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# POSSIBLE METHODS FOR PRICE FORECASTING

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*ABSTRACT*

*The study gives an overview about the different time series analytical methods, which can be used for price forecasting. The comparison of the decomposition and stochastic methods will help to navigate through the many option of analytical techniques. To find a reliable forecasting method, the study introduces an empirical time series price analysis with a hybrid method: forecasting based on creeping trend with harmonic weights. The result show that this method provides an accurate and reliable prediction of future prices.*

## INTRODUCTION

The determination of prices is important in the economy. Prices are one of the major factors of a firm's competitiveness, because it has a huge influence on the future of the company. Acquiring sophisticated knowledge of the past and current internal rules of development is of utmost importance in making a reliable forecasting of the future processes. In order to predict the future, the past and the present have to be carefully analysed since the future is the further development of the present. To make the right decisions it is essential an accurate, reliable, scientific based forecast.
There are several analytical methods for forecasting, and this study aims at presenting the most important ones through the example of price forecast. The first to chapter are presented the most important forecasting methods in the case of decomposition and stochastic relations too. This part contains a comparison too, which includes the advantages and disadvantages of the models. In the third chapter are presented the results of an empirical analysis, with forecasting based on creeping trend with harmonic weights, using methanol price data. This is a mixed method, using difference techniques and gives reliable results. The study concludes with a summary.

## 1. FORECASTING ON THE BASIS OF TIME SERIES TECHNIQUE

"A time series is defined as a set of quantitative observations arranged in chronological order. We generally assume that time is a discrete variable." [1] During an analysis special attention should be paid to the ways the components' linkage. Four types of links can be distinguished in the decomposition models [2]:

| | | |
|---|---|---|
| -additive model: | $Y=T+S+I$, | (1) |
| -multiplicative model: | $Y=T*S*I$, | (2) |
| -log additive model: | $\log Y=\log T+\log S+\log I$, | (3) |
| -pseudo additive model: | $Y=T*(S+I-1)$, | (4) |

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where:
-T – is a long term trend,
-S – is an annual seasonality,
-I – is a random component.

In an additive model the fluctuation in the trend of seasonality element is given in the unit of its original measurement and the deviations from the trend are constant. When it is a multiplicative model the fluctuation in the trend is expressed in percentage, and the indexes show relative levelling off.
The transformation of the multiplicative model gives the log additive model. Studies show that with a logarithmic transformation the distribution of the random component can be changed. As a result in the course of the estimated calculations the model applies corrections from trends and torsions.
In every time series analyses a special attention should be paid to the separation of the components. For example in the case of additive relations a model can be formulates in the following way:

$$Y=T+C+S+TD+H+O+I \qquad (5)$$

where:
-T – is a long term trend,
-C – is a medium term cycle (prosperity),
-S – is an annual seasonality,
-TD – is the impact in deviations in number of working days,
-H – is the impact of banking holidays,
-O – outlier,
-I – is a random component.

It is important that the long term and the medium term cycle often do not separate from each other. In this model the S, the TD and the H can be considered as seasonal components. In this equation the O and the I can be attributed as random components. Because the outlier is an extreme value, it can be taken out from the time series. After the modifications the new, simplified formula is the same as it was in the (1) equation.
There are several methods for determination of the steady trend characteristic. The simplest model is the moving average. This method is the least reliable concerning the mathematical and statistical calculations. This means that in practice it have to be accepted with some reservation even in the case if short-term forecasting. Usually this method is used for general forecasts, combined with other models.
The basic trend in the time series can be determined with the analytical trend calculation, which is a mathematical function. Nowadays there are several methods which can help to choose the proper function. Using this method means that each component of the time series has the same impact on the estimated values. It is important to use the latest information available for economic and social forecasting.
The exponential equalisation derived from the moving averages by the method of giving priorities to data having particular importance in estimating the developments of the expected future events. This method is successfully applied to forecasting short term predictions. 12 types of smoothing techniques introduced in the works by [3]

and these have been widely applied in forecasting. One shortcoming of this model is that the changes are followed with some lateness. On the other hand, it is very difficult to choose between the smoothing techniques.

## 2. FORECASTING ON THE BASIS OF ASSUMPTIONS OF STOCHASTIC LINKS

Sometimes the time series analysis the decomposition models are not perfect. In this case the researcher want to predict the variable through variables linked with it. Forecast based on time series data should be paid special attention, because the stochastic link is not always clear. The relation between time series can be traced in such cases too when there is no correlation between criteria, but there is a third factor which has an impact on it.

In the last few decades have been a huge development in information technologies, which has provided basis for further forecasting methods. For example, with the help of factor and cluster analyses we can get information about the actual relationships between the variables, and it is possible to recognize the so called “hidden” variables. Based on the calculated factor matrix it can be assumed what explanation can be given to the original variables.

If the components are linked differ from time to time, the basic methods can be used only with restrictions, which can cause difficulty during the decision preparation process. In this case the Box-Jenkins models can be reasonable selection. The great advantage of this model is the joint management of the effects in the time series. The method offers a well-determined schedule for researchers.

The values of a time series can depend on the values of the components and their own earlier values too. The dynamic factor analysis can be used with various objectives. It is an unique method, because it determines each factor separately. The method is flexible and it provides chance for more sophisticated use of parameters. The dynamic factor analysis makes it possible to take into account the potential values of factors.

The appearance of computers made the forecasting and the seasonal evaluation faster and simpler. In the 90s the ARIMA (Autoregressive Integrated Moving Average) technique became more and more popular. This method is more reliable than the simple moving average model. It breaks the time series into components: for an autoregressive one and a moving average one. It was further developed and two new methods TRAMO (Time Series Regression with ARIMA Noise Missing Observations) and SEATS (Signal Extraction in ARIMA Time Series) were born. More information about the ARIMA models in the literature [2].

The Table 1 contains a summary of the different forecasting methods.

Table 1: Different forecasting methods
Source: Own compilation

| Method | Characteristics | Advantages | Disadvantages | Possible applications and time horizon |
|---|---|---|---|---|
| MOVING AVERAGE | The trend is produced by the dynamic average of time series | Simple | Mathematically less reliable | Inventory management; 1 or 2 months, maybe quarter |
| ANALYTICAL TREND | Describe the trend with some mathematical function | Simple, clear, graphically well-represented | Overestimation of the past development | Analysis of technology development, product-, market-, technical parameters forecast; short term |
| EXPONENTIAL SMOOTHING | Greater weight is given to those data which have bigger significance | It is possible to build in the professional expertise to the weights | The forecast values are get into the model | Product and market forecast; short term |
| HARMONIC WEIGHTED PARTIAL TREND | Gives different weights to the partial trends of the examined period | Reliable in short term | Easy to became mechanic in the forecast | Analysis of trends in employment, technological development, demand; short and medium term |
| BOX-JENKINS | Complex management of time series | The prevailing effects are treated together | Labour-intensive, requires complex and comprehensive approach | The linkage of the time series components are not clear; excellent in short term, good at medium term |
| DYNAMIC FACTOR ANALYSIS | Combines time series analytical methods with factor analysis | Possibility of multilateral analysis | Labour and time intensive, requires skilled professionals | In all areas of social, economic, technical processes; medium and long term |

## 3. EMPIRICAL PRICE ANALYSIS

In the first part of the study the most common forecasting techniques were compared. The second part was an empirical analysis that made a prediction for the price of methanol. In this way in our analysis the dependent variable is the natural logarithm of the Methanex Monthly Average Regional Posted Contract Price (Methanex European Posted Contract Price) [4], which were in €/MT. As in the global markets the USD is still the dominant payment instrument, the conversion of the original € prices into $ was necessary. The operation based on the average exchange rate of the European Central Bank. [5]

### *3.1. Data*

The examination started with 6 different independent variables, but because of the normality the use of the variables' natural logarithm instead of the original values was more appropriate. Since the methanol price is a non-stationary and an autocorrelating process, it was unavoidable to involve a seventh variable: the "delayed" natural logarithm of the methane price. The analysed period is between February 2002 and October 2015. The database contains monthly data, which means we had 165 data for each variable. Eventually, the used independent variables are the following:

-lnMEPCP_MT2 /natural logarithm of Methanex European Posted Contract Price with 1 lag, $/MT, [4]/
-lnimpetr/natural logarithm of EU28 trade by SITC product group, Unit value index (2010=100), Extra EU-28, Petroleum, petroleum products and related materials [6]/
-lnimpchem /natural logarithm of EU28 trade by SITC product group, Unit value index (2010=100), Extra Eu-28, Chemicals and related products, n.e.s. [6]/
-lnconst/natural logarithm of Production in construction - monthly data (2010 = 100), Volume index of production, Data adjusted by working days [6]/
-lnbuildings/natural logarithm of Production in construction - monthly data (2010 = 100), Buildings, Volume index of production, Seasonally and calendar adjusted data [6]/
-lncrudeoilfut/natural logarithm of crude oil future prices ($) [7]/
-lnnatgasfut /natural logarithm of natural gas future prices ($) [7]/

### *3.2. Methodology and results*

The selected method was the forecasting based on creeping trend with harmonic weights. Creeping trend can be used if variable changes irregularly in time. The method uses OLS (Ordinary least squares) to estimate parameters of partial trends. The determination of the smoothing constant is important, and it depends on the nature of the database. "If great variation in a short time can be observed, small value of smoothing constant need to be selected. If small variation in a short time can be observed, great value of smoothing constant may be selected. In this analysis the smoothing constant was 48, which means 4 years." [8]

After the determination of the smoothing constant came the estimation of parameters with OLS for partial trends. The results of the OLS estimation were 118 different regression equations, with different involved variables and parameters. Each estimates covered 48 data, constantly shifting the time period with one month.
The next phase of the analysis was the calculation of the estimated values for each month. The different values were calculated from the regressions for every 48-month period. The results were weighted by the value of the explanatory power of each regression, and in the end of the calculation there was only one estimated data for every month.
It was necessary to give weight for the trend growth. Weights were in ascending order – this way the newest information were the most important. Then it came the determination of the mean trend growth as the weighted average of trend growth with harmonic weights. After the calculation of the mean trend growth it was possible to make a forecast for the methanol price.
The testing of the accuracy and reliability of the forecast is essential in all cases. In this case the graphical tests were selected. The Figure 1 shows the difference between the actual and the estimated data. The reliability can be accepted if the data are placed randomly around the diagonal. In the figure this is clearly visible; there is no systematic bias in the estimate.

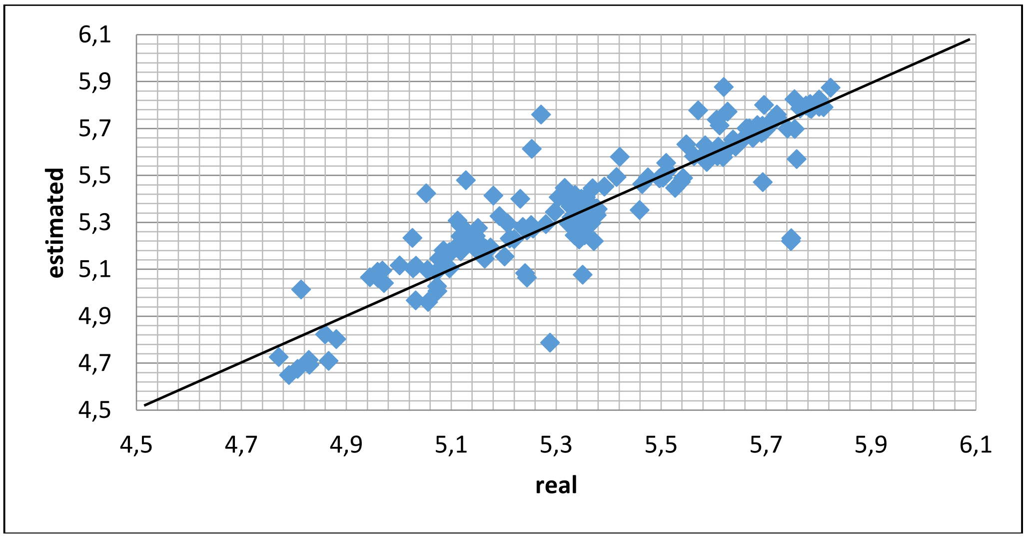


Figure 1. Difference between real and estimated data
Source: own compilation

There are other options for testing. The Figure 2 shows the difference between the deviation from mean of real data and the deviation from mean of estimated data. As in the previous case, if the data are placed around the diagonal the forecast is acceptable.
According to the analysis, the estimation of methanol price can be accepted: there isn't any systematic bias, the values are around the diagonal. There are some exceptions, which are caused by the global financial crisis.

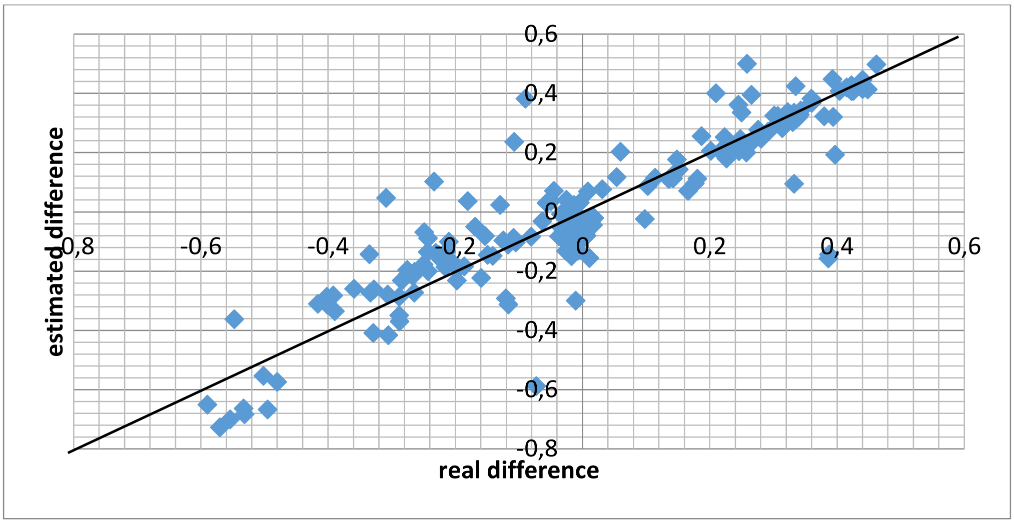


Figure 2. Difference between real and estimated data deviation from mean
Source: own compilation

The Figure 3 illustrates the estimated values as a function of time. The two linear lines represent the limit value accounted from the standard error of estimation. The forecast is mostly in the interval, which means an appropriate estimate. The outliers (such as in the previous case) are the result of the global financial crisis.
Based on the graphic tests, the forecast is considered to be reliable.

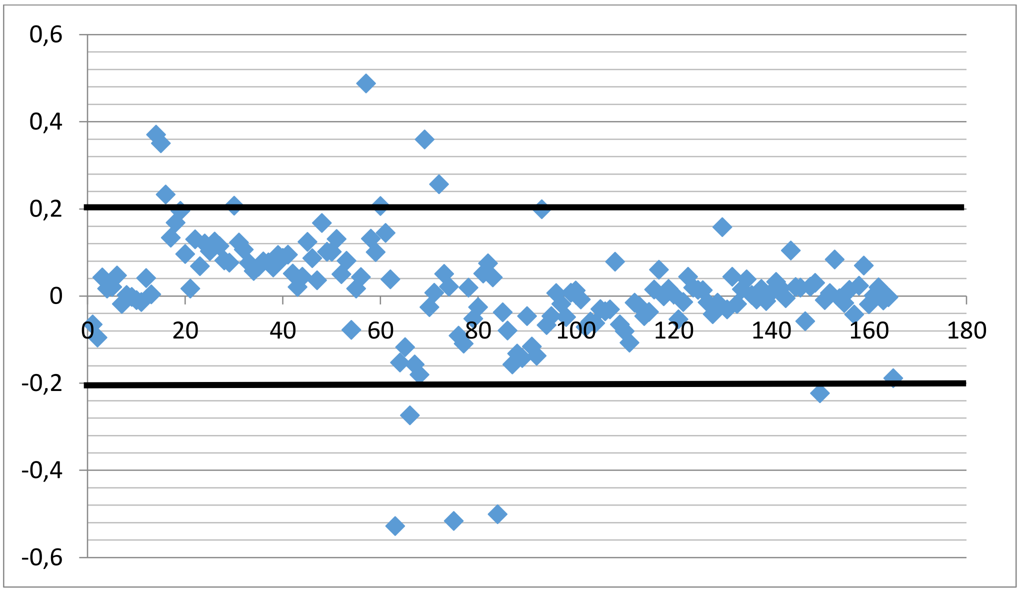


Figure 3. Estimated values, by month
Source: own compilation

## 4. CONCLUSIONS

During a forecasting process it is important to know that only one method usually cannot give a reliable result. The basic principle is to use several methodology. For example among transition economies the methods successfully used in other countries, like the regression analysis and smoothing techniques are difficult to use. Such situations give a great opportunity for those methods in which the role of human judgment and experience is higher. The result of the forecast is depend on the quality of the applied data.

The forecasting based on creeping trend with harmonic weights is an appropriate forecasting method, which can be used for price forecasting with sufficient reliability. The result of the empirical analysis show that the method can predict the development of prices with acceptable error.

Good professional decision cannot be taken without proper forecasting. This is the reason why it is so important to choose between the possible methodologies with caution.

## ACKNOWLEDGEMENT

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