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RELATIONSHIP BETWEEN INVENTORY INVESTMENT AND FORECASTING AND INVENTORY CONTROL

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Abstract: *The aim of this paper is to analyze relationship between inventory investment, as dependent variable, and use of forecasting and inventory control models and software that has built-in these models as independent variables. Random sample consists of 30 companies from the Federation of Bosnia and Herzegovina. This research is performed using regression analysis, while F-test and p-value are used for testing whether the overall models are significant.*
Key words: *inventory, investment, forecasting, control, regression*

1. INTRODUCTION

Study (Wang & Toktay, 2008) investigates inventory models with advance demand information (ADI) and flexible delivery by incorporating flexible delivery into inventory models with ADI. To achieve desired customer satisfaction, companies may need to share some of the cost benefit with their customers by offering a price discount contingent.

Forecasting is a crucial aspect of the whole planning process in supply-chain companies and they usually use a computerized forecasting system to produce initial forecasts and the subsequent judgmental adjustment of these forecasts. (Fildes at al., 2009).

Research (Teunter & Sani, 2009) explains that many companies use single exponential smoothing to forecast intermittent demand, but this generally leads to inappropriate stock levels and Croston's forecasting method (CR) proves to be appropriate and it takes account of both demand size and inter-arrival time between demands. The method is now widely used is incorporated in many forecasting software packages.

Paper (Aviv Y., 2007) examines benefits of collaborative forecasting (CF) partnerships in a supply chain that consists of a manufacturer and a retailer and on what key characteristics of the supply chain these CF benefits depend on.

Study (Syntetos at al., 2009) suggests that the area of inventory planning and forecasting has experienced huge developments over the last 50 years and that these developments have been followed by development of new software applications. Judgmentally adjusting statistical forecasts improved forecasting accuracy when the adjustments are made based on the basis of important information that is not available to the statistical method.

Papers (Pašić at al., 2007, 2008) describe settings of the same slope model. Research results showed that developed model is more efficient with respect to other models of the same complexity. Model developed in these papers is successfully used in forecasting only one step in the future due to the fact that the gradient from the previous season is used to predict the future.

Research (Bajrić at al., 2009) shows that the same slope seasonality forecasting model overcomes disadvantages of the same slope forecasting model and shows reliability in the case of time series with dominated seasonal component, as well as with time series with excessive trend component. Disadvantage of this model is a lack of smoothing component.

2. RESEARCH METHODOLOGY

Regression analysis is performed to examine relationship between inventory investment as dependent variable and use of forecasting and inventory control models as independent variable. Inventory investment, as dependent variable, is defined as participation of total company's inventory in company's assets expressed in percentages. In other words, inventory investment, is represented as ratio between company's inventory and company's assets. Data used in the analysis were obtained from carefully designed questionnaire. Research sample consists of random sample of 30 companies from Federation of Bosnia and Herzegovina. The companies were from retail, manufacturing and civil engineering sectors.

Variables of interest for the research, their symbols and variable types are shown in Table 1.

Variable	Symbol	Variable type
Inventory investment	y	Dependent
Forecasting	x_1	Independent
Inventory control	x_2	Independent

Tab 1. Variables definition

In order to apply regression analysis, it is necessary to quantify responses from questionnaire. Quantification of responses, related to independent variables, is done using categorical variables from 0-2 as follows:

- If a company intuitively forecasts demand or controls the inventory, than the value of any independent variable is 0.
- If a company uses some of quantitative or qualitative models or uses software, that has built-in some of above mentioned models to forecast demand or control inventory, than the value of any independent variable is 1.
- If a company uses some of quantitative or qualitative models in combination with software that has built-in some of above mentioned models to forecast demand or control inventory, than the value of any independent variable is 2.

3. MATHEMATICAL MODELS AND RESULTS

After data were collected and processed, statistical tools such as ANOVA, coefficient of determination R^2, F-test, and t-test are used to prove existence of relationships. A standard software package was used to run regression analysis.

Almost all companies claiming use of forecasting or inventory control models, or use of forecasting and/or inventory control software did not name any widely known forecasting and/or inventory control models and software.

By review and analysis of software used in companies it was noticed that majority of software is equipped with modules for general business activities, with varying business reports and data analysis, but without modules for further data processing, analysis and support for decision making, where forecasting and inventory control models belong.

Predictions of inventory investment by use of forecasting (i=1) and inventory control (i=2) as independent variables individually are defined in simple linear regression equation (1). Many regression models for prediction of inventory investment by use of both forecasting and inventory control models as independent variables were analyzed, but the best results were obtained using quadratic multiple regression equation (2):

$$y = \beta_0 + \beta_1 \cdot x_i \qquad (i=1, 2) \tag{1}$$

$$y = \beta_0 + \beta_1 \cdot x_1 + \beta_2 \cdot x_1^2 + \beta_3 \cdot x_2 + \beta_4 \cdot x_2^2 \tag{2}$$

where:
y – predicted dependent variable,
x_1 – applied forecasting model,
x_2 – applied inventory control model,
β_0 – intercept,
β_1 to β_4 – regression coefficients.

Null and alternative hypothesis for two simple linear regression models given by equation (1) are defined in hypothesis testing formulas (3):

$$H_0: \beta_1 = 0$$
$$H_a: \beta_1 \neq 0 \tag{3}$$

Null and alternative hypothesis for the model given by quadratic multiple regression equation (2) are defined in hypothesis testing formulas (4):

$$H_0: \beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$$
$$H_a: \text{at least one } \beta_i \neq 0 \ (i=1, 2, 3, 4) \tag{4}$$

Analysis of variance (ANOVA) for model defined by equation (1) for i=1 is shown in Table 2. ANOVA shows F ratio value of 0,369. Corresponding critical value for F is 4,2 at 0,05 significance level, for df_1=1 and df_2=28. Value of F ratio and p value show that relationship is very poor.

Analysis of variance (ANOVA) for model defined in equation (1) for i=2 is shown in Table 2. It shows F ratio value of 0,365. Corresponding critical value for F is 4,2 at 0,05 significance level, for df_1=1 and df_2=28. Value of F ratio and p value show that relationship is very poor.

Analysis of variance (ANOVA) for model defined in equation (2) is shown in Table 3. It shows F ratio value of 0,980. Corresponding critical value for F is 2,7587 at 0,05 significance level, for df_1=4 and df_2=25. Value of F ratio and p value show that relationship is very poor.

	i	*df*	*SS*	*MS*	*F*	*p*
R	1	1	272,972	272,972	0,369	0,5485
	2	1	270,292	270,292	0,365	0,5505
E	1	28	20719,423	739,979		
	2	28	20722,103	740,075		
T	1	29	20992,395			
	2	29	20992,395			

Tab. 2. Analysis of variance (ANOVA) for simple linear regression model given by equation (1) for i=1, 2

	df	*SS*	*MS*	*F*	*p*
R	4	2746,341	686,585	0,980	0,4362
E	25	17514,034	700,561		
T	29	20260,375			

Tab. 3. Analysis of variance (ANOVA) for quadratic multiple regression model given by equation (2)

4. CONCLUSION

For all three above described models it can be concluded that the null hypothesis cannot be rejected at 0,05 level. For two simple linear regression models (i=1, 2) F-ratio and *p-value* are used for testing whether the regression slope equals zero. The significance of both models is tested by comparing calculated with critical F value obtained from the table and by comparing *p-value* with given alpha level of significance. Since *p-values* in both cases are greater than 0,05 and calculated F values in both models are lower than critical F values obtained from the table, the null hypothesis cannot be rejected. Since the null hypothesis cannot be rejected at 0,05 level and regression slope coefficients equal to zero, developed simple linear regression models do not explain variability of inventory investment by knowing variability of independent variable. For multiple regression model (2) F-ratio is used for testing whether the regression model explains a significant percentage of the variability in dependent variable and whether the overall model is significant. Since *p-value* is greater than 0,05 and calculated F value is lower than critical F value obtained from the table, the null hypothesis cannot be rejected. Since the null hypothesis cannot be rejected and all regression coefficients equal to zero, developed multiple regression model is of no use in explaining variability of inventory investment by knowing variability of independent variables.

Future research should include more relevant independent variables to get a model that explains significant percentage of variation in inventory investment decision making.

6. REFERENCES

Aviv Y. (2007). On the Benefits of Collaborative Forecasting Partnerships Between Retailers and Manufacturers, *Management Science,* Vol. 53, No. 5, (May 2007) pp. 777–794, ISSN 0025-1909

Bajrić, H.; Bijelonja, I. & Pašić, M. (2009). A Comparison of Same Slope Seasonality and Exponential Smoothing Forecasting Models, *Proceedings of the 20th International DAAAM Symposium*, Katalinic, B. (Ed.), pp. 1343-1344, ISBN 978-3-901509-68-1, Vienna, Austria, November 2009, DAAAM International, Vienna

Fildes R.; Goodwin P.; Lawrence M. & Nikolopoulos K. (2009). Effective Forecasting and Judgemental Adjustments: An Empirical Evaluation and Strategies for Improvement in Supply Shain Planning, *International Journal of Forecasting,* Vol. 25, No. 1, (Jan.-March 2009) pp. 3-23, ISSN 0169-2070

Pašić, M.; Bijelonja, I.; Šunje, A. & Bajrić, H. (2007). Same Slope Forecasting Method, *Proceedings of the 18th International DAAAM Symposium*, Katalinic, B. (Ed.), pp. 547-548, ISBN 3-901509-58-5, Zadar, Croatia, October 2007, DAAAM International, Vienna

Pašić, M.; Bijelonja, I. & Bajrić, H. (2008). A Comparison of Same Slope and Exponential Smoothing Forecasting Models, *Proceedings of the 19th International DAAAM Symposium*, Katalinic, B. (Ed.), pp. 1031-1032, ISBN 978-3-901509-68-1, Trnava, Slovakia, October 2008, DAAAM International, Vienna

Syntetos A. A.; Boylan J. E.; & Disney S. M. (2009). Forecasting for Inventory Planning: A 50-Year Review, *Journal of Operational Research Society*, Vol. 60, No. 5, (May 2010) pp. 149–160, ISSN: 0160-5682

Teunter R. & Sani B. (2009). On the Bias of Croston's Forecasting Method, *European Journal of Operational Research,* Vol. 194, No. 1, (April 2009) pp. 177-183, ISSN **0377-2217**

Tong, W. & Toktay B. L. (2008). Inventory Management with Advance Demand Information and Flexible Delivery, *Management Science*, Vol. 54, No. 4, (April 2008) pp. 716–732, ISSN 0025-1909