FPANDA CLUB

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

by Marina Gorodnicheva

GENERAL FORMULAS (unlimited number of factors)

Below you will find the general formulas of factor analysis which allow 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):

$$Indicator = Factor1 \times Factor2 \times Factor3 \times \dots \times FactorK$$

For example, 2 factors:

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

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

$$Net\ Sales = Total\ Qty \times \%\ Share\ in\ Total\ Qty_{\ of\ a\ product\ X} \times Net\ Price_{of\ a\ product\ X}$$

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

4 factors:

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

(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:

$$COS = Materials + Transport + Value\ Added$$

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

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

Where $Net\ Sales$ and COS can be represented as a product of multiple variables (as seen in the 1st 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:

$$Gross\ Margin\ variance\ =\ Effects\ on\ Net\ Sales - Effects\ on\ COS$$

$$= (Volume\ eff_{sales} + Mix\ eff_{sales} + Price\ eff) - (Volume\ eff_{COS} + Mix\ eff_{COS} + Cost\ eff)$$

$$= Volume\ eff_{margin} + Mix\ eff_{margin} + Price\ eff - Cost\ eff$$

Note: As seen above in the 3rd 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.

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.

FORMULAS

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

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

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

$$Factor1\ eff = (Factor1_{P2} - Factor1_{P1}) \times Factor2_{P1} \times \ldots \times FactorN_{P1}$$
$$Factor2\ eff = Factor1_{P2} \times (Factor2_{P2} - Factor2_{P1}) \times Factor3_{P1} \times \ldots \times FactorN_{P1}$$
…
$$FactorN\ eff = Factor1_{P2} \times Factor2_{P2} \times \ldots \times FactorN{-}1_{P2} \times (FactorN_{P2} - FactorN_{P1})$$

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

$$Indicator\ variance = Indicator_{P2} - Indicator_{P1}$$
$$= Factor1\ eff + Factor2\ eff + \cdots + FactorN\ eff$$

➢ Effects in percentages

$$Factor1\ eff\ in\ \% = \frac{Factor1\ eff}{Indicator_{P1}}$$

$$Factor2\ eff\ in\ \% = \frac{Factor2\ eff}{Indicator_{P1} + Impact_{Factor1}}$$

…

$$FactorN\ eff\ in\ \% = \frac{FactorN\ eff}{Indicator_{P1} + Impact_{Factor1} + \cdots + Impact_{FactorN-1}}$$

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

$$Indicator\ variance\ in\ \% = \frac{Indicator_{P2} - Indicator_{P1}}{Indicator_{P1}} \times 100\%$$
$$= (1 + Factor1\ eff\ in\ \%) \times \ldots \times (1 + FactorN\ eff\ in\ \%) - 1$$

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

$MainIndicator = IndicatorX_1 \pm IndicatorX_2 \pm \cdots$;

Where $IndicatorX_1$, $IndicatorX_2$,.. can be represented as a product of variables:

$IndicatorX_i = Factor1 \times Factor2 \times Factor3 \times \ldots \times FactorN_i$.

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

$$MainIndicator\ variance = MainIndicator_{P2} - MainIndicator_{P1}$$
$$= \sum AllFactors\ eff\_Indicator\ X_1 \pm \sum AllFactors\ eff\_Indicator\ X_2 \pm \cdots$$

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 $IndicatorX_{i_{P1}} + \cdots$ or $MainIndicator_{P1} + \cdots$.

➢ Effects in percentages

On evolution of an indicator X_i:

$$FactorN_i\ \ eff\ in\ \%_{on\ X_i} = \frac{FactorN_i\ \ eff}{IndicatorX_{i_{P1}} + Factor1\ \ eff + \cdots + FactorN_i - 1\ \ eff}$$

On evolution of the main indicator:

$$FactorN_i\ \ eff\ in\ \%_{on\ main} = \frac{FactorN_i\ \ eff}{MainIndicator_{P1} + Factor1\ \ eff + \cdots + FactorN_i - 1\ \ eff}$$

Total evolution in percentages of an indicator X_i:

$$IndicatorX_i\ variance\ in\ \% = \frac{IndicatorX_{i_{P2}} - IndicatorX_{i_{P1}}}{IndicatorX_{i_{P1}}} \times 100\%$$
$$= \left(1 + Factor1\ \ eff\ in\ \%_{on\ X_i}\right) \times \ldots \times \left(1 + FactorN_i\ \ eff\ in\ \%_{on\ X_i}\right) - 1$$

Total evolution in percentages of the main indicator:

$$MainIndicator\ variance\ in\ \% = \frac{MainIndicator_{P2} - MainIndicator_{P1}}{MainIndicator_{P1}} \times 100\%$$
$$= (1 + Factor1\ \ eff\ in\ \%_{on\ main}) \times \ldots \times (1 + FactorN_i\ \ eff\ in\ \%_{on\ main}) - 1$$

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 $Net\ Sales = Factor1 \times \ldots \times FactorK \times FactorK+1 \times \ldots \times FactorM$

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

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:

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

➢ 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.

Read the full article here – Becoming the Master of Factor Analysis of Profit: Secrets of Calculation

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AUTHOR

Marina Gorodnicheva