FEATURES OF THE REGRESSION ANALYSIS METHODOLOGY IN MANAGEMENT ACCOUNTING

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Abstract
As it is known, the budget is made on the basis of forecasts. The forecast may be prepared for production and sales volume, sales revenue, costs, etc. The purpose of forecasting is to establish realistic assumptions for planning during the budget process. The forecast may be based on simple assumptions, such as a forecast of sales volume and sales growth of X%. On the other hand, forecasting can be done using different forecasting models, methods or techniques that take into account the trends and variability of previous years. The main purpose of using these models and techniques is to provide a more accurate and reliable forecast. Regression analysis can be used to predict linear relationships between several variables in management accounting. We discuss a linear relationship between only two variables. There are several methods for identifying this relationship: mini-max, scattered point, and least squaresregression analysis.

Keywords: *Regression analysis, cost function, independent variable, dependent variable, crossing parameter, deviation parameter, mini-max method, scatter point method, least squares method, interpolation, extrapolation.*

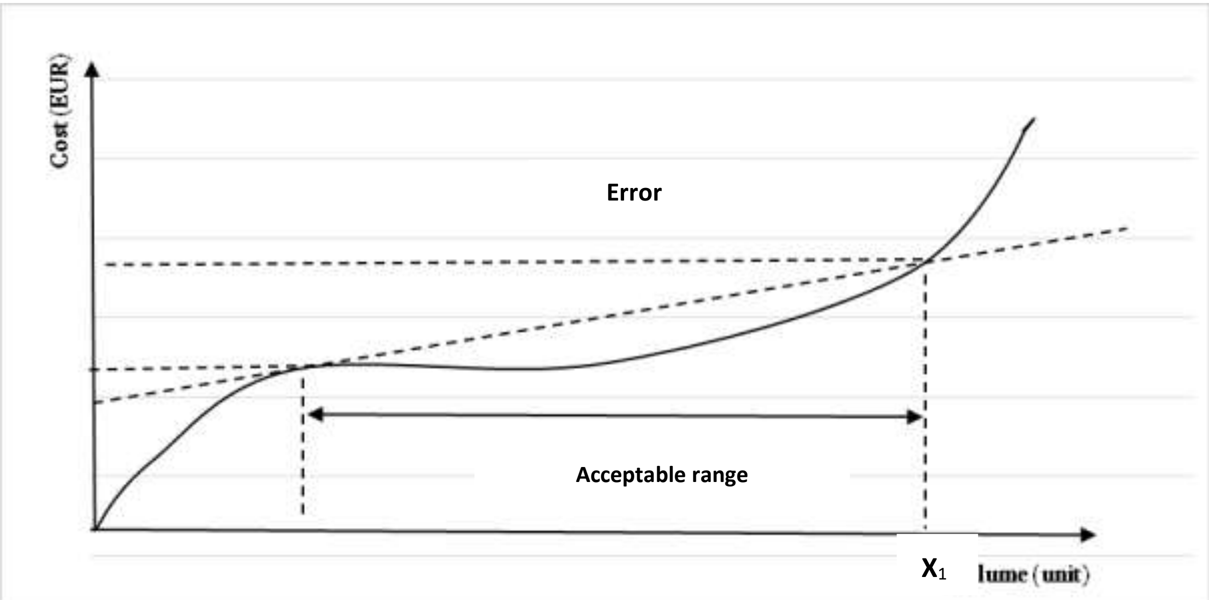
JEL Classification: *M40, M48, M49*

I. GENERAL ANALYSIS

The definition of variable cost allows for a linear relationship between operating costs and the associated carrier. Economists often argue that variable costs increase at a decreasing rate to a certain extent, after which they begin to increase at an increasing rate. Hence, the dependence is nonlinear. The question arises, what should we do if a nonlinear attitude shows the real picture more accurately? One of the ways is to determine the actual cost function. But each activity may have a different cost function and this activity will require a large amount of time and money (if it is possible to do so at all). It is much easier to assume a linear dependence.

If a linear dependence assumption occurs, then the main concern is to determine how close this assumption is to the existing cost function. The acceptable range will be the output interval in which the permissible cost correlation function is justified. This time the rationale is based on how closely we allow the assumption of a linear dependence of costs on an existing cost function. Note that for the number of activity carriers e the X1, the approach becomes senseless.

Graph1

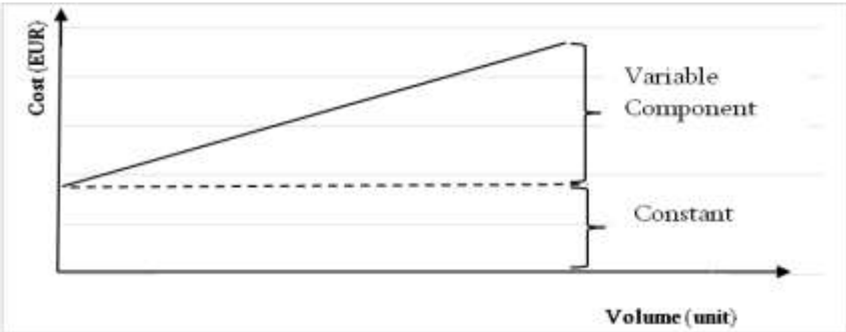


The equation of linear dependence is as follows:

Total cost = constant cost + (variable cost rate x output)

The above equation is thecost formula in which the dependent variable is the cost we are trying to define, or i.e. “total cost”. In the equation, it depends on only one variable - "output", which is a measure of activity. Output is an independent variable. “Constant Cost” is a crossing parameter representing the share of constant cost in total cost.Finally, the “variable cost rate” is the cost per unit of activity. It is also called the deviation parameter.

Graph 2



A dependent variable is a variable whose volume depends on the volume of another variable. It is easy to see that we are trying to find the "total cost", and that its volume depends on the parameters and variables on the right side of the formula. The independent variable is the variable that measures output and explains the change in costs. This is a carrier of activity.The selection of the independent variable is related to its economic viability. This means that the ruler will try to find an independent variable that triggers or is closely related to the dependent variable. The crossing parameter corresponds to a constant cost.Graphically, the intersecting parameter represents the point at which the mixed cost (variable and constant) curve intersects the cost (vertical) axis. The deviation parameter corresponds to the variable cost per unit of activity. Graphically it represents the deviation of the mixed cost curve.

As the accounting records show only the output volume of activity and the total cost, it is necessary to use these volumes to determine the rate of constant cost and variable cost per unit. For this we discuss three methods. We use the same data for all three methods. Data on t he production volume and production costsfor the last five months are given in Table N1.

Table N1

Month	Production volume	Production costs
January	**1 000**	**10 000**
February	2000	12500
March	3 000	22 500
April	4 000	25 000
May	**5000**	**37 500**

Mini-max Method

We remember from elementary geometry that we need to find two points to define a line. If we know two points on a line, we can determine its equation. By giving two points, it is possible to determine the crossing parameter (constant cost rate) and the deviation (variable cost rate). The mini-max method is a method of determining a linear equation by pre-selecting two points (highest and lowest points) that will be used to determine the intersection and deviation parameters.

The mini-max method approach consists of the following steps

Step 1

Select the maximum and minimum levels of activity and associated costs.

5000units 37 500EUR

1000 units **10 000EUR**

Step 2

Find the variable cost per unit.

Variable cost rate per unit=(Costs incurred on the maximum level of activity - costs incurred on the minimum level of activity) / (Maximum activity - minimum activity)

Y = a + bx

b = (37500 – 10 000)/(5000 – 1000) = **6,875EUR**

Step 3

Find a constant cost using the maximum or minimum levels of activity.
Constant cost =Total costs incurred at the activity level–Total variable costs
a = 37500 – 6,875* 5 000= **3125EUR;**

Step 4

Use variable and constant costs to forecast total costs incurred at a certain level of activity.

Y = 3 125 + 6,875*X

Advantages of the Mini-Max Method

- The Mini-Max method takes advantage of objectivity. This means that any two people who use the Mini-Max method for specific data will inevitably get the same answer. However, the mini-max method allows managers to quickly achieve success in establishing cost correlations, thanks only to two-point data;
- Easy to understand and analyze, as well as to use.

Disadvantages of the Mini-Max Method

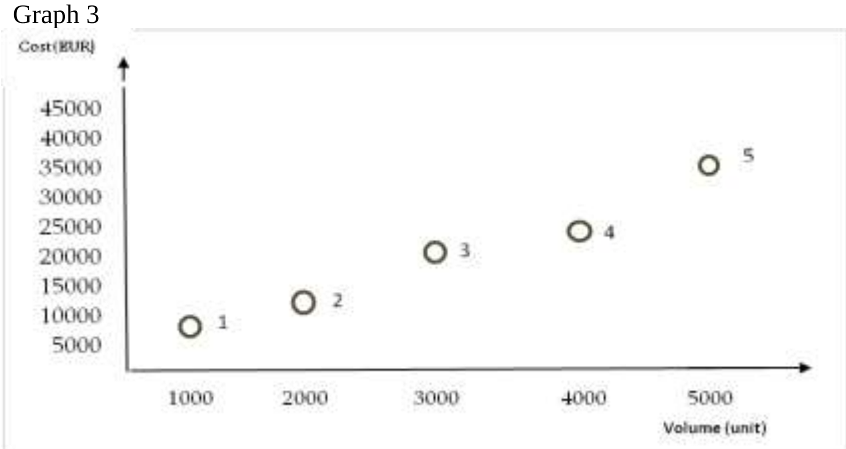
- This method is based on the assumption that costs are affected by only one factor - activity;
- This method also relies on the assumption that past data can reliably determine the amount of future costs;
- It uses only two values, maximum and minimum, so the results may be distorted as a result of random changes in the data.

Scattered point method

The scattered point method is a method of determining the equation of a line - by moving data over a graph. The first step is to move the data points in such a way that the relationship between production costs and activity levels can be seen. The scatter plot is shown in Graph N3. The vertical axis represents the total cost of production, while the horizontal axis represents the volume of output. Graph analysis helps us to ensure that the assumption of a linear relationship between production costs and production volume is reasonable for an established range of activities. At the same time, analysis of the graph may reveal some points that probably do not fit into the general pattern of behavior. Analysis may reveal that these points (falls) are caused by some non-typical case. Knowing this may help us to eliminate them and evaluate better the cost function.

The scattered point graph can help us clarify the relationship between costs and consumption of activities. Indeed, the scattered point graph allows us to draw a visual curve at the points on the graph. Here the selected curve should be the one that best connects the points. In making this choice, the cost analyst is free to use past experience with cost units, which may provide a good intuitive hint of how production costs behave. Drawing a curve on the points in this way is an indication of how the scattered point method works.

Graph 3



Based on the information in the graph, how would we draw the curve at these points? Suppose we decide that the curve passing through point 1 and point 3 is the best line. If so, then how do we use this solution to calculate the variable cost rate of a fixed cost?

If we consider our choice as the best line, then the rate of variable cost per unit can be calculated as follows: first express point 1 as (1000; 10 000 EUR and point 3 as (3000; 22 500 ERUR). Then use these two points to calculate the deviation:

Variable cost rate= (22 500 – 10 000)/(3 000 -1 000)= **6,25 EUR**

After understanding the variable cost per unit, the final step is to calculate the constant cost component. If we use point 3, according to the equation below, we will have the following:

Constant cost = 22 500 EUR - 6,25*3 000 = **3 750 EUR.**

Therefore, the formula for the cost function will look like this:

Y= 3 750+6,25*X

The formula for the cost function for production cost was obtained by combining point 1 with point 3. Some reasoning was used in selecting this curve.While one considers that the best line is the curve leading to point 1 and point 3, the other, considering other criteria, may suppose that the curve must pass through point 2 and point 4, or through point 1 and point 5.

An important advantage of the scatter point method is that it allows us to see the data. The weak point of this method is that it is possible to select subjectively the best line. The quality of the cost formula depends on the quality of the analyst's subjective reasoning. The mini-max method will be reduced to the subjective selection of the best line, and depending on who will use the method, the corresponding line will be obtained.

Table N2 below provides a comparative analysis of the results obtained by the mini-max and scatter point methods (in EUR).

Table N2

Indicators	Constant cost	Variable cost rate per unit	Cost for 3500 units
As per Mini-max method	3 125	6,875	27 187,5
As per scattered point method	3 750	6,250	25 625

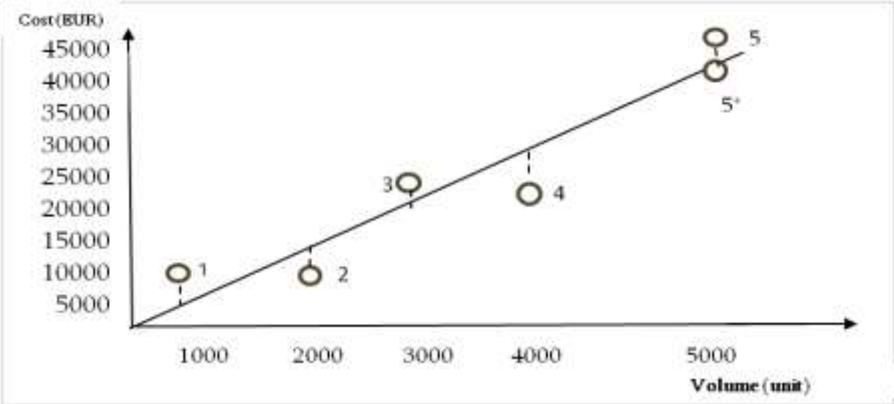
There is a big difference between the constant cost component and the variable cost rate. The pre-calculated total cost for 3,500 units of production volume is 25,625EUR according to the scatter point method and 27,187.5 EUR according to the mini-max method. What is the "correct" number? Since the two methods can give us significantly different cost formulas, the question naturally arises as to which method is best. Ideally, we need a method that is objective and at the same time gives the best line. The least squares method defines the best line and at the same time is objective in the sense that using this method for a given data grid is based on the same cost formula.

The least squares method

Until now, we have relied on the idea of the line that best connects the dots shown on the scatter plot graph. What do we mean by the best line? Intuitively, this is the curve at which the given points are located closest. But what is meant by proximity?

Recall that we are looking for a line that is the best forecaster of the total cost of any activity. To do this, consider Graph 4, in which the curve is arbitrarily passed. The proximity of each point to the line can be measured by the vertical distance from the point to the line. This vertical distance is the difference between the actual cost and the estimated cost per line. The assumed cost for point 5 is 5 * and the deviation is the distance between these points (i.e. the distance from the point to the line).

Graph 4



Vertical distance measureas proximity of a single point to a line. But, we needto measure how close all the points are to the line.One way is to measure the deviation of all points from the line and add them to each other to obtain a total measurement. However, this total measurement may be misleading. For example, the sum of small positive deviations may give a greater total value than the sum of the values obtained by combining large positive and large negative deviations, because in this case positive and negative deviations cancel each other. To correct this problem, the least squares method is used, which first of all finds the quadratic value of each individual deviation and then adds them up to take the measure of total proximity. Squaring the deviations avoids the problem of cancellation each other's values by positive and negative deviations.

To illustrate this concept, let's calculate the proximity measurement for the cost formula obtained by the scatter point method.

Table N3

Actual cost (EUR)	**Projected cost (EUR)**	**Deviation**	**Square deviation**
10 000	10 000	-	-
12 500	16 250	-3 750	14 625 500
22 500	22 500	-	-
25 000	28 750	-3 750	14 625 500
37 500	35 000	2 500	6 250 000
Total proximity	measurement	-	**35 501 EUR**

Notes:

a) Projected cost = 3750 + 6.25 * X, where X represents the actual consumption of the cost-related activity of the activity actually performed;

b) Deviation = Actual cost – Projected cost

Given that the proximity measurement is the sum of the squares of the deviations from the points to the line, the smaller this measurement, the better it connects the curve points.For example, according to the scatter point method, the proximity measurement is 35,501 EUR. Similar calculations for the mini-max method give a proximity measurement equal to 52,343.75 EUR. Thus, the scatter point method combines points better than the mini-max method. This result supports the previous assertion that the reasoning used in the scatter point method is better than the mini-max method.

In principle, comparing proximity measurements might allow us to rank all curves from best to worst. The curve that connects the dots better than any other curve is called the best line. This is a curve with the least sum of square deviations. The least squares method defines the best line to be obtained by the formula proposed by statistical theory, which has the following form:

$$a = \frac{\sum y}{n} - b\left(\frac{\sum x}{n}\right)$$

To calculate a and b values, fived data are needed: n, ∑x, ∑Y, ∑xy, ∑x2, the first data n is the easiest to calculate: just count the amount of data in the data table (see Table N4), the other data is calculated as follows:

Table N4

∑X	∑Y	∑X*Y	$\sum X^2$
1 000	10 000	10 000 000	1 000 000
2 000	12 500	25 000 000	4 000 000
3 000	22 500	67 500 000	9 000 000
4 000	25 000	100 000 000	16 000 000
5 000	37 500	187 500 000	25 000 000
15 000	**107 500**	**390 000 000**	**55 000 000**

$$a = \frac{107\,500}{5} - 6{,}75\left(\frac{15\,000}{5}\right) = 1250\ EUR$$

Thus, the formula for the cost function using the least squares method can be expressed as follows:

Y = 1250+6,75 * X

Given that this cost formula is the best line, it predicts with the best way the activity-related costs. For 3500 units of activity, the least squared projected cost will be EUR 24,875 (GEL 1,250 + 6.75 * 3,500), consisting of EUR 1,250 fixed component and EUR 23,625 variable component. Using this prediction as the standard, the scatter point method is closer to the least squares method.

Therefore, regression analysis can be used to predict when a linear relationship between two variables is implied and historical data are available for analysis. Besides, , a regression equation can be used to predict the Y variable with the X variable, if:

a) The X variable is placed within a known range of data. Such a prediction is called interpolation;

b) The X variable is placed outside the known range of data. Such a prediction is called extrapolation.

In general, interpolation is more reliable than extrapolation.

II. CONCLUSION

Advantages of simple linear regression analysis are as follows:

- Easy to use;
- Considers the main relationship between two sets of data;
- Can be used to prepare forecasts and budgets;
- Simplifies the budgeting process.

Limitations of simple linear regression analysis are as follows:

- It assumes that there is a linear relationship between the variables;
- The relationship between only two variables is evaluated. In fact, the dependent variable is influenced by many other independent variables;
- Tendonously, only interpolation predictions are reliable. Equation should not be used for extrapolation;
- Regression analysis assumes that the historical behavior of data in the past will continue in the near future too;
- Interpolation forecast is reliable between data, only in case of strong correlation.

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