Journal of Revenue and Pricing Management
https://doi.org/10.1057/s41272-021-00369-0

PRACTICE ARTICLE

Sales variance analysis: how state-of-the-art analytical tools can contribute to increased profitability

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Received: 15 May 2021 / Accepted: 11 November 2021

Abstract
This article explains sales variance analysis, a business intelligence tool to compare different financial results, enabling practitioners to determine which component drives changes in sales and take educated actions. The unique angle of this article is that it bridges theory—by delving into all the details of sales variance—with practice—by highlighting the managerial interpretation of what causes such changes and providing insights as to how to act upon it. It also suggests using this tool for marketing and not simple budgeting purposes, in stark contrast with most theory encountered by the authors.

Keywords Pricing · Analytics · Big data · Value-based pricing · Sales variance analysis · Strategy

Understanding sales using sales variance analysis

Companies are often celebrating increases in total revenue—a simple metric that is universally considered the go-to measure of success. Conversely, decreases in revenue are negatively perceived by the top management, so extensive effort is invested into avoiding such decreases at any cost, usually at the expense of profitability. Likewise, increases in total revenue are also prioritized in the media and academic research, implying their paramount importance and making them a favorite key performance indicator (KPI) in the business world.

However, practitioners like ourselves hold an alternative view. While acknowledging that an increase in revenue can be a good thing per se, they hold that sales are a medium-term indicator of success that requires further detailed analysis. For instance, in some consulting projects, a growth in sales can also be accompanied by a decrease in net selling price or, put differently, a decrease in margins. Companies pursuing volume may end up cannibalizing their profits—a slow and steady process caused by an unfounded strategic focus. A loss in pricing power requires the intervention of practitioners who must analyze transactional data and determine which of the two separate "forces"—price variance or volume variance—is at play. If the increase in sales is obtained through volume at the expense of net price, this may eventually be fatal. Sales variance analysis allows to weigh the different forces at play and gain a better understanding of the health of a company, whether it is by looking at "the company overall, a division of the company, a customer segment, or a single customer" (Smith 2021).

Research objective

C-level managers can and should be aware of the factors that drive changes in sales. To address this need, this paper provides a review of theoretical tools to undertake sales variance analysis, also referred to as "variance analysis." We complement this review with managerial knowledge and discuss strategic implications of using sales variance analysis to interpret past pricing initiatives and implementation and monitoring of new ones. The objective of the article is to fill the gap observed in marketing, controlling, and business analytics books—namely the lack of managerial implications related to sales variance analysis, also noted by other authors (Mitchell and Olsen 2003). Table 1 reviews 27 textbooks chosen for their academic impact, relevance to the topics of management and data analytics, or adopted by leading universities worldwide. As shown in Table 1, only two textbooks cover sales variance analysis, about 7.5% of the total, while none of them, 0% of the total, discusses its

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Published online: 30 November 2021

Table 1 Review of 27 globally adopted textbooks

Author(s)	Title	Sales variance	Formulae	Managerial implications
Artun and Levin (2015)	Predictive Marketing (Easy ways every marketer can use customer analytics and big data)	No	No	No
Best (2009)	Market-Based Management (Strategies for growing customer value and profitability), pp. 509–515	Variance Analysis	Net Marketing Contribution	No
Cady (2017)	The Data Science Handbook	No	No	No
Dean (2014)	Big Data, Data Mining, and Machine Learning (Value creation for business leaders and practitioners)	No	No	No
Farris et al. (2010)	Marketing Metrics (The definitive guide to measuring marketing performance)	No	No	No
Franks (2014)	The Analytics Revolution (How to improve your business by making analytics operational in the big data era)	No	No	No
Grigsby (2018)	Marketing Analytics (A practical guide to improving consumer insights using data techniques)	No	No	No
Jain et al. (2000)	Marketing (Planning & Strategy)	No	No	No
Jeffery (2010)	Data-Driven Marketing (The 15 metrics everyone in marketing should understand)	No	No	No
Kotler, Kartajaya, and Setiawan (2019)	Marketing 3.0 (From products to customer to the human spirit)	No	No	No
Kotler et al. (2012)	Marketing Management, pp. 649–650	Sales variance analysis	Variance due to price decline	No
Laursen (2011)	Business Analytics for Sales and Marketing Managers (How to compete in the age of information)	No	No	No
Laursen and Thorlund (2016)	Business Analytics for Managers (Taking business intelligence beyond reporting)	No	No	No
Marr (2016)	Big Data in Practice (How 45 successful companies used big data analytics to deliver extraordinary results)	No	No	No
McDonald and Christopher (2003)	Marketing: A Complete Guide	No	No	No
McDonald and Wilson (2016)	Marketing Plans (How to prepare them, how to profit from them)	No	No	No
McDonald et al. (2014)	Marketing Value Metrics (A new metrics model to measure marketing effectiveness)	No	No	No
Minelli et al. (2013)	Big Data, Big Analytics (Emerging business intelligence and analytic trends for today's businesses)	No	No	No
Mizik and Hanssens (2018)	Handbook of Marketing Analytics	No	No	No
Ohlhorst (2012)	Big Data Analytics (Turning big data into big money)	No	No	No
Palmatier and Sridhar (2017)	Marketing Strategy (Based on first principles and data analysis)	No	No	No

Table 1 (continued)

Author(s)	Title	Sales variance	Formulae	Managerial implications
Sarstedt and Mooi (2014)	A Concise Guide to Market Research (The process, data, and methods using IBM SPSS Statistics))	No	No	No
Siegel (2013)	Predictive analytics (the power to predict who will click, buy, lie, or die)	No	No	No
Simon (2017)	Analytics (The agile way)	No	No	No
Sterne (2017)	Artificial Intelligence for Marketing (Practical applications)	No	No	No
Stubbs (2011)	The Value of Business Analytics (Identifying the path to profitability)	No	No	No
Winston (2014)	Marketing Analytics (Data-driven techniques with Microsoft Excel)	No	No	No

managerial implementation and the centrality of its application in real business circumstances.

Furthermore, most previously published articles and papers tend to focus on the costing or accounting aspects of sales variance analysis, thereby comparing internal budgets with the actual performance of one year (Hulbert and Toy 1977; Kaplan 2000), instead of measuring the variances over longer periods and suggesting how to use the insight for key account management and marketing in general.

Recent studies on pricing also ignore the importance of sales variance (Mohaupt and Hilbert 2015; von Martens and Hilbert 2011; Lord and Yeoman 2012; Choi et al. 2015; Meissner and Strauss 2010; Zhang and Bell 2012; Liozu 2017, 2019, 2021; Cross, Higbie, and Cross 2011; Cleophas and Frank 2011; McMahon-Beattie et al. 2016; Queenan et al. 2011; Yip 2012) with the exception of Smith (2021) who explains the topic under the lens of profit bridge. Smith's (2021) paper focuses "on a profit bridge that decomposes changes in profits to common marketing variables and ignores other issues, such as exchange rates and fixed cost changes," while the current article does delve into such variables in order to provide a fuller spectrum of real business situations. While Smith (2021) recognizes that this analysis allows "to measure the performance of specific business variables under management in comparison to a prior period," the current article takes this general assessment a step further by identifying managerial reasons that could cause changes detected in the analysis or managerial decisions that could spark from the analysis.

How practitioners see EBITDA

As the old adage "turnover is vanity" reminds us that the obsession over revenue and market share could eventually lead to bankruptcy: not being able to discriminate between organic growth—helping overall profitability—and artificial growth—happening at the expense of profitability—is a risk that all companies face. This misconception does not leave unscathed even some of the largest companies in the world. General Motors tended to overly rely on KPIs such as volume and market share and celebrating them publicly; this could be among the major reason behind its decline, ultimately leading to its bankruptcy in 2009—a cautionary tale urging practitioners to master sales variance analysis.

As shown in Fig. 1, two increases in sales of the same magnitude, 5% in our example, may have opposite effects on profitability. The left panel of Fig. 1 shows the optimal case when the price is increased, while there is no change in the volume of sold units. In the real world, this situation can occur when a company starts explaining its unique value to customers, demonstrating its competitive advantages. Conversely, the right panel of Fig. 1 shows the case of a company where an increase in sales is achieved by an excessive price reduction—that is, when many more units are sold but at a much lower price. In a business world scenario, this may occur when a company is lowering the price to boost sales in an effort to gain market share or when it is overly obsessed with revenue. At the end of the day, the second company will probably achieve a lower profitability (EBITDA) than in the previous period.

The remainder of this article is structured as follows. Section Pricing as a discipline and sales variance analysis as a tool provides a short review of sales variance analysis as a tool to analyze price and its evolution over time. The term *variance* suggests that it relates to a *difference*, implying a comparison between two or more sets of data, and such data comparison occurs at different levels. Accordingly, in Section First-level pricing sales variance analysis: price–volume

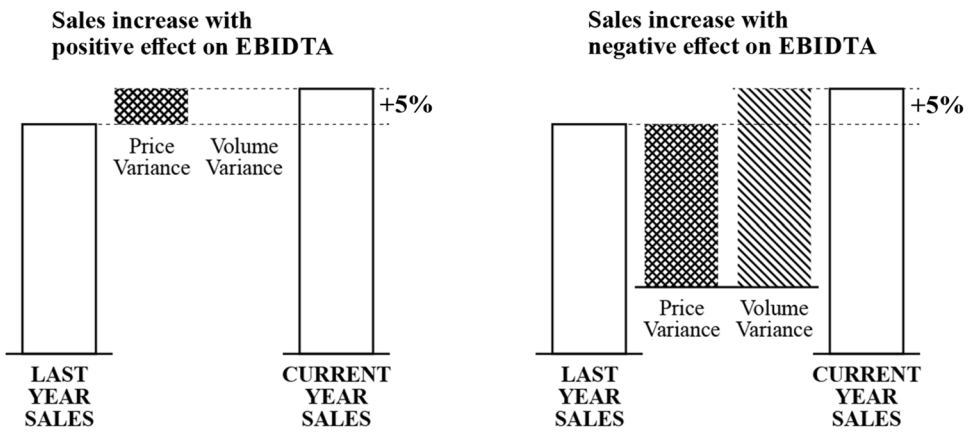


Fig. 1 Sales increases of same magnitude with opposite effects in profitability (two different companies)

variance, first-level variance is discussed, as in the case of a company that sells one product in one currency with varying levels of price and quantity. In Section Second-level pricing sales variance analysis, other levels of sales variance analysis are presented, as in the case of a company trading in multiple currencies and selling multiple products with changing product mix over different years (or generally speaking: over different periods). Section Best practices and criteria for exclusion presents practical situations that practitioners find in business life. Section Summary of formulae gives an overview of the formulae used for reviewing purposes. Section Visual representation of sales variance analysis shows how the sales variance is usually represented graphically to maximize its ability to convey a large amount of information at a glance, while Sections 8 and 9 conclude the article along with the suggestion of future avenues of research.

Pricing as a discipline and sales variance analysis as a tool

Variance analysis used in this article is meant for pricing purposes and compares different periods of actual sales. The same formulas can also be used in costing and accounting to compare budgets with actual sales (Kaplan and Gallani 2016; Simons 2016). However, the strategic objective of the latter application of variance analysis case is different and will not be discussed here.

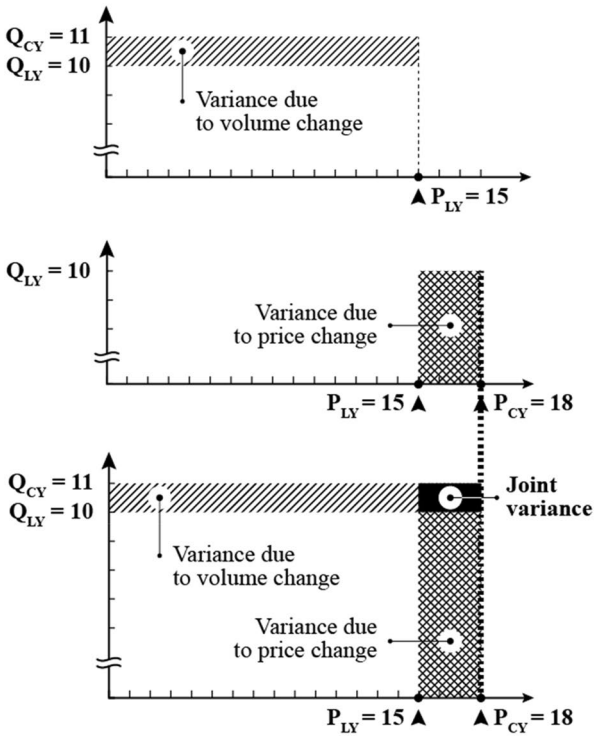
Pricing is a quintessential lever of the marketing mix; it can drive profitability in the short term and is the only element of the marketing mix that has a direct and immediate effect on profits: while changing prices is not cost-free (Bergen et al. 2003), the cost of changing prices is negligible compared to the potential benefits of implementing price changes; in one concept: price is the only revenue-generating element of the marketing mix (Hinterhuber and Snelgrove 2017).

Sales variance analysis is an effective tool to analyze price and its evolution over time. Prior to deciding how to improve the financial position of the company, marketing and finance managers should undertake this analysis on a product-by-product and even product-by-customer level (keeping in mind that the same product can be sold to different customers at different prices). Sales variance analysis usually starts at a company level but should be performed across different dimensions, including business units, departments, single products, single customers, and so forth (see Section Best practices and criteria for exclusion for further detail).

In an *archetypal* textbook scenario, a company sells a single product at one or two price points and at one or two volume levels. In such cases, the impact of a change in price or volume on sales can easily be assessed. In reality, however, multinational companies sell thousands of SKUs to multiple customers over many time periods, in different currencies that frequently change during the period, and at prices varying in terms of volume purchased and with *ad hoc* negotiations. Obviously, this complexity is much more difficult to capture, and most companies give up on making sense of it in a holistic way, preferring to focus on single products and doing their best with limited information at hand.

In this article, however, we argue that there are better ways to capture this complexity and to see how the company as a whole—or a single business unit, department, or even individual sales manager—is performing in terms of sales performance and profitability. Specifically, we argue that sales variance analysis is an indispensable tool to effectively analyze the wealth of information hidden in (big) sales data to make educated decisions.

It is worth adding at this point that the following analyses can be undertaken with simple spreadsheet software in the case of small datasets, while more powerful tools such as Microsoft PowerBI® are better for larger ones; the latter also allows to include add-ons to automatize given tasks for industry-specific needs.



Change in volume

	Volume:	Price:	Sales:
Last Year (LY)	10	€15	€150
Current Year (CY)	11	€15	€165
Variation:	**1 unit**	**0**	**€15**

Change in PRICE (only)

	Volume:	Price:	Sales:
Last Year (LY)	10	€15	€150
Current Year (CY)	10	€18	€180
Variation:	**0**	**€3/unit**	**€30**

Change in PRICE and VOLUME (generating Joint Variance)

	Volume:	Price:	Sales:
Last Year (LY)	10	€15	€150
Current Year (CY)	11	€18	€198
TOT Variation:	**1 unit**	**€3/unit**	**€48**
Of which:	Volume:	Price:	Sales:
Volume (only) variance	1 unit	0	€15
Price (only) variance	0	€3/unit	€30
Joint variance	1 unit	€3/unit	€3

Fig. 2 Visual and textual representation of first-level sales variance

First-level pricing sales variance analysis: price–volume variance

In this section, we discuss the first level of pricing sales variance. Figure 2 summarizes sales of a single product in two periods: Year-1 (Last Year, LY) and Year-0 (Current Year, CY). We focus on the following three scenarios: (1) change in volume; (2) change in price; (3) change in both volume and price. The corresponding scenarios are discussed in Sections Change in volume–Change in price–Changes in both price and volume.

Change in volume

In this scenario, the number of product units sold in the current year has increased with respect to the previous year (Fig. 3). Selling at the same price as last year ($P_{CY} = P_{LY} = 15$), but increasing the number of sold units from 10 to 11 increases yearly revenue from 150 to 165 EUR. Therefore, pure volume variance is 15 EUR.

The formula used here is as follows:

$$\left(Q_{CY} - Q_{LY}\right) * P_{LY}.$$

The practitioner's interpretation: win rate

From a pricing practice perspective, the increase in quantity sold could result from an increase in a win rate, possibly due to a successful explanation of the product's competitive advantages *vis-à-vis* other alternatives (Hinterhuber 2004). Having the ability to isolate sales of products or product lines experiencing such an increase in demand can unveil causes such as new sales techniques implemented by a key account manager if not a whole department, new trends happening in the market, or insights on purchasing behavior of single accounts.

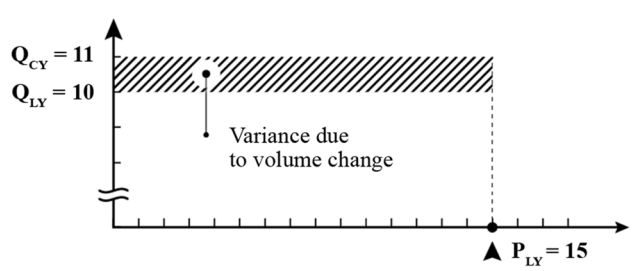


Fig. 3 Example of volume variance

Change in price

In this scenario, the product has witnessed an increase in price from the previous year with respect to the current year (Fig. 4). A unit level (volume or $Q_{CY} = Q_{LY}$) of 10 units and a price increased by 20% (from 15 to 18 EUR) result in a yearly revenue increase from 150 to 180 EUR. Thus, pure price variance is 30 EUR.

The formula in this specific case is $(P_{CY} - P_{LY}) * Q_{LY}$. However, it changes in the event of joint variance (see Section Changes in both price and volume), that is, when both price and volume change as compared to the previous year. Thus, the "complete" formula for Price Variance is $(P_{CY} - P_{LY}) * Q_{CY}$.

The practitioner's interpretation: segmentation

From a pricing perspective, the situation in which prices change within the same product or product line could be the result of a new segmentation where the company sells products to customers who are more able to extract considerable value from the offering and are thus willing to pay a higher price. Pinpointing specific accounts paying a premium for a product with respect to others and analyzing the underlying reasons for it gives tremendous insights on how to improve existing segmentation and, for example, passing from a purely volume-based segmentation to a more sophisticated industry sub-segment or company maturity segmentation; similarly, it allows to monitor if a new segmentation is paying the expected dividends.

Changes in both price and volume

In this scenario, both price and volume have changed between the previous year and the current year, resulting in three separate effects, all of which add up to the total sales variance.

As discussed in Sections Change in volume–Change in price, pure volume and price variances are 15 EUR and 30 EUR, respectively, adding up to EUR 45. However, this amount is not enough to justify the total sales variance. In this scenario, a third effect comes into play: *joint variance*. Joint variance is a result of the current vs. last year price difference multiplied by the current year vs. last year volume difference.

The formula used here is as follows: $(P_{CY} - P_{LY}) * (Q_{CY} - Q_{LY})$. This formula explains only joint variance, for a total of $(18 - 15) * (11 - 10) = 3$. Accordingly, in order to simplify formulas, joint variance is conventionally added to pure price variance, leading to a shorter formula of price variance that covers both pure price variance and joint variance: $(P_{CY} - P_{LY}) * Q_{CY}$. In Fig. 5, price variance is the combination of Variance due to price change and Joint variance.

In the example, the total sales variance is 48 EUR, which consists of volume variance (15 EUR) and price variance (33 EUR). The latter amount consists of 30 EUR of pure price variance and 3 EUR from joint variance. In our experience, this frequently causes confusion, so we shall reiterate: price variance is a combination of joint variance and pure price variance.

The practitioner's interpretation: unique selling proposition

From a pricing perspective, when both prices and quantities witness a change, this is usually a result of multiple activities, such as the company's ability to effectively segment the market and explain to each segment the unique competitive advantages it delivers, which results in both higher win-rates and prices.

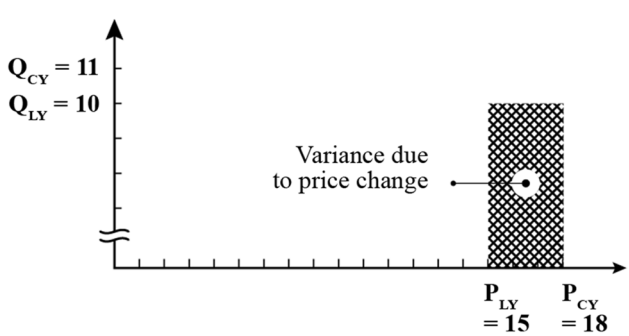


Fig. 4 Example of price variance

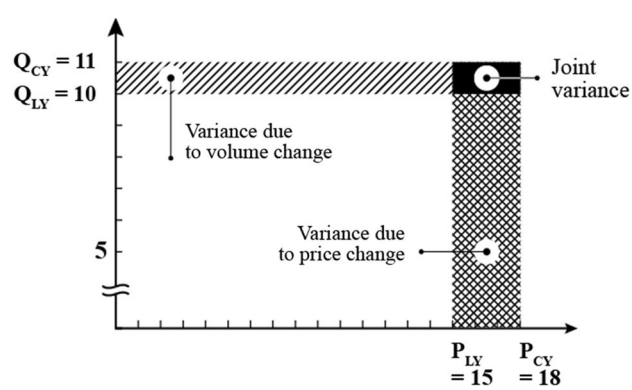


Fig. 5 Example of joint variance

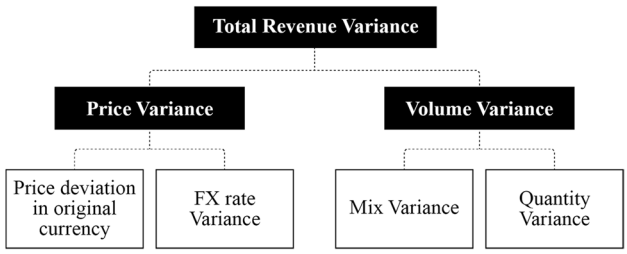


Fig. 6 Overview of variances (Coskun 2016)

Second-level pricing sales variance analysis

Unlike in the examples discussed in Section First-level pricing sales variance analysis: price–volume variance, most companies operate in countries with different currencies and offer a wide range of differently-priced products to their customers. This impact of a changing currency and portfolio of items on the total revenue results in the fact that simple price and volume variances cannot provide a complete and comprehensive picture. Accordingly, price and volume variances need to be "disaggregated" (Hawkin and Cohen 2004). Illustrations of such disaggregation are provided in Sects. Impact of currency exchange–Impact of product portfolio mix.

Figure 6 shows the link among all variances (Coskun 2016), each level representing a further breakdown of the previous one. Practitioners and business analysts drill down even further by adding different filters and exclusion criteria (the managerial implications of which are discussed in Section Best practices and criteria for exclusion). The drilling-down process continues to the point where the effort no longer justifies the obtained insights (Hawkin and Cohen 2004).

Impact of currency exchange

In this section, we discuss the disaggregation of price variance. Let us elaborate on the example discussed in Section First-level pricing sales variance analysis: price–volume variance and assume that EUR is the reporting currency but that actual sales are made in USD (for the sake of conversation it is assumed that there are no bank fees for converting currencies, meaning the *buy* and *sell* exchange rates coincide with one simple exchange rate). In that case, we can and need to disaggregate price variance into the following two components: (1) price variance at fixed exchange rate and (2) Fx rate variance. This disaggregation makes it possible to clearly differentiate between what has been achieved by the company through price (i.e., price variance at fixed exchange rate), on the one hand, and what has been determined by external factors (i.e., Fx rate variance), on the other hand.

Then, let us assume that last year, the price in local currency was 16 USD, while, this year, the price is 15 USD. Accordingly, the EUR/USD exchange rate has changed from 0.9375 last year to 1.2 this year.

Based on the data, we calculate price variance at fixed exchange rate and Fx rate variance as follows:

$$\begin{aligned}
&\text{Price variance @ fixed exchange rate}\\
&= \left(P_{\mathrm{CY}} \text{ in Local currency @ FxRate LY} - P_{\mathrm{LY}} \text{ in Local currency @ FxRate LY}\right) * Q_{\mathrm{CY}}\\
&= (15 \text{ USD} * 0.9375 - 16 \text{ USD} * 0.9375) * 11\\
&= -10.31 \text{ EUR}
\end{aligned}$$

$$\begin{aligned}
&\text{FxRate variance}\\
&= \left(P_{\mathrm{CY}} \text{ in Local currency @ FxRate CY} - P_{\mathrm{CY}} \text{ in Local currency @ FxRate LY}\right) * Q_{\mathrm{CY}}\\
&= (15 \text{ USD} * 1.2 - 15 \text{ USD} * 0.9375) * 11\\
&= 43.31 \text{ EUR}
\end{aligned}$$

From the formulae above, we see that, in line with our calculation in Section First-level pricing sales variance analysis: price–volume variance, the total price variance is 33 EUR:

$$\begin{aligned}
&\text{Price variance}\\
&= \text{Price variance@fixed exchange rate} + \text{FxRate variance} = -10.31 + 43.31 = 33 \text{ EUR}
\end{aligned}$$

However, if the calculation of price variance is done using only the simple formula $(P_{CY} - P_{LY}) * Q_{CY}$, a lot of valuable information would be ignored. If a company operates in multiple markets and deals with various currencies, evaluating consolidated results in reporting currency is not sufficient. In the example above, it is the disaggregation of price variance into price variance at fixed exchange rate and Fx rate variance that allows us to reveal that actual price decreased (which is the opposite effect as compared to what we see if we analyze results only in the reporting currency), and that positive price variance should be solely attributed to favorable currency exchange rate movements.

Impact of product portfolio mix

This section discusses the disaggregation of volume variance. As discussed previously, unlike in the ideal scenario of a company selling one product, in the business world, companies are selling multiple products (in fact, hundreds or even thousands of products) instead of just one.

For the sake of simplicity, let us consider the example of a company that sells two products. Corresponding prices and volumes are summarized in Table 2.

As shown in Table 2, prices of both products have increased by 10% from the previous year with respect to the current year. The total quantity of sold products has also increased by 10%. Nevertheless, total revenue has decreased by 8 EUR. A closer look at the performance of each of the two products suggests that the quantity of Product 1 increased (from 60 to 85), while that of Product 2 decreased (from 40 to 25).

A possible managerial interpretation of this result is that the two products are substitutes, and a price increase of 10% has incentivized customers to switch from the higher-priced product (Product 2) to the lower-priced alternative (Product 1). As a result, total revenue has suffered even though they managed to sell a higher number of units.

While this interpretation is intuitive, the calculation of mix variance makes it possible to quantify this effect. To this end, we need to calculate the sold quantity for each product, assuming there has been no change in product mix. As shown in Table 2, the LY mix has been 60% (Product 1) and 40% (Product 2). Provided there was no change in the mix, 66 units of Product 1 and 44 units of Product 2 would be sold. Based on this, we can calculate *quantity variance* (i.e., share of volume variance with fully eliminated mix variance) and *mix variance* (i.e., share of volume variance coming exclusively from a change in product mix).

These variances need to be calculated for each product separately and then summed up. The corresponding formulas are as follows:

$$\text{Quantity variance} = \sum_i \left(Q_{CY}@\text{LY Mix}_i - Q_{LYi}\right) * P_{LYi}$$

$$= (66-60) * 2 + (44 - 40) * 6 = 12 + 24 = 36 \text{ EUR}$$

Mix variance

$$= \sum_i \left(\text{Q}_{CYi} - Q_{CY}@\text{LY Mix}_i\right) * P_{LYi}$$

$$= (85 - 66) * 2 + (25 - 44) * 6$$

$$= 38 + (-114) = -76 \text{ EUR}$$

The calculations above show that Product 2 has a strongly negative mix variance, which leads to negative volume variance and a decrease in total revenue. Eventually, summing quantity variance and mix variance yields volume variance (see below):

$$\text{Volume variance} = \text{Quantity variance} + \text{Mix variance}$$
$$= 36 + (-76) = -40 \text{ EUR}$$

When dealing with large portfolios, it might be difficult to use mix variance and interpret its implications. However, mix variance analysis can be extremely useful to estimate changes in one specific product category or group. It can reveal whether price changes in supplementary or substitute products have led to favorable changes in product mix and, eventually, have contributed to total revenue growth. Mix variance analysis can also reveal that the introduction of low-price products cannibalized sales of high-price value-added products, meaning that, even with increased sales, the company is worse off at the end.

Best practices and criteria for exclusion

When bridging theory with practice, one may find special scenarios to be particularly daunting. In this section, we discuss the most critical and common circumstances that

Table 2 Two products with varying price and volume levels

	Price LY	Price CY	Quantity LY	Quantity CY	Revenue LY	Revenue CY	Volume variance	Price variance
Product 1	2	2.2	60	85	120	187	50	17
Product 2	6	6.6	40	25	240	165	− 90	15
Total			100	110	360	352	− 40	32

financial managers and C-level decision makers encounter when using sales variance analysis. On some occasions, a product may have a list price, but coming from a period prior to the ones analyzed leaving doubt of whether it should be used or not. In other cases, a product may not have one unique price but one dependent on the quantity purchased—the common case of tiered/scale pricing. In cases like these, the practitioners' experience can be invaluable. The following paragraphs aim at illustrating the most common special cases that can be found in business life and how to solve them.

Tiered or scale pricing

Companies practice *tiered* or *scale pricing* in many industries, meaning that different prices are quoted for different volume brackets. For example, if a customer buys 1–10 units of a product, the unit price is 100 EUR. Furthermore, if the purchase amount ranges from 11 to 100 units, the unit price decreases to 50 EUR. Finally, if the purchased amount exceeds 100 units, then the unit price drops to 25 EUR. Analyzing such pricing structure using sales variance analysis can be a challenging task. For instance, if the company sold 150 units at the unit price of 25 EUR in the previous year and 9 units at the unit price of 100 EUR in the current year, simple sales variance analysis would yield the following results:

$$\begin{aligned}\text{Price variance} &= \left(P_{\mathrm{CY}} - P_{\mathrm{LY}}\right) * Q_{\mathrm{CY}} \\ &= (100-25) * 9 \;=\; 675 \text{ EUR}\end{aligned}$$

$$\begin{aligned}\text{Volume variance} &= \left(Q_{\mathrm{CY}} - Q_{\mathrm{LY}}\right) * P_{\mathrm{LY}} \\ &= (9-150) * 25 \;=\; -\,3'525 \text{ EUR}\end{aligned}$$

As shown in the results, volume variance is strongly negative, which is explained by the dramatic decrease in the number of sold items (from 150 to 9 units). In contrast, the effect of price variance is positive and very strong. Furthermore, while the calculations presented above are mathematically correct, they are difficult to interpret from a business perspective. In this instance, price increases due to the bracket of reference change from high volume/low price to low volume/high -price, and not due to a higher negotiated price.

Therefore, a better approach would be to run sales variance analysis separately for each volume–price bracket and then aggregate the results on the product level. This approach would help to eliminate price variances when purchased products move across brackets. This best practice makes it possible to capture price variances only when there are actual price changes within each volume–price bracket.

Volume discounts/end-of-year rebates

Volume discounts—that is, price reductions offered to customers reaching a certain sales amount—are a consolidated practice in virtually every industry. Volume discount can be expressed as a percentage of current-year or next-year sales or as an absolute amount (end-of-year rebate). This raises the question of how to treat volume discounts and rebates using sales variance analysis.

Here, while there is no single "correct" approach, and different companies apply different approaches, the common practice is to ignore these effects, as it is virtually impossible to assign a given discount/rebate to an individual product. Moreover, decisions about volume discounts/rebates might come from managerial levels different from those that are being optimized through sales variance analysis. In fact, sales variance analysis is frequently used to improve the performance of sales and pricing managers—that is, employees who are not usually responsible for assigning volume discounts/rebates. Therefore, in order not to pollute the performance of departments or managers with the effects that are not attributable to those departments and managers, a justified practice is to omit volume discounts/rebates from sales variance analysis.

New Products

In the case of new products (for which sales start only in the current year), no price and volume information from the previous year is available. In this situation, the common approach is to assume that price in the previous year is the same as in the current year. For considerations of validity, it cannot be assumed that price was 0, as the 0 value would invalidate the results. However, concerning volume, it is valid to assume that volume increased from 0 units to any number of units.

Let us consider an example where, in the current year, a company launched a new product and sold 10 units at the unit price of 5 EUR. Sales variance calculation yields the following results:

$$\text{Price variance} = \left(P_{\mathrm{CY}} - P_{\mathrm{LY}}\right) * Q_{\mathrm{CY}} = (5-5) * 10 = 0$$

$$\begin{aligned}\text{Volume variance} &= \left(Q_{\mathrm{CY}} - Q_{\mathrm{LY}}\right) * P_{\mathrm{LY}} \\ &= (10-0) * 5 \;=\; -\,50 \text{ EUR}\end{aligned}$$

In this case, total sales variance can be fully attributed to volume variance. From a business perspective, this is logical, as no products were sold last year, so there cannot be any price variance.

Discontinued Products

In contrast, new products discussed in Section New Products, discontinued products are products that were sold last year, but had no sales in the current year. Accordingly, no price and volume information for the current year is available. As in the example in Section New Products, the common practice is to assume that price in the current year is the same as that in the previous year.

Therefore, if a company sold 10 units at the unit price of 5 EUR in the previous year, but 0 units in the current year, sales variance calculation yields the following results:

$$\text{Price variance} = \left(P_{\text{CY}} - P_{\text{LY}}\right) * Q_{\text{CY}} = (5-5) * 10 = 0$$

$$\begin{aligned}\text{Volume variance} &= \left(Q_{\text{CY}} - Q_{\text{LY}}\right) * P_{\text{LY}} \\ &= (0-10) * 5 = -50 \text{ EUR}\end{aligned}$$

As in the example with new products discussed in Section New products, total sales variance in the case of discontinued products can be fully attributed to volume variance.

Reactivated products

In another scenario, there are no sales of a given product in one year in-between the other two years where sales of a given product took place. Therefore, this scenario encompasses the circumstances of both new and discontinued products discussed in Sects. New products–Discontinued products.

Let us consider an example where a company sold 10 units of a product at the unit price of 5 EUR in Year-2 had no sales of this product in Year-1, and then sold 9 units of the product at the unit price of 6 EUR in the current year (Year-0, see Table 3). Let us assume that the management wants to understand sales performance in the current year.

In this situation, two available approaches to perform calculations using sales variance analysis are available. The first approach (Approach 1) is to strictly apply basic formulas (see below).

$$\text{Price variance} = \left(P_{\text{CY}} - P_{\text{LY}}\right) * Q_{\text{CY}} = (6-6) * 9 = 0$$

$$\text{Volume variance} = \left(Q_{\text{CY}} - Q_{\text{LY}}\right) * P_{\text{LY}} = (9-0) * 6 = 54 \text{ EUR}$$

Table 3 Varying quantity and price over time

Sales	Year-2	Year-1	Year-0
Quantity	10	0	9
Price	5	NA	6
Total	50	0	54

One of the advantages of this approach is straightforward, as it applies sales variance formulas to compare Year-0 to Year-1. Another advantage of this method is that it is easy to implement. However, its limitation is that it assumes there is no historical price, so it does not provide business insights.

The second approach (Approach 2) is to apply business logic. Here, instead of considering the product as new in Year-0, it can be considered as reactivated, implying that the company holds historic price information from another period that can be used in the calculation. Admittedly, investigating past prices can be a time-consuming activity. With this approach, the last available price (from Year-2 in our example) is used to calculate price variance, while the traditional formula is applied for volume variance (i.e., Year-0 vs. Year-1 in this case).

The calculation was performed as follows:

$$\begin{aligned}\text{Price variance} &= \left(P_{\text{CY}} - P_{\text{LY<-LAST AVAILABLE YEAR}}\right) * Q_{\text{CY}} \\ &= (6-5) * 9 = 9 \text{ EUR}\end{aligned}$$

$$\text{Volume variance} = \left(Q_{\text{CY}} - Q_{\text{LY}}\right) * P_{\text{LY}} = (9-0) * 5 = 45 \text{ EUR}$$

Both Approach 1 and Approach 2 outlined above are correct; the trade-off is between faster results or more insights on given products.

For instance, when a product witnesses a 2-year replacement cycle (e.g., a customer replaces air-filters every two years), Approach 2 (but not Approach 1) guarantees that price changes are captured in the analysis—with respect to the last known price. Conversely, Approach 2 (but not Approach 1) can be applied to longer time horizons until a last available price can be found.

The practitioner's interpretation: the right timeframe

Practitioners agree that investigating prices makes sense only up to a specific point. As a rule of thumb, prices older than five years are typically no longer relevant, as they refer to products that changed even if they maintained the same SKU, or COGS had varied considerably, and the different prices are not comparable, or the effort to find these prices is not justified by their contribution to total sales (if there have been no sales over many years, this is usually the case).

Product level vs. customer-product level

Sales variance analysis can be performed on the product level or the customer-product level. The former level of sales variance analysis is mostly used when there are no client-specific pricing policies, as in the case of retail or "commodity" industries.

The latter level is mostly used in the B2B industry. In this case, the analysis focuses on a product at a time in

the customer portfolio, with the subsequent tracing of its evolution over time. This is so because some policies and actual prices are usually dealt with on the single-customer level, with individual tailoring that cannot be generalized to the entire company. Analyses on the product-customer level are the quintessential elements in the pricing toolbox for sales directors and sales managers to always improve performance.

The practitioner's interpretation: commodity

The reference to "commodity" is used in this example to convey the idea of a "fix" price as in the commodity stock market, where even "fix" is arguable as it is dynamic in nature. Practitioners agree on one thing: "commodities" do not exist in the business practice. Companies will always find an angle to prove to customers that their product is worth a premium or at least worth choosing against an equally priced offer. Even non-product benefits, such as a faster turn-around/delivery, or ease of doing business, or geographical proximity, can be leveraged to differentiate a company from its competitors. Claiming to be in a "commodity industry" is a self-fulfilling prophecy ending in the erosion of margins up to the point of no return.

Summary of formulae

In this section, we summarize the formulae used in this paper for quick reference.

First-level pricing sales variance analysis

$$\text{Sales variance} = \text{Price variance} + \text{Volume variance}$$
$$\text{Price variance} = \left(\mathrm{P_{CY}} - \mathrm{P_{LY}}\right) * \mathrm{Q_{CY}}$$
$$\text{Volume variance} = \left(\mathrm{Q_{CY}} - \mathrm{Q_{LY}}\right) * \mathrm{P_{LY}}$$
$$\text{Price variance, \%} = \text{Price variance} / \left(\mathrm{Q_{CY}} * \mathrm{P_{LY}}\right)$$

Second-level pricing sales variance analysis

$$\begin{aligned}\text{Sales variance} &= \text{Price variance} + \text{Volume variance}\\ &= \big(\text{Price variance@fixed exchange rate}\\ &\quad + \text{FxRate variance}\big)\\ &\quad + (\text{Quantity variance} + \text{Mix variance})\end{aligned}$$

$$\begin{aligned}&\text{Price variance @ fixed exchange rate}\\ &= \big(P_{\mathrm{CY}} \text{ in Local currency @FxRate LY}\\ &\quad - P_{\mathrm{LY}} \text{ in Local currency@FxRate LY}\big) * Q_{\mathrm{CY}}\end{aligned}$$

$$\begin{aligned}&\text{Fx rate variance} = \big(P_{\mathrm{CY}} \text{ in Local currency@FxRate CY}\\ &\quad - P_{\mathrm{CY}} \text{ in Local currency@FxRate LY}\big) * Q_{\mathrm{CY}}\end{aligned}$$

$$\text{Quantity variance} = \sum_{\mathrm{i}} (Q_{\mathrm{CY}} \text{@LY Mix}_i - \mathrm{Q_{LY}}_i) * P_{\mathrm{LY}i}$$

$$\text{Mix variance} = \sum_{i} \left(Q_{\mathrm{CY}i} - Q_{\mathrm{CY}} \text{@LY Mix}_i\right) * \mathrm{P_{LY}}_i$$

Notations: P is price, Q is Quantity, LY is last year, CY is current year, Q_{CY} @ LY Mix $_{\mathrm{I}}$ is total quantity sold (for all products) in current year multiplied by last year product mix weight for product i, $Q_{\mathrm{CY\,I}}$ is current year quantity for product I, $\mathrm{Q_{LY\,I}}$ is last year quantity for Product I, and $P_{\mathrm{LY\,I}}$ is last year price for Product i.

Practice example—application of key concepts discussed

This section illustrates the usefulness of core concepts discussed herein to a real, albeit anonymized, company (Table 4).

A. Price + volume in same currency—first-level pricing sales variance analysis

In Product A, two opposite forces are at play: a price increase of EUR 0.50 and a volume decrease of 5 units. The resulting sales variance is EUR 30. The net result of EUR 30 comes from a negative volume variance of EUR -40 (cell: Prod. A-TOT Vol Var) and a positive price variance of EUR 70 (cell: Prod. A-TOT P. Var). Overall, the result is positive in terms of sales.

A company may decide to implement a price increase to offset increasing COGS, or after finding out the customer's or customer segment's willingness to pay through conjoint analysis on customer preferences. The fact that the net result is positive, is not a reason to let decreasing volume go unnoticed: a better communication to customers of value differentials vis-à-vis the customer's best alternative can prove that the price premium is actually an investment that pays for itself; consultants use value quantification techniques to financially quantify the competitive advantages and avoid a decrease in units sold. Examples of such competitive advantages are as follows: energy savings, longer lifecycle, lower maintenance costs, lower defects in output, and better post-sales service.

Table 4 Three products, two currencies variances

1	Prod	Curr	P. (LY) in Local Cur	P. (CY) in Local Cur	FX rate LY (to EUR)	FX rate CY (to EUR)	P. (LY) in EUR	P. (CY) in EUR	Qnt LY	Qnt CY	Sales LY EUR
2	Prod. A	EUR	8	8.5	1	1	8.00	8.50	145	140	1,160.00
3	Prod. B	USD	12	12.7	1.1	1.25	10.91	10.16	100	105	1,090.91
4	Prod. C	EUR	12	11.7	1	1	12.00	11.70	130	140	1,560.00
5	Total	375	385	38,111.91							

1	Prod	Curr	Sales CY Curr	Sales Var	P. Var @ fixed EXCH rate	FX rate Var	Tot P. Var	Qnt Var	Mix Var	Total Vol Var
2	Prod. A	EUR	1,190.00	30.00	70.00	70.00	30.93	− 70.93 to 40.00		
3	Prod. B	USD	1,066.80	− 24.11	66.82	− 145.47	− 78.65	29.09	25.45	54.55
4	Prod. C	EUR	1,638.00	78.00	− 42.00		− 42.00	41.60	78.40	120.00
Total	3894.80	83.89	94.82	− 145.47	− 50.65	101.62	32.92	134.55		

B. Price + volume @ fixed exchange rate—second-level pricing sales variance analysis

Product B requires the practitioner to account for the exchange rate. Examining financial results under the lens of exchange rate allows to get a clearer financial picture for the mother company, but does have the limitation of ignoring the performance of the subsidiary: *ceteris paribus*, a weak currency where the subsidiary operates may make a record year look like a losing one; C-level managers should therefore evaluate a subsidiary's performance disregarding exchange rates.

One way to offset the risks associated with changing foreign exchange rates is through financial instruments such as hedged ETFs, or contractually asking customers to pay predetermined amounts in the local currency of the mother company. In markets with high volatility, positive or negative effects of Fx rate are a reality that can hardly be predicted and does represent risks for the companies operating there: such companies should charge their customers a *risk premium* for doing business with them and explain—through value quantification—why the premium is fair and the offering still attractive. Alternatively, they should be prepared to walk away from unprofitable/risky deals.

C. Mix variance—second-level pricing sales variance analysis

Product C sees a volume increase (140 vs 130 = 7.7%) stronger than the relative price decrease (11.7 vs 12 = − 2.5%). The volume growth of product C is greater than the volume growth of the whole portfolio (385 vs 375 = 2.7%). The generated mix effect for this product (EUR 78.4) is the strongest of the portfolio.

Under a managerial point of view, this scenario could be the result of a product with high elasticity: demand changes with larger magnitude than the associated price change with opposite sign, as in the case of a durable product purchased infrequently that customers can stock up. A pricing strategy practitioner may bundle this product with others where customers are more price sensitive. Alternatively, ad hoc thresholds could be set in order to give discounts only if quantity is increased significantly, a tactic called tiered-pricing designed to win a larger share of the customer's portfolio.

Visual representation of sales variance analysis

Upon completing the arithmetic part of sales variance analysis, the next step enabling one to quickly grasp, interpret, and act upon complex data, is visualization. To this end, using a series of waterfall charts, anchored to have the "same

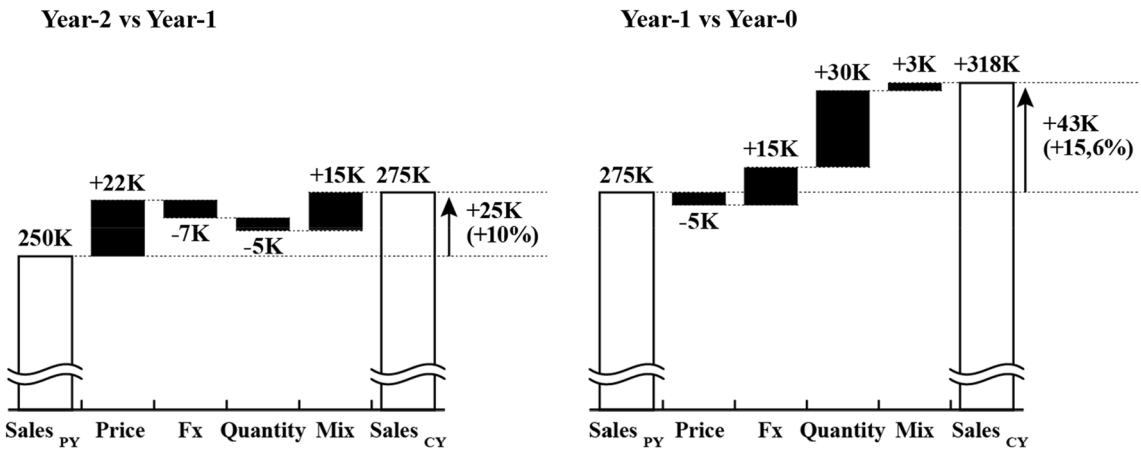


Fig. 7 Two full-period analyses

year" aligned, is recommended. Figure 7 provides such an example, it is worth noticing that sales bars of EUR 275 K are aligned, as they represent the same year.

The practitioner's interpretation: multi-period analysis

The example in Fig. 7 shows that, in 'Year -1,' the company witnessed a strong positive price variance in local currency, albeit slightly offset by a negative Fx rate variance. With respect to volume, the quantity of sold items decreased; however, as revealed by the positive mix variance, the company was able to upsell customers away from lower-priced products and onto higher-priced ones.

Furthermore, in Year-0, a comparison with Year-1 yields a different result: price variance was negative, yet offset by a positive change in currency Fx rate. With regard to volume, as demonstrated by the positive quantity variance, the company increased the total quantity of sold items; similarly, as depicted by the positive mix variance, the share of high-priced products also increased.

A company with clear data on contribution margin for selected products can also determine whether a loss in volume is offset by a price increase. From a hierarchical point of view, sales variance analysis unfolds in the following order: first, full company level, followed by filtering by product groups, countries, regions, customers, and, finally, if such granularity is needed, the analysis continues on individual products.

Limitations and future venues of research

Current research does not provide any solid measure of the impact of implementing sales variance. The authors believe it can improve EBITDA for the equivalent of 0.1% to 5% of sales for most companies, but a more solid, precise, and industry-specific benchmark is much needed. The task is daunting: some companies may apply sales variance effectively while others only marginally; different industries in different countries or companies of different sizes may reap benefits differently. In our consulting firm, the minimum return of a typical project is equivalent to 200 basis points of sales directly going into superior profitability (EBITDA), in most occasions far more than this; the *engineering* of the levers responsible for this improvement—such as price changes, adoption of new discounting guidelines, simplification of controlling mechanisms, vertical delegation of pricing authority, just to name a few—starts from the results of sales variance at least half of the times, making it the most critical single element of a pricing improvement initiative.

It is worth noting that sales variance analysis allows to get a better understanding of a firm's revenue sources, as it provides a snapshot of current and past sales data which one can use to make 'educated decisions' moving forward, but a limit it has is that it does not represent a predictor of how demand will behave with changing prices. To predict demand behavior, a company could analyze the elasticity of demand for each customer segment: a possible contribution to the literature could be investigating such effects and perhaps going as far as suggesting the best strategies that companies with different cost structures (ex.: high vs low fix costs) could adopt.

Another interesting research area is combining the hallowed yet simple (Guidry et al. 1998) management accounting tool of Cost Volume Profit analysis with sales variance in order to pinpoint the ideal margin ranges where sales variance works best, as in low- versus high-margin products. The excessive focus on sales and volume rather than on price and margin can be put in perspective by the adoption of CVP, being one element in the overall pricing efforts (Hinterhuber 2004).

Expanding on what we treated in Section Best practices and criteria for exclusion, namely, providing best practices coming from the real business world, as well as complementing the latter with how any obstacle found has been overcome—may that be in information retrieval, analysis implementation, or obtaining the buy-in from the stakeholders of the company—is the best and most useful contribution one can make.

Finally, we believe that pricing is a distinct discipline from change management, but the two go hand-in-hand; it could be interesting to measure the results provided by the implementation of sales variance in change management initiatives, perhaps making it a quick-win to drive the buy-in of stakeholders, complementing what Kotter (1995) suggests.

Conclusions

Sales variance analysis is the tool that practitioners, C-level managers, and business analysts can effectively use to gain meaningful insights from their transactional data. The most obvious rewards of using this analysis include—but are not limited to—acquiring a better interpretation of past pricing initiatives and gaining more confidence in implementing and monitoring new ones.

More specifically, practitioners should base and incorporate the insights derived from the results of sales variance analysis in all price change recommendations. In the area of customer segmentation, practitioners can use the findings of sales variance analysis to infer groupings from purchase patterns and to make informed strategic decisions.

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