The International Journal of
TRANSPORT &LOGISTICS
Medzinárodný časopis
DOPRAVA A LOGISTIKA

ISSN 1451-107X

SALE AND PRODUCTION FORECAST IN THE TIME OF ECONOMIC CRISIS

Peter Kačmáry[1], Dušan Malindžák[2], Dušan Dorčák[3]

[1]Logistics Institute of Industry and Transport (ÚLPaD), Technical University of Košice, Park Komenského 14, 04384 Košice, Slovakia, tel: +421 55 602 3158, e-mail: peter.kacmary@tuke.sk

[2] Logistics Institute of Industry and Transport (ÚLPaD), Technical University of Košice, Park Komenského 14, 04384 Košice, Slovakia tel: +421 55 602 2813 , e-mail: dusan.malindzak@tuke.sk

[3] Development and realisation workplace of raw materials extracting and treatment, Technical University of Košice, B. Němcovej 32, 043 84 Košice, Slovensko, Tel./Fax: 00421 55 6025193, e-mail: dusan.dorcak@tuke.sk

Abstract: *The trade dynamic changes of offers and demands strongly support ambitions of usage or development of forecast methods, which are able to use for solving of specified dynamic tasks. Solution of these tasks as a prediction of a future status is not only depended on the behaviour of the system in the past, but there are composed some kinds of inputs for information, which has a big value for formation of a true forecast in the future.*

Key words: *Forecast, Prediction, Time-Series, Methodology, Dynamic Changes*

1 INTRODUCTION

Problems presented in this article have a long history and it is the subject of researches of several institutes in areas of education, industry, trade or state. Also our institute of industrial logistics has started to deal with this problem based on requires from the practice, which is our institute closely related with.

However the industry potential of Slovakia is strongly conditioned on numbers of investors from abroad, owned their production plants in Slovakia, who have brought their strategies, know-how and production style in strict secret and it resulted into hard initialisation of collaboration with the native research organisations. But there are still some enterprises, owned by 100% numbers of Slovak holders, which has given an initialisation to start such a forecasting research for our institute.

One of initiators is a huge mining company, mining the important energetic commodity for the industry and households – brown coal. This company has participated in a research of sale development of brown coal in Slovakia. Based on this study, the company better utilised its production capacity at brown coal mining and kept sustainable growth.

The research subjects, presented in this article, are forecast and making forecasting and basically they can be interpreted as followed:

Forecast is the future prediction. [9] Forecast is defined as a transformation of past experience into expected future. [3]

Forecast is systematically derivated and reliable evaluated deposition of the future status of a process, which will occur in certain conditions in certain time. Generally it is formatted by a set of alternative possibilities of the future and variable ways leading towards them. To create forecast more complexly it was attained by the use of application of forecasting methods together with scientific knowledge. [2]

Forecasting is a systematic research of the future and formatting of scientific depositions of possible variants of the development. It is not a single theoretical activity but it is related to general scientific knowledge which comes out of the past, present status and by scientific evaluation it is transformed to future expectations. In a wide area of practice it becomes a part of the process of management and planning. The scientific level of forecasting is given by a complexness, completeness, variableness and objectiveness of solutions. [2].

As it was mentioned above, the importance of research forecasting methods is definitely important at the establishment of an enterprise where there is formed strategy and strategic planning.

In spite of the fact that strategic routing of an enterprise is hardly defined without a long-term prognosis, due to changes in trade surroundings there is high probability of occurrence of lots of inaccuracy at preparing long term prognosis. There are different causes and they can be found mainly in present economic crisis, which results into the followed changes:

- jumping changes of trade demands,
- mainly bankruptcy and slow establishment of new enterprises,
- change of sale or consumption trends of wide range of manufactured goods and products,
- oscillation of prices of manufactured goods and products,
- increase of unemployment and thus lower buying power of inhabitants, etc.

Because there is lack of forecasting methods to create a suitable forecast in the condition mentioned above or in the conditions of economic crisis, this article shows especially certain methods and methodologies of forecast, which were also applied in the practice with the results that prove the application possibilities in wide range of industrial and non-industrial areas.

There are various ways to classify the forecasting methods. One of the approaches is by the time horizon in the future covered by forecasts: [13]

- Long-term forecasts look ahead several years (typically needed to build a new plant);
- Medium-term forecast (needed to replace an old product by a new one);
- Short-term forecast (describing the continuing demand for a product).

Another very important forecasting classification can be characterised by two major groups, well-known also from basic research methodology: the quantitative (objective or statistical) methods and the qualitative (subjective, judgmental or fundamental) methods. While each technique group has advantages and disadvantages, every forecasting situation is limited by constraints like time shortage, insufficient funds, competencies restrictions or inadequate data). [4]

This basic division of forecasting methods can be interpreted by each author differently. However it is done, there is a brief list of quantitative forecasting methods and their possibility of practical application.

2 CLASSICAL METHODS

2.1 Quantitative methods

The first category of forecasting techniques, the quantitative methods can be implemented when the historical time-series data exist and are available and when they can be quantified. [1]

Therefore the preparation of the quantitative forecast involves the initial a number of observed values, observations and past data [6]. When the time series exist, the statistical methods subsequently imply on them in order to active deeper understanding and to identify the underlying factors [10] leading to further analyses in order to forecast future demand. There are two distinct alternatives. [13]

The first one studies the historical time series relying on the substantial presumption that the past behaviour can imply the future trend of changes in the observed variable. [5] These quantitative forecasting techniques are also known as the "projective" quantitative forecast methods. The second group analyses the effect of outside influences in order to produce forecasts and therefore they are known as "causal" quantitative forecast methods. [13] At this point it is important to mention, that all quantitative forecasting techniques are in their essence based on the statistical extrapolation. [6]

The first step should always be the data investigation, using graphic and charts, so the basic structures and properties can be examined. Usually before the determined forecast method is applied, the data time-series are plotted into a chart, "so called scatterplot and X-Y plot, and two dimensional plot among other names". Estimation follows from observation of random samples of the dependent variable for fixed values of the independent variable [5], [8].

Quantitative methods, which are used in practical application in this paper, were chosen as followed: exponential smoothing and regression analysis. Although these methods are not suitable and conforming at all, they can be applied as a part of new methodology described down in this paper.

Exponential smoothing is a method, which is described in detail in several numbers of publications and that is why the author of this paper supposes that there is no need to describe this method here and it is skipped. Similar situation is also with the methods of regression analysis, but this method is a part of new method described in detail in the chapter 3.2.

The choice of non-linear regression model (NLRM) based on an existed diagram is not easy. As a tool can be used a set of typical trend models and then the most suitable model is chosen and to calculate it by method the least squares directly or indirectly by their adjustment by linearity.

Methods of linear or non-linear regression are also included in almost all statistical-mathematical programs and spreadsheet programs. This is the reason, why there is not mentioned the detailed description of calculation of function for each model. Thus, thanks to the widely spread of specific software this linear and non-linear methods have a big popularity because a user has only to define the type and degree of regression model briefly and he obtains results after a relatively difficult calculation of the certain event. Methods can be applicable to lightly changing events but not to alternated (jumping) changes of events at trade like today.

In present economic practice (and still existing economic crisis) we meet the number of events which are in time unstable:

The extrapolation prognostic methods do not provide system forecast, where each event is evaluated separately. Economic event are accompanied by the number of other parameters – random, it means stochastic and extrapolation methods do not know how to utilize them.

The quality of an analysis and forecast strongly depends on a chosen type of the model. The choice of the model is usually made empirically at processing, analysis and forecast.

Possibilities of applicability of economic models are not able to determine only on the basis of formal statistic criteria. Besides that it is necessary to form also some economic suppositions about the dynamic of forecasted events. So, it is necessary to respect quantitative analysis together with the results of qualitative analysis and often to take intuition into consideration. [11]

2.2 Qualitative methods

These forecasting approaches represent a set of techniques that are not entirely dependent on the numerical data analysis. [5] They are usually applied when quantitative data cannot be applied due to absent time-series data, when the economic environment is too unstable or when impending changes in business condition are unexpected. [8]

The forecaster should include the qualitative methods especially in dynamically changing environment when the quantitative models do not reflect significant internal and external changes. [5] In long-term periods and in unstable conditions the forecast is based solely on quantitative approaches rarely possible. Judgmental forecasting approaches offer an alternative in these and other cases [1], [8].

Similarly as in the case of quantitative methods there are also chosen only the most important and the most often used methods in practice, and with their character of subjective appraisal they can be used in various branches and in various times (times of the grow, stable situation or crisis, insecurities). They are also applicable as a complement or improvement to the quantitative methods.

Sales force polling

This approach of sales forecasting is based on the sales forces, which reflects the customer needs. Salespeople are asked to create sales forecasts about product, which they offer to customers in a geographic area, and the results are rolled up into an aggregate figure. The main advantage of this method is that it places the responsibility of forecasting on the people whose aim is most affected by meeting and exceeding sales targets.

Panel agreement (Brainstorming, the group opinion)

This is one of the most spread methodology techniques. This is not a real method literally but this is a considerable addition to other methods. The principle is to create the expert groups (panels), which members search for the answers to certain questions (questions are determined by setting a programme or by the different steps of forecast) within the idea exchange or brainstorming. There are formed the initial lines of the future outputs of the forecast within the panels. As it was mentioned above, this is a very applicable addition to the creation of forecast for periods with dynamic changes.

Delphi method

This method is based on putting the questions to experts in, at least two phases, with the aim to achieve the common opinion and the certain consensus within the appropriate problem. In each next phase questions are formed according to the answers where the biggest agreement of experts from the previous phase was achieved. The basic idea of the method is that the consensus achieved by the group of experts is more reliable that the opinion of one expert. In comparison to the brainstorming, the experts do not discuss the topic among themselves. Although there is very hard to guarantee the anonymity of the experts and the time of creation

of forecast can be very long (there can be many phases) this method is applicable to any type of product at anytime.

Market (consumer) surveys

The method of market surveys is used to collect the information from the market in the form of expectation, demands, shortages etc. Market research reflects the present status of markets and that is why this method is excellent to obtain actual momentary information, but the value of the information is limited to the time – long-term prognosis can be more or less distorted.

3 SUGGESTION OF NEW FORECASTING TECHNIQUES

As it was mentioned in the introduction, the need of new quantitative method suitable for the empiric and stochastic situation was enormous. To avoid the fatal error, to decrease the uncertainity, the calculation cannot be made and proofed by one exact method. There is need to create a methodology of combination the calculations of more methods in one model, which give us one result of the forecast situation. This is the main principle of this chapter is to find out solution with the stochastic and dynamic influences in the processes. There are two main applied methods for the dynamic forecasting classification:

- Harmonic weights and Head of a Snake – a new trend methods;
- Methodology for forecasting of the dynamic change system.

3.1 Harmonic weight method

The method of harmonic weights (elaborated by Malindžák, 1998) [4] belongs to methods from the group of the quantitative methods and they are suitable and applicable to the creation of forecast of events in dynamic changed conditions, because of using geometric weight mean. Just the presence of harmonic weights valuates the progress of an event in the period "N" and this is the base on setting up the forecast in the future period "N+1". This method was applied in practice by the author [12] in the research of the sale of packaging materials produced in the firm Chemosvit fólie a.s. just in the time of economic crisis. Here is the technique of calculation by the method of harmonic weights.

Harmony weight method is based on the following ideas:

a) The closer the value in time sequence to forecast time is, the higher priority it has.

b) The highest dominance should be located in the last value of the time series $Y_{N.}$

We can calculate ratio indexes from the time sequence values:

$$RI(t) = YI(t) / Y(t-1) \quad (1)$$

where: t = 2,3, ... ,n;

I = number of product group (if forecast is developed for several product groups).

If I=1 and n=4 is number of intervals, considered for forecast calculation, then 3 ratio indexes (RI) exist:

$$RI(2), RI(3), RI(4) \text{ then: } RI(2) = \frac{Y_{N-2}}{Y_{N-3}}; RI(3) = \frac{Y_{N-1}}{Y_{N-2}}; \; RI(4) = \frac{Y_N}{Y_{N-1}} \quad (2)$$

From these ratio indexes can be calculated product group "I" index, known as average ratio index (ARI) for a product group "I". The ARI is based on geometric mean:

$$ARI(I) = \sqrt[\sum_{t=2}^{n} w_t]{\prod_{t=2}^{n} (RI(I,t)^{w_t})} \quad (3)$$

where: RI(I,t) – ratio indexes

w_t – are so called harmonic weights, which are calculated as followed:

$$w_t = \sum_{j=2}^{t} \frac{1}{(n-(j-1))} \quad (4)$$

If n = 4, then: $w_2 = 1/(4-1) = 0{,}33$
$w_3 = 1/(4-1) + 1/(4-2) = 0{,}83$
$w_4 = 1/(4-1) + 1/(4-2) + 1/(4-3) = 1{,}83$

It means that for the different kinds of products there are the same weights, if "n" is the same. The average index of product group I, PI(I) gives us extrapolation directive for the development of Y_N.
Forecast:

$$Y(I)_{N+1} = Y(I)_N + (ARI(I) - 1) \times Y(I)_N \quad (5)$$

where: $(ARI(I) - 1)$ - represents $\Delta Y_N(I)$, by which value $Y_N(I)$ is changed and the forecasted value is $Y_{N+1}(I)$.

This method is similar to the exponential smoothing method, but it has two advantages:

- The weights consider data information acquisition for forecast
- They are not chosen at random. [7]

The method is sustainable and applicable to the systems with relatively big dynamic changes especially with hidden trends.

3.2 Head of a Snake method

The "head of a snake" method is a method coming out of classical quantitative methods as a trend method, which can be used in dynamic changes of the processes. There is even better availability for process applications where a relatively stable process traverses into a changeable one. Information about a trend direction or about development of a certain process is located in a section of a time period from the time where some turbulent changes have occurred. One remark should not be forgotten – every process has a kind of inertia and it is the same in this case. The influence of changes is expressed itself after some time with some intensity. The trend from the last part of the time series period of an examined process contains the most accurate and authentic information about a possible direction of the process in the future because they are closed at present. There can be used a principle of division of information from the examined time series of a process based on philosophy of comparison of "the global trend" and "the local trend" (figure 1).

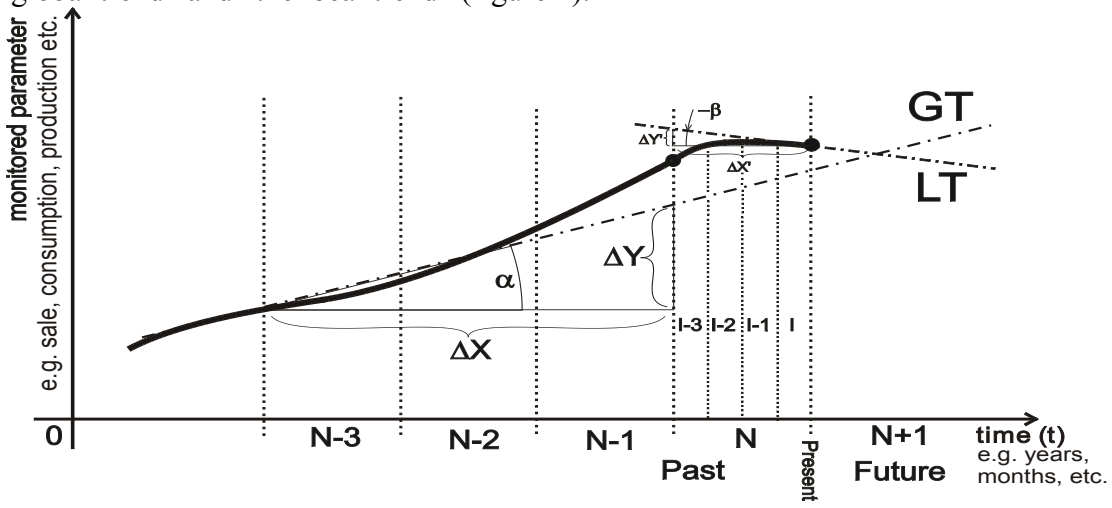

Fig. 1 *The principle of the "global" and "local" trend line.*

While directions of "GT" and "LT" are overlaid it is an ideal situation, which predicts stable system. The development of a trend in the next period with high probability will copy the development of "GT". In dynamically changed processes this situation will not be probable and directions of "GT" and "LT" can be totally different. In this case, the direction of future trend of a process will probable copy the trend "LT". Thus, there are two different situations: the future trend will be according to the "GT" or "LT". The calculation can be provided by comparisons of angles of these two trends, i.e. angles α and β:

$$tg(\alpha) = \frac{\Delta X}{\Delta Y}\,; \qquad tg(\beta) = \frac{\Delta X'}{\Delta Y'} \tag{6}$$

Another way of calculation (used in applications) is by comparisons of forecast results of "GT" and "LT" values for N+1 period. As the easiest way is used linear regression to calculate values GT_{N+1} and LT_{N+1} as followed:

$$a + b.x_{N+1} = GT_{N+1} \tag{7}$$

$$a' + b'.\, x_{N+1} = LT_{N+1} \tag{8}$$

where: the roots of trend lines a and b (also a' a b') are calculated by the Least-Squares method, according to the formulas (9), (10), with values of x variable from the certain case.

$$a = \frac{\sum y_i \sum x_i^2 - \sum x_i \sum y_i.x_i}{n\sum x_i^2 - (\sum x_i)^2} \tag{9}$$

$$b = \frac{n\sum y_i.x_i - \sum x_i \sum y_i}{n\sum x_i^2 - (\sum x_i)^2} \tag{10}$$

By above mentioned comparison of GT_{N+1} a LT_{N+1} values there is a calculated difference between them and the future – forecasted period is determined according to the followed conditions:

- If the difference is up to ± 10%, next direction of trend will be considered as „GT". This came out from the thoughts that forecast with error within 10% is considered as excellent forecast.
- If this difference is higher the future direction of trend will be considered as „LT".

3.3 The way of comparison of more method results

The way to achieve the results as objectively as possible is definitely by combining results from more methods. This is one of the interpretation of a combination by comparison of more results. This is also the case when the process dynamics is tested. There are three methods and their results coming into this comparison, two are suitable for dynamic process (*harmonic weights - HW* and *head of snake - HS*) and one is suitable for stable process (*regression analysis - RA*). Evaluation of the results is according to the following steps:

a) If the value of HS i.e. $LT_{N+1} \approx HW_{N+1}$ (allowed difference is ±10%), the calculation of forecast will be according to HS respectively to LT and the process is considered as dynamic – radically changeable;
b) If the difference is higher, then there is another comparison between HW and RA. It means $HV_{N+1} \approx RA_{N+1}$ (allowed difference ±10%), the calculation of forecast will be according to RA respectively to GT and the process is considered as relatively stable.
c) If these two conditions above are not fulfilled i.e. the results are out of allowed tolerance (± 10% difference) the calculation of forecast is not determined by this methodology and the calculation should be made by the combined model of forecasting.

3.4 Combined model of forecasting

This methodology describes the way of combination of results from more forecast calculations into one definite result unlike the previous methodology. The modern process of forecast calculation is not only based on a result from one method that is why it is essential to combine more results from forecast methods into one definite. The following model or methodology is built on the multicriteria decision and the assessment conception. The principle is to rectify the results from many forecasts into one, which creates consensus of partial results. This correcting of results depends on the process for which it is calculated. This is ensured by the way of evaluating the results by weights, which ratio is configured according to the three variants, which represent the level of dynamics of the process. The summary of all weights is equal as it is in the following formula (11):

$$\sum_{i=1}^{P} w_i = 1 \tag{11}$$

where: p – number of methods in the combined model
w_i – determined weights

Based on this philosophy the principle of combination of forecasting methods was adapted to methods, which were used in the application. There are four methods coming into this consideration: exponential smoothing, regression analysis, harmonic weights and head of a snake. The mentioned variants and the configured weights are in the following table 1 and figure 2:

Tab 1 *Forecasting methods evaluation by weights according to types of variants*

Forecasting methods:	Weights	**1st variant of weights**	**2nd variant of weights**	**3rd variant of weights**
Expon. smoothing (ES)	w_1 =	0,4	0,2	0,1
Regression analysis (RA)	w_2 =	0,4	0,2	0,1
Harmonic weights (HW)	w_3 =	0,1	0,3	0,4
Head of a Snake (HS)	w_4 =	0,1	0,3	0,4

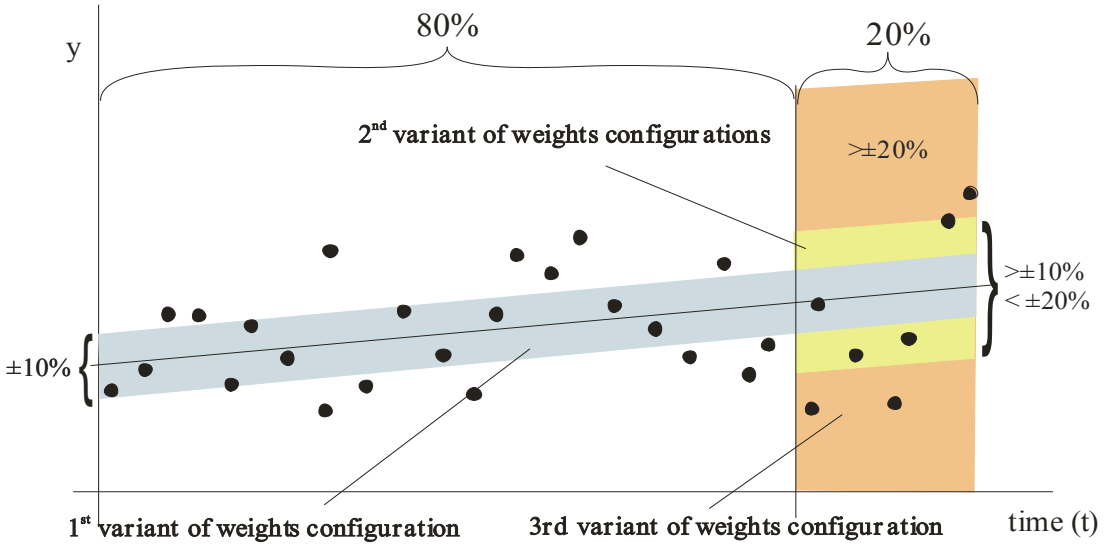

Fig. 2 *Graphical means of variants*

There are defined conditions of validation of these variants. The definition is important for a correct and objective choice of weight variants and can be varied for a different type of processes:

1. variant: all time series values are scattered maximum ±10% according to a trend line correlation created by linear regression. In case of this correlation the process is considered as relatively stable, there are not the signs of sudden changes even at values in the last period. The weights are configured as for stable, non-dynamic process and that is why the higher weight is put to methods for stable environment.
2. variant: values from the last period i.e. 20% of all time series values are scattered more than 10% but less than 20% according to a trend line correlation created by linear regression. In this case it is possible to consider the last period as slightly dynamic that is why the higher weight is put more to methods applicable to dynamic processes.
3. variant: is similar to variant 2, but there is even higher scatter in the last period i.e. 20% of all time series values. Because the scatter is higher than 20% it is considered as dynamic dependency and that is why the weight configuration is changed again. The high accent is put to methods applicable to dynamic processes and it results to high volume of weight.

4 POSSIBLE APPLICATIONS

As it was mentioned in the introduction, one possible application came out from case study of brown coal production and m. The following two figures describe the situation of production of the mine company HBP a.s. and the total consumption (the energetic coal and coal for households or smaller consumers). The aim of the study was to compare forecasted values with the real numbers and that is why the forecast calculation is created for year 2009. This year was the latest for comparison in the time of making study. The consumption and production of brown coal do not have the signs of typical dynamic processes as it if visible from the following diagrams, also forecast do not include any other influences (changes in legislation, strategy, prices or economic crisis). But this demonstrate possible example of application.

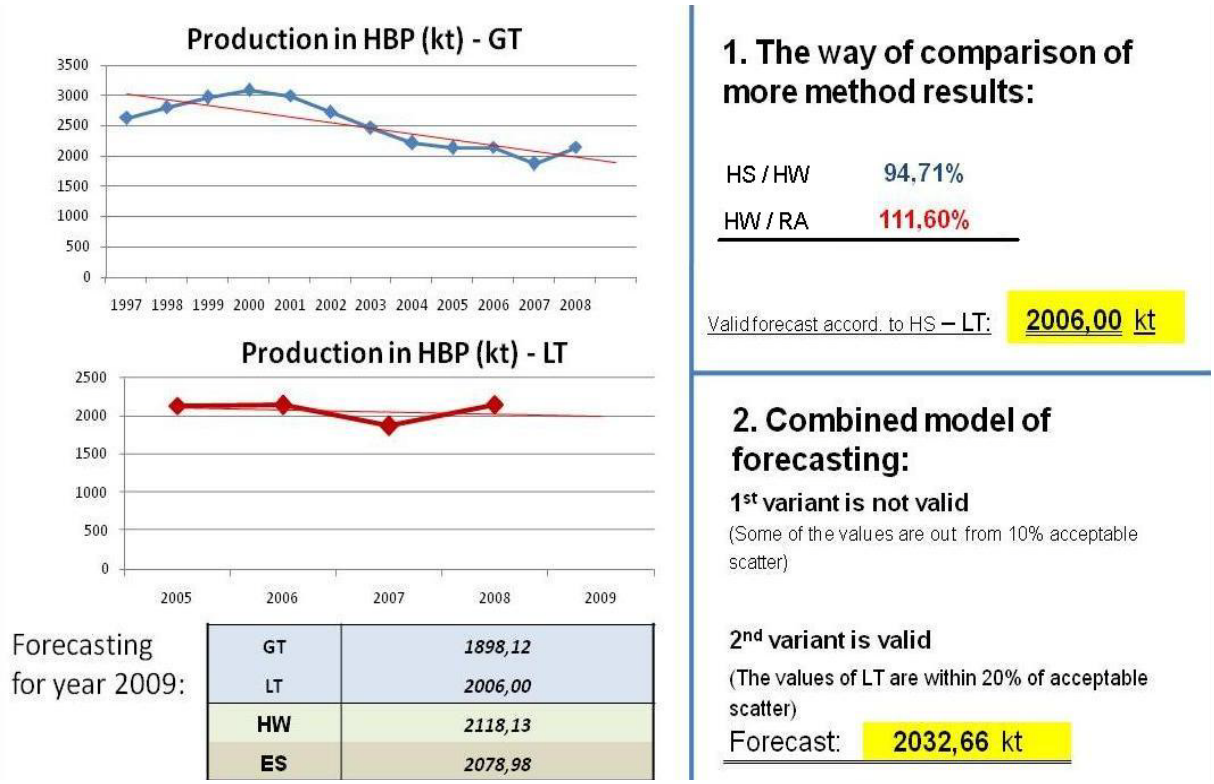

Fig. 3 *The application of production forecasting of brown coal in HBP a.s.*

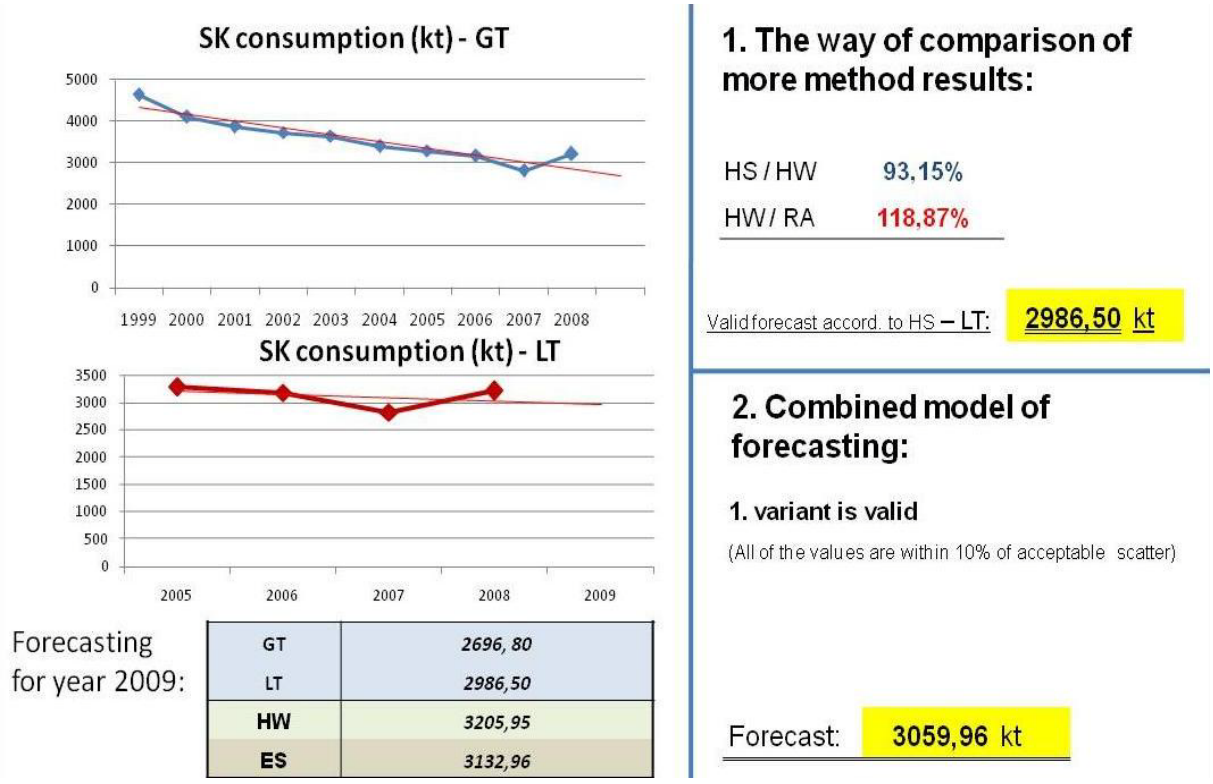

Fig. 4 *The application of consumption forecasting of brown coal in Slovakia*

5 CONCLUSION

Although data are not the latest, these examples (Figure 3 and Figure 4) show the using and mainly the comparison of new approaches in the previous studies. The aim was to apply two approaches: *the way of the comparison of more method results* and *the combined model of forecasting* in practice. The forecasted year was 2009, it was the last year we had also the real consumption and production values, while carrying out research.

The case study of consumption in 2009 has brought the following situation:

- The real consumption:.....3127 kt.
- Old forecast according to the regression analysis:.....2696 kt.
- Forecast created by the comparison of more method results:.....2986 kt.
- Forecast created by the combined model:.....3059 kt.

It is evident that the discrepancy by a classical forecast method - ordinary regression analysis is the biggest (13,8%). In the case of comparison of more method results the discrepancy is smaller (4,5%) and in the case of the combined model of forecasting the discrepancy is the smallest (2,2%). This proved that the suggested approaches are more preferable.

The case study of HBP a.s. production in 2009 has brought the following situation:

- The real consumption:.....2277 kt.
- Old forecast according to the regression analysis:.....1898 kt.
- Forecast created by the comparison of more method results:.....2006 kt.
- Forecast created by the combined model:.....2032 kt.

It is evident that the discrepancy by classical forecast method - ordinary regression analysis is the biggest (19,9%). Again, the evaluation is based on both methodologies: calculations by the comparison of more method results resulted to smaller discrepancy (12,7%) and calculation by the combined model of forecasting resulted in even smaller discrepancy (11,8%). This proved that the suggested approaches are more preferable, too.

References

[1] Anderson, R.D., Sweeney, J.D. and Williams, A.T.: *An Introduction to Management Science; In Quantitative Approaches to Decision Making*, Minneapolis: West Publishing (1994).

[2] Buřita, L.: *Prognostické metody a jejich využití v resortu MO*. Univerzita Obrany: Obrana a Strategie (Defence and Strategy), Vol. I. (2003), ISSN 1802-7199

[3] Forecasting.com: Forecasting, Business forecasting [on-line]. Forecasting.com. [cit. 2009-11-03]. Reachable on internet: <http://www.forecasting.com/>

[4] Georgoff, D. and Murdick, R.: *Manager's Guide to Forecasting*, Harvard Business Review, Vol. 1, No. 86104, January-February (1986), pp. 110-121.

[5] Jarret, J.: *Business Forecasting Methods*, Oxford: Blackwell (1993).

[6] Makridakis, S., Wheelwright, C.S.: *Forecasting Methods for Management*, New York: Wiley (1989).

[7] Malindžák, D.: *Production Logistics I.,* Košice: ŠTROFFEK Publishing (1998).

[8] Malindžák, D. Jr.: *A Mixed – Mode Modelling Approach to Using Forecasting and Simulation in the Slovakian Coal Industries.*PhD thesis. Technical University of Košice, Košice, Slovak Republic (2006).

[9] Nikolaj, J., Kľučka, J., Vančo, B.*: Plánovanie a prognostika, Žilina: FŠI ŽU, (2005). ISBN 9788096914838.*

[10] Rothermel, W.T.: *Accurate Business Forecasting*, In: Boston: Harvard Business Review (1991).

[11] Seger, J. and Hindls, R.: *Statistical methods in the market economy*, Praha: Viktoria Publishing (1995).

[12] Šveda, M.: *The trade planning model in the Chemosvit fólie a.s. company*, M.Sc. thesis. Technical University of Košice, Košice, Slovak Rep. (2009),.

[13] Waters, D.: *Quantitative methods for business*, In: Quantitative Methods for Bussines and Economics, Harlow: Addison Wesley Longman (1997) Ch. 14. p.274