THE APPLICATION OF MULTI-REGRESSION ANALYSIS IN AN ENTERPRISE SALE FORECAST

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Abstract

This paper deals with multi factor analysis to obtain more reliable forecast. The sale is influenced very strongly by the prices of offered products especially in retails. And thus, the aim of the paper is to show, how the forecasted volume could be influenced by the price expectation in near future. The forecast uses the application of the multiple linear regression.

Keywords: Forecast, multi-regression analysis, sale, retails

1. INTRODUCTION

Nowadays, at daily consumption products, people look more for the price than quality when deciding which product to purchase. Quality is mostly considered as a standard and that is why people stopped differentiate the quality differences among products of the same kind [1, 2]. Therefore, the quality of these products is not considered much while buying decisions. This thinking of people is also used by many chain stores and supermarkets, so they can regulate the price. When analyzing the sales of chosen daily consumed foods on the basis of data obtained from one big supermarket chain, which uses massive price sales promotions and discounts, the deformation of the real needs in the market was found and it makes more difficult to create any (even short-term) forecasts [3]. This paper tries to bring simple application of one of the multi-factorial methods i.e. method where the outcome depends on several variables. The one of such methods, which includes multi-factorial consideration is the multi-regression analysis. The chosen method is linear, to keep the calculation simple and is able to use in the following case.

Multiple linear regression is used for data where one data series is a function of, or depends on, other data series [4, 5].

The goal of multiple linear regression is to find an equation that most closely matches the historical data. Multiple linear regression finds the coefficients for the equation:

$$Y_t = b_0 + b_1x_{1,t} + b_2x_{2,t} + b_3x_{3,t} + ... + b_nx_{n,t} + e_t \quad (1)$$

where: $b_1, b_2, b_3, ... b_n$ - are the coefficients of the independent variables, b_0 is the y-intercept constant,
$x_1, x_2, x_3, ..., x_n$ - are the parameters,
e_t - is an error in time t.

This multiple regression equation is linear and it means that coefficients $\boldsymbol{b_0, b_1, b_2, ... , b_n}$, if applicable, are calculated by the least square method. It is recommended to use a computer program, because of a complication procedure [6].

2. INPUT DATA AND THE METHOD APPLICATION

There were chosen two groups of daily consumed foods (bread and beer) and 4 items of each kind for the mentioned application of linear multi-regression analysis. Data, that a retail supermarket chain provides,

contain monthly sale reports, from years 2013 and 2014 with the average final prices within the month (**Table 1** - bakery products and **Table 2** - the beer products).

Table 1 The sale volumes of the chosen bakery products

Year	Month	BUN CEREAL 60g		FRENCH BAGUETTE 105g		WHITE BAGUETTE SMALL 49g		STANDARD ROLL 40g	
		Sold pcs.	Av. Price [€]	Sold pcs.	Av. Price [€]	Sold pcs.	Av. Price [€]	Sold pcs.	Av. Price [€]
2013	January	15178	0.13	4408	0.15	30148	0.11	97363	0.05
	February	17717	0.13	5511	0.15	26890	0.11	92324	0.05
	March	21326	0.13	5253	0.15	33186	011	105289	0.05
	April	18812	0.13	3970	0.15	28730	0.11	95498	0.05
	May	20080	0.13	4898	0.17	23732	0.10	110652	0.05
	June	21730	0.12	4773	0.16	24750	010	100184	0.05
	July	25352	0.12	5898	0.16	29220	0.10	93148	0.05
	August	27164	0.10	6588	0.16	35125	0.11	90615	0.05
	September	23766	0.11	7269	016	29393	0.11	92216	0.05
	October	21891	0.13	7814	0.16	27251	0.11	93221	0.05
	November	20462	0.13	6851	0.16	27811	0.12	97583	0.05
	December	18484	0.13	7589	0.16	25480	0.12	104701	0.05
2014	January	17770	0.13	5495	0.16	19864	0.14	96357	0.05
	February	15841	0.13	4528	0.16	14102	0.13	83725	0.05
	March	21021	0.10	7477	0.15	17217	0.13	96535	0.06
	April	18448	0.11	5643	017	16189	0.13	90613	0.06
	May	7618	0.13	2052	016	5529	0.13	28610	0.06
	June	7082	0.13	4096	016	11198	0.12	43712	0.05
	July	11026	0.12	5838	0.16	18268	0.12	73871	0.05
	August	13464	0.12	4851	016	19374	0.12	74743	0.05
	September	12863	0.11	7603	0.16	18827	0.12	70043	0.05
	October	13246	0.11	7299	0.16	18595	0.12	77081	0.05
	November	10315	0.12	7541	0.16	18670	0.12	70791	0.05
	December	7860	0.12	6868	0.15	21280	0.12	81240	0.05

The forecast for the first three months was done by a computer program. The results forecasted quantity to be sold by the price assumption is in the following table:

Table 2 The forecast of sold volumes in Jan. - Mar. 2015 influenced by the price assumption (bakery prod.)

2015	BUN CEREAL 60g		FRENCH BAGUETTE 105g		WHITE BAGUETTE SMALL 49g		STANDARD ROLL 40g	
	Predicted volume [pcs.]	Price assumpt. [€]	Predicted volume [pcs.]	Price assumpt. [€]	Predicted volume [pcs.]	Price assumpt. [€]	Predicted volume [pcs.]	Price assumpt. [€]
January	14775	0.10	6675	0.15	21399	0.10	N / A	no assum.
February	14097	0.10	6734	0.15	20935	0.10	N / A	no assum.
March	13418	0.10	6793	0.15	20472	0.10	N / A	no assum.
January	9019	0.12	6554	0.16	15942	0.12	67382.12	0.05
February	8340	0.12	6613	0.16	15479	0.12	65809.52	0.05
March	7662	0.12	6672	0.16	15015	0.12	64236.92	0.05
January	6140	0.13	6433	0.17	10486	0.14	57765.13	0.06
February	5462	0.13	6492	0.17	10022	0.14	56192.53	0.06
March	4783	013	6550	0.17	9559	0.14	54619.93	0.06
MAPE	18.4%		11. 7%		20.0%		6.8%	

Table 3 The sale volumes of the chosen beer products

Year	Month	ZLATY BAZANT 10% 0.5l BOTTLE		SMADNY MNICH 10% 0.5l BOTTLE		ZLATY BAZANT 12% 0.5l BOTTLE		SARIS 12% LIGHT LAGER 0.5l BOTTLE	
		Sold pcs.	Av. Price [€]	Sold pcs.	Av. Price [€]	Sold pcs.	Av. Price [€]	Sold pcs.	Av. Price [€]
2013	January	139	0.54	1795	0.48	892	0.69	305	0.71
	February	236	0.53	1147	0.45	2423	0.59	308	0.79
	March	445	0.50	1017	0.45	1757	0.59	427	0.69
	April	805	0.50	1021	0.45	2382	0.59	370	0.69
	May	724	0.54	2517	0.39	2589	0.64	518	0.69
	June	553	0.52	1604	0.39	1380	0.65	955	0.69
	July	653	0.52	1643	0.39	1804	0.64	662	0.69
	August	430	0.51	1103	0.39	964	0.66	414	0.69
	September	745	0.49	601	0.39	1553	0.62	395	0.69
	October	689	0.49	587	0.42	1709	0.59	270	0.72
	November	891	0.53	578	0.44	1569	0.59	231	0.71
	December	252	0.50	547	0.45	2516	0.62	285	0.69

Year (continue)	Month	ZLATY BAZANT 10% 0.5l BOTTLE		SMADNY MNICH 10% 0.5l BOTTLE		ZLATY BAZANT 12% 0.5l BOTTLE		SARIS 12% LIGHT LAGER 0.5l BOTTLE	
		Sold pcs.	Av. Price [€]	Sold pcs.	Av. Price [€]	Sold pcs.	Av. Price [€]	Sold pcs.	Av. Price [€]
2014	January	350	0.49	401	0.45	858	0.59	329	0.69
	February	1021	0.50	206	0.46	904	0.59	269	0.69
	March	737	0.51	403	0.46	646	0.59	358	0.69
	April	660	0.51	2450	0.39	615	0.59	277	0.71
	May	125	0.52	777	0.39	332	0.61	190	0.69
	June	886	0.51	1100	0.39	503	0.64	112	0.69
	July	456	0.49	977	0.39	2388	0.64	369	0.69
	August	729	0.49	964	0.39	964	0.62	393	0.69
	September	1071	0.49	498	0.39	1502	0.59	524	0.69
	October	613	0.49	1482	0.44	1393	0.59	584	0.69
	November	681	0.49	654	0.39	1301	0.62	169	0.69
	December	742	0.49	370	0.45	1732	0.64	378	0.72

Table 4 The forecast of sold volumes in Jan. - Mar. 2015 influenced by the price assumption (beer products)

2015	ZLATY BAZANT 10% 0.5l BOTTLE		SMADNY MNICH 10% 0.5l BOTTLE		ZLATY BAZANT 12% 0.5l BOTTLE		SARIS 12% LIGHT LAGER 0.5l BOTTLE	
	Predicted volume [pcs.]	Price assumpt. [€]	Predicted volume [pcs.]	Price assumpt. [€]	Predicted volume [pcs.]	Price assumpt. [€]	Predicted volume [pcs.]	Price assumpt. [€]
January	767	0.49	749	0.39	1081	0.59	303	0.69
February	777	0.49	708	0.39	1048	0.59	295	0.69
March	787	0.49	666	0.39	1014	0.59	287	0.69
January	726	0.51	506	0.42	1043	0.61	192	0.74
February	736	0.51	465	0.42	1010	0.61	184	0.74
March	746	0.51	423	0.42	977	0.61	177	0.74
January	664	0.54	183	0.46	986	0.64	81	0.79
February	674	0.54	141	0.46	953	0.64	74	0.79
March	684	0.54	100	0.46	920	0.64	66	0.79
MAPE	10.2%		28.9%		16.9%		24.7%	

3. RESULTS

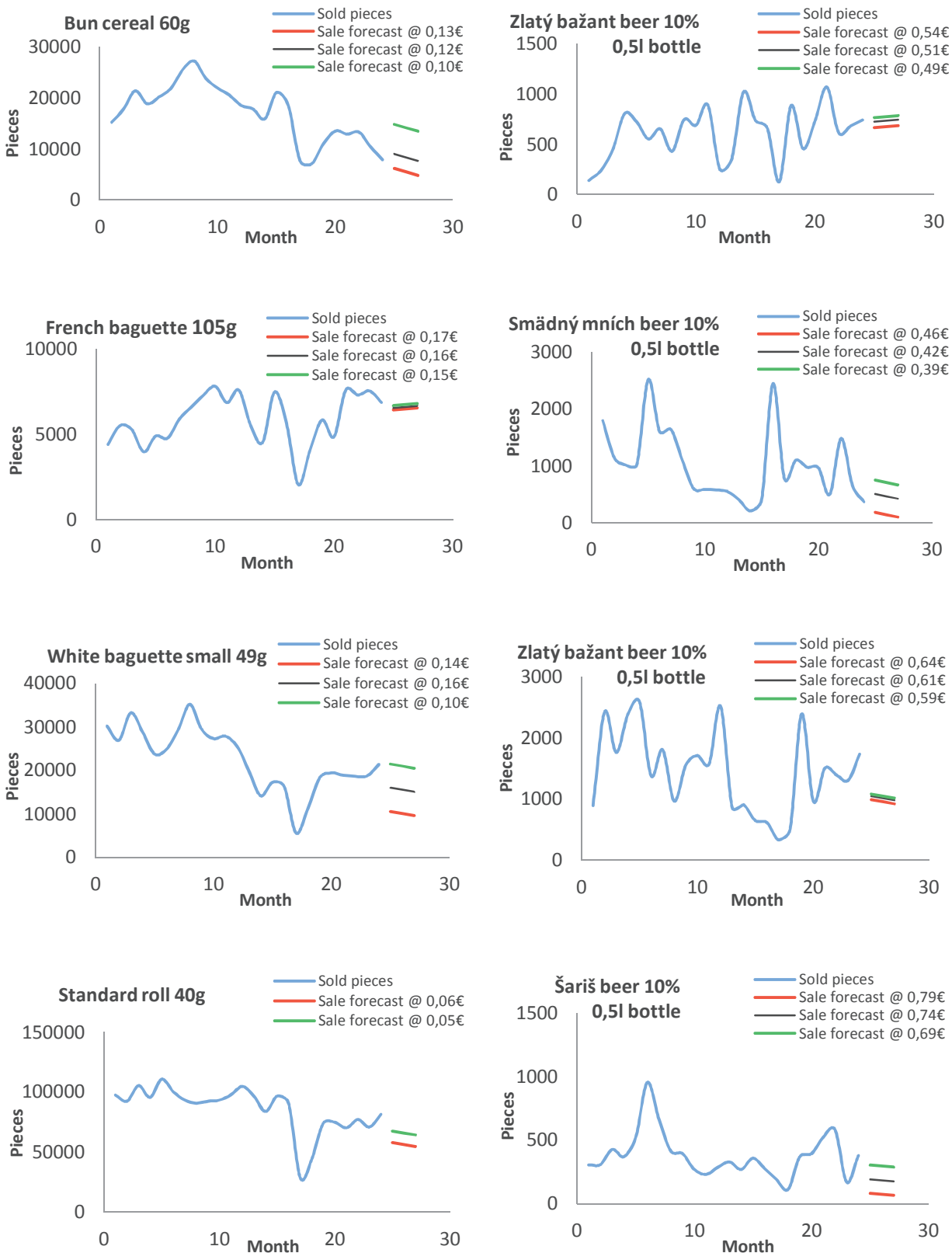

Figure 1 The diagrams of sale behavior and forecast intervals of the observed products

The graphical results from the forecasts have proved that the sale of bakery products is a slightly smoother. It means that the forecasting of these products is more accurate what is also proved by MAPE indicators [7]. It is still need to be remained that the consumption of both groups are quite dynamic and the use of the multiple linear regression is limited and for orientate purpose only.

4. CONCLUSION

The sale of products in the big chain store is GREATLY influenced by its price. It is an important tool to influence the volume of a sale. This paper brings the simple prediction model of a sale volume, when the price is determined. The practical use of the model is possible at preparing the sale discount, which is usually done each week. The forecast horizon of one week is quite short period to create relatively suitable prediction of the sale volume of particular product. There are cases of smaller supermarkets too, where the sale of the product is not so turbulent and the usage of such tool can be even more relevant.

ACKNOWLEDGEMENTS

This paper was created within the VEGA grant project No. 1/0216/13 „Methods and new approaches study to measurement, evaluation and diagnostic performance of business processes in the context of management company logistics“.

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