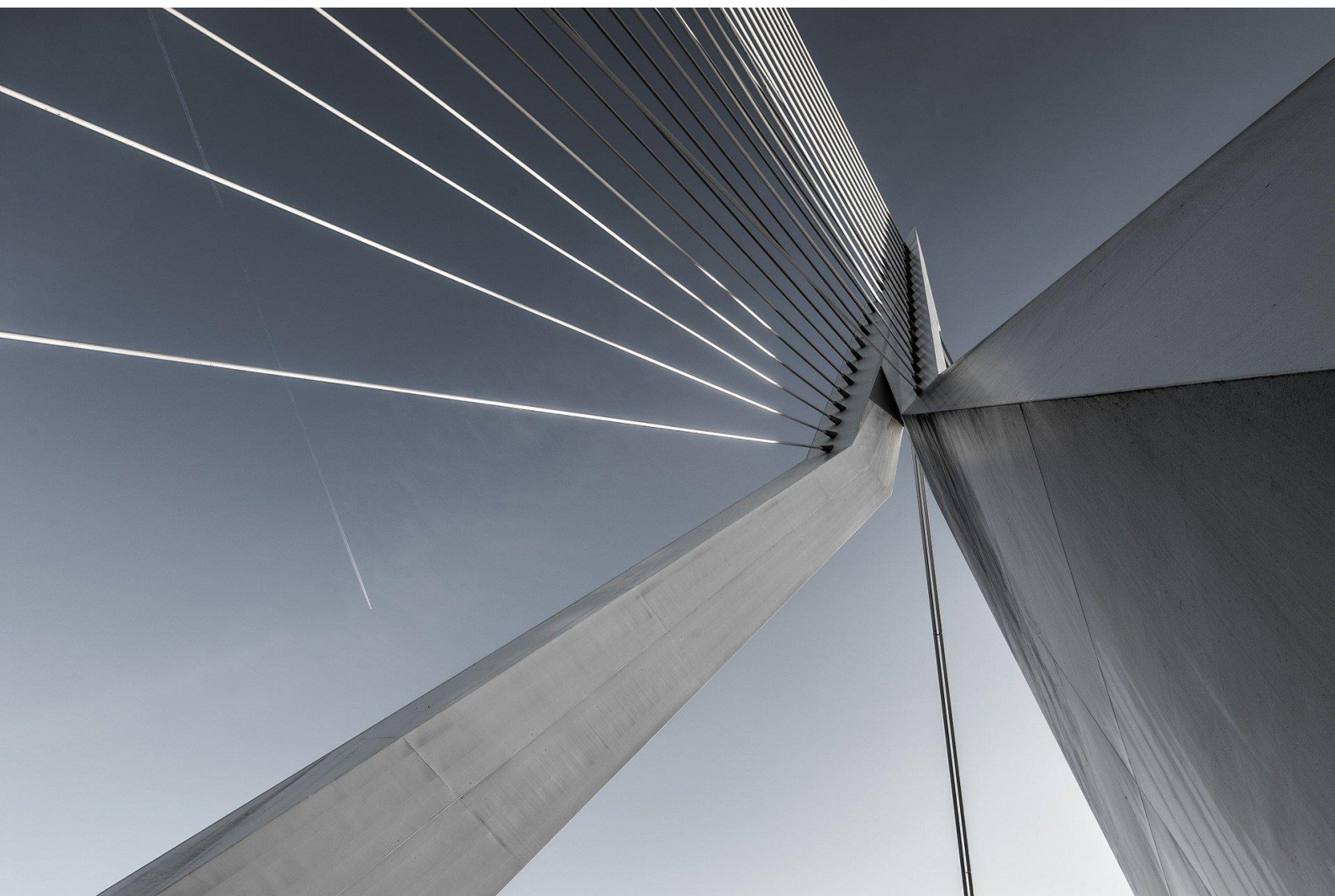


# Becoming the Master of Factor Analysis of Profit: Secrets of Calculation



Marina Gorodnicheva

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## CONTENTS

<b>INTRODUCTION .....</b>	<b>3</b>
<b>EXAMPLES PART 1 .....</b>	<b>6</b>
<b>FACTOR ANALYSIS OF NET SALES.....</b>	<b>6</b>
STEP-BY-STEP SOLUTION.....	9
FACTOR ANALYSIS OF NET SALES – FORMULAS .....	11
<b>FACTOR ANALYSIS OF COST OF SALES.....</b>	<b>14</b>
<b>FACTOR ANALYSIS OF GROSS MARGIN .....</b>	<b>15</b>
GROSS MARGIN IN %. CONTRIBUTION OF PRODUCTS.....	16
FACTOR ANALYSIS OF GROSS MARGIN – FORMULAS .....	18
RESULTS INTERPRETATION.....	21
<b>GENERAL FORMULAS (unlimited number of factors) .....</b>	<b>23</b>
FORMULAS .....	25
<b>EXAMPLES PART 2 .....</b>	<b>28</b>

## INTRODUCTION

In the [introductory article to the factor analysis of profit](#), we discussed the benefits and objectives of this economic tool, its importance for understanding how your business performs and deciding in which direction it should evolve. Having taken a close look at the variety of possible influencing factors and the necessary steps to determine them, now we turn to the calculation details and the interpretation of the results.

This article will cover the most essential aspects and nuances of decomposing your revenues and expenses into price, volume, assortment mix, material cost change and other contributions. You will be able to define profit drivers and killers, find the reasons behind gains or losses, and transform your business performance into meaningful insights. Get ready to become the Master of Factor Analysis!

### Before we start

First, let us introduce the terminology that we use:

$$\text{Net Sales} = \text{Sales at invoiced prices} - \text{Returns} - \text{Allowances} - \text{Discounts}$$

$$\text{Net Sales} = \text{Number of Units sold (Qty)} \times \text{Net Price}$$

$$\text{Cost of Sales (COS)} = \text{Number of Units sold (Qty)} \times \text{Cost per unit}$$

$$\text{Gross Margin} = \text{Net Sales} - \text{COS}$$

$$\text{Gross Margin in \%} = \frac{\text{Gross Margin}}{\text{Net Sales}} \times 100\% = \frac{\text{Net Sales} - \text{COS}}{\text{Net Sales}} \times 100\%$$

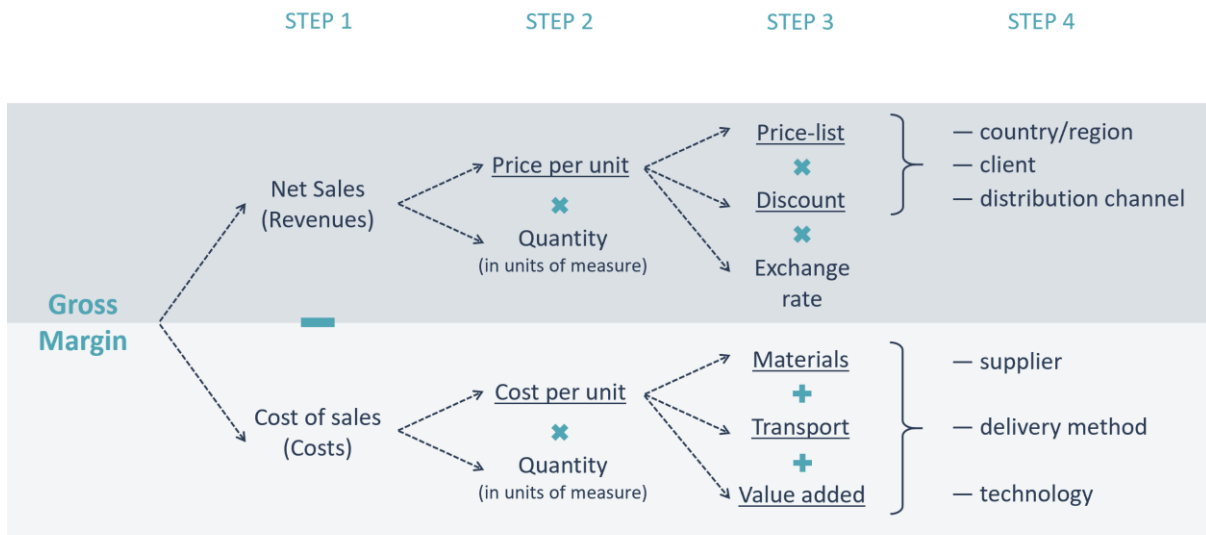
$$\text{Average Net Price} = \frac{\text{Total Net Sales}}{\text{Total Qty}}$$

$$\text{Average Cost per unit} = \frac{\text{Total COS}}{\text{Total Qty}}$$

$$\text{Average Gross Margin per unit} = \frac{\text{Total Gross Margin}}{\text{Total Qty}}$$

### Contents

Decomposition into factors is most frequently applied to explain the variances of sales, costs, gross margin and gross margin in %.



Referring to the scheme of factors determination above (described earlier in the introductory article), in Part 1 of this article we will explain how to calculate the impacts of volume, assortment mix, price and cost on the evolution of gross margin (corresponds to STEP 2 of the scheme), and in Part 2 we will go further by breaking down net prices into list prices and discounts, and costs – into materials and value added (STEP 3 of the scheme).

We will start each part by decomposing the evolution of net sales into factors (in values and in %), moving to the evolution of cost of sales (in values and in %), and, finally, – the evolution of gross margin (in values and in percentage points). Also, we will calculate the contribution of each product to the total evolution of gross margin.

Examples Part 1

- The evolution of net sales (3 factors): volume, assortment mix, net price
- The evolution of cost of sales (3 factors): volume, assortment mix, cost per unit
- The evolution of gross margin (4 factors): volume, assortment mix, net price, cost per unit

General formulas (unlimited number of factors)

Examples Part 2

- The evolution of net sales (4 factors): impacts of volume, assortment mix, list price, price discount
- The evolution of cost of sales (4 factors): impacts of volume, assortment mix, material cost per unit, value added cost per unit
- The evolution of gross margin (6 factors): impacts of volume, assortment mix, list price, price discount, material cost per unit, value added cost per unit

**We recommend studying the Excel file accompanying this article for better understanding.** It was created in MS Office 365 (check for compatibility).

Further text will be entirely practical and will contain formulas to explain the calculations demonstrated in the Excel file.

**Examples**

Below are 4 examples based on hypothetical data (sheet "Examples" in Excel file).

Table 1

Example 1	N-1		Evolution N/N-1		
	Product	Qty	Net Price	Qty	Net Price
	A	100	10,00 €	+10,0%	0,0%
	B	100	2,00 €	+10,0%	0,0%

Example 2	N-1		Evolution N/N-1		
	Product	Qty	Net Price	Qty	Net Price
	A	100	10,00 €	+15,0%	0,0%
	B	100	2,00 €	-15,0%	0,0%

Example 3	N-1		Evolution N/N-1		
	Product	Qty	Net Price	Qty	Net Price
	A	100	10,00 €	0,0%	+10,0%
	B	100	2,00 €	0,0%	+10,0%

Example 4	N-1			Evolution N/N-1			
	Product	Qty	Net Price *	Cost /unit **	Qty	Net Price	Cost /unit
	A	100	10,00 €	8,50 €	+25,0%	-7,0%	-5,0%
	B	100	2,00 €	1,00 €	-5,0%	+10,0%	+2,0%

Product	Price		Materials		Price		Materials	
	List Price	discount in %	/unit	Value added /unit	List Price	discount in %	/unit	Value added /unit
A	14,00 €	28,6%	5,95 €	2,55 €	-5,0%	+1,5 pp	-3,5%	-8,5%
B	2,40 €	16,7%	0,40 €	0,60 €	+5,0%	-4,0 pp	+5,0%	0,0%

\* [ Net price ] =[ List price ] x ( 1 - [Price discount in %] )  
 \*\* [ Cost /unit ] =[ Materials ] + [Value added]

Each example consists of 2 products A and B and shows initial values (number of units sold (qty), net prices, and costs – Ex.4) at the period N-1, and the evolution of these values (in % or in percentage points) at the period N versus N-1.

## EXAMPLES PART 1

### FACTOR ANALYSIS OF NET SALES

Let's start by calculating the impacts of factors on net sales. Below are the solutions for Examples 1-3 (*sheet "Part1\_Sales" in Excel file*).

As you can see in Table 2, these examples represent the simplest situations with only one influencing factor.

#### **Example 1. Volume effect**

Total volume (quantities sold) has increased by 20 units and by 10%. Mix of products hasn't changed, since the shares of products A and B are the same in both compared periods N-1 and N, or, in other words, products A and B have grown in quantities by the same percentage +10%. Prices of products A and B remain constant.

Net sales have grown by 120 € and by 10% due to volume effect. Average net price hasn't changed.

#### **Example 2. Mix effect**

Total volume variance is equal to 0 (200 units in N-1 versus 200 units in N), so we can say that volume hasn't changed. Prices of both products are also the same in 2 periods. However, net sales and average net price have increased because the shares of products A and B have changed (from 50% to 57,5 % and from 50% to 42,5% correspondingly).

Net sales have grown by 120 € and by 10% due to mix effect. Average net price has grown by 0,6 € and by 10%.

#### **Example 3. Price effect**

Here quantities remain the same for both products, so, there is neither volume nor mix effect. Only prices have increased by 10%.

Net sales and average net price have increased by 10% due to price effect.



Table 2

Example 1 (sales)		VOLUME EFFECT																			
INPUT:		→ SOLUTION:																			
Product	N-1		Evolution N/N-1		Product	N-1					N					Evolution		Evolution in % / pp			
	Qty	Net Price	Qty	Net Price		Qty	Share in Qty	Net Price	Net Sales	Share in Sales	Qty	Share in Qty	Net Price	Net Sales	Share in Sales	Qty	Net Price	Net Sales	Qty (%)	Net Price (%)	Net Sales (%)
A	100	10,00 €	+10,0%	0,0%	A	100	50,0%	10,00 €	1 000 €	83,3%	110	50,0%	10,00 €	1 100 €	83,3%	+10	0,00 €	+100 €	+10,0%	0,0%	+10,0%
B	100	2,00 €	+10,0%	0,0%	B	100	50,0%	2,00 €	200 €	16,7%	110	50,0%	2,00 €	220 €	16,7%	+10	0,00 €	+20 €	+10,0%	0,0%	+10,0%
<b>Total</b>	<b>200</b>	<b>6,00 €</b>	<b>1 200 €</b>	<b>100,0%</b>	<b>Total</b>	<b>200</b>	<b>100,0%</b>	<b>6,00 €</b>	<b>1 200 €</b>	<b>100,0%</b>	<b>220</b>	<b>100,0%</b>	<b>6,00 €</b>	<b>1 320 €</b>	<b>100,0%</b>	<b>+20</b>	<b>0,00 €</b>	<b>+120 €</b>	<b>+10,0%</b>	<b>0,0%</b>	<b>+10,0%</b>
																	=Volume effect		=Volume effect in %		
Example 2 (sales)		MIX EFFECT																			
INPUT:		→ SOLUTION:																			
Product	N-1		Evolution N/N-1		Product	N-1					N					Evolution		Evolution in % / pp			
	Qty	Net Price	Qty	Net Price		Qty	Share in Qty	Net Price	Net Sales	Share in Sales	Qty	Share in Qty	Net Price	Net Sales	Share in Sales	Qty	Net Price	Net Sales	Qty (%)	Net Price (%)	Net Sales (%)
A	100	10,00 €	+15,0%	0,0%	A	100	50,0%	10,00 €	1 000 €	83,3%	115	57,5%	10,00 €	1 150 €	87,1%	+15	0,00 €	+150 €	+15,0%	0,0%	+15,0%
B	100	2,00 €	-15,0%	0,0%	B	100	50,0%	2,00 €	200 €	16,7%	85	42,5%	2,00 €	170 €	12,9%	-15	0,00 €	-30 €	-15,0%	0,0%	-15,0%
<b>Total</b>	<b>200</b>	<b>6,00 €</b>	<b>1 200 €</b>	<b>100,0%</b>	<b>Total</b>	<b>200</b>	<b>100,0%</b>	<b>6,60 €</b>	<b>1 320 €</b>	<b>100,0%</b>	<b>200</b>	<b>100,0%</b>	<b>6,60 €</b>	<b>1 320 €</b>	<b>100,0%</b>	<b>0</b>	<b>+0,60 €</b>	<b>+120 €</b>	<b>0%</b>	<b>+10,0%</b>	<b>+10,0%</b>
																	=Mix effect		=Mix effect in %		
Example 3 (sales)		PRICE EFFECT																			
INPUT:		→ SOLUTION:																			
Product	N-1		Evolution N/N-1		Product	N-1					N					Evolution		Evolution in % / pp			
	Qty	Net Price	Qty	Net Price		Qty	Share in Qty	Net Price	Net Sales	Share in Sales	Qty	Share in Qty	Net Price	Net Sales	Share in Sales	Qty	Net Price	Net Sales	Qty (%)	Net Price (%)	Net Sales (%)
A	100	10,00 €	0,0%	+10,0%	A	100	50,0%	10,00 €	1 000 €	83,3%	100	50,0%	11,00 €	1 100 €	83,3%	0	+1,00 €	+100 €	0,0%	+10,0%	+10,0%
B	100	2,00 €	0,0%	+10,0%	B	100	50,0%	2,00 €	200 €	16,7%	100	50,0%	2,20 €	220 €	16,7%	0	+0,20 €	+20 €	0,0%	+10,0%	+10,0%
<b>Total</b>	<b>200</b>	<b>6,00 €</b>	<b>1 200 €</b>	<b>100,0%</b>	<b>Total</b>	<b>200</b>	<b>100,0%</b>	<b>6,60 €</b>	<b>1 320 €</b>	<b>100,0%</b>	<b>200</b>	<b>100,0%</b>	<b>6,60 €</b>	<b>1 320 €</b>	<b>100,0%</b>	<b>0</b>	<b>+0,60 €</b>	<b>+120 €</b>	<b>0,0%</b>	<b>+10,0%</b>	<b>+10,0%</b>
																	=Price effect		=Price effect in %		

Table 3

Example 4 (sales)

VOLUME + MIX + PRICE EFFECT

INPUT: → ?

Product	N-1		Evolution N/N-1		N-1					N					Evolution			Evolution in % / pp		
	Qty	Net Price	Qty	Net Price	Qty	Share in Qty	Net Price	Net Sales	Share in Sales	Qty	Share in Qty	Net Price	Net Sales	Share in Sales	Qty	Net Price	Net Sales	Qty (%)	Net Price (%)	Net Sales (%)
A	100	10,00 €	+25,0%	-7,0%	100	50,0%	10,00 €	1 000 €	83,3%	125	56,8%	9,30 €	1 163 €	84,8%	+25	-0,70 €	+163 €	+25,0%	-7,0%	+16,3%
B	100	2,00 €	-5,0%	+10,0%	100	50,0%	2,00 €	200 €	16,7%	95	43,2%	2,20 €	209 €	15,2%	-5	+0,20 €	+9 €	-5,0%	+10,0%	+4,5%
<b>Total</b>	<b>200</b>				<b>200</b>	<b>100,0%</b>	<b>6,00 €</b>	<b>1 200 €</b>	<b>100,0%</b>	<b>220</b>	<b>100,0%</b>	<b>6,23 €</b>	<b>1 372 €</b>	<b>100,0%</b>	<b>+20</b>	<b>+0,23 €</b>	<b>+172 €</b>	<b>+10,0%</b>	<b>+3,9%</b>	<b>+14,3%</b>

What factors?      What factors?

→ STEP-BY-STEP SOLUTION:

Step 1 - volume

Qty N  
Share in Qty N-1  
Price N-1

Product	Step 0 (starting point N-1)					Step 1					Evolution			Evolution in % / pp		
	Qty	Share in Qty	Net Price	Net Sales	Share in Sales	Qty	Share in Qty	Net Price	Net Sales	Share in Sales	Qty	Net Price	Net Sales	Qty (%)	Net Price (%)	Net Sales (%)
A	100	50,0%	10,00 €	1 000 €	83,3%	110	50,0%	10,00 €	1 100 €	83,3%	+10	0,00 €	+100 €	+10,0%	0,0%	+10,0%
B	100	50,0%	2,00 €	200 €	16,7%	110	50,0%	2,00 €	220 €	16,7%	+10	0,00 €	+20 €	+10,0%	0,0%	+10,0%
<b>Total</b>	<b>200</b>	<b>100,0%</b>	<b>6,00 €</b>	<b>1 200 €</b>	<b>100,0%</b>	<b>220</b>	<b>100,0%</b>	<b>6,00 €</b>	<b>1 320 €</b>	<b>100,0%</b>	<b>+20</b>	<b>0,00 €</b>	<b>+120 €</b>	<b>+10,0%</b>	<b>0,0%</b>	<b>+10,0%</b>

=Volume effect      =Volume effect in %

Step 2 - mix

Qty N  
Share in Qty N  
Price N-1

Product	Step 1					Step 2					Evolution			Evolution in % / pp		
	Qty	Share in Qty	Net Price	Net Sales	Share in Sales	Qty	Share in Qty	Net Price	Net Sales	Share in Sales	Qty	Net Price	Net Sales	Qty (%)	Net Price (%)	Net Sales (%)
A	110	50,0%	10,00 €	1 100 €	83,3%	125	56,8%	10,00 €	1 250 €	86,8%	+15	0,00 €	+150 €	+13,6%	0,0%	+13,6%
B	110	50,0%	2,00 €	220 €	16,7%	95	43,2%	2,00 €	190 €	13,2%	-15	0,00 €	-30 €	-13,6%	0,0%	-13,6%
<b>Total</b>	<b>220</b>	<b>100,0%</b>	<b>6,00 €</b>	<b>1 320 €</b>	<b>100,0%</b>	<b>220</b>	<b>100,0%</b>	<b>6,55 €</b>	<b>1 440 €</b>	<b>100,0%</b>	<b>0</b>	<b>+0,55 €</b>	<b>+120 €</b>	<b>0,0%</b>	<b>+9,1%</b>	<b>+9,1%</b>

=Mix effect      =Mix effect in %

Step 3 - price

Qty N  
Share in Qty N  
Price N

Product	Step 2					Step 3					Evolution			Evolution in % / pp		
	Qty	Share in Qty	Net Price	Net Sales	Share in Sales	Qty	Share in Qty	Net Price	Net Sales	Share in Sales	Qty	Net Price	Net Sales	Qty (%)	Net Price (%)	Net Sales (%)
A	125	56,8%	10,00 €	1 250 €	86,8%	125	56,8%	9,30 €	1 163 €	84,8%	0	-0,70 €	-88 €	0,0%	-7,0%	-7,0%
B	95	43,2%	2,00 €	190 €	13,2%	95	43,2%	2,20 €	209 €	15,2%	0	+0,20 €	+19 €	0,0%	+10,0%	+10,0%
<b>Total</b>	<b>220</b>	<b>100,0%</b>	<b>6,55 €</b>	<b>1 440 €</b>	<b>100,0%</b>	<b>220</b>	<b>100,0%</b>	<b>6,23 €</b>	<b>1 372 €</b>	<b>100,0%</b>	<b>0</b>	<b>-0,31 €</b>	<b>-69 €</b>	<b>0,0%</b>	<b>-4,8%</b>	<b>-4,8%</b>

=Price effect      =Price effect in %

Example 4 (sales)



**Example 4. Volume/Mix/Price effects**

Such examples 1-3 are very rare in reality, in most cases we deal with numerous factors. Next, in Example 4 we will analyse all 3 factors (volume, mix and price) influencing the evolution of net sales (*sheet "Part1\_Sales" in Excel file*).

In Table 3 we see that total quantities have increased by 10%, shares of products A and B have changed (from 50% to 56,8% and from 50% to 43,2% correspondingly), prices of both products have also changed. As a result, net sales have grown by 172 € and by 14,3%, while average net price has grown by 0,23 € and by 3,9%.

Now let's analyse what factors and to what extent have impacted such evolution of net sales and average net price.

**STEP-BY-STEP SOLUTION****Step 1. Volume effect**

We will consider volume as a first factor. To calculate the impact of volume variance, we will eliminate all other factors (here – mix and price). So, let's assume that only volume has changed, which means that total quantities have increased by 10 units and by 10%, while mix of products and prices remain the same.

To be clear, the same mix of products means that the share of each product in total quantities remains the same as at the period N-1. In our example, if the share of product A remained 50%, its quantities N would be 110 units (50% from 220 units = 110 units). In other words, if quantities of each product increased by the same percentage (+10% in our example), then there would be no mix effect.

So, at Step 1 we have: quantities N recalculated so that the total amount equals 220 units and products' shares correspond to N-1; net prices N-1. By multiplying these quantities by net prices, we can calculate net sales at Step 1.

The difference between net sales at this step and net sales N-1 is volume effect (in values and in percentage).

*Net sales have increased by 120 € and by 10% due to volume effect. As for average net price, it hasn't changed.*

**Step 2. Mix effect**

The next factor is assortment mix. To calculate the impact of mix variance, we will keep in mind that volume has already changed at Step 1, prices haven't changed yet. We will take actual quantities of all products at the period N with their actual shares and net prices N-1 to calculate net sales at Step 2.

The difference between net sales at this step and net sales at previous step (Step 1) is mix effect (in values and in percentage).

*Net sales have increased by 120 € and by 9,1% due to mix effect. Average net price has also increased by 9,1% due to mix effect (even though prices for each product haven't changed yet).*

### Step 3. Price effect

Now it's time to change net prices. Net sales at this step are equal to net sales at the period N.

The difference between net sales at this step and net sales at previous step (Step 2) is price effect (in values and in percentage).

*Net sales have decreased by 69 € and by 4,8 % due to price effect. Average net price has also decreased by 4,8 % due to price effect.*

### **Results interpretation**

We have calculated the impacts of all 3 factors on net sales. Please note that at each step net sales at the current step are compared to net sales at the previous step (not to net sales at the period N-1).

To summarize, total net sales have increased by 172 €, of which +120 € due to volume growth, +120 € due to positive mix effect and -69 € due to negative price effect. In percentages: net sales have grown by 14,3%, of which +10% due to volume, +9,1% due to mix and -4,8% due to price effect.

$$172€ = 120€ + 120€ - 69€$$

$$(1 + 14,3\%) = (1 + 10\%) \times (1 + 9,1\%) \times (1 - 4,8\%)$$

Volume: Volume effect (+10%) corresponds to total quantities evolution  $(220-200)/200 \times 100\% = +10\%$ .

Mix: Positive mix effect on sales means that the share of more expensive products has increased (Product A).

Price: Price effect can also be called the weighted average price change of a portfolio of products (it takes into account the shares of products in total sales). In our example:

$$-4,8\% = -7\% \times 86,8\% + 10\% \times 13,2\%$$

Concerning average net price, it has grown by 0,23 €, of which +0,55 € due to positive mix effect and -0,31 € due to negative price effect. In percentages: average net price has grown by 3,9%, of which +9,1% due to mix and -4,8% due to price effect.

$$0,23€ = 0,55€ - 0,31€$$

$$(1 + 3,9\%) = (1 + 9,1\%) \times (1 - 4,8\%)$$

## FACTOR ANALYSIS OF NET SALES – FORMULAS

$$\text{Net Sales variance} = \text{Net Sales}_N - \text{Net Sales}_{N-1}$$

$$\text{Net Sales variance in \%} = \frac{\text{Net Sales variance}}{\text{Net Sales}_{N-1}} \times 100\%$$

From the step-by-step solution above we can derive the following formulas for further quick and easy calculation of effects on net sales.

### ➤ Effects on Net Sales (in values)

$$\text{Volume effect (on Net Sales)} = (\text{Qty}_{N\_mix\_N-1} - \text{Qty}_{N-1}) \times \text{Net Price}_{N-1}$$

$$\text{Mix effect (on Net Sales)} = (\text{Qty}_N - \text{Qty}_{N\_mix\_N-1}) \times \text{Net Price}_{N-1}$$

$$\text{Price effect (on Net Sales)} = \text{Qty}_N \times (\text{Net Price}_N - \text{Net Price}_{N-1})$$

$$\text{Net Sales variance} = \text{Volume eff}_{sales} + \text{Mix eff}_{sales} + \text{Price eff}_{sales}$$

Where  $\text{Qty}_{N\_mix\_N-1}$  represents theoretical quantities, that is, quantities at the period N which would be if shares of all products remained the same as in period N-1.

These formulas are applied at the level of products, and then effects by products can be summed up to calculate totals and subtotals by product group/line/business unit/etc.

### ➤ Effects on Net Sales (in percentages)

$$\text{Volume effect in \% (on Net Sales)} = \frac{\text{Volume eff}_{sales}}{\text{Net Sales}_{N-1}}$$

$$\text{Mix effect in \% (on Net Sales)} = \frac{\text{Mix eff}_{sales}}{\text{Net Sales}_{N-1} + \text{Volume eff}_{sales}}$$

$$\text{Price effect in \% (on Net Sales)} = \frac{\text{Price eff}_{sales}}{\text{Net Sales}_{N-1} + \text{Volume eff}_{sales} + \text{Mix eff}_{sales}}$$

$$\begin{aligned} (1 + \text{Net Sales variance in \%}) \\ = (1 + \text{Volume eff in \%}_{sales}) \times (1 + \text{Mix eff in \%}_{sales}) \times (1 \\ + \text{Price eff in \%}_{sales}) \end{aligned}$$

With the help of these formulas, we can represent the factor analysis of net sales from our example in a more compact way (see Table 4).

**Note 1:** Calculating mix effect on net sales only gives a meaningful result if all products are expressed in the same units of measure (e.g., kilograms, liters, meters) or in comparable pieces. If products cannot be measured in the same units, it is preferable to calculate the combined effect of volume&mix. Below are the formulas.

**In values:**

$$\text{Volume\&Mix effect (on Net Sales)} = (Qty_N - Qty_{N-1}) \times \text{Net Price}_{N-1}$$

$$\text{Price effect (on Net Sales)} = Qty_N \times (\text{Net Price}_N - \text{Net Price}_{N-1})$$

$$\text{Net Sales variance} = \text{Volume\&Mix eff}_{sales} + \text{Price eff}_{sales}$$

**In percentages:**

$$\text{Volume effect in \% (on Net Sales)} = \frac{\text{Volume\&Mix eff}_{sales}}{\text{Net Sales}_{N-1}}$$

$$\text{Price effect in \% (on Net Sales)} = \frac{\text{Price eff}_{sales}}{\text{Net Sales}_{N-1} + \text{Volume\&Mix eff}_{sales}}$$

$$\begin{aligned} (1 + \text{Net Sales variance in \%}) \\ = (1 + \text{Volume\&Mix eff in \%}_{sales}) \times (1 + \text{Price eff in \%}_{sales}) \end{aligned}$$

**Note 2:** What factor goes first in factor analysis does matter – the impacts of factors in values and in % will differ depending on the order of factors. Most commonly in our practice, volume goes first, then product mix and finally price. We would recommend following this order of factors unless there are arguments in favor of putting prices first.

For example, if quantities are more “adequate” at the period N-1 than at the current period N due to manufacturing problems, then it can be more relevant to calculate price effect based on quantities at the period N-1, that is, to put price first.

Table 4

Example 4 (sales)

**VOLUME + MIX + PRICE EFFECT**

INPUT:

Product	Qty	Net Price	Evolution in %	
			Qty	Net Price
A	100	10,00 €	+25,0%	-7,0%
B	100	2,00 €	-5,0%	+10,0%

→ SOLUTION SUMMARY:

Product	N-1				N				Evolution			Evolution in % / pp				Effects on Net Sales			Qty N (mix N-1)			
	Qty	Share in Qty	Net Price	Net Sales	Qty	Share in Qty	Net Price	Net Sales	Qty	Net Price	Net Sales	Qty (%)	Share in Qty (pp)	Net Price (%)	Net Sales (%)	in values (EUR)				in % (evolution of Net Sales)		
A	100	50,0%	10,00 €	1 000 €	125	56,8%	9,30 €	1 163 €	+25	-0,70 €	+163 €	+25,0%	+6,8 pp	-7,0%	+16,3%	+100 €	+150 €	-88 €	+10,0%	+13,6%	-7,0%	110
B	100	50,0%	2,00 €	200 €	95	43,2%	2,20 €	209 €	-5	+0,20 €	+9 €	-5,0%	-6,8 pp	+10,0%	+4,5%	+20 €	-30 €	+19 €	+10,0%	-13,6%	+10,0%	110
<b>Total</b>	<b>200</b>	<b>100,0%</b>	<b>6,00 €</b>	<b>1 200 €</b>	<b>220</b>	<b>100,0%</b>	<b>6,23 €</b>	<b>1 372 €</b>	<b>+20</b>	<b>+0,23 €</b>	<b>+172 €</b>	<b>+10,0%</b>	<b>0,0 pp</b>	<b>+3,9%</b>	<b>+14,3%</b>	<b>+120 €</b>	<b>+120 €</b>	<b>-69 €</b>	<b>+10,0%</b>	<b>+9,1%</b>	<b>-4,8%</b>	<b>220</b>

Table 5

Example 4 (cost of sales)

**VOLUME + MIX + COST EFFECT**

INPUT:

Product	Qty	Cost per unit	Evolution in %	
			Qty	Cost per unit
A	100	8,50 €	25,0%	-5,0%
B	100	1,00 €	-5,0%	2,0%

→ SOLUTION SUMMARY:

Product	N-1				N				Evolution			Evolution in % / pp				Effects on Cost of Sales			Qty N (mix N-1)			
	Qty	Share in Qty	Cost per unit	Cost of Sales	Qty	Share in Qty	Cost per unit	Cost of Sales	Qty	Cost per unit	Cost of Sales	Qty (%)	Share in Qty (pp)	Cost per unit (%)	Cost of Sales (%)	in values (EUR)				in % (evolution of Cost of Sales)		
A	100	50,0%	8,50 €	850 €	125	56,8%	8,08 €	1 009 €	+25	-0,43 €	+159 €	+25,0%	+6,8 pp	-5,0%	+18,8%	+85 €	+128 €	-53 €	+10,0%	+13,6%	-5,0%	110
B	100	50,0%	1,00 €	100 €	95	43,2%	1,02 €	97 €	-5	+0,02 €	-3 €	-5,0%	-6,8 pp	+2,0%	-3,1%	+10 €	-15 €	+2 €	+10,0%	-13,6%	+2,0%	110
<b>Total</b>	<b>200</b>	<b>100,0%</b>	<b>4,75 €</b>	<b>950 €</b>	<b>220</b>	<b>100,0%</b>	<b>5,03 €</b>	<b>1 106 €</b>	<b>+20</b>	<b>+0,28 €</b>	<b>+156 €</b>	<b>+10,0%</b>	<b>0,0 pp</b>	<b>+5,9%</b>	<b>+16,5%</b>	<b>+95 €</b>	<b>+113 €</b>	<b>-51 €</b>	<b>+10,0%</b>	<b>+10,8%</b>	<b>-4,4%</b>	<b>220</b>



## FACTOR ANALYSIS OF COST OF SALES

Next, we move to the factor analysis of cost of sales (*sheet "Part1\_COS" in Excel file*). The calculation of effects on COS and their interpretation are identical to the analysis of net sales variance. The only difference: net prices are replaced by costs per unit, as shown below.

$$COS\ variance = COS_N - COS_{N-1}$$

$$COS\ variance\ in\ \% = \frac{COS\ variance}{COS_{N-1}} \times 100\%$$

### ➤ Effects on Cost of Sales (in values)

$$Volume\ effect\ (on\ COS) = (Qty_{N\_mix\_N-1} - Qty_{N-1}) \times Cost\ per\ unit_{N-1}$$

$$Mix\ effect\ (on\ COS) = (Qty_N - Qty_{N\_mix\_N-1}) \times Cost\ per\ unit_{N-1}$$

$$Cost\ effect\ (on\ COS) = Qty_N \times (Cost\ per\ unit_N - Cost\ per\ unit_{N-1})$$

$$COS\ variance = Volume\ eff_{COS} + Mix\ eff_{COS} + Price\ eff_{COS}$$

### ➤ Effects on Cost of sales (in percentages)

$$Volume\ effect\ in\ \% (on\ COS) = \frac{Volume\ eff_{COS}}{COS_{N-1}}$$

$$Mix\ effect\ in\ \% (on\ COS) = \frac{Mix\ eff_{COS}}{COS_{N-1} + Volume\ eff_{COS}}$$

$$Cost\ effect\ in\ \% (on\ COS) = \frac{Cost\ eff_{COS}}{COS_{N-1} + Volume\ eff_{COS} + Mix\ eff_{COS}}$$

$$(1 + COS\ variance\ in\ \%) = (1 + Volume\ eff\ in\ \%_{COS}) \times (1 + Mix\ eff\ in\ \%_{COS}) \times (1 + Cost\ eff\ in\ \%_{COS})$$

You can find the factor analysis of COS from our example 4 in a compact way in Table 5.

**Note 3:** If products are measured in incomparable units, it is preferable to calculate the combined effect of volume&mix, like it was demonstrated earlier for the analysis of net sales. Below are the formulas for COS.

### In values

$$Volume\&Mix\ effect\ (on\ COS) = (Qty_N - Qty_{N-1}) \times Cost\ per\ unit_{N-1}$$

$$Cost\ effect\ (on\ COS) = Qty_N \times (Cost\ per\ unit_N - Cost\ per\ unit_{N-1})$$

$$COS\ variance = Volume\&Mix\ eff_{COS} + Cost\ eff_{COS}$$

### In percentages

$$Volume\ effect\ in\ \% (on\ COS) = \frac{Volume\&Mix\ eff_{COS}}{COS_{N-1}}$$

$$Cost\ effect\ in\ \% (on\ Net\ Sales) = \frac{Cost\ eff_{COS}}{COS_{N-1} + Volume\&Mix\ eff_{COS}}$$

$$(1 + COS\ variance\ in\ \%) = (1 + Volume\&Mix\ eff\ in\ \%_{COS}) \times (1 + Cost\ eff\ in\ \%_{COS})$$

## FACTOR ANALYSIS OF GROSS MARGIN

Having considered the rules of calculation to break down the variances of net sales and cost of sales into factors, we move to the analysis of gross margin evolution (in values and in % of net sales).

Table 6

Quantity											
Product	Qty								Products' mix in Qty		
	N-1	N	Diff	% Diff	N-1	N	Diff	% Diff	N-1	N	Diff in pts
A	100	125	+25	+25,0%					50%	57%	+6,8 pp
B	100	95	-5	-5,0%					50%	43%	-6,8 pp
<b>Total</b>	<b>200</b>	<b>220</b>	<b>+20</b>	<b>+10,0%</b>					<b>100%</b>	<b>100%</b>	
Net Sales											
Product	Net Price per unit				Net Sales				Products' mix in Net Sales		
	N-1	N	Diff	% Diff	N-1	N	Diff	% Diff	N-1	N	Diff in pts
A	10,00 €	9,30 €	-0,70 €	-7,0%	1 000 €	1 163 €	+163 €	+16,3%	83%	85%	+1,4 pp
B	2,00 €	2,20 €	+0,20 €	+10,0%	200 €	209 €	+9 €	+4,5%	17%	15%	-1,4 pp
<b>Total</b>	<b>6,00 €</b>	<b>6,23 €</b>	<b>+0,23 €</b>	<b>+3,9%</b>	<b>1 200 €</b>	<b>1 372 €</b>	<b>+172 €</b>	<b>+14,3%</b>	<b>100%</b>	<b>100%</b>	
Cost of sales											
Product	Cost per unit				Cost of Sales				Products' mix in COS		
	N-1	N	Diff	% Diff	N-1	N	Diff	% Diff	N-1	N	Diff in pts
A	8,50 €	8,08 €	-0,43 €	-5,0%	850 €	1 009 €	+159 €	+18,8%	89%	91%	+1,8 pp
B	1,00 €	1,02 €	+0,02 €	+2,0%	100 €	97 €	-3 €	-3,1%	11%	9%	-1,8 pp
<b>Total</b>	<b>4,75 €</b>	<b>5,03 €</b>	<b>+0,28 €</b>	<b>+5,9%</b>	<b>950 €</b>	<b>1 106 €</b>	<b>+156 €</b>	<b>+16,5%</b>	<b>100%</b>	<b>100%</b>	
Gross Margin											
Product	Gross Margin per unit				Gross Margin				Products' mix in GM		
	N-1	N	Diff	% Diff	N-1	N	Diff	% Diff	N-1	N	Diff in pts
A	1,50 €	1,23 €	-0,28 €	-18,3%	150 €	153 €	+3 €	+2,1%	60%	58%	-2,3 pp
B	1,00 €	1,18 €	+0,18 €	+18,0%	100 €	112 €	+12 €	+12,1%	40%	42%	+2,3 pp
<b>Total</b>	<b>1,25 €</b>	<b>1,21 €</b>	<b>-0,04 €</b>	<b>-3,6%</b>	<b>250 €</b>	<b>265 €</b>	<b>+15 €</b>	<b>+6,1%</b>	<b>100%</b>	<b>100%</b>	
% of Gross Margin in Net Sales (GM in %)											
Product	For each item			Contribution of items to total GM in %							
	N-1	N	Diff in pp	N-1	N	Diff in pp					
A	15,0%	13,2%	-1,8 pp	12,5%	11,2%	-1,3 pp					
B	50,0%	53,6%	+3,6 pp	8,3%	8,2%	-0,2 pp					
<b>Total</b>	<b>20,8%</b>	<b>19,3%</b>	<b>-1,5 pp</b>			<b>-1,5 pp</b>					

Let's have a look at Table 6 in which we summarize Net Sales / Cost of Sales / Gross Margin / % of Gross Margin for our Example 4 (sheet "Part1\_Margin" in Excel file).

In "Gross margin" section of this table we see that gross margin of a portfolio has grown by 15 € (from 250 € to 265 €) and by 6,1%. However, profitability, or % of gross margin in net sales, ("% of Gross Margin in Net Sales" section) has decreased by 1,5 percentage points (from 20,8% to 19,3%), which can be explained by a lower growth rate of net sales compared to cost of sales (+14,3% < +16,5%).

So, our next task is to explain these variances of gross margin by answering the following questions:

- What are the impacts of 4 factors we have already defined – volume, assortment mix, price and cost?
- What are the contributions of products – overall and within each factor?

But before, let us focus in more detail on the second point.

## GROSS MARGIN IN %. CONTRIBUTION OF PRODUCTS

In our simple example we can evaluate the contribution of 2 products to total variance of % gross margin. In real business cases the same rule of calculation can be applied not only to products but also to any classification of products – by family / segment / product line / etc.

In Table 6 the contribution of products is calculated in the right part of “% of Gross Margin in Net Sales” section, which should not be confused with the evolution of “Gross Margin in %” for each product shown in the left part of this section:

$$\begin{array}{rcll} -1,5 \text{ pp} & = & -1,3 \text{ pp} & + 0,2 \text{ pp} \\ \text{(Total evolution of GM in \%)} & & \text{(due to contribution of A)} & \text{(due to contribution of B)} \end{array}$$

while

$$\begin{array}{rcll} -1,5 \text{ pp} & \neq & -1,8 \text{ pp} & + 3,6 \text{ pp} \\ \text{(Total evolution of GM in \%)} & & \text{(Evolution of GM in \% of A)} & \text{(Evolution of GM in \% of B)} \end{array}$$

Formulas to calculate the contribution of products:

$$\begin{aligned} \text{Contribution}_{\text{of a product}} \text{ (to Total Gross Margin)} &= \frac{\text{Gross Margin}_{\text{of a product}}}{\text{Total Net Sales}} \times 100\% = \\ &= \text{Gross Margin in \%}_{\text{of a product}} \times \% \text{ Share in total Net Sales}_{\text{of a product}} \quad * \end{aligned}$$

$$\begin{aligned} \text{Contribution}_{\text{of a product}} \text{ (to variance of Total Gross Margin in \%)} \\ &= \text{Contribution}_{\text{of a product}_N} - \text{Contribution}_{\text{of a product}_{N-1}} \end{aligned}$$

\*This formula is derived from the equation:

$$\begin{aligned} \text{Total Gross Margin in \%} &= \frac{\text{Total Gross Margin}}{\text{Total Net Sales}} \times 100\% = \\ &= \frac{\text{Gross Margin}_{\text{of a product A}} + \text{Gross Margin}_{\text{of other products}}}{\text{Total Net Sales}} \times 100\% = \\ &= \frac{\text{Gross Margin}_{\text{of a product A}}}{\text{Total Net Sales}} \times 100\% + \frac{\text{Gross Margin}_{\text{of other products}}}{\text{Total Net Sales}} \times 100\% \\ &\quad \text{(Contribution of a product A in total \% GM)} \quad \text{(Contribution of other products in total \% GM)} \end{aligned}$$

Therefore, the contribution of a product A to total Gross Margin in % is:

$$\begin{aligned} \frac{\text{Gross Margin}_{\text{of a product A}}}{\text{Total Net Sales}} \times 100\% &= \\ &= \frac{\text{Gross Margin in \%}_{\text{of a product A}} \times \% \text{ Share in total Net Sales}_{\text{of a product A}} \times \text{Total Net Sales}}{\text{Total Net Sales}} = \\ &= \text{Gross Margin in \%}_{\text{of a product A}} \times \% \text{ Share in total Net Sales}_{\text{of a product A}} \end{aligned}$$

BECOMING THE MASTER OF FACTOR ANALYSIS OF PROFIT: SECRETS OF CALCULATION

Table 7

INPUT					STEP-BY-STEP SUMMARY						SOLUTION SUMMARY												
Quantity					Quantity at each step						Evolution of Units Sold												
Product	Qty				N-1	Volume eff	Mix eff	Price eff	Cost eff	N	in units sold		Total qty diff	in % (evolution of Units Sold)			% Total qty diff						
	N-1	N	Diff	% Diff							Volume eff	Mix eff		Volume eff	Mix eff	Price eff							
A	100	125	+25	+25,0%	100	110	125	125	125	125	+10	+15	+25	+10,0%	+13,6%		+25,0%						
B	100	95	-5	-5,0%	100	110	95	95	95	95	+10	-15	-5	+10,0%	-13,6%		-5,0%						
<b>Total</b>	<b>200</b>	<b>220</b>	<b>+20</b>	<b>+10,0%</b>	<b>200</b>	<b>220</b>	<b>220</b>	<b>220</b>	<b>220</b>	<b>220</b>	<b>+20</b>	<b>0</b>	<b>+20</b>	<b>+10,0%</b>	<b>0,0%</b>		<b>+10,0%</b>						
Net Sales					Net Sales at each step						Effects on Net Sales in EUR												
Product	Net Price per unit				Net Sales				N-1	Volume eff	Mix eff	Price eff	Cost eff	N	in values (EUR)		Total sales diff	in % (evolution of Net Sales)			% Total sales diff		
	N-1	N	Diff	% Diff	N-1	N	Diff	% Diff							Volume eff	Mix eff	Price eff		Volume eff	Mix eff	Price eff		
A	10,00 €	9,30 €	-0,70 €	-7,0%	1 000 €	1 163 €	+163 €	+16,3%	1 000 €	1 100 €	1 250 €	1 163 €	1 163 €	1 163 €	+100 €	+150 €	-88 €	+163 €	+10,0%	+13,6%	-7,0%	+16,3%	
B	2,00 €	2,20 €	+0,20 €	+10,0%	200 €	209 €	+9 €	+4,5%	200 €	220 €	190 €	209 €	209 €	209 €	+20 €	-30 €	+19 €	+9 €	+10,0%	-13,6%	+10,0%	+4,5%	
<b>Total</b>	<b>6,00 €</b>	<b>6,23 €</b>	<b>+0,23 €</b>	<b>+3,9%</b>	<b>1 200 €</b>	<b>1 372 €</b>	<b>+172 €</b>	<b>+14,3%</b>	<b>1 200 €</b>	<b>1 320 €</b>	<b>1 440 €</b>	<b>1 372 €</b>	<b>1 372 €</b>	<b>1 372 €</b>	<b>+120 €</b>	<b>+120 €</b>	<b>-69 €</b>	<b>+172 €</b>	<b>+10,0%</b>	<b>+9,1%</b>	<b>-4,8%</b>	<b>+14,3%</b>	
Cost of sales					Cost of Sales at each step						Effects on Cost of Sales												
Product	Cost per unit				Cost of Sales				N-1	Volume eff	Mix eff	Price eff	Cost eff	N	in values (EUR)		Total cost diff	in % (evolution of Cost of Sales)			Total cost diff		
	N-1	N	Diff	% Diff	N-1	N	Diff	% Diff							Volume eff	Mix eff	Cost eff		Volume eff	Mix eff	Cost eff		
A	8,50 €	8,08 €	-0,43 €	-5,0%	850 €	1 009 €	+159 €	+18,8%	850 €	935 €	1 063 €	1 063 €	1 009 €	1 009 €	+85 €	+128 €	-53 €	+159 €	+10,0%	+13,6%	-5,0%	+18,8%	
B	1,00 €	1,02 €	+0,02 €	+2,0%	100 €	97 €	-3 €	-3,1%	100 €	110 €	95 €	95 €	97 €	97 €	+10 €	-15 €	+2 €	-3 €	+10,0%	-13,6%	+2,0%	-3,1%	
<b>Total</b>	<b>4,75 €</b>	<b>5,03 €</b>	<b>+0,28 €</b>	<b>+5,9%</b>	<b>950 €</b>	<b>1 106 €</b>	<b>+156 €</b>	<b>+16,5%</b>	<b>950 €</b>	<b>1 045 €</b>	<b>1 158 €</b>	<b>1 106 €</b>	<b>1 106 €</b>	<b>1 106 €</b>	<b>+95 €</b>	<b>+113 €</b>	<b>-51 €</b>	<b>+156 €</b>	<b>+10,0%</b>	<b>+10,8%</b>	<b>-4,4%</b>	<b>+16,5%</b>	
Gross Margin					Gross Margin at each step						Effects on Gross Margin												
Product	Gross Margin per unit				Gross Margin				N-1	Volume eff	Mix eff	Price eff	Cost eff	N	in values (EUR)		Total cost diff	in % (evolution of Gross Margin)			Total GM diff		
	N-1	N	Diff	% Diff	N-1	N	Diff	% Diff							Volume eff	Mix eff	Price eff	Cost eff	Volume eff	Mix eff	Price eff	Cost eff	
A	1,50 €	1,23 €	-0,28 €	-18,3%	150 €	153 €	+3 €	+2,1%	150 €	165 €	188 €	100 €	153 €	153 €	+15 €	+23 €	-88 €	+53 €	+10,0%	+13,6%	-46,7%	+53,1%	
B	1,00 €	1,18 €	+0,18 €	+18,0%	100 €	112 €	+12 €	+12,1%	100 €	110 €	95 €	114 €	112 €	112 €	+10 €	-15 €	+19 €	-2 €	+10,0%	-13,6%	+20,0%	-1,7%	
<b>Total</b>	<b>1,25 €</b>	<b>1,21 €</b>	<b>-0,04 €</b>	<b>-3,6%</b>	<b>250 €</b>	<b>265 €</b>	<b>+15 €</b>	<b>+6,1%</b>	<b>250 €</b>	<b>275 €</b>	<b>283 €</b>	<b>214 €</b>	<b>265 €</b>	<b>265 €</b>	<b>+25 €</b>	<b>+8 €</b>	<b>-69 €</b>	<b>+51 €</b>	<b>+15 €</b>	<b>+10,0%</b>	<b>+2,7%</b>	<b>-24,2%</b>	<b>+23,9%</b>
% of Gross Margin in Net Sales (GM in %)					% of Gross Margin in Net Sales at each step						Effects on % of Gross Margin in Net Sales												
Product	For each item			Contribution of items to total GM in %			N-1	Volume eff	Mix eff	Price eff	Cost eff	N	in pts (evolution for each item)		Total GM diff	in pts (contribution of items to total evolution of GM in %)			Total GM diff				
	N-1	N	Diff in pp	N-1	N	Diff in pp							Volume eff	Mix eff	Price eff	Cost eff	Volume eff	Mix eff	Price eff	Cost eff			
A	15,0%	13,2%	-1,8 pp	12,5%	11,2%	-1,3 pp	15,0%	15,0%	50,0%	8,6%	13,2%	13,2%	0,0 pp	0,0 pp	-6,4 pp	+4,6 pp	-1,8 pp	0,0 pp	+0,5 pp	-5,7 pp	+3,9 pp	-1,3 pp	
B	50,0%	53,6%	+3,6 pp	50,0%	53,6%	+3,6 pp	50,0%	50,0%	54,5%	53,6%	53,6%	53,6%	0,0 pp	0,0 pp	+4,5 pp	-0,9 pp	+3,6 pp	0,0 pp	-1,7 pp	+1,7 pp	-0,1 pp	-0,2 pp	
<b>Total</b>	<b>20,8%</b>	<b>19,3%</b>	<b>-1,5 pp</b>	<b>20,8%</b>	<b>19,3%</b>	<b>-1,5 pp</b>	<b>20,8%</b>	<b>20,8%</b>	<b>19,6%</b>	<b>15,6%</b>	<b>19,3%</b>	<b>19,3%</b>	<b>0,0 pp</b>	<b>-1,2 pp</b>	<b>-4,0 pp</b>	<b>+3,7 pp</b>	<b>-1,5 pp</b>	<b>0,0 pp</b>	<b>-1,2 pp</b>	<b>-4,0 pp</b>	<b>+3,7 pp</b>	<b>-1,5 pp</b>	

## FACTOR ANALYSIS OF GROSS MARGIN – FORMULAS

In Excel file (*sheet "Part1\_Margin"*) you can find a step-by-step solution followed by a summary. Here in the article, we will get straight to the compact solution summary and the formulas behind it – see Table 7.

$$\text{Gross Margin variance} = \text{Gross Margin}_N - \text{Gross Margin}_{N-1}$$

$$\text{Gross Margin variance in \%} = \frac{\text{Gross Margin variance}}{\text{Gross Margin}_{N-1}} \times 100\%$$

$$\text{Gross Margin in \% variance} = \text{Gross Margin in \%}_N - \text{Gross Margin in \%}_{N-1}$$

### ➤ Effects on Gross Margin (in values)

Since

$$\text{Gross Margin} = \text{Net Sales} - \text{COS},$$

it is also true that

$$\text{Effects on Gross Margin} = \text{Effects on Net Sales} - \text{Effects on COS}.$$

Thus,

$$\text{Volume effect (on GM)} = \text{Volume effect (on Net sales)} - \text{Volume effect (on COS)}$$

$$\text{Mix effect (on GM)} = \text{Mix effect (on Net sales)} - \text{Mix effect (on COS)}$$

$$\text{Price effect (on GM)} = \text{Price effect (on Net sales)}$$

$$\text{Cost effect (on GM)} = -\text{Cost effect (on COS)}$$

$$\text{Gross Margin variance} = \text{Volume eff}_{GM} + \text{Mix eff}_{GM} + \text{Price eff}_{GM} + \text{Cost eff}_{GM}$$

### ➤ Effects on Gross Margin (in percentages)

$$\text{Volume effect in \% (on GM)} = \frac{\text{Volume eff}_{GM}}{\text{Gross Margin}_{N-1}}$$

$$\text{Mix effect in \% (on GM)} = \frac{\text{Mix eff}_{GM}}{\text{Gross Margin}_{N-1} + \text{Volume eff}_{GM}}$$

$$\text{Price effect in \% (on GM)} = \frac{\text{Price eff}_{GM}}{\text{Gross Margin}_{N-1} + \text{Volume eff}_{GM} + \text{Mix eff}_{GM}}$$

$$\text{Cost effect in \% (on GM)} = \frac{\text{Cost eff}_{GM}}{\text{Gross Margin}_{N-1} + \text{Volume eff}_{GM} + \text{Mix eff}_{GM} + \text{Price eff}_{GM}}$$

$$(1 + \text{GM variance in \%})$$

$$= (1 + \text{Volume eff in \%}_{GM}) \times (1 + \text{Mix eff in \%}_{GM}) \times (1 + \text{Price eff in \%}_{GM}) \times (1 + \text{Cost eff in \%}_{GM})$$



➤ Effects on Gross Margin in % (in percentage points)

The effects in percentage points represent the difference of “Gross Margin in %” between the current step and the previous one (“*Step-by-step summary*” part in Excel file). So, first, below are the formulas to calculate “Gross Margin in %” at each step (in percentages):

$$\text{Gross Margin in \% (volume eff)} = \frac{\text{Gross Margin}_{N-1} + \text{Volume eff}_{GM}}{\text{Net Sales}_{N-1} + \text{Volume eff}_{sales}} \times 100\%$$

$$\text{Gross Margin in \% (mix eff)} = \frac{\text{Gross Margin}_{N-1} + \text{Volume eff}_{GM} + \text{Mix eff}_{GM}}{\text{Net Sales}_{N-1} + \text{Volume eff}_{sales} + \text{Mix eff}_{sales}} \times 100\%$$

$$\begin{aligned} \text{Gross Margin in \% (price eff)} &= \\ &= \frac{\text{Gross Margin}_{N-1} + \text{Volume eff}_{GM} + \text{Mix eff}_{GM} + \text{Price eff}_{GM}}{\text{Net Sales}_{N-1} + \text{Volume eff}_{sales} + \text{Mix eff}_{sales} + \text{Price eff}_{sales}} \times 100\% \end{aligned}$$

$$\begin{aligned} \text{Gross Margin in \% (cost eff)} &= \\ &= \frac{\text{Gross Margin}_{N-1} + \text{Volume eff}_{GM} + \text{Mix eff}_{GM} + \text{Price eff}_{GM} + \text{Cost eff}_{GM}}{\text{Net Sales}_{N-1} + \text{Volume eff}_{sales} + \text{Mix eff}_{sales} + \text{Price eff}_{sales}} \times 100\% \end{aligned}$$

And then, formulas to calculate effects on “Gross Margin in %” (in percentage points):

$$\text{Volume effect (on GM in \%)} = \text{GM in \%}_{\text{volume eff}} - \text{GM in \%}_{N-1}$$

$$\text{Mix effect (on GM in \%)} = \text{GM in \%}_{\text{mix eff}} - \text{GM in \%}_{\text{volume eff}}$$

$$\text{Price effect (on GM in \%)} = \text{GM in \%}_{\text{price eff}} - \text{GM in \%}_{\text{mix eff}}$$

$$\text{Cost effect (on GM in \%)} = \text{GM in \%}_{\text{cost eff}} - \text{GM in \%}_{\text{price eff}}$$

**Note 4:** Volume effect (on Gross Margin in %) is always equal to 0 percentage points since at this step Net Sales and Gross Margin have changed by the same % (=percentage of total quantities variance).

**Note 5:** Even if products are measured in different units, “Mix effect on Gross Margin in %” can still be calculated. To do that, volume effect and mix effect on gross margin should be replaced by the combined effect volume&mix, the same way as the effects on net sales and COS.

The formula for Gross margin in % (volume&mix eff) is as follows:

$$\text{Gross margin in \% (volume&mix eff)} = \frac{\text{Gross Margin}_{N-1} + \text{Volume&mix eff}_{GM}}{\text{Net Sales}_{N-1} + \text{Volume&mix eff}_{sales}} \times 100\%$$

And for Mix effect on Gross margin in % (in pp):

$$\begin{aligned} \text{Mix effect (on GM in \%)} &= \text{Volume&Mix effect (on GM in \%)} = \\ &= \text{GM in \%}_{\text{volume&mix eff}} - \text{GM in \%}_{N-1} \end{aligned}$$

Mix effect is equivalent to Volume&Mix effect because “Gross Margin in %” never changes due to volume effect, as mentioned above in Note 4.

➤ Gross Margin in %. Contribution of products within each factor (in percentage points)

We have already discussed how to calculate the contribution of products to the evolution of “Total Gross Margin in %”. Next, we go further to answer the question: what products have contributed to the evolution of total gross margin in % due to mix effect, price effect, etc.

First, it is necessary to calculate the “Contribution of each product to Total Gross Margin in %” at each step of the analysis (Volume, Mix, Price, Cost), and, second, - the difference of this contribution between the current step and the previous one.

$$\begin{aligned} \text{Contribution}_{\text{of a product}} \text{ (to variance of Total Gross Margin in \% due to Volume effect)} \\ = \text{Contribution}_{\text{of a product\_volume eff}} - \text{Contribution}_{\text{of a product}_{N-1}} \end{aligned}$$

$$\begin{aligned} \text{Contribution}_{\text{of a product}} \text{ (to variance of Total Gross Margin in \% due to Mix effect)} = \\ = \text{Contribution}_{\text{of a product\_mix eff}} - \text{Contribution}_{\text{of a product\_volume eff}} \end{aligned}$$

$$\begin{aligned} \text{Contribution}_{\text{of a product}} \text{ (to variance of Total Gross Margin in \% due to Price effect)} = \\ = \text{Contribution}_{\text{of a product\_price eff}} - \text{Contribution}_{\text{of a product\_mix eff}} \end{aligned}$$

$$\begin{aligned} \text{Contribution}_{\text{of a product}} \text{ (to variance of Total Gross Margin in \% due to Cost effect)} = \\ = \text{Contribution}_{\text{of a product\_cost eff}} - \text{Contribution}_{\text{of a product\_price eff}} \end{aligned}$$

## RESULTS INTERPRETATION

Below is the illustration of the factor analysis of gross margin (based on Example 4). Charts on the left explain the evolution of gross margin (in values), charts on the right – the evolution of gross margin in % of net sales (in percentage points).



### Gross Margin

The overall gross margin has grown by 15 € (from 250 € to 265 €).

Positive factors:

- The growth of volume by 10% has naturally led to the increase of gross margin by 25 €.
- Slightly positive mix effect of 8 € takes place because the share (in total quantities) of Product A with a higher margin per unit (1,5 € vs 1,0 € of product B) has increased.
- The most considerable positive factor is cost effect (+51 €) – thanks to the decrease of cost per unit by 5% of Product A, which accounts for approximately 90% of total COS.

Negative factors:

- Price effect has significantly degraded gross margin – by 69 €, of which -88 € is due to the decrease of net price by 7% of Product A.

### Gross Margin in % of Net sales

Despite the growth of gross margin in values, overall profitability (gross margin in % of sales) has declined by 1,5 percentage points (from 20,8% to 19,3%).

Positive factors:

- The only positive factor is cost effect. The average decrease of costs per unit by 4,4% (of which -5% for Product A and +2% for Product B) has increased total gross margin by 3,7 pp.

Negative factors:

- The average drop of prices by 4,8% has degraded total gross margin by 4 pp, which is mostly due to Product A, whose contribution equals -5,8 pp.
- Even though mix effect is positive in values, it destructs profitability by 1,2 pts, which is caused by the decreased share of a highly profitable product (Product B).

## GENERAL FORMULAS (unlimited number of factors)

So, we have considered a simple example of factor analysis of net sales, cost of sales and gross margin. First, we divided net sales into 3 factors (volume, mix and net price), then cost of sales - also into 3 factors (volume, mix and cost per unit), and in the final step we assessed the effects of all these factors on gross margin by subtracting cost factors from sales factors.

Now let's move on to general formulas that allow us to explain the changes of any indicator by an unlimited number of factors.

**The main key points to keep in mind are:**

➤ The indicator to be explained must be represented as a product of variables (where each variable is an influencing factor):

$$\text{Indicator} = \text{Factor1} \times \text{Factor2} \times \text{Factor3} \times \dots \times \text{FactorK}$$

For example, 2 factors:

$$\text{Net Sales} = \text{Qty} \times \text{Net Price} \text{ (possible to calculate the effects of volume+mix and price)}$$

Alternatively, we can rewrite the above equation as follows, 3 factors:

$$\text{Net Sales} = \text{Total Qty} \times \% \text{ Share in Total Qty of a product } x \times \text{Net Price of a product } x$$

(possible to calculate the effects of volume, mix and price respectively)

4 factors:

$$\text{Net Sales} = \text{Total Qty} \times \% \text{ Share in Total Qty of a product } x \times \text{List Price} \times (1 - \text{Discount})$$

(possible to calculate the effects of volume, mix, listed price and price discount respectively)

Etc.

➤ If the equation of indicator to be explained doesn't meet the above condition and contains addition or subtraction, then this equation should be rewritten to split it into several parts (connected by addition or subtraction), each of which contains only multiplication of variables (factors).

An example of such indicator that contains addition is cost of sales split into several components:

$$\text{COS} = \text{Materials} + \text{Transport} + \text{Value Added}$$

And, of course, the most obvious example of an indicator that contains subtraction is gross margin:

$$\text{Gross Margin} = \text{Net Sales} - \text{COS} = \text{Qty} \times \text{Net Price} - \text{Qty} \times \text{Cost per unit}$$

Where *Net Sales* and *COS* can be represented as a product of multiple variables (as seen in the 1<sup>st</sup> point for 2/3/4-factors equations of net sales).

Once these two equations are solved and the effects of net sales and COS (in values) are calculated, we can apply the subtraction operation to find the effects on gross margin:



$$\begin{aligned}
 \text{Gross Margin variance} &= \text{Effects on Net Sales} - \text{Effects on COS} \\
 &= (\text{Volume eff}_{\text{sales}} + \text{Mix eff}_{\text{sales}} + \text{Price eff}) - (\text{Volume eff}_{\text{COS}} + \text{Mix eff}_{\text{COS}} + \text{Cost eff}) \\
 &= \text{Volume eff}_{\text{margin}} + \text{Mix eff}_{\text{margin}} + \text{Price eff} - \text{Cost eff}
 \end{aligned}$$

*Note: As seen above in the 3<sup>rd</sup> line of the equation, similar effects (like volume or mix) should be combined to deliver meaningful insights on the variations of the main indicator – gross margin here.*

As for the effects in percentages, same rules apply as for an indicator represented as a product of variables.

➤ The order of factors matters and leads to differences in the calculated effects in values, percentages and % points. In our practice the most common order of factors is following:

- 1 – Volume
- 2 – Assortment mix
- 3 – Net sales factors in a logical sequence (e.g., price-list in local currency, then various discounts, then exchange rate, etc.)
- 4 – Cost of sales factors (starting from the most important ones depending on your business)

However, please note that the above-mentioned order of factors is not mandatory and can be changed if that is required by the purpose of the analysis.

FORMULAS

1) Indicator is represented as a product of variables (such as Net Sales).

$$Indicator = Factor1 \times Factor2 \times Factor3 \times \dots \times FactorN .$$

We will explain the evolution

in values:  $Indicator_{P2} - Indicator_{P1}$

and in percentages:  $\frac{Indicator_{P2} - Indicator_{P1}}{Indicator_{P1}} \times 100\% .$

where:  $N$  is the number of influencing factors,  $P1$  and  $P2$  are two analysed periods.

➤ Effects in values

$$\begin{aligned}
 Factor1\ eff &= (Factor1_{P2} - Factor1_{P1}) \times Factor2_{P1} \times \dots \times FactorN_{P1} \\
 Factor2\ eff &= Factor1_{P2} \times (Factor2_{P2} - Factor2_{P1}) \times Factor3_{P1} \times \dots \times FactorN_{P1} \\
 \dots & \\
 FactorN\ eff &= Factor1_{P2} \times Factor2_{P2} \times \dots \times FactorN-1_{P2} \times (FactorN_{P2} - FactorN_{P1})
 \end{aligned}$$

Total evolution of an indicator in values due to  $N$  factors is explained by equation:

$$\begin{aligned}
 Indicator\ variance &= Indicator_{P2} - Indicator_{P1} \\
 &= Factor1\ eff + Factor2\ eff + \dots + FactorN\ eff
 \end{aligned}$$

➤ Effects in percentages

$$\begin{aligned}
 Factor1\ eff\ in\ \% &= \frac{Factor1\ eff}{Indicator_{P1}} \\
 Factor2\ eff\ in\ \% &= \frac{Factor2\ eff}{Indicator_{P1} + Impact_{Factor1}} \\
 \dots & \\
 FactorN\ eff\ in\ \% &= \frac{FactorN\ eff}{Indicator_{P1} + Impact_{Factor1} + \dots + Impact_{FactorN-1}}
 \end{aligned}$$

Total evolution of an indicator in percentages due to  $N$  factors is explained by equation:

$$\begin{aligned}
 Indicator\ variance\ in\ \% &= \frac{Indicator_{P2} - Indicator_{P1}}{Indicator_{P1}} \times 100\% \\
 &= (1 + Factor1\ eff\ in\ \%) \times \dots \times (1 + FactorN\ eff\ in\ \%) - 1
 \end{aligned}$$

2) Indicator contains addition (such as COS split into components) or subtraction (such as Gross Margin).

$$\text{MainIndicator} = \text{Indicator}X_1 \pm \text{Indicator}X_2 \pm \dots ;$$

Where  $\text{Indicator}X_1, \text{Indicator}X_2, \dots$  can be represented as a product of variables:

$$\text{Indicator}X_i = \text{Factor}1 \times \text{Factor}2 \times \text{Factor}3 \times \dots \times \text{Factor}N_i .$$

Once the impacts of all factors on the variance of each indicator  $X_i$  between two periods  $P1$  and  $P2$  are found, the evolution of the main indicator can be explained using the following rule:

➤ Effects in values

$$\text{MainIndicator variance} = \text{MainIndicator}_{P2} - \text{MainIndicator}_{P1}$$

$$= \sum \text{AllFactors eff\_Indicator } X_1 \pm \sum \text{AllFactors eff\_Indicator } X_2 \pm \dots$$

Effects in percentages can be calculated with the help of formulas described in Point 1. Please note that these effects can explain the evolution of each indicator  $X_i$  and the evolution of the main indicator. The only difference in a formula is its denominator: either  $\text{Indicator}X_{iP1} + \dots$  or  $\text{MainIndicator}_{P1} + \dots$ .

➤ Effects in percentages

On evolution of an indicator  $X_i$ :

$$\text{Factor}N_i \text{ eff in \%}_{\text{on } X_i} = \frac{\text{Factor}N_i \text{ eff}}{\text{Indicator}X_{iP1} + \text{Factor}1 \text{ eff} + \dots + \text{Factor}N_i - 1 \text{ eff}}$$

On evolution of the main indicator:

$$\text{Factor}N_i \text{ eff in \%}_{\text{on main}} = \frac{\text{Factor}N_i \text{ eff}}{\text{MainIndicator}_{P1} + \text{Factor}1 \text{ eff} + \dots + \text{Factor}N_i - 1 \text{ eff}}$$

Total evolution in percentages of an indicator  $X_i$ :

$$\begin{aligned} \text{Indicator}X_i \text{ variance in \%} &= \frac{\text{Indicator}X_{iP2} - \text{Indicator}X_{iP1}}{\text{Indicator}X_{iP1}} \times 100\% \\ &= (1 + \text{Factor}1 \text{ eff in \%}_{\text{on } X_i}) \times \dots \times (1 + \text{Factor}N_i \text{ eff in \%}_{\text{on } X_i}) - 1 \end{aligned}$$

Total evolution in percentages of the main indicator:

$$\begin{aligned} \text{MainIndicator variance in \%} &= \frac{\text{MainIndicator}_{P2} - \text{MainIndicator}_{P1}}{\text{MainIndicator}_{P1}} \times 100\% \\ &= (1 + \text{Factor}1 \text{ eff in \%}_{\text{on main}}) \times \dots \times (1 + \text{Factor}N_i \text{ eff in \%}_{\text{on main}}) - 1 \end{aligned}$$

2.1) Focus on Gross Margin.

We will consider that the evolution of *Gross Margin* is explained by *N* factors, of which:

1 to *K* factors exist both in *Net Sales* and *COS* (e.g. volume, mix),

*K+1* to *M* factors are only present in *Net Sales* (e.g. price, discount),

*M+1* to *N* factors are only present in *COS* (e.g. material cost, value added cost).

$$Gross\ Margin = Net\ Sales - COS$$

Where  $Net\ Sales = Factor1 \times \dots \times FactorK \times FactorK + 1 \times \dots \times FactorM$

$$COS = Factor1 \times \dots \times FactorK \times FactorM + 1 \times \dots \times FactorN$$

We will explain the evolution

in values:  $Gross\ Margin_{P2} - Gross\ Margin_{P1}$

and in percentage points:  $Gross\ Margin\ in\ \%_{P2} - Gross\ Margin\ in\ \%_{P1}$ .

➤ Effects on Gross Margin (GM) in values

1 to *K* factors:

$$Factor1\ eff_{GM} = Factor1\ eff_{sales} - Factor1\ eff_{COS}$$

...

$$FactorK\ eff_{GM} = FactorK\ eff_{sales} - FactorK\ eff_{COS}$$

*K+1* to *M* factors:

$$FactorK + 1\ eff_{GM} = FactorK + 1\ eff_{sales}$$

...

$$FactorM\ eff_{GM} = FactorM\ eff_{sales}$$

*M+1* to *N* factors:

$$FactorM + 1\ eff_{GM} = -FactorM + 1\ eff_{COS}$$

...

$$FactorN\ eff_{GM} = -FactorN\ eff_{COS}$$

Total evolution of Gross Margin in values due to *N* factors is explained by equation:

$$Gross\ Margin\ (GM)\ variance = GM_{P2} - GM_{P1} = Factor1\ eff_{GM} + \dots + FactorN\ eff_{GM}$$

➤ Effects on Gross Margin in percentages can be calculated with the help of formulas described in Point 1 and 2.

➤ Effects on Gross Margin in percentage points represent the difference of "Gross Margin in %" between the current step and the previous one, as mentioned in Part 1 of this article.

## EXAMPLES PART 2

In our second part of examples, we will demonstrate how to use the general formulas when dealing with multiple factors influencing the gross margin. You can find all the detailed calculations in the Excel file (sheets starting with “Part2\_...”).

It is worth recalling what effects have already been calculated in **Part 1** (Table 8).

Table 8

FACTOR ANALYSIS - SUMMARY (4 factors - volume, mix, price, cost)												
Effects	Factors	Net Sales = [Qty] X [Net price]				COS = [Qty] X [Cost per unit]				Gross margin = [Net Sales] - [COS]		
		Net Sales		Average Net Price		COS		Average Cost/unit		GM	GM/unit	GM in %
Period N-1 →		1 200 €		6,00 €		950 €		4,75 €		250 €	1,25 €	20,8%
	in %	in values	in %	in values	in %	in values	in %	in values	in %	in values	in values	in pp
		+172 €	+14,3%	+0,23 €	+3,9%	+156 €	+16,5%	+0,28 €	+5,9%	+15 €	-0,04 €	-1,5 pp
		due to:		due to:		due to:		due to:		due to:		due to:
Evolution →	Volume	+120 €	+10,0%			+95 €	+10,0%			+25 €		
	Mix	+120 €	+9,1%	+0,55 €	+9,1%	+113 €	+10,8%	+0,51 €	+10,8%	+8 €	+0,03 €	-1,2 pp
	Net Price	-69 €	-4,8%	-0,31 €	-4,8%					-69 €	-0,31 €	-4,0 pp
	Cost/unit					-51 €	-4,4%	-0,23 €	-4,4%	+51 €	+0,23 €	+3,7 pp
Period N →		1 372 €		6,23 €		1 106 €		5,03 €		265 €	1,21 €	19,3%

Equations for Net Sales and COS contain only multiplication, while Gross Margin is the difference between them (contains subtraction of 2 indicators each of which represents a product of variables).

- $Net\ Sales = Total\ Qty \times \% \text{ Share in Total Qty of a product } X \times Net\ Price_{of\ a\ product\ X}$   
3 factors: *Total Qty* accounts for volume effect, *% Share in Total Qty of a product X* – for mix effect and *Net Price<sub>of a product X</sub>* – for net price effect
- $COS = Total\ Qty \times \% \text{ Share in Total Qty of a product } X \times Cost\ per\ unit_{of\ a\ product\ X}$   
3 factors: *Total Qty* accounts for volume effect, *% Share in Total Qty of a product X* – for mix effect and *Net Price<sub>of a product X</sub>* – for net price effect
- $Gross\ Margin = Net\ Sales - COS$   
4 factors: volume and mix effects (common factors from Net Sales and COS), net price effect (derived from Net Sales) and cost effect (derived from COS).

Note: In Part 1 we use an additional variable  $Qty_{N,mix,N-1}$  to calculate volume and mix effects. Since we have introduced formulas for an unlimited number of factors, it is not necessary to add this variable. Instead, we can rewrite equations of Net Sales and COS as shown above by replacing:

$$Qty_{of\ a\ product\ X} = Total\ Qty \times \% \text{ Share in Total Qty of a product } X \cdot$$

**In Part 2**, we will break net price effect into two factors: list price and price discount.

$$\text{Net Price} = \text{List Price} \times (1 - \text{Price Discount})$$

$$\text{Net Sales} = \text{Total Qty} \times \% \text{ Share in Total Qty of a product } X \times \text{List Price} \times (1 - \text{Discount})$$

The new equation of Net Sales still represents a product of variables, so we can easily estimate the impact of 4 factors: volume, mix, list price and discount.

Next, we will split COS into two parts: materials and value added.

$$\text{COS} = \text{Materials} + \text{Value Added}$$

Where

$$\text{Materials} = \text{Total Qty} \times \% \text{ Share in Total Qty of a product } X \times \text{Material cost of a product } X$$

$$\text{Value Added (VA)} = \text{Total Qty} \times \% \text{ Share in Total Qty of a product } X \times \text{VA cost of a product } X$$

The equation of COS contains addition, and it is necessary to break it down into two equations - Materials and Value Added – both of which represent a product of variables. So, there is no obstacle to calculate the effects of 4 factors on COS: volume and mix (common factors from Materials and Value Added), material cost (from Materials) and value added cost (from Value Added).

Finally, we can explain Gross Margin by 6 factors: volume and mix (common factors from Net Sales, Materials and Value Added), list price and discount (from Net Sales), material cost and value added cost (from COS). See the summary of calculations in Table 9.

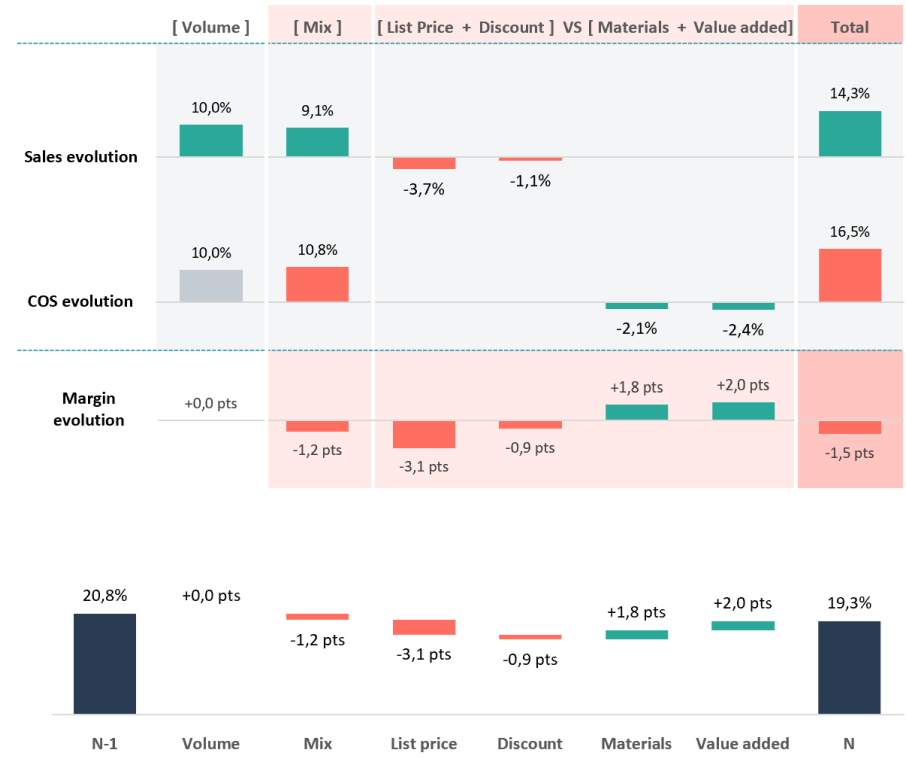
Table 9

**FACTOR ANALYSIS - SUMMARY**  
**(6 factors - volume, mix, list price, price discount, material cost, value added cost)**

Effects	Factors	Net Sales =[Qty] X [List price] X (1 - [Price discount in %])				COS =[Qty] X ([Materials/unit] + [Value added/unit])				Gross margin = [Net Sales] - [COS]				
		Net Sales		Average Net Price		COS		Average Cost/unit		GM	GM/unit	GM in %		
Period N-1 →		1 200 €		6,00 €		950 €		4,75 €		250 €	1,25 €	20,8%		
		At List Price	1 640 €	List Price	8,20 €	Materials	635 €	Materials	3,18 €					
		Discount	26,8%	Discount	26,8%	Value Added	315 €	Value Added	1,58 €					
		<b>in %</b>		<b>in %</b>		<b>in %</b>		<b>in %</b>		<b>in values</b>	<b>in values</b>	<b>in pp</b>		
		<b>in values</b>	<b>in %</b>	<b>in values</b>	<b>in %</b>	<b>in values</b>	<b>in %</b>	<b>in values</b>	<b>in %</b>	<b>in values</b>	<b>in values</b>	<b>in pp</b>		
		+172 €	+14,3%	+0,23 €	+3,9%	+156 €	+16,5%	+0,28 €	+5,9%	+15 €	-0,04 €	-1,5 pp		
		<i>due to:</i>		<i>due to:</i>		<i>due to:</i>		<i>due to:</i>		<i>due to:</i>	<i>due to:</i>	<i>due to:</i>		
Evolution →	Volume	+10,0%		+120 €	+10,0%	+95 €	+10,0%	+25 €		+25 €				
	Mix			+120 €	+9,1%	+0,55 €	+9,1%	+113 €	+10,8%	+0,51 €	+10,8%	+8 €	+0,03 €	-1,2 pp
	Net Price	List Price	-3,7%		-53 €	-3,7%	-0,24 €	-3,7%			-53 €	-0,24 €	-3,1 pp	
		Discount	-1,1%	-4,8%	-15 €	-1,1%	-0,07 €	-1,1%			-15 €	-0,07 €	-0,9 pp	
Cost/unit	Materials	-3,1%				-24 €	-2,1%	-0,11 €	-2,1%	+24 €	+0,11 €	+1,8 pp		
	Value Added	-7,2%	-4,4%			-27 €	-2,4%	-0,12 €	-2,4%	+27 €	+0,12 €	+2,0 pp		
		explains the evolution of cost components (materials and value added) without taking into account the weight of components in total cost				explains the evolution of total cost by its components taking into account the weight of components in total cost								
Period N →		1 372 €		6,23 €		1 106 €		5,03 €		265 €	1,21 €	19,3%		
		At List Price	1 902 €	List Price	8,65 €	Materials	758 €	Materials	3,44 €					
		Discount	27,9%	Discount	27,9%	Value Added	349 €	Value Added	1,58 €					



## BECOMING THE MASTER OF FACTOR ANALYSIS OF PROFIT: THE SECRETS OF CALCULATION



We let you further explore the formulas and calculations in the Excel file. Below are a few remarks:

### Net Sales

- Volume and mix effects return the same result no matter how many factors are taken into consideration.
- Net price effect (-68,5€ or -4,8%) is determined by two negative factors: list price effect (-53,0€ or -3,7%) and discount effect (-15,5€ or -1,1%).

$$-68,5\text{€} = -53,0\text{€} - 15,5\text{€}$$

$$-4,8\% = (1 - 3,7\%) \times (1 - 1,1\%) - 1$$

*Note: The evolution of an average net price of a portfolio is not a synonym of an average net price change (equal to price effect in %). In our example, net price of a portfolio has increased by 3,9%, even though, on average, net prices have decreased by 4,8% (driven by two negative factors: decline of list prices by 3,7% and a higher percentage of discount given), while the growth is explained by a positive mix effect of 9,1%.*

### COS

- Volume and mix effects obtained by summing up the corresponding effects from Materials and Value Added return the same result as the equation of COS in Part 1.
- Cost effect (-51,2€) consists of two components - materials cost effect (-24,1€) and value added effect (-27,1€) – both of which have a positive impact on gross margin, since, on average, costs per unit reduce by 3,1% and by 7,2% correspondingly.

$$-51,2\text{€} = -24,1\text{€} - 27,1\text{€}$$

*Note: The total cost effect in % is not explained by components effects (linked by addition) the same way as net price effect in % is explained by list price and discount effects (linked by multiplication).*

$$-4,4\% \neq (1 - 3,1\%) \times (1 - 7,2\%) - 1$$

*However, there exists a logical connection between these percentages of cost effects – we should consider the share of each component in total cost. In our example, materials contribute to approximately 67% (=635/950) and value added – to 33% (=315/950) of total cost.*

$$-4,4\% \approx^* -3,1\% \times 67\% - 7,2\% \times 33\%$$

*\*To be exact, we need to take the shares of components at the step of mix effect calculation, but for the purpose of simplification we can use the shares of a period N-1.*

Table 10

COS				=	Material cost				+	Value Added cost			
= [Qty] X [Cost per unit]					= [Qty] X [Materials per unit]					= [Qty] X [Value added per unit]			
COS		Average Cost/unit			Materials		Average Cost/unit			Value Added		Average Cost/unit	
950 €		4,75 €			635 €		3,18 €		315 €		1,58 €		
in values	in %	in values	in %		in values	in %	in values	in %		in values	in %	in values	in %
+156 €	+16,5%	+0,28 €	+5,9%		+123 €	+19,3%	+0,27 €	+8,5%		+34 €	+10,7%	+0,01 €	+0,6%
due to:					due to:					due to:			
+95 €	+10,0%				+64 €	+10,0%				+32 €	+10,0%		
+113 €	+10,8%	+0,51 €	+10,8%		+83 €	+11,9%	+0,38 €	+11,9%		+29 €	+8,4%	+0,13 €	+8,4%
-51 €	-4,4%	-0,23 €	-4,4%		-24 €	-3,1%	-0,11 €	-3,1%		-27 €	-7,2%	-0,12 €	-7,2%
1 106 €		5,03 €			758 €		3,44 €		349 €		1,58 €		

- The above-mentioned cost effects of -3,1% and -7,2% explain the evolution of Materials part of COS and Value Added part of COS correspondingly (see Table 10). In order to explain the evolution of total COS, it is necessary to apply the formulas to the main indicator, as mentioned in the section “General Formulas (unlimited number of factors)” – Point 2.

$$\text{COS Variance} = \text{Volume eff} + \text{Mix eff} + \text{Materials eff} + \text{Value Added eff}$$

$$\text{Materials eff in \%} = \frac{\text{Materials eff}}{\text{COS}_{N-1} + \text{Volume eff} + \text{Mix eff}}$$

$$\text{Value Added eff in \%} = \frac{\text{Value Added eff}}{\text{COS}_{N-1} + \text{Volume eff} + \text{Mix eff} + \text{Materials eff}}$$

In our example (see Table 9), COS has decreased by 2,1% due to materials and by 2,4% due to value added, or in total by 4,4% due to total cost.

$$-4,4\% = (1 - 2,1\%) \times (1 - 2,4\%) - 1$$

**To summarize, COS has decreased by 24,1€ or by 2,1% because materials costs per unit have reduced by 3,1% on average; and COS has further decreased by 27,1€ or by 2,4% because value added costs per unit have reduced by 7,2% on average.**

### Gross Margin

- Effects on gross margin are the most representative in values and in percentage points (see Table 9 and chart that follows this table for visual interpretation). They are calculated according to the formulas described in the section “General Formulas (unlimited number of factors)” – Point 2.1.
- The growth of gross margin in values doesn’t necessarily mean the growth of gross margin in percentage points. Profitability will increase if net sales grow at a greater rate than cost of sales.
- The same is true for evolution of gross margin due to mix effect. Mix effect in percentage points will be positive if the growth rate of net sales due to mix is higher than that of COS.
- Price effect will cover costs variance if its percentage is greater than cost effect in %.
- Price effect in % and cost effect in % are translated into percentage points of gross margin evolution depending on the initial profitability of a portfolio. More details about sensitivity of gross margin to variations of prices and costs – in our article “[How \(Not\) to Lose a Profit in 10 Days?](#)”.

**To conclude, here are some practical tips on successful factor analysis:**

➤ The above-mentioned formulas to calculate *the effects in values* should be applied *at the product level*. Then, these effects should be summed up for further analysis by brand, product type, product line/etc.

*The effects in percentages and in % points* are of the most interest *at the consolidated level*.

➤ The source data should be prepared in such a way that *all lines in the table are unique*. For example:

- If the purpose of the analysis is to compare year to year, then each product should be present in the table with its total yearly volume and not repeated 12 times in case of monthly initial data.
- If a product has changed its ID code in the analysed period or it has several actual ID codes, then this product should only be present in the table once with its unique general ID.

➤ In practice, it is commonly encountered that the offer of products is different between 2 analysed periods. *For products which are present in 1 of 2 periods (new or discontinued) we can only estimate volume and mix effects*. All other effects are equal to zero. So, formulas should be carefully written to take these cases into account.

Do not hesitate to contact us if you have any questions or comments regarding the article.

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#### AUTHOR

Marina Gorodnicheva

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