Promotional Indices Application in Business Forecasting of Promotion Events

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Abstract: Implementation of promotional events is one of the main reasons why the accuracy of business forecasts is so low, and so promotional forecasting represents in production companies a key part of demand planning. Production companies, which can only rely on a limited source of information about the effects of promotion events on their sales, do not have many possibilities of how to forecast sales during a promotion event. That is why this paper deals with the possibilities of promotional forecasting based on the analysis of sales time series implemented by production companies with distribution intermediaries. On the basis of the research in the chemical and food industry enterprises, the paper proposes a forecasting model based on promotional indices and the possibilities of its utilization, which could bring improvements in the accuracy of business forecasting.

Key-Words: Business Forecasting, Demand Forecasting, Demand Planning, Promotional Forecasting, Promotional Indices, Promotion Event.

1 Introduction

In the present market environment, an important precondition for a successful production company is an effective demand planning process that primarily aims to make as accurate as possible estimate of the volume of the future demand for the company products as input information for management of the other business processes [1]. The quality of the demand forecast has a direct impact on the effectiveness of utilization of corporate sources, on the supply chain management, and on the level of customer services [2].

The most serious problems when forecasting the demand include forecasting the effects of marketing events on the volume of the future sales. Short-term promotion events, which significantly influence customers (see e.g. [3]), are usually a source of major deviations in the sales time series, and so they cannot be forecast using classical approaches based on the time series analysis. A few forecasting models have been developed for retailers. They can increase the forecasting accuracy compared to simple approaches to promotional forecasting (see e.g. [4], [5], [6]).

Such models can hardly be used in production companies without sufficient amount of information about the factors affecting promotional sales, but also about the behaviour of final consumers. The reason of this situation is still low level of common information sharing in the Czech business environment [7]. It also results in barriers in implementation of collaborative business practice like method CPFR, which has proved useful in promotional forecasting within whole supply chain [8].

This paper aims to propose an approach to promotional forecasting in the lack of information and identify the possibilities of its utilization in production companies that could lead to an increase in the forecasting accuracy compared to common forecasting procedures. The outcomes of this paper are based on surveys carried out in Czech chemical and food industry enterprises, whose names cannot be published due to the sensitivity of the released information.

2 The Principle of Forecasting Based on Promotional Indices

The approach that is common in forecasting the impact of promotion events in production companies is so-called simple forecast, also called naïve forecast [9]. The principle of this method consists in utilization of the "last like" rule in forecasting sales for upcoming promotion events. This means that demand planners forecast the same

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quantity of goods that was sold during a similar past promotion [5].

However, from the point of view of marketing, it is much more practical to forecast the volume of sales achieved by the company thanks to the promotion beyond regular sales. In this context, regular sales refer to the value of expected sales in the given period provided that there was no such an event. In such a case, the impact of an event can be assessed either in the absolute figures as an increase in sales beyond regular sales, or relatively as a relation to a certain reference value. Our research experience [10] shows that accuracy of forecasts can be increased just by the second method, where the reference value is the value of regular sales achieved out of the event.

This idea leads to the definition of the promotional index $I_{p,t}$ (1) as a relative increase in sales within the period of promotion compared to regular sales the company would achieve without promotion:

$$I_{p,t} = \frac{Y_t}{F_t^*} \tag{1}$$

where Y_t represents the value of actual sales achieved in within period t (time of event) and F_t^* is the sales forecast in time t on the assumption that there was no promotion.

Obviously, it is possible to use promotional indices with an advantage not only in the assessment of effectiveness of the event impact on the sales, but also in the process of creation of forecasts concerning the event impact on the sales achieved in the future. The forecasting algorithm based on the analysis of time series can easily involve the promotional impact through point intervention in all the periods where the promotion has a significant influence on the achieved sales. However, the promotional index must be defined for each such period on the basis of an analysis the impact of promotion events organized in the past. As an example, we can state the algorithm (2) of creation of forecasts F_t for the time series of sales affected by promotion events effective in a single time period:

$$F_t = \begin{cases} I_{p,t} \cdot F_t^*, & \text{if } t = \text{time of event} \\ F_t^*, & \text{otherwise} \end{cases} \tag{2}$$

For creation of forecasts in regular period F_t^*, it is possible to use any method from a large scale of statistical methods based on time series analysis (see e.g. [9]). However, during preparation of the data it is necessary to purge the sales time series of the influence of events within the period of the promotion event. The promotional indices definition (1) implies that the most suitable promotional adjustment of time series is replacement of promotional sales with the value of forecast sales F_t^* the company would achieve in the case there was no promotion event.

To determine the promotional index value $I_{p,t}$ for the forthcoming promotion event, it is possible to use the value of the index specified on the basis of the sales data achieved within the last monitored event. However, it is the same short-sighted approach as if demand planners relied, while creating a demand forecast, on the information about the demand in the immediately preceding period only. If we work on the assumption that promotional sales are also subject to random deviations and it is possible to see a pattern in the form of trends or seasonal fluctuation in them, it is suitable to determine the current value of promotional indices on the basis of the exponential smoothing principle, which is still applied when forecasting sales in regular periods. In the simplest case, it could be simple exponential smoothing of time series of historical promotional indices (3):

$$I_{p,t+1}^* = \alpha I_{p,t} + (1-\alpha) I_{p,t}^* \tag{3}$$

where $I_{p,t+1}^*$ is the promotional index for the upcoming promotion, $I_{p,t}$ is the promotional index for the last monitored promotional period determined on the basis of actual sales according to the formula (1), $I_{p,t}^*$ is the promotional index for the last monitored promotional period forecast on the basis of the recurrent formula (3), and α is the smoothing constant, which is a number between 0 and 1.

However, the above mentioned recurrent formula can be enriched with smoothing of the trend or seasonal component, as well as in Holt-Winters Exponential Smoothing methods of forecasting (see e.g. [9]).

3 Possibilities of Promotional Indices Application

Promotional indices can be used when forecasting sales achieved during repeated events, in the case of lack of information about the factors affecting sales, including step changes in the sales time series, during analogical forecasting of promotional sales of a product for which no promotion events have ever been organized, but also when using expert estimates.

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In order to better presentation of the promotional indices usage, we attach the typical examples of time series that were forecasted during our research in Czech chemical and food industry enterprises. Analysed time series represented sales of key company product achieved through the key retailer in all cases. To determine the value of promotional indices in the following examples, the recurrent formula (3) was used with the initializing value corresponding with the first observed promotional index value. To determine the forecast value F_t^*, we used the method of exponential smoothing, which showed the highest accuracy when smoothing the sales time series in the periods unaffected by a promotion event. The accuracy of forecasts based on promotional indices is compared to naïve forecast using the mean absolute percentage error (MAPE) indicator (4) in Appendix at the end of this paper.

$$MAPE = \frac{1}{n}\sum_{t=1}^{n}\left|\frac{Y_t - F_t}{Y_t}\right| \cdot 100\% \qquad (4)$$

where Y_t corresponds with the observed value of the sales time series in period t, value F_t represents the sales forecast in period t, and n the number of periods of the time series for which the percentage error value has been specified.

3.1 Mitigation of Random Effects and Chain Effects in Repeated Promotion Events

Just as time series of regular sales are subject to random fluctuations in time, it is also possible to expect random fluctuations in sales achieved during repeated events. On the assumption of ordinary division of the size of promotional sales, it is obviously more advantageous to forecast sales using the promotional index, which reflects the average influence of the promotion on the sales, than to create estimates based on the information about the volume of production that was sold during the previous promotion.

Moreover, the situation is complicated in production companies that do not run promotion events directly with the final consumers, but through intermediaries. A typical example can be a promotion event organized in retail chain stores. The expected increase in sales during the event leads to an increase in the volume of orders for goods placed with the producer, which however does not have to correspond with the actual purchases by the final consumers within the event. The main causes of this material, but also time discrepancy in the sales include inaccurate promotional forecasting on the side of the retailer, the way of stock management among the producer, distribution warehouses and individual stores, but also various speculative reasons when the order is being dealt with. For example, in the case of a large order, the producer usually provides advantageous price rebates, which may lead to purposeful stocking up on a product in the dealer's warehouse, particularly in the cases of fast moving consumer goods with long shelf life. Thus the retailer can sell these goods in the period after the event for regular price, but with lower purchase costs. This results in chain effects (see e.g. [11]), whose importance usually grows together with the rising number of distribution intermediaries between the producer and the final consumer, but also with the increasing length of delivery time between individual distribution intermediaries.

Although it is not possible to consider the influence of chain effects as completely accidental, using the average of promotional indices can reduce the forecast errors even in the case of repeated promotion events, which are a source of irregular deviations in promotional sales to distribution intermediaries. As an example we can state repeated promotional sale of a cleaning detergent performed by a researched chemical industry enterprise with a certain retail chain (see in Figure 1). The mean absolute percentage error of promotional forecasts was reduced by application of promotional indices from 23.61 % to 14.19 % in this case.

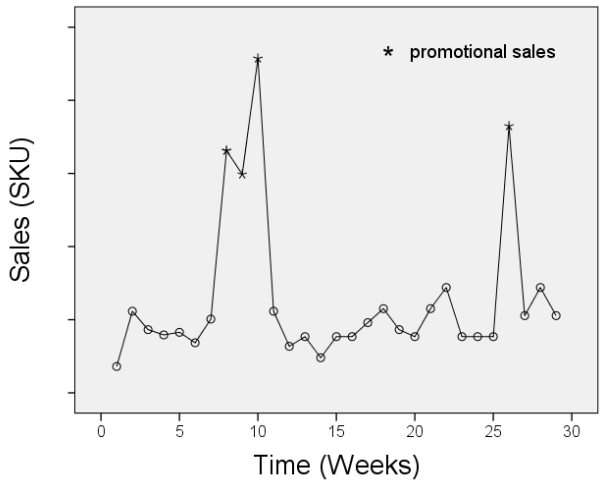

Fig.1: Time Series of Actual Sales of the Selected Product (Cleaning Detergent) to the Key Retail Chain (source: researcher's analysis)

3.2 Lack of Information about Sales-Affecting Factors

When analysing the influence of promotion events on the sales, it is often possible to meet the situation where a similarly focussed event can have a totally different impact on the size of final sales. The thing

is that effectiveness of a well-prepared and also implemented event is affected by some other factors, which are usually out of control of production companies (a wide range of macroeconomic and microeconomic factors, but also the way of promotion and product placement on the retail shelves, effects of cannibalization of competing products, etc.).

Volatility of such factors in time might be one of the reasons for high variability between promotional sales with the same type of event, implemented in different time periods. As production companies do not usually have enough information about changes in these factors in time, they cannot reflect their influence effectively in forecasting models. However, if these factors strongly correlate with regular sales and promotional sales, it is also possible to expect strong correlation between regular sales and promotional sales even though there does not have to be a direct causal relation between them. The effects of such factors on promotional sales can be reduced using promotional indices, which can be demonstrated on time series of spread butter sales achieved by the retail with a researched food industry enterprise. In Figure 2, the sales time series show a significant decreasing trend resulting in lower promotional effectiveness in the period where there was a lower demand for the product. While naïve forecast overestimates the volume of promotional sales (MAPE = 32.55 %), the method of promotional indices provides a lower forecast error (MAPE = 10.16 %) due to decreasing forecasts in regular period F_t^*.

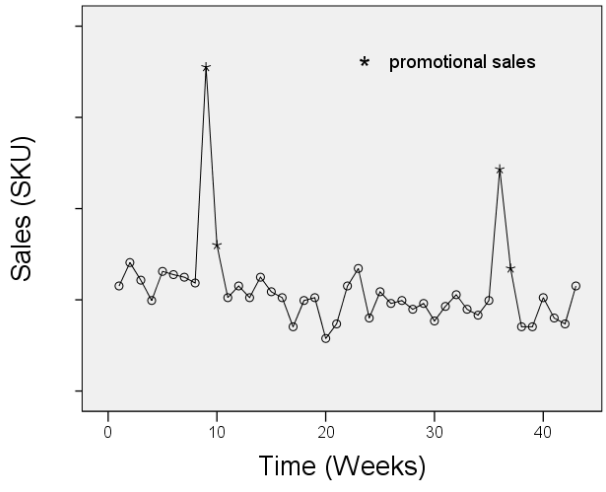

Fig.2: Time Series of Actual Sales of the Selected Product (Spread Butter) to the Key Retail Chain (source: researcher's analysis)

3.3 Step Changes in Sales Time Series

Even more striking variability in the size of promotional sales can be found in the situation where there are significant changes in the customer structure. Their mergers and also divisions result in step changes in sales time series due to an increase or a decrease in the new customers' demand.

Such changes may also occur on the side of the distributors, who are the production company's customers, but they resell the purchased goods to next distribution intermediaries. Although the company does not see any changes in the structure of their customers, the impact on the corporate sales is analogous. The corporate sales to the distributor might see a step increase (e.g. when the distributor starts to sell the products to a new retail chain) or, by contrast, a decrease (e.g. when the distributor stops cooperating with an important customer). This obviously also shows in the effectiveness of the running events with all the customers affected by the change.

A similar case has been observed in a researched food industry enterprise, where there was a step increase in the sales to one of the customers after a merger of two retail chains (see Figure 3). While naïve forecast of promotional sales after a step change significantly underestimated the actual figures, the method of promotional indices helped to achieve a reduction in the forecast error from 46.10 % to 4.55 % during the promotion after the merger (MAPE is reduced from 23.9 % to 2.6 %).

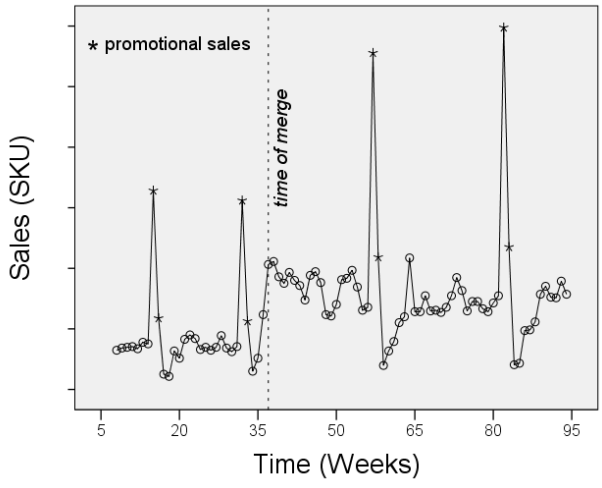

Fig.3: Time Series of Actual Sales of the Selected Product (Creamy Yoghurt) to the One of the Key Retail Chains (source: researcher's analysis)

3.4 Analogous Forecasting

One of the possible approaches to forecasting promotional sales of a product for which there has never been a promotion event before, the method of

analogy, where the final forecast usually has the form of the volume of sales the company has already achieved with a similar (i.e. analogous) product as a result of a similar promotion event.

However, this approach has a significant weak point in the case where the volumes of regular sales of the forecast product and the analogous product are substantially different. In a product with one level higher regular sales, it is possible to expect one level higher promotional sales even though the parameters of the organized promotion event are identical. Such a problem could also be elegantly eliminated using promotional indices as they specify the effectiveness of the event relatively.

Using promotional indices when forecasting using the method of analogy can be demonstrated on estimation of the influence of price promotion the researched food industry enterprise provided their final consumers through a retail chain with two flavours of creamy yoghurt (see Figure 4). On the basis of a known effect of a promotion event on the sales of one of the products (product B), it was possible to decrease the promotional forecast error in the forecasted product (product A) from 17.41 % to 10.01 %.

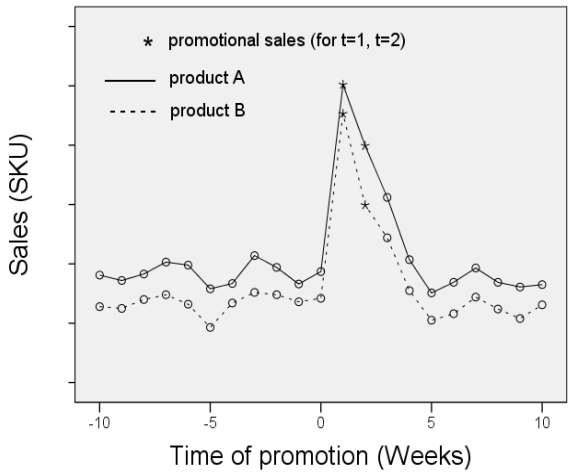

Fig.4: Time Series of Actual Sales of the Selected Product (Two Flavours of Creamy Yoghurt) to the One of the Key Retail Chains (source: researcher's analysis)

3.5 Judgmental forecasting

An important role in promotional forecasting is played by the techniques of judgmental forecasting, which often provide more accurate estimates of the volume of promotional sales in contrast to highly sophisticated quantitative methods. Moreover, expert estimates represent the only approach to forecasting in the case the company tries to estimate the influence of a promotion event in a rapidly changing market environment, or when they are using a brand new way of product promotion.

Even in such a case, using promotional indices might bring a lot of advantages into the process of forecasting, especially for the reason of easy interpretation of its value. In combination with quantitative forecasting techniques for sales estimation in a regular period, it can represent a strong tool for analysing expert estimates in the past.

The principle of qualitative approach to promotional sales forecasting using promotional indices is estimation of a relative sales growth within the period of an event compared to regular sales (i.e. expert estimate of the promotional index) in contrast to classical forecast of the absolute volume of sales during an event. The benefit of so defined forecasts resides in the possibilities of simple comparison of the effects of historical events in different products, where the absolute values of regular sales are sometimes beyond any comparison.

4 Conclusion

On the basis of the surveys carried out in the chemical and food industry production enterprises, the researchers have proposed a method of promotional forecasting that is suitable for making corporate sales forecasts within the period of affected by a promotion event. The principle of the method is based on the assumption that similar promotion events have a similar impact on the sales time series in relation to the current level of sales the company would achieve without the event. Therefore, a key part of the method is determination of a so-called promotional index as a relative increase in sales during a promotion event compared to regular sales using exponential smoothing. As compared with common techniques now used in business forecasting, it is possible to achieve a decrease in the forecasting error thanks to mitigation of undesirable impacts of both random and chain effects during repeated implementation of a similar promotion event.

Promotional forecasting based on promotional indices can be used with benefits especially in such cases where regular sales show strong correlation with promotional sales. Thanks to this fact, it is possible to reduce the forecasting error resulting from the time volatility of the sales-affecting factors, but also from step changes in the sales time series. Practically for the same reasons, it is possible to make effective use of indices during analogous forecasting as the time series of similar products

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usually show similar reactions to marketing events in relation to the level of regular sales.

Application of promotional indices also has appreciable importance in judgmental forecasting thanks to easy and unambiguous interpretation of the value of promotional indices. In fact, better sizable information about the effectiveness of past events is an essential precondition for creating quality estimates of the effects of promotion events in the future.

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Appendix: Comparison of Forecast Accuracy Achieved by Naïve Forecasting Method and Method Based on Promotional Indices (source: researcher's analysis)

Characteristic		**Example 1 (see Fig 1)**			**Example 2 (see Fig 2)**		**Example 3 (see Fig 3)**						**Example 4 (see Fig 4)**	
Week*)		9	10	26	36	37	32	33	57	58	82	83	1	2
Actual Sales (SKU)		1494	2286	1824	12160	6720	3120	1128	5556	2184	5976	2352	10040	7980
Naïve Forecast	Forecast (SKU)	1656	1494	2286	17760	8000	3284	1176	3120	1128	5556	2184	9060	5980
	Forecast Error (%)	10.84	34.65	25.33	46.05	19.05	5.26	4.26	43.84	48.35	7.03	7.14	9.76	25.06
	MAPE (%)	**23.61**			**32.55**		**23.90**						**17.41**	
Promotional Indices Forecast	Forecast (SKU)	1656	1572	1815	13359	6018	3117	1116	5972	2149	6165	2283	11856	7825
	Forecast Error (%)	10.84	31.23	0.49	9.86	10.45	0.11	1.06	7.50	1.60	3.16	2.92	18.09	1.94
	MAPE (%)	**14.19**			**10.16**		**2.60**						**10.01**	

*) number of the week in which promotion event was realized; the first observed case is exclude from analysis because it is used to initialize the both forecast models

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