Technical and Economic Justification of the Functions and their Graphic Representation of a High-tech Enterprise

Jordanka Angelova
Faculty of Management
Technical University of Sofia
Sofia, Bulgaria
j.angelova@abv.bg

Vasil Kuzmov
Faculty of Management
Technical University of Sofia
Sofia, Bulgaria
vasil.y.kuzmov@gmail.com

Abstract - Functions and their graphic presentation are some of the most widely used tools in various economic analyses of a business. After a graph is drawn, it is necessary to interpret it correctly in order to accurately assess the situation of the industrial company. The types of functions presented in the paper are viewed in terms of their application in economic analysis. A study of a particular firm has been made, the obtained data has been presented in table form and the graphic approach has been used to depict their functions. The authors have drawn conclusions and have made recommendations.

Keywords - Economic analysis; Functions; Revenue; Costs; Profit; Trend.

I. Nature of the Function

The process of managing a firm is related to the manifestation of a number of functions, one of which is the analysis of the economic processes in the course of its activities. The application of functions in economic analysis is a prerequisite for the realization and study of the economic, technical-economic and socioeconomic processes in the firm. It follows that analysis is a subjective human activity of exploring and studying the processes and phenomena of business activities in particular.

Thus, for example, if there are two sets **A** and **B** and the elements of set **A** are denoted by **x**, and the elements of set **B** by **y**, when written it will be in the form of:

A → x; B→ y

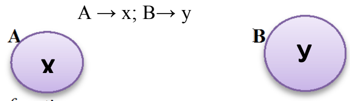

Fig. 1. Sets of a function

It is then said that there is a set function when for an element *x* of the defined area - *A*, according to a certain rule, is referred to one or several elements *y* of set *B*. [2; 9; 11]

In general a function is set in the following way: y = f (x). The main attributes of the main function **y = f (x)** are as follows:

- **y** – dependent variable (value of the function) or just function;
- **x** – independent variable (argument);
- **A** – domain of a function or a domain of the permissible values of the argument;
- **B** – domain of the permissible values of the function [3, 5].

There are several types of functions:

- ***one-to-one*** – if to any element x ∈ A corresponds exactly one element y ∈ B
- ***many-to-one*** – if to any element x ∈ A correspond several elements y ∈ B

II. Types of Functions Applicable to Economic Analysis of an Industrial Firm

A. Cost, revenue, profit [1; 3; 8]

function of the revenue:

R(x) /R – revenue/

- *function of the costs:*

C(x) /C – costs/

- *function of the profit:*

P(x) /P – profit/

In order to calculate the profit we need to write the equation in the following way:

$$P(x) = R(x) – C(x),$$

where: *x* is the volume of the products.

There is a profit when P > 0 (R > C) and a loss when P < 0 (R < C).

Economic analysis makes use of optimization models whose application aims to achieve:

- *maximum value of the profit;*
- *maximum value of the revenue;*
- *minimum value of the costs.*

B. Functions of two or more variables

If the variables *x*,*y* and *z* are given x and y are not related but z is considered to be dependent on them, i.e. to be their function and *z* is defined as an aggregate of the two variables (x,y). Z will be called a function of the two variables *x* and *y*, when a certain value of z corresponds to each pair of numbers (x,y) from set D. It is denoted by: [6;10]

$$z = f (x,y)$$

For example, if an industrial company produces laptops *(x)* and mobile phones *(y)* it is known that the constant daily costs for *x* and *y* are respectively:

- *x* = 700 EUR;

- y = 300 EUR.

The variable costs for a unit of production for x and y respectively are:

- x = 120 EUR;
- y = 170 EUR.

Therefore, for the daily production the function of the costs would look as:

C (x,y) = 700 + 120x + 300 + 170y = 1000 + +120x + 170y

∴ C (x,y) = 1000 + 120x + 170y

III. MOVING AVERAGE

The moving average value has an application in technical analysis rather than in economic analysis. The moving average is by its nature a statistical function. It includes the average values of a certain series which have been calculated. These average values are values of different subsets of values from a certain set. It is employed mostly in time series for analysis of changing trends.

It can be employed in economic analysis if there is the need to study the average of products sold over a time period *t*. It is also possible to use several moving average functions, each of them set for a particular time period. The crossing point of the moving averages shows the change in the trend.

IV.COEFFICIENT OF DETERMINATION IN ECONIMIC ANALYSIS

The coefficient of determination is a very important part of an economic or statistic analysis, especially when some relationship between the objects of the analysis is studied or must be found. From the perspective of functions it will refer to the relation and the effect x has on y or vice versa - the relation and the effect y has on x.

The coefficient of determination (Kdet=R^2), is equal to the square of the coefficient of correlation and describes the so called explained dispersion. It usually varies within the range of $0 \leq R^2 \leq 1$. Through the coefficient of determination a check is made about the availability of linear relation between x and y. It shows what part of the Y variation is due to the differences between the values of X, i.e. the impact of the studied factor. If it is multiplied by 100, it expresses the force of the impact of the dependent variable and then we obtain limits in percentage: $0\% \leq R^2 \leq 100\%$. In scientific literature the coefficient of determination is also present as "coefficient of definiteness". The coefficient of definiteness (determination) and indefiniteness are added to get one (100%). If we have R^2 = 70 %, and K^2 = 30% then we get:

$R^2 + K^2 = 70\% + 30\% = 100\%$

As limits of the coefficient of correlation are given two scales which are formed from the scales of the coefficient of correlation (R) [3, 7,10]:

Table. 2. Values of the coefficient of correlation (R)

Variant 1R	Interpretation - R	Variant 2R
0 < R < 0,3	*weak correlation*	0 – 0,2
0,3 < R < 0,5	*moderate correlation*	0,2 – 0,4
0,5 < R< 0,7	*significant correlation*	0,4 – 0,6
0,7 < R < 0,9	*high correlation*	0,6 – 0,8
0,9 < R < 1	*very high correlation*	0,8 - 1

Table. 3. Values of the coefficient of correlation (R^2)

Variant 1R^2	Interpretation – R^2	Variant 2R^2
0% < R^2 < 9%	*weak correlation*	0% – 4%
9% < R^2 < 25%	*moderate correlation*	4% – 16%
25%< R^2 < 49%	*significant correlation*	16% – 36%
49%< R^2 < 81%	*high correlation*	36% – 64%
81%<R^2< 100%	*Very high correlation*	64% - 100%

The calculations are made in the following way:
If we take as the coefficient of correlation the value of R = 0,3 in order to obtain the coefficient of determination (R^2) we must square the value of the coefficient of correlation and multiply it by 100 in order to obtain the number in %, i.e.: [12]

$$R = 0,3 \Rightarrow R^2 = (0,3)^2 * 100\% = 9\%$$

V. PRACTICAL APPLICATION OF THE FUNCTIONS IN ECONIMICS. DRAWING A TREND AND ITS INTERPRETATION

The object of study is an industrial company, which produces 2 types of items, respectively "A" – contactors and "B"- relays. The sales of the two products are presented in Table 4:

Table. 4. Sales of items "A"and "B"

Month	Item		Σ (A+B)
	A [number]	B [number]	
1	100	120	220
2	95	130	225
3	110	100	210
4	125	140	265
5	135	130	265
6	120	140	260
7	120	150	270
8	100	140	240
9	130	140	270
10	135	130	265
11	140	150	290
12	120	140	260
Σ	1430	1610	3040

The total number of products "A" sold for the whole year is 1430 and of "B"1610.

The graph below shows sales of product "A" and the trend is obtained through the use of the different types of functions. In a similar way the graph for product "B" can be drawn.

A. Exponential function

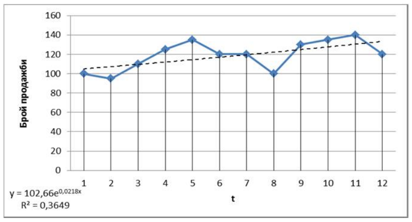

Fig. 10. Exponential fuction

$$y = 102{,}66e^{0{,}0218x}$$
$$R^2 = 0{,}3649$$

We have obtained an equation, which is not with a negative sign and that means that the trend is positive, i.e. if the sales have similar values the firm will have a good profit and will not have any losses. There is a moderate correlation between the values. [13]

It is necessary to pay attention to the fact that the values for each month are interlinked with previous months and future periods as in a system there is the impact of both direct and indirect factors. Figure 11 illustrates the impact of the external and internal factors. The ellipsis shows the external environment of the firm. The numbers 1,2 and 3 stand for the volume of sales and the size of the circle demonstrates whether sales have decreased or increased as compared to the previous period. The arrows pointing to the inside of the ellipsis show how external factors penetrate the internal environment of the firm, and the triangles (Δ) denote internal factors. External factors can be, for example political and legal changes, inflation, etc. Internal factors can be problems within the enterprise itself such as: lack of assembly elements for a specific item or an abrupt deterioration of its financial situation, insufficient workforce and as a result of these factors reduction in orders. That is why it is necessary to seek and study a "hidden" relation between the values in order for the enterprise to be able to respond adequately in a certain situation.

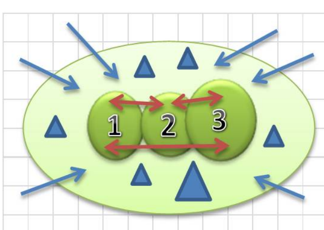

Fig. 11. External and internal factors of an enterprise

B. Linear function

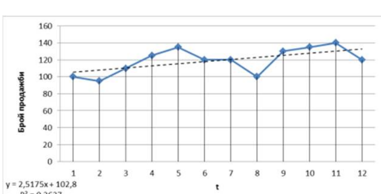

Fig. 12. Linear function

$$y = 2{,}5175x + 102{,}8$$
$$R^2 = 0{,}3637$$

With the linear function there is also positive trend with moderate correlation.

The linear function is one of the most widely used functions for interpretation in economic analysis. That advantage is manifested by the fact of the easy calculation and interpretation of the obtained equation and with its graphic image. It is important to note the slope of the line if one is not capable of dealing with equations. In that particular case the line is with a positive slope, therefore, we can come to the conclusion that the trend (tendency) is positive. If we have to come up with a more accurate interpretation we can say that the tendency is moderately positive because as it can be seen from the graph there is not a strictly expressed slope of the line to the *x* axis, i.e. the angle coefficient has a small positive value. The interpretation of the line can be made even as an analogue to the different types of monotonic functions.

C. Logarithmic function

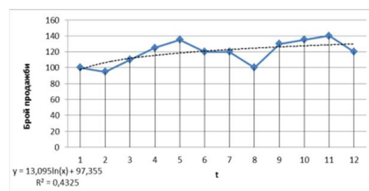

Fig. 13. Logarithmic function

$$y = 13{,}095\ln(x) + 97{,}355$$
$$R^2 = 0{,}4325$$

With the logarithmic function we again have a positive trend. The coefficientът of determination is within moderate limits.

Here the trend is shown by means of a natural logarythm – ln. It is a logarythm with a base of the number *e* = 2,718 281 828 459 045 235 360 287 471 35… The *e* number is called Napier's number.

D. Polynomial function

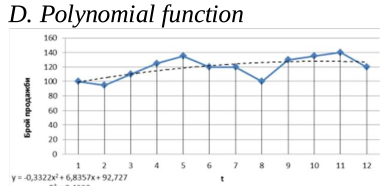

Fig. 14. Polynomial function

$$y = 0{,}3322x^2 + 6{,}8357x + 92{,}727$$
$$R^2 = 0{,}4228$$

As this is a polynomial function, respectively the function is obtained through polynoms, which are used for interpolation and extrapolation. In that particular case we also have positive values, the trend is a positive value, and the coefficient of determination is moderate.

E. Power function

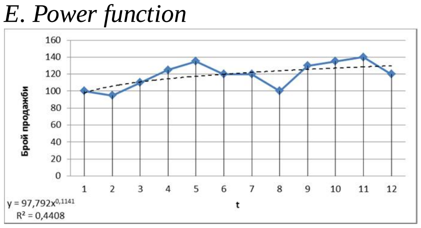

Fig. 15. Power function

$$y = 97{,}792x^{0{,}1141}$$
$$R^2 = 0{,}4408$$

The power function is with a positive value like the other functions and tendency with the same coefficient of determination, i.e. it is with a moderate value.

With the exponential, logarithmic, polynomial and power functions the way of interpreting them is the same as with the linear function, but unlike the linear function, they are more difficult to interpret in view of the obtained equations and images. They are not straight lines and that further makes their interpretation more difficult. That is why it is recommended that the linear graph is used in economic and technical analyses.

F. Moving average

Table 5 shows a moving average plotted on the basis of average values by quarters using the data in Table 4.

Table 5. Average sales of products "A" and "B"

Месец	Изделие		Σ (A+B)
	A [бр.]	B [бр.]	
1	0	0	0
2	***102***	***117***	***219***
3	0	0	0
4	0	0	0
5	***127***	***137***	***264***
6	0	0	0
7	0	0	0
8	***117***	***143***	***260***
9	0	0	0
10	0	0	0
11	***132***	***140***	***272***
12	0	0	0
Σ	**478**	**537**	**1015**

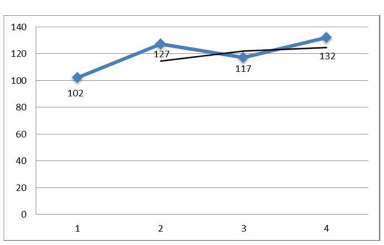

Fig. 16. Moving average

Using the moving average plotted in Fig. 16 we can come to the conclusion that there is a change in trend in the third quarter as the graph has a V-imaged bottom. It is further noted that the trend will be positive as there is a slight positive slope between the third and the fourth quarter.

Fig. 17 shows what, with the same average values, a trend will look like if it is plotted using a linear function. It can again be seen that it is positive, both visually, and from the interpretation of the analytically set function.

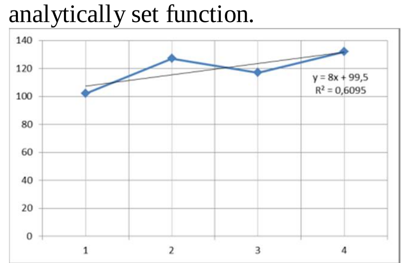

Fig. 17. Linear function of the trend at averaged values

$$y = 8x + 99{,}5$$
$$R^2 = 0{,}6095$$

Conclusion

On the basis of the study that was carried out we can come to the conclusion that the function with the greatest application in economic analysis is the linear one when there are sequential data for a certain period of time t. It is the function that provides clear and accurate picture of the dynamics of the resulting indicator on the basis of more than one period of study. When we deal with averaged values it is appropriate to use the moving average function. We need to point out that with averaged values we can also obtain information about a trend from a linear function.

It is a matter of judgement on behalf of the experts whether to use an exponential, logarithmic, polynomial or power function in their future financial-economic analyses.

References

1. Avramov A., Visha matematika -1 /s prilozhenija v ikonomikata i biznessa/, Veliko Tarnovo, 2000;
2. Aleksandrova M., Optimizaciq na investicionniq izbor, Trakiya-M, UNSS; 2017;
3. Boyadzhiev L., Kamenov O., Visha matematika – 2, Sofia, 2002;
4. Dimitrova E., Sbornik zadachi po visha matematika – vtora chast, Plovdiv, 2002;
5. Kirkorov Iv., Bonev K., Visha matematika, Sofia, 1980;
6. Tanolov S. i k-v, Sbornik ot zadachi po visha matematika – vtora chast, Sofia, 1979;
7. Chukov Kr., Ivanova R., Finansovo-stopanski analiz, UNSS, 2017;
8. Dellago Chr., „Einführung in die Physikalischen Rechenmethoden I + II", Skriptum zur Vorlesung, Universität Wien, 2010;
9. Grifell E., C.A. Knox Lovell, Productivity Accounting: The Economics of Business Performance, Cambridge University Press, 2015;
10. http://basaga.org/wiki/index.php?title=Видове_функции_(математика)
11. https://bg.wikipedia.org/wiki/Функция#Видове_функции
12. https://bg.wikipedia.org/wiki/Експоненциална_функция
13. https://www.matematika.bg/algebra/functions.html