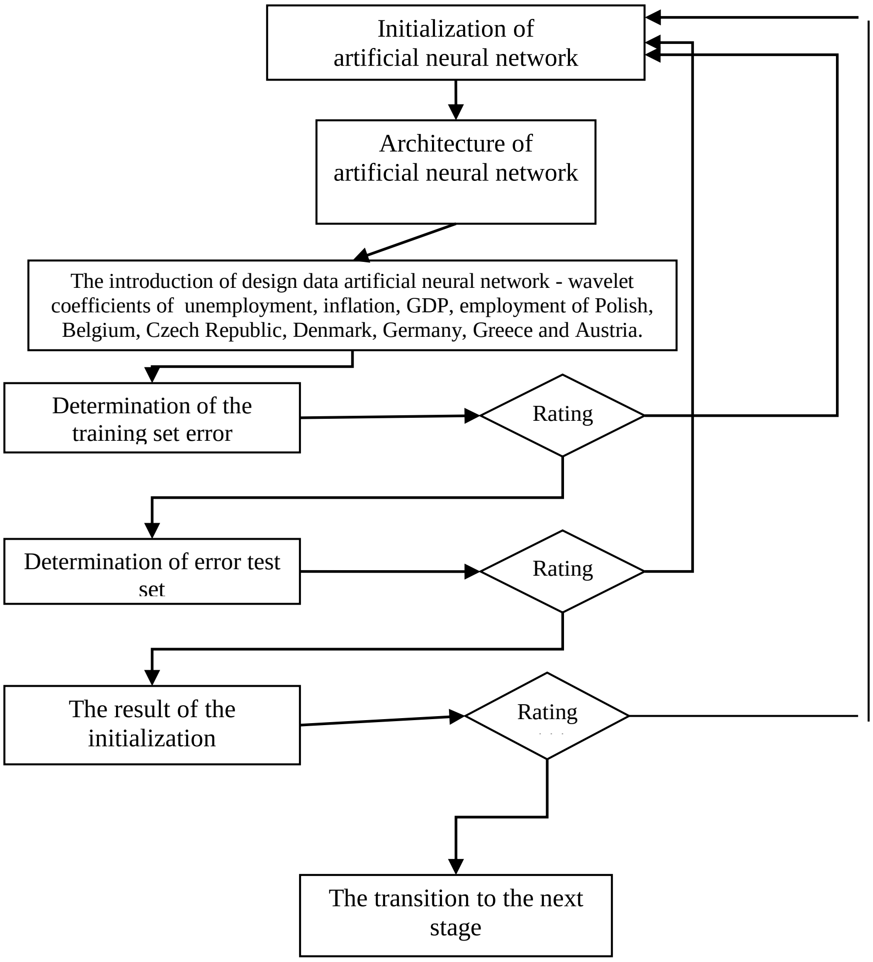


**Fig. 6.** Schematic of the third stage of the algorithm.

At the output of an artificial neural network we get the coefficients of wavelet transform for future observations of the test series. The resulting wavelet coefficients via inverse wavelet transform operation, gain the values of the real number, i.e. the number of future values for a pointed time interval forecasts.

## 3. Prediction

Application model was made for a numbers presenting the unemployment rate. Prediction is made for a period of one year and a half.

For prediction of Polish unemployment rate for 6 months and 1 year, were applied series presenting the unemployment rate, inflation, GDP and employment countries such as Belgium, the Czech Republic, Denmark, Germany, Greece and Austria. Thus, the prediction of Polish unemployment rate made on 28 time series.

Each of the 28 series were divided into under-series so-called. sample with an even number of observations, which are multiples of two. In the application model, there was adopted the division of each series into under-series two-piece.

As the input of artificial neural network, there were wavelet coefficients for appropriate under-series each of the 28 series listed under consideration. That is, the network taught on archived data unemployment rate, inflation, GDP, employment of Belgium, Czech Republic, Denmark, Germany, Greece and Austria shifted in time of a year and a half year in relation to Polish unemployment rate. At the entrance of artificial neural network there are given in the case of semi-annual forecasts: wavelet coefficients under-series received from the ranks of unemployment rate, inflation, GDP, employment of Belgium, Czech Republic, Denmark, Germany, Greece and Austria, shifted with half a year, and wavelet coefficients under-series algorithm, therefore, wavelet coefficients generated a series of Polish unemployment rate for a specified period of the forecast.

The study divided into sets of learners and the test was considered taking into account the percentage of the expected length of the forecast. Adopted two strategies placed into the input data to the neural network (Fig. 7).

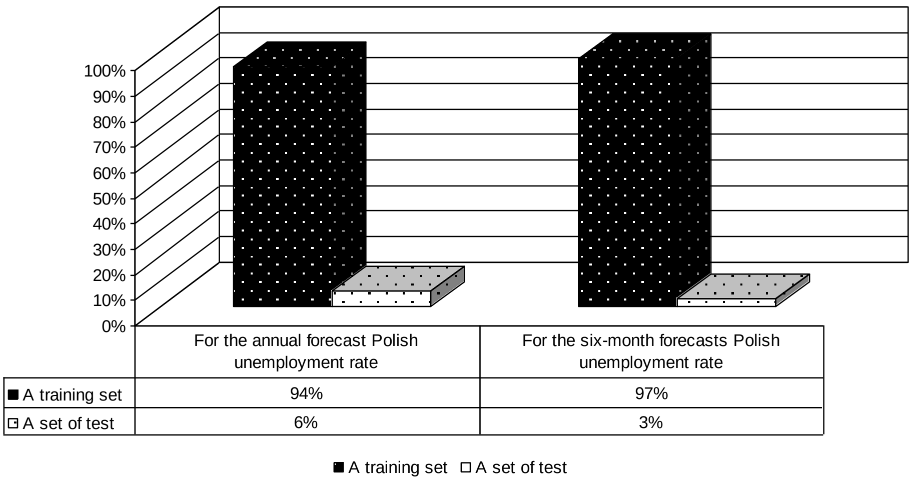


**Fig. 7.** Strategies placed into the input data to the neural network.

Source: The author's calculations.

## 4. The results of the study

Average absolute percentage error of wavelet coefficients (the division series listed on under-series two-factor with one level of resolution, the network designed for the 70 hidden layers):

annual forecast for Polish unemployment rate were for the test set 0.3%, for the output file 0.4 %. Error for the six-month forecast was higher than the annual forecast (Fig. 8).

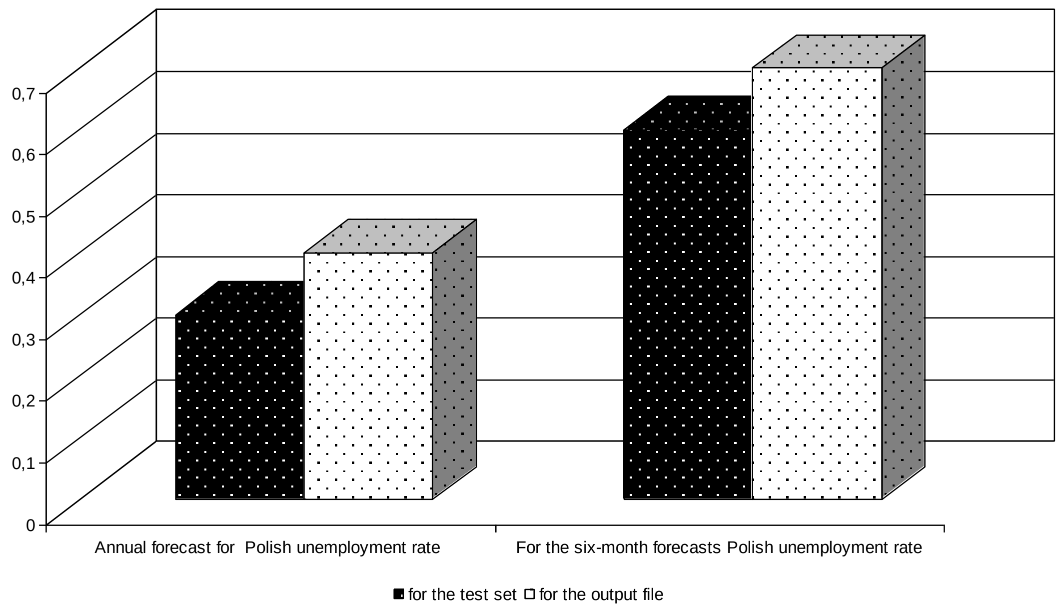


**Fig. 8.** Strategies placed into the input data to the neural network.

Source: The author's calculations.

Having generated coefficients of wavelet transform for the future value of the Polish unemployment rate for the highlighted time periods (one year, half a year) algorithm there was used inverse wavelet transform. The result of inverse wavelet transform, Daubechies wavelets were future values, i.e. the value of the forecast range of Polish unemployment rate respectively for a period of one year and a half year.

An average absolute percentage error of each forecast was:

- 1% – for the annual forecast of Polish unemployment rate,
- 0.9% – for the six-month forecasts of Polish unemployment rate.

## Conclusion

The paper presents an original method for time series forecasting based on artificial neural networks and wavelet transform - wavelet Daubechies, including a sliding time window, and analyzed the distribution of ranks for under-series *n*-elements.

The proposed prediction method is not the only method. Can be used to predict macroeconomic indicators other methods based on wavelet analysis (Joo and Kim, 2015) or another's methods (Sroczyńska-Baron, 2013).

The proposed model may have been encountered as an additional element in each analize portfolio. Using the described model can predict wallets, as an alternative to the methods used so far (Węgrzyn, 2013, 2013a, 2013b, 2014).

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