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THE COST OF FORECAST ERRORS IN COMPANY SALES FORECAST

Abstract: To ensure company success on the market, managers need to design and employ a variety of forecasts. One of the most important forecasts for any company is the sales forecast. Similarly to other types of prognostic tools, sales forecast may be burdened with errors. Any such error will bear cost, resulting from the difference between demand for company products and their supply. Sum of such costs will influence company financial standing. This paper addresses the need to consider potential errors in the process of company sales forecasting and postulates a method for error evaluation.

Key words: forecasting, forecast error, cost of forecast error.

1. Introduction

Since financing both current and future operation of a company requires cash resources (gathered mainly through sales), the sales forecast should be regarded as one of the most important forecasts employed in company management. If demand for company products or services were fixed and constant, sales forecast as such would be an obsolete tool. Since that is not the case in most situations, sales forecasts should be perceived as an invaluable tool in company success. At the same time, it should be noted that any economic forecast bears a certain error margin, and sales forecast errors will result in additional cost, thus influencing the overall financial standing of the company.

This paper aims to substantiate the need for including the error cost margin evaluation in design of sales forecasts.

2. Sales forecasting

Data and information are two important elements of any manager's work. *Data* is a collection of unprocessed (raw) numbers and facts that reflect a certain aspect of reality (such as company operation), whereas *information* constitutes data represented (interpreted) in meaningful form.

Data and information of *retrospective* character represent the past of a phenomenon under study, while *prospective* data and information describe the phenomenon's future shape. Company management utilizes data and information of both retrospective and prospective type. The former are based on reporting of the company or its surrounding, while the latter are evaluated using forecasts. The former are employed in evaluation (controlling) of company operation, the latter serve as an instrument in the planning process.

Company demand for forecasts stems from two fundamental issues – the lack of certainty in regard to company future and the delay between the act of decision-making and the effects thereof. If demand for company products or services were fixed and constant, there would be no need for forecasts. Since this is not the case (for a number of reasons), any company seeking to succeed on the market needs to design and utilize forecasts.

The aim of forecasting is to limit the risk inherent in decision-making process. Forecasts – as one of the methods used in the planning process – takes on special significance in company management, since misanticipation of future trends may prove destructive for company operation [Abraham, Ledolter 2005, pp. 1-2; Clements, Hendry 2002, pp. 12-13; Gallagher, Andrew 2000, pp. 118-119; Palepu, Healy, Bernard 2000, pp. 10-11]. Forecasts are useful in such areas of management as: sales, production, personnel, reserves and finance management.

Forecasting is a process of rational, scientific anticipation of future events [Cieślak 2005, p. 20], such as the sales figures of a company. Rationality in forecasting implies that the reasoning process flows from formulation of prognostic premises to forecast design, while scientific approach postulates the use of scientific methods, such as theories and research instruments. The outcome of such process is referred to as the forecast.

Forecast is a judgment of future state of a forecasted phenomenon – both precise and uncertain.

Of many types of forecast, sales forecast plays a particularly significant role in company management, forming a fundament for future decisions made in regard to production, supply, stock, finance, and so on.

Company sales forecast describes anticipated level of company sales on selected target markets over a particular time interval, as estimated based on company strategy and formulated hypotheses concerning the influence of company environment on sales level [Bennett, Lamm, Fry 1988, p. 260; Stanton, Buskirk 1987, p. 447].

Sales forecast serves as basis for formulation of company sales plans which, in turn, allow to determine company material, financial and personnel resources needed.

3. Point forecast, *ex ante* forecast error, forecast interval

Forecast of sales level may be based on existing (or assumed) regularities in company sales or on existing (or assumed) regularities between sales and factors that

influence sales level. Forecast design may be based both on formal models (of first and second degree) and informal models [Dittmann et al. 2009, p. 23].

In the case of forecast design based on a formal model (such as trend model, seasonal fluctuation model, regression model), the forecast result, referred to as point forecast, is calculated through extrapolation of the model used.

After estimation of the forecast, it is necessary to determine its degree of uncertainty. For this purpose, several methods may be used, such as: *ex ante* error, forecast probability (*forecast reliability*) and *ex post* error of past forecasts.

The *ex ante* error is an evaluation of difference between the forecast result and the actual value of variable Y at the moment/interval $t > n$ (where n represents the last known observation of the forecasted variable). This error may be calculated only for quantitative forecasts designed using some of the formal models of the first degree.

For evaluation of *forecast reliability* (probability of the forecast being true) one can use either objective probability (calculated from the distribution of forecasted variable) or subjective probability (determined by an expert).

Forecast uncertainty can also be determined using *ex post* errors. These may involve forecasts designed for past intervals, for which the actual values of a forecasted variable are known and formulated:

- prior to the forecast being appraised,
- at the moment of evaluation of the forecast being appraised. In this case, prognostic data used in forecast design are divided into two sets. The first set is utilized in design of a forecast model and design of past forecasts, the second – to appraise the accuracy of both forecasts.

A forecast, for which the calculated *ex ante* or *ex post* error of past interval is at most equal to assumed value or such, for which the probability of accuracy is at least equal to assumed value (at the point of formulation of requirements as to the accuracy of the forecast), will be referred to as *preliminary sales forecast*.

Oftentimes, apart from determining the point forecast, a *forecast interval* is calculated, i.e. numeric interval which, at an assumed probability (p), referred to as *forecast reliability*, will contain the future value of forecasted variable.

There are many methods of forecast interval design. In practical applications, it is typically designed symmetrically around the assumed value of the forecasted variable $E(Y_t)$, i.e. the value calculated from the model for τ interval of y_τ^* forecast:

$$P\left(y_\tau^* - uv_\tau \le y_\tau \le y_\tau^* + uv_\tau\right) = p, \tag{1}$$

where: u – coefficient related to forecast reliability, distribution of forecasted variable and the time series length ($u > 0$), p – forecast reliability.

4. Forecast errors and their cost for the company

Forecasts are not always accurate; some may prove extremely false. One must get used to the thought that forecasts of economic phenomena (even with advance of knowledge on the mechanisms involved) will never reach the level of accuracy as observed in relation to forecasts of natural (physical) phenomena. Practice shows that design of economic forecasts is not always attempted at favourable conditions – those phenomena are considerably more complex and less-determined than physical phenomena. Volatility of human behaviours, resulting from individual needs, variability of their reactions to stimuli and individual aspirations will always be reflected in decreased potential to foresee economic phenomena. Those phenomena are subject to so many unknown or uncertain factors, that proper identification of each single phenomenon is practically unfeasible. Moreover, these phenomena cannot be subject to experimentation, i.e. observation in artificial setting with causal discrimination. Thus, for example, in the case of company sales forecast, one must remember that:

– complete information on purchasers of company products is unavailable,
– actions of competitors may significantly influence the effects of company activities,
– company setting (environment) is independent and may be subject to change at any time.

Ramifications of these three factors alone will undoubtedly affect the accuracy of any forecast conducted in relation to company sales level.

Accuracy of a sales forecast can be evaluated using various methods, for example absolute ex post forecast error or mean ex post forecasts error.

Absolute forecast error at t (q_t) moment/interval is a difference between actual (y_t) and anticipated (y_t^*) sales volume over forecasted period t:

$$q_t = y_t - y_t^*. \tag{2}$$

Mean *ex post* forecasts error (*mean error*, ME) calculated for $n + 1$, ..., T moments/intervals is calculated from the following equation:

$$q = \frac{1}{T-n}\sum_{t=n+1}^{T}(y_t - y_t^*). \tag{3}$$

where: n – number of the last known observation of the forecasted variable,
T – number of the last known moment/interval, for which the forecast was verified.

In the case of unbiased forecasts, the error value should equal 0; however, in practical application, a value approaching 0 is considered satisfactory.

Company sales volume forecast error may result in improper planning of production volume, inappropriate designation of manpower or equipment, and so on. If the forecast turns out to be overstated $q_t < 0$ (actual sales volume is lower than forecasted), the company will incur the cost of surplus storage or decommission (for

example, if the products in question are on short expiry date), as well as debt servicing (if the production was loan-financed), affecting company profitability.

Example 1. Let us assume that a trade company buys product A at wholesale price of 3 PLN a piece, and resells it for 5 PLN a piece. The producer will not accept returns. Fixed cost of the company is 3000 PLN. As shown in the latest sales forecast, sales volume is assumed at 20,000 pieces – such is the number of pieces ordered from the producer of A. Profit is estimated at 37,000 PLN (20,000 × 5 PLN – 20,000 × 3 PLN – 3000 PLN). However, circumstances unforeseen at forecast design (consumer behaviour) result in sales decrease down to 15,000 pieces, with resulting profit in the potential range of up to 27,000 PLN (15,000 × 5 PLN – 15,000 × 3 PLN – 3000 PLN). The actual profit amounted to 12,000 PLN (15,000 × 5 PLN – 20,000 × 3 PLN – 3000 PLN), so the forecast error cost is in the amount of 15 000 PLN.

If the forecast turns out to be understated $q_t > 0$ (actual sales volume may have been greater than anticipated), the cost of forecast error will take the form of lost opportunity to make profit on sale, dissatisfaction of consumers, as well as idle run of equipment and manpower. This may negatively affect company competitive edge or actual drop of company share in the market. To face this danger, the company may increase production, but the cost per unit will probably turn out higher than average. Another solution is to buy the product outside the company, with the intent to sell to own customers.

5. Inclusion of forecast error cost at design of a final sales forecast

The use of forecasts in company management should be based on the assumption that the forecasts hold accurate. However, one must take into consideration the potential forecast error. Design of a final forecast of sales volume should include the effects of potential errors, i.e. the cost incurred by the company if the forecast proves inaccurate, as such cost will negatively affect the company financial standing [Shim 2009, p. 83].

As already stated, forecast errors may result in various types of cost.

The cost incurred by company as a result of forecast error, in relation to a single sales unit of (q), will be referred to as forecast error unit cost $K_j(q)$.

Total cost (K_c) of forecast error is a product of absolute value (calculated from equation 2) of an absolute forecast error and a forecast error unit cost:

$$K_c = \left| (q) \right| \times K_j(q). \tag{4}$$

Managers naturally tend to limit the forecast error margin and bring down the cost of any potential error to minimum. Consequently, the forecast employed in design of sales plan should include forecast error cost.

Hence, the preliminary company sales forecast should be adjusted in such a way as to bring the total cost of forecast error K_c to minimum. Such adjusted sales forecast will be referred to as company **final** (conclusive) **sales forecast**:

preliminary sales forecast + adjustment = final sales forecast.

The need for adjusting (inclusion of cost calculation) will depend on the distribution of forecast error unit costs.

Let us assume that forecast error unit costs are fixed (independent of the forecast error deviation). Figure 1 illustrates a case of equal under- and overstatements of forecast errors (symmetric distribution of forecast error unit costs), while Figure 2 illustrates unequal distribution of errors (asymmetric distribution of forecast error unit costs).

The adjustment of preliminary sales forecast will be justified in the case when distribution of forecast error unit costs is asymmetric, since in this case the unit costs and total costs of under-and overstated errors will differ. In such a case, it will be useful to adjust the preliminary point forecast or the preliminary interval forecast. In the case of symmetric distribution of forecast error unit costs, the cost will be equal; unit cost and total cost of under- and overstated errors will be equal. Consequently, there will be no need to adjust the preliminary sales forecast. In this case, the preliminary sales forecast, be it point or interval forecast, can be considered final.

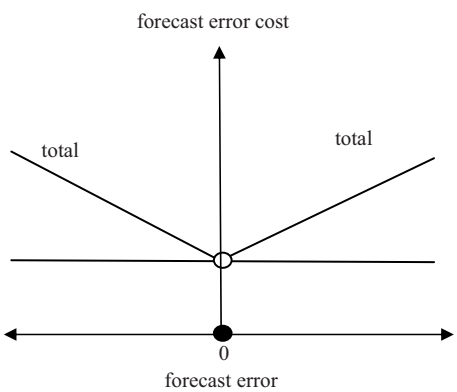

Figure 1. Symmetric distribution of forecast error unit costs of forecast error unit costs

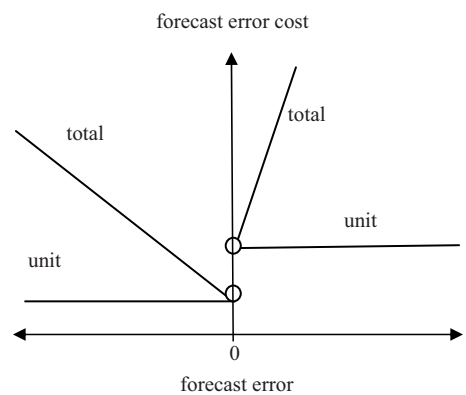

Figure 2. Asymmetric distribution

It seems that in certain cases, the forecast error unit cost will not be fixed, but will increase with the forecast error value. An example of such a case is presented on Figure 3 (symmetric distribution of forecast error unit costs) and Figure 4 (asymmetric distribution of forecast error unit costs). Similarly to previously discussed cases, the adjustment of a preliminary sales forecast will be justified if the distribution of forecast error unit costs is asymmetric. If distribution of forecast error unit costs is symmetric, there is no need to adjust the forecast.

The adjustment of a preliminary cost forecast should be undertaken in such a way as to minimize the total cost of forecast error.

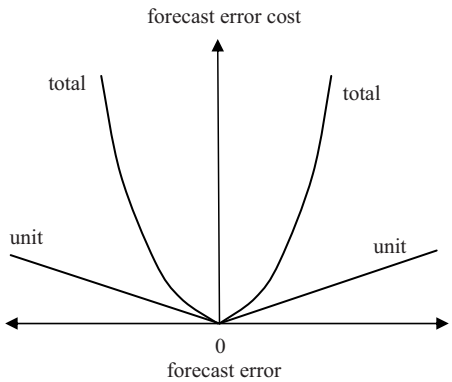

Figure 3. Symmetric distribution of forecast error unit costs

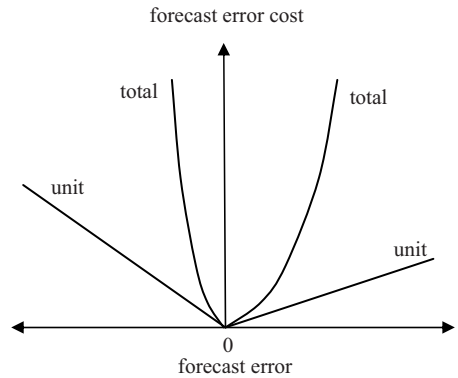

Figure 4. Asymmetric distribution of forecast error unit costs

6. Conclusions

Inclusion of the cost of potential errors in relation to forecasted cost of company sales volume is an important aspect of company management. Certain aspects of the subject under study should be studied more extensively, namely:

1. Method of calculating the forecast error unit cost. It seems that one of the possible approaches would be to base cost evaluation on managerial appraisal.

2. The function form of forecast error unit cost distribution. For this paper, the most simple function form was adopted, i.e. uniform distribution.

Both of the above issues will be addressed in this author's future research.

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