

Abstract

Marketing controllers traditionally analyze the profit contribution variance between actual and plan by decomposing it into a quantity and a price variance. This, however, enables them only to identify areas where problems exist rather than to diagnose their causes. In order to get more insights, this paper proposes making the planning assumptions for achieving a certain profit contribution explicit beforehand by specifying appropriate response functions. This information can be used after the fact to calculate the amount of profit contribution variance associated with different sources. In particular, the paper offers a novel decomposition principle of total variance into partial variances associated with possible sources such as incorrect market response assumptions (planning variance), deviations of actual marketing actions from planned ones (execution variance), and misanticipation of competitive reactions (reaction variance). Each of these variances can be decomposed further into the separate effects of single marketing instruments. By distinguishing between a response function for market share and one for market size, controllers can also estimate for which part of the variance the product manager may be responsible.

1. Introduction

An important responsibility of marketing planning and control is analysis of deviations of the actual profit contribution of a product from the planned contribution. Such analyses can provide valuable feedback information about what went wrong in the past and can be improved in the future. The literature suggests analyzing revenue variances by applying the standard accounting practice of calculating quantity and price variances, which was originally developed for the costs of production processes of manufactured goods (e.g. Horngren, 1967). This widely accepted practice has subsequently been made more sophisticated by: a) splitting the price variance into a yield and mix variance, and b) splitting the quantity variance into a market size and market share variance (e.g. Kaplan, 1982, p. 295 ff.; Hulbert and Toy, 1977). The latter represents an attempt to isolate the impact of the total market (factors beyond the control of a product manager) from market share variations, which are considered part of the product manager's performance.

Despite these refinements, the so-called traditional approach has been criticized for the assumption that price and quantity are independent of each other when they are really interrelated in sales (Manes, 1983). In fact, a negative price variance is the result from every price reduction, but this does not necessarily imply that a poor decision has been made, because the revenue loss of a price reduction may be offset by additional revenue from selling a larger quantity. Hulbert and Toy point out that this type of analysis "has limited potential for diagnosing the causes of problems. Rather, its major benefit is in the identification of areas where problems may exist" (1977, p. 13). The authors further maintain that "determining the factors which have actually caused favorable or unfavorable variances requires the skill and expertise of the manager." Instead of being dependent on the subjective view of the person who is controlled, we are interested in a more objective system that offers the controller clearer insight into the possible sources of profit variance and their magnitudes (expressed in monetary values).

Manes (1983) was the first to propose the estimation of an ex post elasticity from a sales and price variation in order to determine whether this price variation was headed in the right direction, as indicated by optimal prices according to the Amoroso-Robinson-relationship. Unfortunately, this is possible only for a monopolistic market. In the presence of competition,

any judgment on the optimality of price requires knowledge of an explicit reaction function that models competitors' prices in terms of one's own price. However, such knowledge is usually not available. Furthermore, the proposal by Manes (1983) cannot be applied if revenue variances result not only from price variations but also from variations in other marketing instruments such as advertising and distribution.

An insightful analysis of the causes of profit contribution variance requires appropriate market response functions. Causal inferences can be made only using the true market response functions, however, which are not known. Instead we propose using the planning assumptions of the product manager or higher-level managers for the calibration of the response functions. These assumptions represent the best a priori knowledge. By specification of the assumptions on the response functions, the controller also ensures that the planned price and marketing budgets are consistent with the planned revenue. If the firm learns from ex post statistical analysis that the assumed parameter values of the response function have been inadequate, it can base its variance analysis on this updated function and calculate the impact of the incorrect planning assumptions on profit contribution.

While the existence of a response function allows for any kind of what-if analysis, no approach so far allows for the decomposition of total profit contribution variance into partial variances associated with multiple sources that add up again to the total variance. We use the expression "source" for deviations between actual and planned marketing actions as well as parameter values in the assumed response functions. The objective is to describe a decomposition principle that quantifies the partial variances associated with the following sources:

- Planning variance: The manager has worked with wrong a priori parameter values for the response functions.
- Execution variance: The manager has not executed the planned budgets and price, but chosen deviating marketing actions.
- Reaction variance: The competitors have not reacted as anticipated.
- Unexplained variance.

As the development of market volume is rarely under the control of a product manager, we distinguish between effects on market share and on market volume. Moreover, we show how

to separate variances associated with any such sources into the effects of single marketing instruments.

This approach can be interpreted as a simultaneous what-if analysis of the isolated effects of all variations of variables and parameter values of the response function that sum up to the total observed profit contribution variance. Thus, a controller can assess the relative importance of possible sources of profit contribution variance simply by plugging actual values of the variables into the assumed or ex post response function to indicate possible causes. Of course, this is no substitute for a more thorough analysis. It does, however, have the advantage that the controller is not dependent on the product manager's self-analysis.

The approach does not attempt to assess the optimality of the plan or the actual decision as compared to the optimal levels of price, quality, and advertising as given by the formulae of Rasmussen (1952) and Dorfman/Steiner (1953). These formulae hold only for monopolistic markets. In the more realistic case of competition, we must specify not only the response function, but also a complete reaction function describing the reactions of competitors to any possible action of the firm. This is usually impossible. Nevertheless, one has to specify the anticipated reaction of the competition to the planned marketing actions in order to estimate the planned profit contribution. Our aim is to evaluate the product manager's actions based on the anticipated as well as actual competitive reaction, but we refrain from drawing conclusions on optimal actions because these may cause different competitive reactions. In summary, we analyze the impact of various sources on profit contribution variance but do not intend to compare actual or planned decisions with optimal ones.

Section 2 of this paper discusses in more detail why the traditional approach may be misleading in explaining profit contribution variances, and identifies questions to which the decomposition of variance into different sources should offer quantitative answers. Section 3 presents the types of response functions necessary for our proposed approach, while section 4 describes the basic principles of the decomposition of revenue variance into various sources using these response functions. Section 5 extends this analysis to a profit contribution variance analysis by taking into account all cost variations caused by marketing actions. This is followed, in section 6, by a discussion of the availability of the required data. The value of

the proposed approach is then illustrated with the help of an example in section 7. The paper closes with concluding remarks on the applicability of this new approach.

2. Controller's information requirements for profit contribution variance analysis

To understand the limitations of the traditional profit contribution variance analysis, consider the example in Table 1:

Table1: Data for profit contribution variance analysis

| | Plan (Index P) | Actual (Index A) | Deviation in % |
|---------------------|----------------|------------------|----------------|
| Price (P) | 4 | 3 | -25% |
| Quantity (Q) | 3,000,000 | 6,000,000 | +100% |
| Revenue | 12,000,000 | 18,000,000 | +50% |
| Unit Cost (C) | 2 | 2 | 0% |
| Total Cost | 6,000,000 | 12,000,000 | +100% |
| Profit Contribution | 6,000,000 | 6,000,000 | 0% |
| Price Elasticity | | +100%/-25%=-4 | |

In the traditional approach, total variance is decomposed into:

$$\begin{aligned}
 \text{total variance} &= \text{price variance} + \text{quantity variance} + \text{interaction variance} && (1) \\
 &= (P_A - P_P) Q_P + (Q_A - Q_P) (P_P - C) + (P_A - P_P) (Q_A - Q_P) \\
 &= (3-4)3,000,000 + (6,000,000-3,000,000)(4-2) + (3-4)(6,000,000-3,000,000) \\
 &= -3,000,000 + 6,000,000 - 3,000,000 \\
 &= 0
 \end{aligned}$$

In the context of production cost controlling (where variances between plan and actual are calculated), this could mean that a manager has purchased materials at an attractive price but caused a high consumption of materials in the production process. As supply and production are relatively independent of each other, such an analysis provides useful information. In our revenue context, however, a marketing manager would find these conclusions very strange, because quantity depends on price. As a consequence, any price reduction results in a negative price variance, which is not necessarily an indication of a poor decision. Rather, the

profitability of the decision depends on the responsiveness of quantity with respect to price. If the price elasticity is equal to -4 , as in the example, all the product manager has done is to choose a price-quantity combination with exactly the same profit contribution as the planned combination. In this case, the zero variance is fully explained.

In general, sales also depends on marketing instruments such as advertising and distribution as well as competitive reactions and/or the development of market size. Therefore, sales as expected from the price response function is normally not equal to actual sales. In order to provide valuable control and feedback information for the controller and the product manager, it is highly desirable to disentangle the various sources of profit contribution variance.

Managers can thus assess which source had a positive or negative impact on the variance and to what extent. For any such assessment, we need a calibrated response function of quantity depending on the levels of the marketing instruments. Because controllers want to know whether contribution variances are due to changes in non-controllable market size or due to actions of the product manager (thereby substantiating the evaluation of his performance), we need separate response functions for market share and market size. These functions should, moreover, distinguish between the actions of the firm under consideration and those of its competitors, so that the impact of competitive actions (or reactions) can also be assessed.

3. Response functions as a basis for profit contribution variance analysis

Any analysis of the effectiveness of marketing actions must be based on a response function describing how sales (in units) depends on marketing instruments such as price, advertising, and distribution. Maintaining the goal of distinguishing between exogenous effects of the entire market and endogenous effects of the firm's own marketing mix, we must base our analysis on two different response functions. One relates market size to exogenous factors, but also to average industry price as well as industry marketing effort with respect to advertising and distribution. The other one expresses the way a firm's market share depends on levels of marketing mix instruments.

For simplicity, we describe the idea of the proposed profit contribution variance analysis (PCVA) using one specific type of response function, namely, the multiplicative form. This is a widely accepted functional form among marketing researchers. It offers the properties of

diminishing marginal returns and parsimony with respect to the number of parameters (Naert and Leeflang, 1978, p. 74 ff.; Hanssens, Parsons, and Schultz, 1990, p. 38). Note, however, that the principles of the proposed PCVA are universal and can be applied to any other form of response function. Furthermore, we simplify notation by considering only three basic marketing instruments - price, advertising, and distribution. This is no constraint, since the multiplicative response function allows for the incorporation of any additional marketing instruments. We initially focus on short-term response functions, and later relax this condition. We start with the market share response function:

$$MS = MS_R \cdot \left(\frac{RP}{RP_R} \right)^a \cdot \left(\frac{SA}{SA_R} \right)^b \cdot \left(\frac{SD}{SD_R} \right)^d \quad (2)$$

MS: unit-based market share,

R: index (subscript) for reference (baseline) values,

RP: relative price,

SA: share of advertising,

SD: share of distribution,

a, b, d: elasticities of market share with respect to changes in relative price, share of advertising, and share of distribution, respectively.

The independent variables are all expressed in relative terms with respect to industry levels. The relative price is defined as price divided by the average industry price. The other marketing variables, advertising and distribution, are defined as shares of the respective industry activities. Advertising can be operationalized as budgets, gross rating points, or measures such as awareness rates, while distribution can be measured through distribution rates. The use of shares resulting from the relation of one firm's advertising budget and distribution rate to those of the industry is motivated by the fact that the advertising and distribution power of a single firm decrease if new competitors enter the market. Typically, MS_R is the market share of the previous period achieved with the previous marketing mix RP_R , SA_R , and SD_R . It can, however, represent any other baseline value.

Note that response function (2) differs from the well known multiplicative form $MS = a \times RP^a \times SA^b \times SD^d$. It can easily be seen, however, that for $\alpha = MS_R \times RP_R^{-a} \times SA_R^{-b} \times SD_R^{-d}$, function (2) is equivalent to the simpler multiplicative form. We believe that expressing variations of the dependent variable relative to a reference or baseline value that depends on relative variations of an independent variable is intuitively more logical for managers. The elasticities a, b, and d can also be subjectively estimated (see section 6) in case no knowledge

from statistical analyses is available. A function similar to (2) has been proposed in BRAND-AID in order to separate the effects of multiple independent variables (Little, 1975, p. 635 ff.).

The market size response function is analogous to (2):

$$TM = TM_R \cdot \left(\frac{IP}{IP_R} \right)^A \cdot \left(\frac{IA}{IA_R} \right)^B \cdot \left(\frac{ID}{ID_R} \right)^D \cdot \left(\frac{EXO}{EXOR} \right)^E \quad (3)$$

TM: total market size (in units),

R: index (subscript) for reference (baseline) values,

IP: average industry price,

IA: industry advertising (operationalized as the sum of advertising budgets, or the sum of gross rating points, or the sum of awareness rates of all firms in the industry),

ID: industry distribution (operationalized as the sum of distribution budgets, or the sum of distribution rates of all firms in the industry),

EXO: variable representing exogenous effects, such as growth in population, or an increase in household income,

A, B, D, E: elasticities of market size with respect to changes in average industry price, industry advertising, industry distribution, and exogenous effects.

Response function (3) reflects the fact that market size is influenced by completely exogenous factors such as demographics or macroeconomics, as well as by partly exogenous factors such as the marketing actions of the industry as a whole. The latter assumption implies that a firm with a market share of 10% also influences market size by a weight of 10% through the sums of industry marketing instruments.

4. Basic principle of decomposing the revenue variance into sources

To facilitate understanding of our approach to profit contribution variance analysis, we begin with the analysis of revenue variance, and only later extend the approach to the case of profit contribution. Rather than accept the traditional calculation of the revenue effect of deviations of price and quantity, thereby providing only information on the symptoms, we want to gain insight into the causes of these effects. Therefore, we propose a novel approach that allows for the decomposition of total revenue variance into partial variances associated with multiple sources of interest to the marketing controller. Sources analyzed are deviations of actual marketing actions and market developments from plan. Their effects can be calculated using a prespecified functional relationship between revenue and marketing actions as well as market

developments. The remaining variance that cannot be associated with these sources is considered to be unexplainable.

Since we would like to disentangle the part of the variance for which the product manager is responsible, our approach separates the exogenous influence of the market from the consequences of the firm's actions (endogenous factors). This is made possible by a decomposition of revenue into (volume-based) market share, which is mainly endogenously influenced, and market volume, which is mainly exogenously influenced (see Figure 1).

< please insert Figure 1 somewhere here >

The endogenously influenced revenue variance can be decomposed further by estimating the market shares (based on the market response function) that would have been obtained under various scenarios. This is illustrated graphically for the marketing instrument "advertising" in Figure 2, assuming that all other marketing instruments are implemented according to plan.

< please insert Figure 2 somewhere here >

Using algebra we obtain the planned, new, expected, forecasted, and actual market shares as follows:

- a) The originally planned market share MS_P is that achieved with the planned share of advertising SA_P . It expresses the relation of the planned advertising budget A_P to the anticipated industry advertising level of IA_P , thus $SA_P = A_P/IA_P$ (Plan/Plan). It enters into the originally assumed response function R_1 .

$$MS_P(SA_P) = MS_R \cdot \left(\frac{RP_R}{RP_R}\right)^{a_1} \cdot \left(\frac{SA_P}{SA_R}\right)^{b_1} \cdot \left(\frac{SD_R}{SD_R}\right)^{d_1} \quad (4)$$

- b) If the firm learns ex post that R_2 is a better specified response function, it can calculate the associated new market share MS_N for the planned share of advertising $SA_P = A_P/IA_P$ (Plan/Plan).

$$MS_N(SA_P) = MS_R \cdot \left(\frac{RP_R}{RP_R}\right)^{a_2} \cdot \left(\frac{SA_P}{SA_R}\right)^{b_2} \cdot \left(\frac{SD_R}{SD_R}\right)^{d_2} \quad (5)$$

c) If the product manager has chosen an actual (denoted by subscript A) advertising level A_A that deviates from the planned A_P , we can determine the expected (denoted by subscript E) share of advertising $SA_E = A_A/IA_P$ (Actual/Plan), and calculate the associated expected market share MS_E on the basis of the updated response function R_2 .

$$MS_E(SA_E) = MS_R \cdot \left(\frac{RP_P}{RP_R}\right)^{a_2} \cdot \left(\frac{SA_E}{SA_R}\right)^{b_2} \cdot \left(\frac{SD_P}{SD_R}\right)^{d_2} \quad (6)$$

d) If the competitors' reactions occurs in an unexpected way, the actual industry advertising level IA_A will deviate from the planned one (IA_P). This leads to a new actual share of advertising $SA_A = A_A/IA_A$ (Actual/Actual), which is associated with the forecasted market share MS_F for the ex post updated response function R_2 .

$$MS_F(SA_A) = MS_R \cdot \left(\frac{RP_E}{RP_R}\right)^{a_2} \cdot \left(\frac{SA_A}{SA_R}\right)^{b_2} \cdot \left(\frac{SD_E}{SD_R}\right)^{d_2} \quad (7)$$

e) The actual market share MS_A is observable.

Having derived these market share levels [planned (P), new (N), expected (E), forecasted (F), actual (A)] from our market response functions, we can calculate the amount of partial revenue variance associated with different sources. This can be carried out by sequentially taking the deviations of these market shares and translating them into partial revenue variances by multiplying the (unit-based) market share deviations with the corresponding relative price (resulting in volume-based market share deviations) and planned market volume MV_P . This implies that we assume (at least conceptually) the existence of sequentially related sources of variance. To analyze the variance associated with the variation of one instrument, we take the value of that marketing instrument at the respective planned, expected, or actual level [e.g. actual as in (7)] while all other marketing instruments are at respective values of the preceding level [e.g. expected as in (7)].

1) First, we calculate the planning variance as the difference between the market shares MS_N and MS_P resulting from the difference between the updated and originally assumed response functions:

$$\text{Planning variance with respect to market share} = (MS_N(SA_P) - MS_P(SA_P)) \cdot RP_P \cdot MV_P \quad (8)$$

2) Second, we determine the execution variance as the difference between the market shares MS_E and MS_N resulting from the deviation between the actual advertising level A_A and the planned level A_P . By analyzing this based on the ex post response function R_2 , we can assess whether a product manager has successfully adapted to the new response situation. If advertising is operationalized by the awareness rate, we can also evaluate the revenue loss due to the inability to achieve the planned awareness rate:

$$\text{Execution variance with respect to market share} = \left(MS_E(SA_E) - MS_N(SA_P) \right) \cdot RP_P \cdot MV_P \quad (9)$$

3) Third, we can determine the reaction variance as the difference between the market shares MS_F and MS_E resulting from the deviation between the actual industry advertising level IA_A and the anticipated level IA_P . This difference provides information on the extent to which the firm has been hurt by unexpected competitive reactions. This part of the variance is generally considered to be beyond the control of a product manager. Some might argue, of course, that a product manager is also expected to provide good forecasts of competitive reactions, and therefore make the product manager responsible for this source of variance:

$$\text{Reaction variance with respect to market share} = \left(MS_F(SA_A) - MS_E(SA_E) \right) \cdot RP_E \cdot MV_E \quad (10)$$

4) Finally, we can determine the unexplained variance as the difference between the market shares MS_A and MS_F . There are two possible reasons for observing an actual market share MS_A that is different from the market share MS_F forecasted for the actual marketing actions and industry levels according to the ex post response function: Either the effectiveness of marketing instruments not explicitly modeled in the response function has changed, or the ex post response function R_2 is still not completely accurate:

$$\text{Unexplained variance with respect to market share} = \left(MS_A - MS_F(SA_A) \right) \cdot RP_A \cdot MV_A \quad (11)$$

The analysis here is in terms of a single marketing instrument, namely advertising. The same decomposition principle can be applied to other marketing instruments, including price. To analyze revenue variances that are due to price deviations, however, there is a change in the

procedure relating unit-based market shares into volume-based market shares. With respect to price variations, we must weight (multiply) the unit-based market share variance not by the relative price of the preceding level (i.e. not expected relative price for actual share of advertising) but by the relative price of the same level (i.e. actual relative price for actual relative price). We do want to take into account not only the market share consequences of different relative prices, but also the revenue effect of the price itself.

In the case of multiplicative response functions, the isolated market share differences due to the variations in single marketing instruments do not fully add up to the total difference associated with the corresponding marketing mix variation. This difference can be dealt with by introducing a residual mix variance to compensate for this usually small difference.

Up to this point, we have analyzed differences of volume based market shares due to deviations of actual from plan. To calculate the corresponding revenue variances, we multiply volume-based market share differences by the appropriate market volume figures. Market volume is affected through market size (in units) by the same variables as market share [although not in the same way; see response functions (2) and (3)]. So, the same variance sources as discussed under 1) through 4) can be associated with market volume differences. Combining the corresponding volume-based market share and market volume differences, total revenue variance can be decomposed as seen in Fig. 3. Due to the complexity of the various equations we have chosen a graphical illustration, but offer a spreadsheet with all equations for the readers (see section 9). Note that the spatial representation gives no indication of the magnitude of the various partial revenue variances. The scale is chosen instead to enhance comprehensibility. Most of the variance areas are actually relatively small compared to the area representing planned revenue.

< please insert Figure 3 somewhere here >

5. From revenue to profit contribution variance analysis

The framework for revenue variance analysis already provides detailed and valuable information on the effectiveness of particular marketing actions. If we want to go further and analyze the profitability of deviations between actual and planned marketing efforts, we must include the costs of all marketing mix policies evaluated and subtract them from revenue. As

we are interested only in cost variances due to marketing decisions, we can confine our analysis to the unit cost and the marketing budgets for advertising and distribution.

In general, unit cost differences between actual and plan can be attributed to the production operations department and therefore constitute an exogenous (unexplained) source of profit contribution variance. In some situations, however, a product manager may argue that a marketing policy leading to more units sold will also cause economies of scale and/or experience curve effects that should be attributed to the marketing policy. We therefore assume a simple functional relationship between unit cost and quantity:

$$C = C_R \cdot \left(\frac{Q}{Q_R} \right)^\delta \quad (12)$$

C: unit cost,

R: index for reference (baseline) value,

Q: quantity (as given by unit-based market share \times market size),

δ : economies of scale and/or experience curve elasticity.

Because each component of the revenue variance consists of the difference between two revenue figures explicitly given by quantity (= market share (unit-based) \times market size) multiplied by price (= relative price \times average industry price), it is possible to calculate the corresponding costs for each revenue situation. The profit contribution variance can be computed accordingly as follows:

$$\begin{aligned} \text{profit contribution variance} = & \text{revenue variance} \\ & - \text{marketing budget variance} \\ & - \text{unit cost variance due to economies of scale} \\ & - \text{unit cost variance due to improved production} \\ & \text{efficiency (exogenous)} \end{aligned} \quad (13)$$

Again, we refer to section 9 for details regarding the exact equations.

6. Data availability and planning assumptions

While our framework offers a detailed analysis of various sources of profit contribution variance, it requires somewhat more data than the traditional approach, which uses only price

and quantity. Although most of this additional data is not available from internal accounting sources, much of it can be procured from outside sources.

In the case of consumer products, a firm usually subscribes to panel data providing the firm with quantities, market shares, prices and distribution rates for itself as well as for all competitors. Given one's own market share and internally known sales quantity, market size can easily be inferred. In addition, market research companies offer tracking studies providing data on advertising budgets and awareness rates.

For durables or standardized industrial goods such as copy-machines or computers, panel data may not be available. Here, the firm must either rely on industry association reports, or acquire data on quantities and prices from market research companies. Advertising budget data may also be purchased from the sources described above. Distribution is much more a problem of personal selling for industrial companies. Here, some market research companies provide reports on salesforce sizes of all competitors in the field.

In addition to this data, the parameter values of the response functions must be calibrated. This can generally be achieved in two different ways. If sufficient historical and/or cross-sectional (e.g. across regions or segments) data exists, elasticities should be estimated statistically. If this does not prove feasible, the firm must rely on subjective estimates. This does not constitute a weakness in the approach, because the planning authority must have based its plan on some intuitive estimate of the market response in any case.

Take, for example, the market share elasticity c with respect to advertising. If the planning authority can provide an estimate on the market share $MS(RP_R, SA_P, SD_R)$ that would result from a change of advertising from SA_R to SA_P while all other marketing instruments remain at their reference values, the corresponding elasticity can easily be inferred from

$$b = \frac{\ln(MS(RP_R, SA_P, SD_R) / MS_R)}{\ln(SA_P / SA_R)} \quad (14)$$

Note that the planned market share MS_P and market size TM_P must be equal to the calculated values resulting from the response functions (1) and (2) when inserting the planned levels for all marketing instruments. This provides a consistency check of the plan.

While a plan can rely on subjective estimates of the response function's parameter values, this is often not suitable for the corresponding ex post values used as a basis for determining the planning variance. Instead of adjusting the ex post elasticities until they fully explain the total profit contribution variance, we recommend using estimates from statistical analyses for ex post values. Only if the controller and the product manager agree on specific circumstances should subjective parameter values be used.

7. Illustration

The usefulness of this framework can best be demonstrated through an example. Assume the circumstances as described in Table 2.

< please insert Table 2 somewhere here >

The product manager of SONAL was given a plan that requested a price decrease from 4.10 Euro to 3.80 Euro, an advertising budget decrease from 20 Mill. Euro to 16 Mill. Euro (anticipating a decrease of awareness from 33% to 29%), and a distribution budget increase from 12 Mill. Euro to 16 Mill. Euro (hoping for an increase of the distribution rate from 48% to 54%). This plan is expected to improve the profit contribution from 7,200,000 Euro to 16,500,000 Euro. In fact, the product manager decreased the price even further, to 3.70 Euro, and decided to reallocate the budget from distribution to advertising by increasing the advertising budget to 21 Mill. Euro and decreasing the distribution budget to 13 Mill. Euro. He was lucky and achieved more than the planned profit contribution, namely 16,701,975 Euro. Does this mean that everybody is satisfied, and the controller can dispense with a detailed analysis? Hardly, because the product manager may have benefited from a favorable increase of the exogenous factors, from 1.10 to 1.20 (index scale). To disentangle the various sources of variance, our framework is applied to this scenario. As we have described, any variance analysis of sources must be based upon response functions. Table 3 therefore

supplies the values for the elasticities assumed during the planning process and the values measured ex post.

< please insert Table 3 somewhere here >

Given these elasticity values and the response functions (2) and (3), the effects of the marketing mix decisions on unit-based market share and market size can be computed. The respective deviations are transformed into monetary values of profit contribution variance according to Figures 3 and 4. All these detailed computations are carried out by SAPCOV (Source Analysis of Profit Contribution Variance), which implements the proposed approach in a spreadsheet software developed by the author (it will be sent upon request, see section 9). The resulting matrices of profit contribution variance, organized by sources and marketing instruments and separated into market share and market volume effects, are displayed in Table 4.

< please insert Table 4 somewhere here >

The column "Subtotal" of the last matrix "due to total of share, volume, and interaction deviations resulting from deviations of ..." shows that the product manager's positive total profit contribution variance of 201,975 Euro is not an indicator of good performance. The product manager apparently benefited from a change in exogenous factors that actually should have provided a surplus of 2,467,619 Euro (total market volume effect). Moreover, if we evaluate the plan according to the market share response function estimated ex post instead of the originally assumed elasticities, the planned marketing mix should have produced an additional profit contribution of 739,863 Euro (planning variance, subtotal in first matrix). The net effect should have been an increase in profit contribution of more than 3 Mill. Euro, which the product manager did not achieve. We can explore in detail the sources and marketing instruments that might explain this "loss".

Decreasing price further would have been a good decision if competitors had not reacted (total execution variance = 1,108,864 Euro). Assuming that their price reduction was a retaliation, the overall result of the decision is negative (subtotal price variance in last matrix = -3,294,186 Euro). Increasing the advertising budget from 16 Mill. Euro to 21 Mill. Euro did not prove profitable: The respective execution variance (last matrix) is negative by -

2,735,937 Euro. Even worse, competitors increased their sum of awareness rates, accounting for another -421,680 Euro contribution loss. In contrast, decreasing the distribution budget from 16 Mill. Euro to 13 Mill. Euro proved to be profitable. Obviously, the loss of market share was offset by a savings in budget (execution variance = 1,384,926 Euro). This positive value was diminished by the competition's increasing the sum of distribution rates, leading to a reaction variance of -192,945 Euro. Overall, reallocation of the budget in favor of advertising was a questionable policy.

In summary, the marketing mix chosen had negative effects. For the ex post elasticities, we observe a total execution variance (last matrix) of -284,036 Euro. The measured response would have promised a decrease of profit contribution of 1,549,441 Euro (planning variance), while the exogenous factors offered a surplus of 6,053,355 Euro. Compared to these figures, the amount of unexplained variance at 217,510 Euro is rather small.

For the controller, this analysis offers interesting insights. Overall, the product manager has achieved the planned contribution, but merely by taking advantage of a favorable development in market size. A close look at the variances by sources and marketing instruments reveals questionable decisions on the part of the product manager. The detailed analysis provided by the program SAPCOV allows the controller to detect weaknesses in the planning process as well as in the execution of actions planned.

8. Limitations and conclusions

We have proposed an approach for analyzing profit contribution variances between actual and plan that improves on the traditional approach by identifying and quantifying sources rather than symptoms. This is made possible by decomposing total profit contribution variance into the particular sources that are of interest to controllers. With only slightly more data on planning assumptions than once utilized, the technique provides detailed information regarding the effects of assuming incorrect values for the parameters of the response function (planning variance), choosing marketing actions that differ from planned ones (execution variance), and misanticipating competitive reactions (reaction variance). Moreover, total profit contribution variance can also be decomposed into partial variances associated with single marketing instruments. The main idea of the approach is to base the decomposition on

response functions. By distinguishing between response functions for market share and market size, we are able to separate endogenously caused variances from exogenously influenced variances.

The approach is implemented using simple multiplicative response functions, but the decomposition principle works with any other response function, too. While this approach is chosen for its generality, more specific sources of variance can be isolated by the analogous application of our decomposition principles.

The analysis provides concrete revenue numbers for the various partial variances. This is possible because we work with deterministic response functions. Since we cannot be sure about the true response function, we must be as careful in the use of these numbers as with any other output of statistical response function estimation.

Our objective is to demonstrate the advantages of basing profit contribution variance analysis on response functions. In order to facilitate the discussion, we have neglected dynamics in market response and have not dealt with the specific problems of product lines. These limitations do not appear to be severe. Dynamic response can be modeled in response functions via lagged variables. Using the Koyck transformation, long-run market share can be inferred from short-run market share by multiplying it by a marketing-multiplier λ , which, in turn, is given by $\lambda = 1/(1 - \text{carry-over coefficient})$ (see Lilien/Kotler/Moorthy, 1992, p. 664). Long-run market size can be calculated similarly. The whole analysis can then be based on corresponding long-run variances. The only problem is that the actual carry-over coefficient cannot be observed, but must be estimated statistically from historical data. If a controller wants to perform variance analysis at the product line level, the traditional approach proposes calculation of a yield variance for the whole line and a mix variance for single product deviations from the average. Using the approach proposed here, it seems preferable to carry out the analyses on a disaggregate level and incorporate substitutional or complementary effects into the respective response functions in order to properly quantify the variance associated with interrelated marketing actions.

This type of profit contribution variance analysis does not address optimality of the plan and the actual actions because of the difficulty of obtaining a complete reaction function of the

competitive (re)actions depending on one's own actions. Future research should address this limitation.

Overall, the approach suggested here provides much more information than the traditional approach, while requiring only a little more data. This additional data is generally available or easily obtainable via subjective estimation. A controller who has different response functions or additional sources of variance in mind, can use this framework to overcome shortcomings in the traditional approach to variance decomposition. We hope that this approach will give rise to a stream of helpful and implementable approaches.

9. Software Availability

Since a complete description of all equations used for the computation of the various partial variances is impossible within the usual space constraints of a journal article, the author makes available the complete system of profit contribution variance analysis in form of the spreadsheet software SAPCOV. To obtain it from the author, please e-mail your request to albers@bwl.uni-kiel.de.

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Table 2: Planned and actual data for product SONAL

| Product SONAL | Reference | Plan | Actual |
|-----------------------------|---------------|---------------|---------------|
| Price us | 4.10 | 3.80 | 3.70 |
| Price them | 4.00 | 3.90 | 3.75 |
| Average Industry Price | 4.01 | 3.89 | 3.75 |
| Relative Price | 1.0227 | 0.9769 | 0.9880 |
| Advertising Budget | 20,000,000 | 16,000,000 | 21,000,000 |
| Awareness us | 33 | 29 | 34 |
| Awareness them | 270 | 280 | 290 |
| Industry Awareness | 303 | 309 | 324 |
| Share of Advertising | 0.1089 | 0.0939 | 0.1049 |
| Distribution Budget | 12,000,000 | 16,000,000 | 13,000,000 |
| Distribution us | 48 | 54 | 51 |
| Distribution them | 450 | 460 | 465 |
| Industry Distribution | 498 | 514 | 516 |
| Share of Distribution | 0.0964 | 0.1051 | 0.0988 |
| Exogenous Factors | 1.00 | 1.10 | 1.20 |
| Market Share (unit based) | 9,00 % | 10,00 % | 9,85 % |
| Market Size (unit based) | 300,000,000 | 350,000,000 | 383,000,000 |
| Market Share (volume based) | 9,20 % | 9,77 % | 9,73 % |
| Market Volume | 1,202,700,000 | 1,361,150,000 | 1,434,363,725 |
| Units | 27,000,000 | 35,000,000 | 37,725,000 |
| Revenue | 110,700,000 | 133,000,000 | 139,584,350 |
| Unit Cost | 2.50 | 2.30 | 2.25 |
| Total Cost | 67,500,000 | 80,500,000 | 84,882,375 |
| Contribution I | 43,200,000 | 52,500,000 | 54,701,975 |
| Total Budget | 36,000,000 | 36,000,000 | 38,000,000 |
| Contribution II | 7,200,000 | 16,500,000 | 16,701,975 |

Table 3: Assumed and ex post elasticities for product SONAL

| Elasticities | Assumed (Plan) | Ex Post (New) |
|--|----------------|---------------|
| Unit Cost with respect to Number of Units | -0.3213 | -0.3213 |
| Market Share with respect to | | |
| - Relative Price | -2.1075 | -2.4000 |
| - Share of Advertising | 0.3097 | 0.2000 |
| - Share of Distribution | 0.6363 | 0.4000 |
| Market Size with respect to | | |
| - Industry Price | -1.2699 | -0.8000 |
| - Industry Advertising | 0.0397 | 0.0300 |
| - Industry Distribution | 0.1228 | 0.1500 |
| - Exogenous Factors | 1.1670 | 1.0000 |

Table 4: Analysis of sources of profit contribution for product SONAL

| Profit Contribution Variance in Euro | Planning Variance | Execution Variance | Reaction Variance | Subtotal | Total |
|--|----------------------|-----------------------|----------------------|------------|-------------|
| due to market share deviations resulting from deviation of | | | | | |
| Price | 1,059,683 | 1,293,770 | -1,908,792 | 444,661 | Explained |
| Advertising | 1,292,624 | -2,065,929 | -495,807 | -1,269,113 | -2,243,423 |
| Distribution | -1,575,425 | 501,643 | -308,435 | -1,382,217 | Unexplained |
| Residual Mix | -37,019 | -36,498 | 36,763 | -36,753 | 209,330 |
| Subtotal | 739,863 | -307,013 | -2,676,272 | -2,243,423 | Total |
| | | | | | -2,034,093 |
| due to market volume deviations resulting from deviation of | | | | | |
| Price | -1,099,986 | -178,159 | -2,572,582 | -3,850,727 | Explained |
| Advertising | -14,846 | -671,321 | 74,701 | -611,466 | 2,506,534 |
| Distribution | -1,168,927 | 881,613 | 116,044 | -171,270 | Unexplained |
| Exogenous Factors | -1,235,057 | 0 | 7,288,411 | 6,053,355 | -38,915 |
| Residual Mix | 1,255,692 | 17 | -169,066 | 1,086,642 | Total |
| Subtotal | -2,263,124 | 32,149 | 4,737,508 | 2,506,534 | 2,467,619 |
| due to share-volume interaction deviations resulting from deviation of | | | | | |
| Price | -18,207 | -6,747 | 136,835 | 111,881 | Explained |
| Advertising | -300 | 1,313 | -573 | 440 | -278,646 |
| Distribution | 28,815 | 1,670 | -554 | 29,930 | Unexplained |
| Residual Mix | -36,487 | -5,408 | -379,003 | -420,898 | 47,096 |
| Subtotal | -26,179 | -9,172 | -243,295 | -278,646 | Total |
| | | | | | -231,551 |
| due to total of share, volume and interaction deviations resulting from deviation of | | | | | |
| Price | -58,510 | 1,108,864 | -4,344,539 | -3,294,186 | Explained |
| Advertising | 1,277,479 | -2,735,937 | -421,680 | -1,880,138 | -15,535 |
| Distribution | -2,715,537 | 1,384,926 | -192,945 | -1,523,557 | Unexplained |
| Exogenous Factors | -1,235,057 | 0 | 7,288,411 | 6,053,355 | 217,510 |
| Residual Mix | 1,182,185 | -41,888 | -511,306 | 628,991 | Total |
| Total | -1,549,441 | -284,036 | 1,817,942 | -15,535 | 201,975 |