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Choice of Quantitative Method for Forecasting of Parquet Sales

Izbor kvantitativne metode za predviđanje prodaje parketa

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ABSTRACT • *Companies that cannot predict business forecasts for their sales always find themselves in ambiguity. In this research we analyzed two quantitative methods that gave the best results for forecasting the sales: Holt-Winters method of exponent smoothing of higher orders and linear regression of the 1st order. The data for the implementation of these two methods were obtained in a wood company that deals with parquet sales. The data were gathered for parquet sales by month in the years 2000 to 2009. The calculations of sales forecasts enabled to compare both methods. On the basis of smaller deviations from data obtained, we determined the most appropriate method. We received the best result with the use of Holt-Winters multiplicative model of exponent smoothing of higher orders. Thus, according to this research, this method should be used for further forecasting of parquet sales in the analyzed wood company.*

Key words: *wood company, parquet, sales forecasting, quantitative methods, Holt-Winters multiplicative model*

SAŽETAK • *Poduzeća koja ne mogu predvidjeti prodaju svojih proizvoda posluju u neizvjesnosti. U ovom smo istraživanju analizirali dvije kvantitativne metode koje daju najbolje rezultate u predviđanju prodaje: Holt-Wintersovu metodu eksponencijalnog izglađivanja viših redova i jednostruku linearnu regresiju. U poduzeću koje se bavi prodajom parketa radi predviđanja buduće prodaje prikupljeni su podaci o mjesečnoj prodaji u razdoblju od 2000. do 2009. godine. Na temelju izračunatih predviđenih vrijednosti prodaje omogućena je usporedba primijenjenih metoda. Ovisno o manjim odstupanjima od realiziranih vrijednosti izabrana je prikladnija metoda. Primijenom Holt-Wintersova multiplikativnog modela eksponencijalnog izglađivanja viših redova dobiveni su bolji rezultati, te bi ta metoda trebala biti rabljena za predviđanje prodaje parketa u analiziranome drvnom poduzeću.*

Ključne riječi: *drvno poduzeće, parket, predviđanje prodaje, kvantitativne metode, Holt-Wintersov multiplikativni model*

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1 INTRODUCTION
1. UVOD

In the business world, companies constantly face uncertainty. It was a big challenge for the companies to reduce these uncertainties and ambiguity by good sales forecasting. On the basis of good future planning, a company can develop an appropriate strategy, according to which business should be performed in the future (Anderson *et al*, 2010).

Due to the existence of many factors that may influence the sales, each company has its own characteristics regarding forecasting. In forecasting, qualitative or quantitative methods are used as well as the combination of these two methods. The decision as to what method to use depends on the available data, knowledge and experience of the decision maker (Ljubič, 2006).

Our research includes two quantitative methods for forecasting: Holt-Winters method of exponent smoothing of higher orders and linear regression of the 1st order. They are both based on past numeric data. Using these two methods, we attempted to get as close as possible to the values of parquet sales obtained in the selected wood company given by month in the years 2000 to 2009. We compared the results of both methods. Consistent with the results of short-term forecasts, the most appropriate method was established. We believe that the use of the method selected in such a way could enable accurate forecasts of parquet sales in the investigated/selected company in the years to come.

2 METHODS AND MATERIALS
2. METODE I MATERIJALI

2.1 Forecasting
2.1. Predviđanje

Methods of forecasting have started to develop with acceleration in the 19th century, nevertheless their use in practice increased with the arrival of computers (Bowerman and O'Connell, 1993). The main problem was that such methods needed to perform many complicated and time consuming mathematical operations. Nowadays, the use of forecasting procedures is simplified. There are many computer programs available to predict the development of future business events, as for example the forecasting of the sales.

For forecasting any kind of events, the researcher has to acquire certain knowledge, because, if he/she uses data that are not the key data of the forecasting problem, or not appropriate for the used prediction model/method, the outcome of the model will be definitely wrong. The researcher also has to be able to correctly interpret the forecast from the obtained results, as numbers and diagrams do not disclose everything. It is practically impossible for a certain event to be forecasted accurately by the use of the forecasting method. Forecasting methods are only a decision support tool and only help to reduce the error or difference between a forecasted event and an actual event (Bovas and Ledolter, 2005).

2.2 Quantitative methods
2.2. Kvantitativne metode

Quantitative models are based on mathematical and statistical methods. For such models, numerical data from the past are needed/used. For calculating parquet sales forecasts in the wood company, we decided to use two methods that gave the best results regarding the actual/obtained data: Holt-Winters method of exponent smoothing of higher orders and linear regression of the 1st order.

2.2.1 Holt-Winters multiplicative model
2.2.1. Holt-Wintersov multiplikativni model

Multiplicative model assumes that the sales decrease or increase each year for a given factor, or that the basic value is multiplied by the seasonal factor (Kotsialos *et al*., 2005). If the factor is more than 1, the sales increase, if it is less than 1, the sales decrease. This method uses smoothing with uneven seasonal oscillation (Mole, 2011).

The basic equations for Holt-Winters multiplicative method are as follows (Makridakis *et al*., 1998):

Level: $$L_t = \alpha \cdot \frac{Y_t}{S_{t-s}} + (1-\alpha)\cdot(L_{t-1} + b_{t-1}) \quad (1)$$

Trend: $$b_t = \beta \cdot (L_t + L_{t-1}) + (1-\beta)\cdot b_{t-1} \quad (2)$$

Seasonal: $$S_t = \gamma \cdot (\frac{Y_t}{L_t}) + (1-\gamma)\cdot S_{t-s} \quad (3)$$

Forecast: $$F_{t+m} = (L_t + b_t\, m)\cdot S_{t-s+m} \quad (4)$$

where s is the length of seasonality (e.g., number of months in the year), L_t represents the level of the series, b_t denotes the trend, S_t is the seasonal component, and F_{t+m} is the forecast for m periods ahead.

Equation (3) is comparable to a seasonal index that is found as a ratio of the current values of the series, Y_t, divided by the current single smoothed value for the series, L_t. If Y_t is larger than L_t, the ratio will be greater than 1, while if it is smaller than L_t, the ratio will be less than 1. To understand this method, it is important to realize that L_t is a smoothed (average) value of the series that does not include seasonality (this is the equivalent of saying that the data have been seasonally adjusted). The data values Y_t, on the other hand, do contain seasonality. It must also be considered that Y_t includes randomness. In order to smooth this uncertainty, equation (3) weights the newly computed seasonal factor with γ and the most recent seasonal number corresponding to the same season with (1-γ). This prior seasonal factor was computed in the period $t - s$, since s is the length of seasonality (Mole, 2011).

2.2.2 Linear regression of the 1st order
2.2.2. Jednostruka linearna regresija

Linear regression of the 1st order is the simplest and very commonly used method in forecasting. It is used for long-term forecasting of sales or demand, forecasting of storage stocks and similar. It is employed if linear regression function is considered, and namely:

$$Y = a + bX + e \quad (5)$$

where X is the independent variable, Y is the dependent variable, a is the intercept, b is the slope of the line

Table 1 Sales of different types of parquet in the selected company from 2000 to 2009 (in m^2)
Tablica 1. Prodaja različitih tipova parketa u promatranom poduzeću od 2000. do 2009. (u m^2)

Parquet *Parket*	**Classic** *Klasični*	**Lamellate** *Laminat*	**Techno** *Tehno*	**Lam** *Lamel*	**Ready made** *Mozaik*	**Terrace** *Brodski pod*	**Sum** *Zbroj*
2000	16,360.18	19,042.29	0.00	5,271.44	962.52	0.00	41,636.43
2001	14,090.67	30,975.19	240.00	5,328.24	1,933.12	0.00	52,567.22
2002	20,486.88	22,189.91	0.00	5,342.20	1,978.10	0.00	49,997.08
2003	16,556.99	16,871.25	268.34	4,105.91	2,253.45	0.00	40,055.94
2004	12,391.97	13,800.34	1,547.97	2,144.14	1,903.15	24.50	31,812.07
2005	15,699.13	9,588.45	1,052.73	2,917.90	4,250.60	134.01	33,642.81
2006	16,334.66	5,861.84	1,041.57	1,829.52	6,892.76	274.79	32,235.14
2007	17,517.67	12,496.05	2,273.05	1,801.95	6,760.53	3,978.33	44,827.59
2008	11,643.23	5,166.51	3,179.49	1,590.12	8,230.08	877.90	30,687.34
2009	14,513.39	3,358.48	652.43	810.14	10,408.53	1,214.06	30,957.02
Sum / *Zbroj*	155,594.77	139,350.31	10,255.58	31,141.56	45,572.84	6,503.59	388,418.65

(how much Y changes for each one-unit change in X), and e denotes the error (the deviation of the observation from the linear relationship).

The objective is to find the values a and b. The linear function $Y=a+bX$ presents the »best fit« to the given data. The main goal of the linear regression is to fit a straight line through the data that predict Y based on X. To estimate the intercept and slope regression parameters that determine this line, the least square method is commonly used. It is not necessary for the errors to have a normal distribution, although the regression analysis is more efficient with this assumption. With this regression method, the regression parameters are found such that the sum of squared residuals (i.e., the difference between the observed values of the outcome variable and the fitted values) is minimized. The fitted value y is then computed as a function of the given x value and the estimated intercept and slope regression parameter. For example, in Equation (5), once the estimates for a and b are obtained from the regression analysis, the predicted value y at any given x value is calculated as $a + bx$.

It is meaningful to interpret the coefficient of determination, i.e., the value r^2. It is in the range of 0 to 1 and measures the portion of the variability in Y that can be explained by the variability in X through their linear relationship, or vice versa:

$$r^2 = \frac{SS_{\text{regression}}}{SS_{\text{total}}} \qquad (6)$$

where SS stands for the sum of squares.

This method is subject to several disadvantages sourcing from input data and the question of linearity or non-linearity the trend function presenting the investigated phenomenon.

3 RESULTS AND DISCUSSION
3. REZULTATI I RASPRAVA

3.1 Parquet sales data in the considered wood company
3.1. Podaci o prodaji parketa u promatranome drvnom poduzeću

The wood company made available to us the parquet sales data by month from 2000 to 2009. On the basis of the obtained data and by the use of the appropriate forecasting method, we were able to deliver the short-term forecasts of parquet sales for the selected company. Table 1 presents the data on sales of different types of parquet in the selected wood company from 2000 to 2009.

The company was the most successful in 2001, when they sold over 52,560 m^2 of parquet. They reached the lowest level of sales in 2008, when they sold only 30,687.34 m^2 of parquet. Together, from 2000 to 2009, they sold more than 388,410 m^2 of parquet.

Figure 1 shows high sales in 2001, 2002 and 2007. In these years the company received an order to furnish big apartment complexes. The sales decreased in 2003 and 2004, and from then on the sales stood at more or less the same level. The major cause for lower

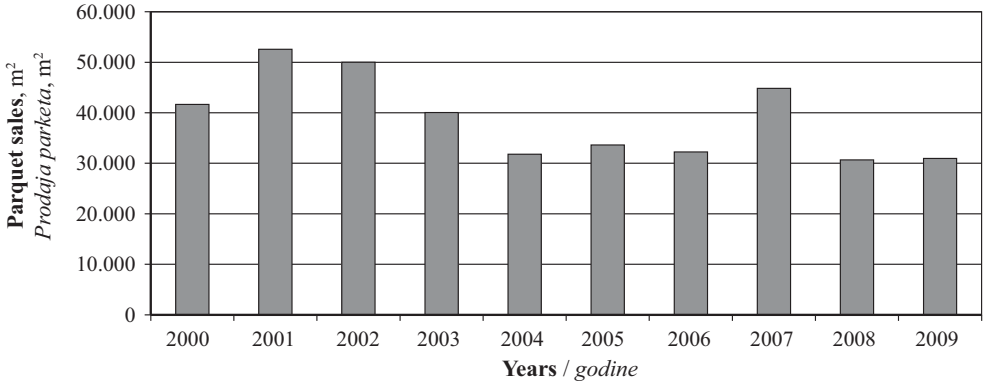

Figure 1 Sum of parquet sales in the invstigated company from 2000 to 2009
Slika 1. Ukupna prodaja parketa promatranog poduzeća od 2000. do 2009.

Table 2 Constants of basic value smoothing, trend and seasonal components used in calculating the parquet sales with Holt-Winters multiplicative model
Tablica 2. Primijenjene konstante temeljnih vrijednosti izglađivanja, trenda i sezonskih komponenata pri izračunu prodaje parketa Holt-Wintersovim multiplikativnim modelom

Forecasting method *Metoda predviđanja*	**Constants** / *Konstante*		
	basic value "α" *temeljna vrijednost α*	trend value "β" *trend vrijednost β*	seasonal component "γ" *sezonska komponenta γ*
Holt-Winters multiplicative model *Holt-Wintersov multiplikativni model*	0.22	0.035	0.01

sales in the years 2003-2006 is that in 2003 the company focused on sales of more expensive products and services of higher quality. The economic crisis in 2008 has certainly contributed to the decrease of sales in 2008 and 2009.

3.2 Parquet sales forecast with Holt-Winters multiplicative model
3.2. Prodaja parketa predviđena Holt-Wintersovim multiplikativnim modelom

In forecasting with Holt-Winters multiplicative model, the basic value for December 2000 was the average of all data in the year 2000. For the first trend value, the difference was calculated between the first and last data in 2000 and divided by 11.

Table 2 shows the smoothing constants used in the calculation with Holt-Winters multiplicative model. We calculated the values of constants with the help of "rescuer" in the program MS Excel. We entered the limits, i.e. the intervals [0.01; 0.99] in the rescuer. The program calculated the values of constants under the condition that the MAD (Mean Absolute Deviation) error was the smallest.

Table 2 shows that the values of constants are close to zero. This explains that the error and trend were considered as minimum. This can be clarified by the use of "older" data.

Table 3 shows that parquet sales were the lowest in January and the highest in October. In winter months, January and February, the sales were lower because of low temperatures, as it is difficult to guarantee appropriate climate conditions for drying screeds and parquet installation in the winter. At the end of the year, even at low outside temperatures, the sales were higher. The explanation for so high values lies in the fact that the companies invest profit into material to reduce taxes.

Table 4 shows the data of Holt-Winters multiplicative model for forecasting the sales of the selected wood company. The value of MAPE (Mean Absolute Percentage Error) and MAD are very low. TS (Tracking Signal) is a tracking signal used for monitoring forecasting through a longer period and for determining the forecasting accuracy compared to the actual values. It should be emphasized that through this method the trend represents a disturbing factor in forecasting sales.

3.3 Forecasting sales with Linear Regression of the 1st order
3.3. Prodaja predviđena modelom jednostruke regresije

It turned out that the original data that we used for the calculation with the linear regression of the 1st order had a seasonal character. Thus, we corrected the final forecast by a seasonal index, which was calculated by the use of Holt-Winters multiplicative model.

For the calculation, we used MS Excel and its function LINEST. We computed two parameters that describe the linear function, i. e., the regression constant, *a,* and regression coefficient, *b*. The value of the determination coefficient and its square root the coefficient of regression were calculated as well.

3.4 Comparison of results
3.4. Usporedba rezultata

The results for forecasting of parquet sales with linear regression of the 1st order, corrected with the seasonal component and multiplicative Holt-Winters model of exponent smoothing of higher order are shown in Figure 2.

Tables 4 and 5 and Figure 2 show that the MAPE and MAD errors are lower with Holt-Winters multiplicative model than with linear regression of the 1st or-

Table 3 Values of multiplicative seasonal components (MSC)
Tablica 3. Vrijednosti multiplikativnih sezonskih komponenata (MSK)

Month *Mjesec*	**January** *Siječanj*	**February** *Veljača*	**March** *Ožujak*	**April** *Travanj*	**May** *Svibanj*	**June** *Lipanj*	**July** *Srpanj*	**August** *Kolovoz*	**September** *Rujan*	**October** *Listopad*	**November** *Studeni*	**December** *Prosinac*
MSC *MSK*	0.67	0.70	0.95	0.94	0.79	1.14	1.13	1.09	1.08	1.30	1.05	1.13

Table 4 Calculation of sales forecasts with Holt-Winters multiplicative model
Tablica 4. Izračun predviđene prodaje primjenom Holt-Wintersova multiplikativnog modela

Forecasting method / *Metoda predviđanja*	**MAPE**	**MAD**	**TS max**	**TS min**
Holt-Winters multiplicative model / *Holt-Wintersov multiplikativni model*	26.8	758.8	29.9	1.0

MAPE error (Mean Absolute Percentage Error / s*rednja apsolutna postotna greška*); MAD (Mean Absolute Deviation / *srednja apsolutna devijacija*); TS max (Tracking Signal Maximum/ *maksimalni signal*); TS min (Tracking Signal Minimum/ *minimalni signal*)

Table 5 Calculation of sales forecast with linear regression of the 1st order
Tablica 5. Izračun predviđene prodaje primjenom modela jednostruke linearne regresije

Forecasting method *Metoda predviđanja*	**MAPE**	**MAD**	**TS max**	**TS min**	**Function** *Funkcija*
Linearn regression of 1th order *Jednostruka linearna regresija*	29.0	780.5	22.3	1.0	$y = 3717.486\text{-}8.430 \cdot x$

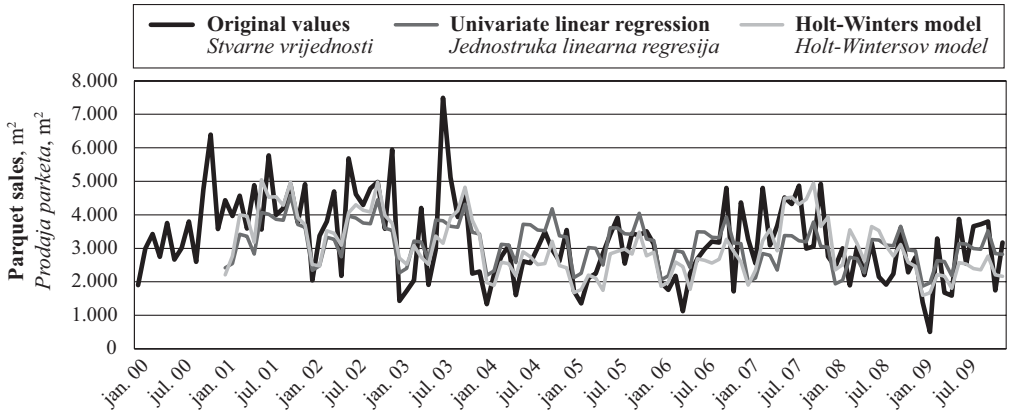

Figure 2: Parquet sales forecasts with linear regression of the 1st order, corrected with the seasonal component and multiplicative Holt-Winters model of exponent smoothing of higher order.
Slika 2. Prodaja parketa predviđena jednostrukom linearnom regresijom uz korigirane sezonske komponente i multiplikativnim Holt-Wintersovim modelom eksponencijalnog izglađivanja viših redova

der, but for the latter the tracking signal TS shows that the forecasted sales values are more appropriate than with Holt-Winters multiplicative model.

3.5 Selection of the most appropriate model
3.5. Izbor najprikladnijeg modela

According to the calculations performed, we selected the method which could be reasonably used for short term forecasting of parquet sales in the investigated wood company. We set the criteria that the method should fulfill for this selection. The chosen criteria were:

- Reliability or accuracy – MAD and MAPE errors and tracking signal TS;
- Understandability – an inexperienced person can quickly understand what a method demands and represents;
- Scope of forecast calculations – the time that a person without experience needs to perform forecasts;
- Updating – how will the method or forecast work if updated with more recent data;
- Adapting – is regular adaptation of forecasting possible;

Accuracy is the most important criterion for evaluating the forecasting method. In our case, the Holt-Winters multiplicative model is better regarding the accuracy criteria because MAD and MAPE errors are small. On the other hand, it should be said that this method yields quite a high value of the tracking signal TS, which means that the forecasts of parquet sales were too low. As the linear regression of the 1st order generated higher values of MAD and MAPE errors, according to the criterion of accuracy, Holt-Winters multiplicative model proved to be better.

Regarding the criterion of understandability, the linear regression of the 1st order is more appropriate, because linear regression in commonly known and widely used. To understand the Holt-Winters multiplicative model, the researcher has to master the theory.

The size of calculation is smaller with linear regression of the 1st order, because it simply captures the data and statistical computer program calculates and draws the forecast figures. With Holt-Winters multiplicative model the procedure of calculation is much more complicated.

Updating of models is important and in some cases a very complicated procedure. Updating should be simple, i.e., entering new data in the model should rapidly update the forecast for the next period. With linear regression of the 1st order, we have to enter new data and then again calculate the optimal values of all coefficients. With Holt-Winters multiplicative model we have to enter data and then again calculate the forecast function. Here, both models are equally suitable, because both need some additional work for updating the forecasts.

Model adaptation followed by forecast adaptation is desirable. Adaptations are only possible with Holt-Winters multiplicative model, because this method has three coefficients available that enable the adaptation of the forecast. With linear regression of the 1st order, the adaptation of the forecast is not possible, because the forecast is in the form of a function that depends on the data obtained and in our case on the seasonal component.

Taking into account all the findings regarding the criteria for the selection of the appropriate forecasting method, Holt-Winters multiplicative model is more ap-

propriate. Although we need some time to master this method, it is a more sophisticated choice. Thus, using the Holt-Winters multiplicative model, the investigated wood company could obtain the most appropriate short-term forecast of parquet sales.

4 CONCLUSION
4. ZAKLJUČAK

For any company, business forecasting has always been a very complex process. The company has to make at least a rough forecast to be able to decide how and in which direction it will do business in the future.

The investigated wood company deals with parquet sales. They made available to us the parquet sales data from 2000 to 2009, by individual months. The object of forecasting parquet sales was to select the forecasting method which provides the forecasts of sales that are as close as possible to the data achieved in the years 2000 to 2009.

The results of forecast calculations showed that among the two most often used methods for this kind of forecasting - Holt-Winters method of exponent smoothing of higher order and linear regression of the 1st order, corrected with seasonal component – the quantitative Holt-Winters method of exponent smoothing of higher order was more appropriate. Hence, we strongly recommended it for the use in forecasting of parquet sales in the investigated wood company.

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