INTRODUCTION TO THE COMBINED MODEL OF FORECASTING AND ITS APPLICATIONAND COMPARATION WITH ARIMA MODEL

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Abstract

This paper describes the principle and calculation of combined model of forecasting, describes also the choice of methods for calculation, which should be used in the model, examples of forecasts creations by using historic time series of two types of magnesite sales in a big mining company in Slovakia. The resulted forecast is compared with well-known and widely used ARIMA model and finally the forecasts are compared with the real sale.

Keywords: Forecast, combined model of forecasting, time series, method, sale

1. INTRODUCTION

The topic of this paper is based on the sale prediction in one mining company in Slovakia, where the magnesite is mined and sold in a form of magnesite for bricks (MB) and magnesite for steel industry (MS). Good and flexible planning system cannot be done efficiently without forecasting [1, 2]. Number of methods, methodologies or techniques and also program application which are used at creation of any kind of forecasting, are limited to be properly used in the time of inherent market volatility during economic crisis. A forecast-updating company might react faster than a company with no forecast updating. [3]. It initiates the thoughts to prepare some new, reliable methodology or techniques just to solve the company's problems [4].

The selection of forecast methods depends on the market characteristics of a product, time period, amount and character of historical data, etc. Not only these problems are mentioned and solved in the references [5, 6], but also there is described the principle of how the results of different methods of forecasting should be joined together to get one result. Then it needs of verification of the forecasted results and the achievement of one objective result, because it is not possible to avoid of any fatal error by the forecasting calculation especially, which are based only on one method [7]. One of methodologies, that can join various results from forecast calculations, can be combined model of forecasting (CF). The advantage of using of the combined model of forecasting is especially when there are conditions like unstable situation of observed events, uncertain decision about which method is the most accurate, error proof - when you want to minimise errors. It is expected that combining reduces errors [8, 9].

This article tries to prove the affirmation of needs of the CF by the proposed model of combined forecast calculation. This calculation is based on the sale data of magnesite for bricks (MB) and magnesite for steel industry (MS).

2. THE COMBINED MODEL OF FORECASTING

Combining forecasts (CF), sometimes referred to as composite forecasts, is a kind of the averaging of separate forecast results. These results can be based on different data or different methods or both. The averaging is one of the various ways of combining, and the following described combining principle uses a rule that can be represented as a weighted average of the forecasts with the variable weights. The following model or

methodology is built on the multicriteria decision and it was already described in the paper from one of previous conference proceeding [10, 11] but the variability of weights for CF is kept in this paper.

There are four methods coming into this consideration: Weighted Average (WA), Harmonic Weights (HW), Holt exp. smoothing (Holt), Moving Average (MA). All the methods except for the Harmonic Weights are generally known. The methods of Harmonic Weights are detailed explained in [11]. The proposed variants and the configured weights are in the following Table 1 and graphically described in **Fig. 1**:

Table 1 Forecasting methods evaluation by weights according to types of variants [11]

Forecasting methods:	Weights	**Ist variant of weights**	**IInd variant of weights**	**IIIrd variant of weights**
Weighted Average(HS)	w_1 =	0.1	0.3	0.4
Harmonic Weights (HW)	w_2 =	0.1	0.3	0.4
Holt exp. smooth. (Holt)	w_3 =	0.4	0.2	0.1
Moving Average (MA)	w_4 =	0.4	0.2	0.1

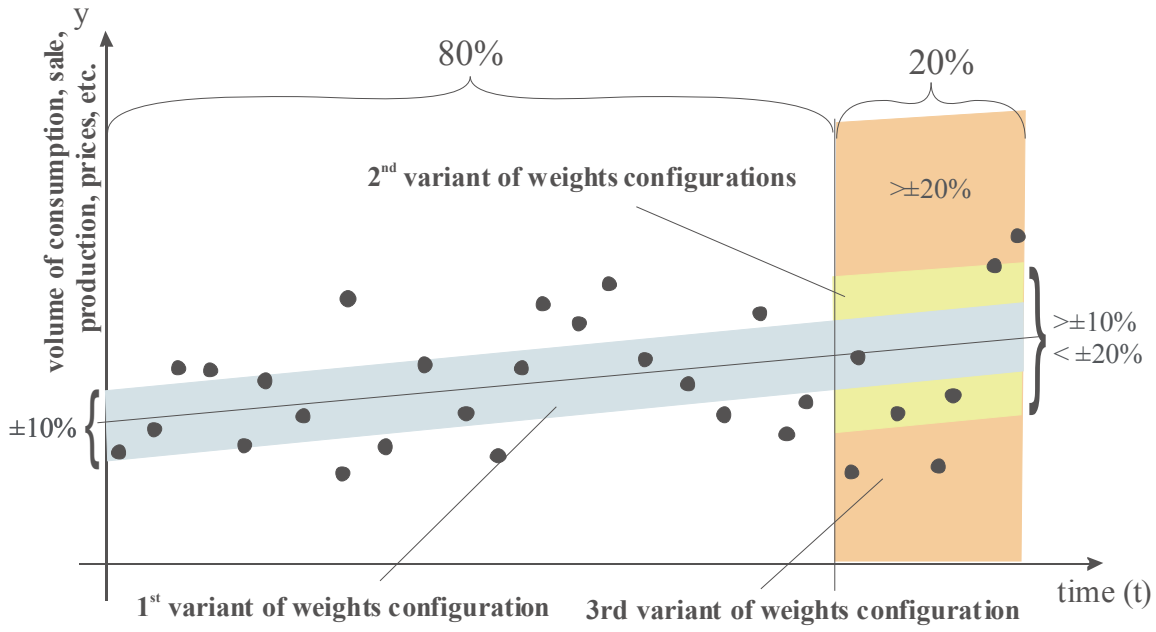

Fig. 1 Graphical means of variants [11]

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:

1st 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 [11].

2nd 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 [11].

3rd 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 [11].

3. THE FORECAST CALCULATION WITH THE COMBINED MODEL OF FORECASTING

This chapter describes the example of the application of the combined model of forecasting. There are calculations, comparing of results and the verification of positive expectation, mentioned in introduction. This calculation can be applied in a wide range of time series analysis, in industrial or commercial sector. The following example is the forecast calculation of the magnesite products sale in the quarters of year 2014. Forecast uses data from the year 2009 up to 2013 and data from the year 2014 are only for comparison of forecast results (**Table 2**). These data are in tons but they are intentionally misrepresented, however the shape of the sale curves were kept.

Because there are two types of magnesite products, the application was provided for each of the product:

1. Forecasting of magnesite for bricks (MB) which is used for building industries. Data were taken from the year 2009 (the first year of the economic crisis officially said) by the year quarters.
2. Forecasting of magnesite for steel industry (MS), which is used mainly in metallurgical industries. Data were also taken from the year 2009 by the year quarters (**Table 2**).

Table 2 The sale of magnesite products

Year	Quarters	Real sale of magnesite for bricks (MB)[t]	Real sale of magnesite for steel ind. (MS) [t]
2009	1	6054.08	15373.12
2009	2	5783.04	12185.34
2009	3	12399.41	18098.28
2009	4	20225.35	19343.40
2010	1	22133.50	13205.13
2010	2	22565.06	16805.97
2010	3	20460.16	14502.06
2010	4	18909.24	17899.74
2011	1	18498.89	13615.29
2011	2	15072.26	19638.23
2011	3	15678.26	16701.88
2011	4	12651.44	16907.53
2012	1	11851.70	17115.52
2012	2	10215.07	18012.17
2012	3	6728.39	15407.35
2012	4	11170.99	13596.96
2013	1	9510.86	10218.15
2013	2	11155.87	10569.10
2013	3	9851.21	11655.35
2013	4	9848.95	8967.64
2014	1	*9593.04*	*12517.03*
2014	2	*9630.38*	*11595.40*
2014	3	*10186.19*	*10856.00*
2014	4	*10948.16*	*12212.03*

The graphical interpretation of the sale of the MB is shown in the **Fig. 2** and the sale of MS is in the **Fig. 3**, where there are also trend lined and limits of trends ± 10 % and ± 20 %.

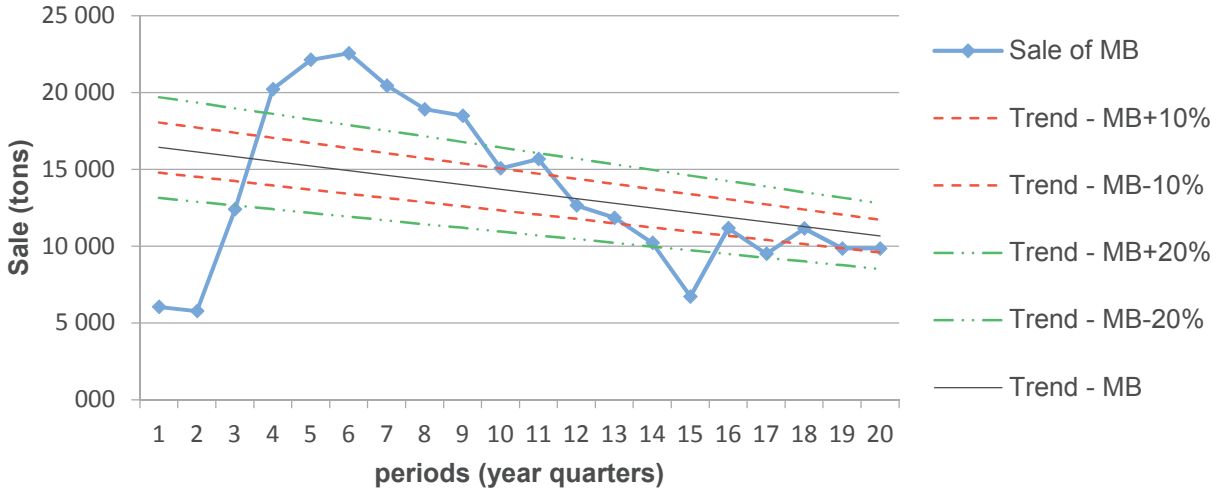

Fig. 2 The sale of magnesite for bricks (MB)

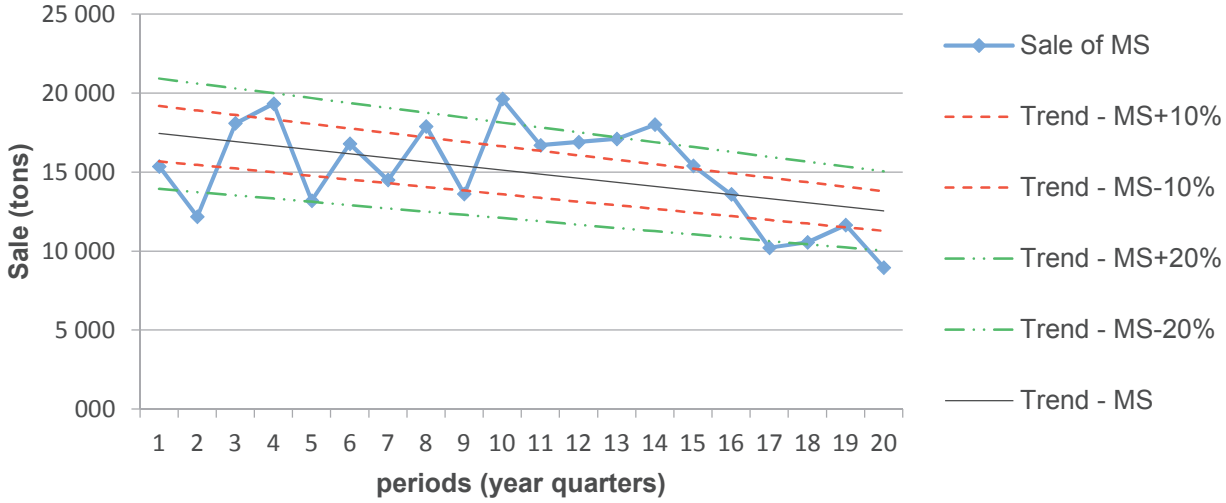

Fig. 3 The sale of magnesite for steel industry (MS)

In the following **Table 3** there are forecast calculations by using the above mentioned methods including results from ARIMA models, which were calculated by the Minitab 17 software. The forecast was created for the whole year i.e. for the following 4 quarters of the year 2014.

Table 3 Forecasts by ARIMA method

Magnesite for bricks (MB):		***Magnesite for steel industry (MS):***	
ARIMA:		ARIMA:	
1Q/2014	**9994.28**	1Q/2014	**10104.35**
2Q/2014	**10189.92**	2Q/2014	**9368.54**
3Q/2014	**10415.25**	3Q/2014	**9270.78**
4Q/2014	**10658.09**	4Q/2014	**8955.61**

Table 4 Forecasts by other methods and by CF

Magnesite for bricks (MB):		*Magnesite for steel industry (MS):*	
WA:		WA:	
1Q/2014	**11500.02**	1Q/2014	**13377.19**
2Q/2014	**11246.03**	2Q/2014	**13262.63**
3Q/2014	**11039.98**	3Q/2014	**13049.99**
4Q/2014	**10935.52**	4Q/2014	**12781.58**
HW:		HW:	
1Q/2014	**9618.82**	1Q/2014	**8342.30**
2Q/2014	**9388.33**	2Q/2014	**7797.00**
3Q/2014	**9160.61**	3Q/2014	**7301.31**
4Q/2014	**8936.76**	4Q/2014	**6844.65**
Holt:		Holt:	
1Q/2014	**9944.79**	1Q/2014	**9268.50**
2Q/2014	**9902.07**	2Q/2014	**9151.54**
3Q/2014	**9880.29**	3Q/2014	**9091.89**
4Q/2014	**9869.18**	4Q/2014	**9061.47**
MA:		MA:	
1Q/2014	**10307.57**	1Q/2014	**11001.44**
2Q/2014	**10134.89**	2Q/2014	**10482.33**
3Q/2014	**10259.70**	3Q/2014	**10535.17**
4Q/2014	**10080.46**	4Q/2014	**10528.38**

Combined forecast (CF):			
MB - variant 2		MS - variant 3	
1Q/2014	**10386.13**	1Q/2014	**10714.79**
2Q/2014	**10197.70**	2Q/2014	**10387.24**
3Q/2014	**10088.17**	3Q/2014	**10103.23**
4Q/2014	**9951.61**	4Q/2014	**9809.48**

Table 5 MAPE indicators for year 2014

MAPE of ARIMA for MB	MAPE of ARIMA for MS	MAPE of CF for MB	MAPE of CF for MS
3.72 %	**19.94 %**	**6.06 %**	**12.86 %**

4. CONCLUSION

The aim of the paper was to highlight the importance of combined forecasting model even in its simple form, as it was presented in the chapter 2 with the following results (see Tables 4 and 5).

In the first case of the calculation of the of the sale of the MB, the MAPE is under 10 % for ARIMA and CF forecast, what is considered as successful forecast. The total difference of both MAPE is 2.34.

In the second case of the sale of MS, although there were higher MAPE values, the combined forecast has even better (lower) MAPE indicator. It proved the validity of CF and it can be used in the future forecast calculation for the mining company.

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